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Editors' Remarks

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Closed Path

by Rabindranath Tagore

I thought that my voyage had come to its

end at the last limit of my power,- that the

path before me was closed,

that provisions were exhausted and the time
come to take shelter in a silent obscurity.

But I find that thy will knows no end in me.
And when old words die out on the tongue,
new melodies break forth from the heart;

and where the old tracks are lost,
new country is revealed with its wonders.
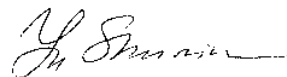
Rabindranath Tagore (1861-1941)♣

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This 19th volume No.3 consists of four topical parts, namely, **Part A: Mathematical and Computer Modelling**, **Part B: Computer and Information Technologies**, **Part C: Operation Research and Decision Making** and **Part D: Nature Phenomena and Innovative Engineering**. These parts have a particular page numbering. References should include the symbols belonging to the part of the journal issue (A, B, C or D) and the pages of the paper quoted. (e.g.: … **19**(3C) 77-89) We are planning to expand CMNT topics within the scope of its scientific interests.

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EDITORS

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♣ **Rabindranath Tagore (7 May 1861 – 7 August 1941),** was a Bengali poet, novelist, musician, painter and playwright who reshaped Bengali literature and music. As author of Gitanjali with its "profoundly sensitive, fresh and beautiful verse", he was the first non-European and the only Indian to be awarded the Nobel Prize for Literature in 1913. His poetry in translation was viewed as spiritual, and this together with his mesmerizing persona gave him a prophet-like aura in the west. His "elegant prose and magical poetry" still remain largely unknown outside the confines of Bengal.

Content A

Approximation of unit-hypercubic infinite two-sided noncooperative game via dimension-dependent irregular samplings and reshaping the multidimensional payoff matrices into flat matrices for solving the corresponding bimatrix game

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Abstract

The problem of solving unit-hypercubic infinite two-sided noncooperative games is considered. The ultimate goal is to approximate the infinite game with bimatrix game, ranking the approximation accurateness. This is fulfilled in three stages. Primarily the players' payoff functions are sampled under stated conditions of dimension-dependent irregular samplings. Then the sampled payoff functions as multidimensional payoff matrices are mapped into ordinary flat matrices under a reversible matrix map. Finally, after obtaining the solution of the corresponding bimatrix game, equilibrium finite support strategies are checked out for their consistency, being used as the approximation accurateness rank. If consistent, then the bimatrix game can be regarded as the approximation of the initial noncooperative game. For particular cases, conditions of the weakened consistency are stipulated. Different types of consistency ensure the corresponding bimatrix game solution varying reasonably by changing the sampling steps minimally. If the solution is not even weakly consistent by the most primitive consistency in ranking the approximation accurateness, then the sampling intervals should be shortened. If any shortening is impossible then the sampling points must be set otherwise. The suggested approximation tool is fully applicable to games, which are isomorphic to the unit-hypercubic infinite two-sided noncooperative game.

Keywords: two-sided noncooperative games, unit hypercube, approximation, irregular sampling, bimatrix game, multidimensional matrix, equilibrium finite support strategy, approximate solution, equilibrium solution consistency

1 Games in Euclidean finite-dimensional subspaces of non-single dimension

Conflict events are result of everlasting natural disproportion of resources and demands. To allocate resources properly and adequately, there are game models whose principal purpose is in ensuring equilibrium, equity, efficiency, and utility of the allocation [1, 2]. Two-sided noncooperative game (TSNCG) solutions are applied to economics [3, 4], politics [5], military science, jurisprudence [6, 7], social [7, 8] and ecologic processes [9, 10], technological and technical processes, reducing their risks or losses on average [1, 11, 12]. However, often there is a problem of uncertainty of the equilibrium type [13]. Nowadays, there are a lot of equilibrium types, whose origins are regarding mainly to Nash and Pareto equilibrium [1, 2, 4, 8, 13]. Another problem is infiniteness and dimensions. The matter is that for a great many of conflict events the player's pure strategy is an action, featured with a sequence of parameters, belonging to some intervals of their acceptable values. Thus players get infinite multidimensional sets of their pure strategies. These sets are equivalent to Euclidean finite-dimensional subspaces of non-single dimension [14, 15]. And even TSNCG on such subspaces' product is very difficult to get solved analytically [1, 2, 16], unless the players' payoff functions (PPF) are specific cases.

2 Solutions of infinite TSNCG

There is a few ways for obtaining the exact solution of infinite TSNCG. When the game is infinite, there is no any universal method of solving, but just narrowly specified

technique, oriented on particular cases [1, 17]. One of those particularities works on compact games with continuous PPF, having solutions at least in mixed strategies [1, 2, 17, 18]. In more general, bounded games can be solved in ε - equilibrium finite support strategies (FSS) [1, 19, 20]. And with unbounded or non-measurable or discontinuous PPF there are only approximations available.

The approximation implies either of two directions: straightforward approximation over infiniteness or initial transition from infiniteness to finite game. Every direction has its own shortcomings. While approximating straightforwardly over infiniteness, one should be aware of hard analytical reasonings, including limit theorems not always giving the constructive decision even if proved. Moreover, the solution with a mixed infinite support strategy, whatever it is (exact or approximate), carries a problem of its implementation in practice. Impossibility of full practicability of the infinite support is from that the number of plays (rounds of game or its recurrence) is finite. This apparent lack of infinite approximation is beyond finite games [21, 22]. Transition from infiniteness to finite game will definitely give FSS, whose practical implementation is easier. But the transition must be fulfilled carefully, not losing important properties of PPF. Rank of this carefulness is to be ascertained later. When ε - net-construction technique is applied, the rank is roughly equal to ε. Well, ε_1 -equilibrium FSS are more accurate than ε_2 -equilibrium FSS for $\varepsilon_1 < \varepsilon_2$, although, firstly, it is unknown how to select ε_1. Secondly, it is also unknown whether exists a limit $\varepsilon_0 < \varepsilon_1$ such that ε -equilibrium FSS have similar accurateness as ε_0 -equilibrium FSS for $\varepsilon < \varepsilon_0$.

Finite TSNCG is represented with two multidimensional

matrices (MDM), whose elements are values of the sampled PPF. If every player acts within single dimension, its MDM is ordinal flat two-dimensional array. Then finite TSNCG is bimatrix game (BMG), which is solved with well-known methods of linear programming by algorithm of Lemke — Howson [23] or related simplex-pivoting-operation modifications based on this algorithm [24, 25]. Nonetheless, if MDM is not a flat matrix, the corresponding finite TSNCG cannot be solved as BMG — the additional transformation of MDM into two-dimensional array is needed.

3 Goal and tasks

In suggesting an approximation method, a class of infinite TSNCG should be considered. Other game classes, if they are isomorphic to the considered class, will be treated similarly. For instance, if players' action spaces are compacts in Euclidean finite-dimensional spaces then they can be "normalized" to unit hypercubes in these spaces. Then, without loss of generality, the class of infinite TSNCG on unit hypercube is going to be considered.

　　The ultimate goal is to approximate unit-hypercubic infinite TSNCG with BMG, exposing accurateness of the approximation and defining its eligibility. This goal is going to be attained via accomplishing four tasks. Primarily the conditions of acceptance of the sampled PPF must be declared. They are for transforming PPF into MDM and not losing important properties of PPF. Then, having represented the finite TSNCG with two MDM, there must be substantiated a mapping of MDM into ordinary flat matrices. This mapping will allow to solve the corresponding BMG and to map its solution to the initial finite TSNCG. The task at the third stage is to rank accurateness of the approximation for elementary case. Eventually, the conception of this rank has to be spread out to more general cases. If the solution of BMG is of the satisfactory accurateness rank then this solution is going to be called the approximation of the initial TSNCG solution. The rank ought to answer whether BMG solution varies vastly by changing the sampling steps. And these steps are to be selected regarding the dimension, where along the dimension the sampling interval can vary as needed.

4 Conditions of sampling PPF

Let there be a TSNCG

$$\langle H_1, H_2, K_1(\mathbf{X}, \mathbf{Y}), K_2(\mathbf{X}, \mathbf{Y}) \rangle \quad (1)$$

with the players' pure strategies sets

$$H_1 = \bigtimes_{m=1}^{M} [0; 1] \subset \mathbb{R}^M, \ M \in \mathbb{N} \quad (2)$$

and

$$H_2 = \bigtimes_{n=1}^{N} [0; 1] \subset \mathbb{R}^N, \ N \in \mathbb{N} \quad (3)$$

and PPF $K_1(\mathbf{X}, \mathbf{Y})$ and $K_2(\mathbf{X}, \mathbf{Y})$, defined on $(M+N)$-dimensional unit hypercube

$$H_1 \times H_2 = \left\{ \bigtimes_{m=1}^{M} [0; 1] \right\} \times \left\{ \bigtimes_{n=1}^{N} [0; 1] \right\} =$$
$$= \left\{ \bigtimes_{k=1}^{M+N} [0; 1] \right\} \subset \mathbb{R}^{M+N} \quad (4)$$

by

$$\mathbf{X} = \left[x_m \right]_{1 \times M} \in H_1, \quad (5)$$

$$\mathbf{Y} = \left[y_n \right]_{1 \times N} \in H_2. \quad (6)$$

　　Primarily, TSNCG is assumed to be such that each of the functions $K_1(\mathbf{X}, \mathbf{Y})$ and $K_2(\mathbf{X}, \mathbf{Y})$ is differentiable with respect to any of variables

$$\left\{ \{ x_m \}_{m=1}^{M}, \ \{ y_n \}_{n=1}^{N} \right\}. \quad (7)$$

　　Also let there exist mixed derivatives of each of those functions by any combination of variables (7) in any situation

$$\{ \mathbf{X}, \mathbf{Y} \} \in H_1 \times H_2,$$

where every variable is included no more than just once. Afterwards, these conditions can be broken.

　　PPF $\left\{ K_r(\mathbf{X}, \mathbf{Y}) \right\}_{r \in \{1, 2\}}$ are sampled along each of dimensions of hypercube (4) with a specific sampling rule. These are going to be dimension-dependent irregular samplings, where each dimension is the unit segment. Let $S_m^{\langle 1 \rangle}$ be the number of intervals between the selected points in m-th dimension of hypercube (2), and $S_n^{\langle 2 \rangle}$ be the number of intervals between the selected points in n-th dimension of hypercube (3). In the utmost case of sampling, $S_m^{\langle 1 \rangle} \in \mathbb{N}$ and $S_n^{\langle 2 \rangle} \in \mathbb{N}$. Therefore, endpoints of the unit segment are included into the sampling necessarily, while there is no fixed sampling step. Thus, in m-th dimension the first player (FP) instead of the segment $[0; 1]$ of values of m-th component of its pure strategy (5) now possesses the set of points

$$D_m^{\langle 1 \rangle}\left(S_m^{\langle 1 \rangle}\right) = \left\{ x_m^{\langle s_m \rangle} \right\}_{s_m=1}^{S_m^{\langle 1 \rangle}+1}, \ x_m^{\langle 1 \rangle} = 0,$$
$$x_m^{\langle S_m^{\langle 1 \rangle}+1 \rangle} = 1,$$
$$x_m^{\langle d_m \rangle} < x_m^{\langle d_m+1 \rangle}, \ \forall \, d_m = \overline{1, \, S_m^{\langle 1 \rangle}}, \ m = \overline{1, \, M}. \quad (8)$$

　　In n-th dimension the second player (SP) instead of the segment $[0; 1]$ of values of n-th component of its pure strategy (6) now possesses the set of points

$$D_n^{\langle 2 \rangle}\left(S_n^{\langle 2 \rangle}\right) = \left\{ y_n^{\langle s_n \rangle} \right\}_{s_n=1}^{S_n^{\langle 2 \rangle}+1}, \ y_n^{\langle 1 \rangle} = 0,$$
$$y_n^{\langle S_n^{\langle 2 \rangle}+1 \rangle} = 1,$$
$$y_n^{\langle d_n \rangle} < y_n^{\langle d_n+1 \rangle}, \ \forall \, d_n = \overline{1, \, S_n^{\langle 2 \rangle}}, \ n = \overline{1, \, N}. \quad (9)$$

Subsequently, the finite hypercubic irregular lattice (FHCIL)

$$D^{\langle 1 \rangle} = \underset{m=1}{\overset{M}{\bigtimes}} D_m^{\langle 1 \rangle} \left(S_m^{\langle 1 \rangle} \right) = \underset{m=1}{\overset{M}{\bigtimes}} \left\{ \left\{ x_m^{\langle s_m \rangle} \right\}_{s_m=1}^{S_m^{\langle 1 \rangle}+1} \right\} \quad (10)$$

substitutes the hypercube (2), and FHCIL

$$D^{\langle 2 \rangle} = \underset{n=1}{\overset{N}{\bigtimes}} D_n^{\langle 2 \rangle} \left(S_n^{\langle 2 \rangle} \right) = \underset{n=1}{\overset{N}{\bigtimes}} \left\{ \left\{ y_n^{\langle s_n \rangle} \right\}_{s_n=1}^{S_n^{\langle 2 \rangle}+1} \right\} \quad (11)$$

substitutes the hypercube (3). This transforms the infinite TSNCG (1) to finite TSNCG

$$\left\langle D^{\langle 1 \rangle}, D^{\langle 2 \rangle}, K_1(\mathbf{X}, \mathbf{Y}), K_2(\mathbf{X}, \mathbf{Y}) \right\rangle, \mathbf{X} \in D^{\langle 1 \rangle}, \mathbf{Y} \in D^{\langle 2 \rangle} \quad (12)$$

on FHCIL $D^{\langle 1 \rangle} \times D^{\langle 2 \rangle}$, where hypersurface $K_r(\mathbf{X}, \mathbf{Y})$ is transformed into $(M+N)$-dimensional array (matrix)

$$\left\{ \left\{ K_r(\mathbf{X}, \mathbf{Y}) \right\}_{\mathbf{X} \in D^{\langle 1 \rangle}} \right\}_{\mathbf{Y} \in D^{\langle 2 \rangle}}, r \in \{1, 2\}. \quad (13)$$

The sampling numbers

$$\left\{ \left\{ S_m^{\langle 1 \rangle} \right\}_{m=1}^{M}, \left\{ S_n^{\langle 2 \rangle} \right\}_{n=1}^{N} \right\} \quad (14)$$

shall clearly not be assigned arbitrarily, because the sampling mustn't erase specificities of PPF. These specificities are information about local extremums and gradient over hypersurfaces $\left\{ K_r(\mathbf{X}, \mathbf{Y}) \right\}_{r \in \{1, 2\}}$. That is $\forall\, s_m = \overline{1,\, S_m^{\langle 1 \rangle}}$ and $\forall\, s_n = \overline{1,\, S_n^{\langle 2 \rangle}}$ by $m = \overline{1,\, M}$, $n = \overline{1,\, N}$, $r \in \{1, 2\}$ there ought to be

$$\frac{\partial^{M+N} K_r(X,Y)}{\partial x_1 \partial x_2 ... \partial x_M \partial y_1 \partial y_2 ... \partial y_N} \geq 0,$$

$$\frac{\partial^{M+N} K_r(X,Y)}{\partial x_1 \partial x_2 ... \partial x_M \partial y_1 \partial y_2 ... \partial y_N} \leq 0, \quad (15)$$

$$\forall\, x_m \in \left[x_m^{\langle s_m \rangle};\, x_m^{\langle s_m+1 \rangle} \right],\ \forall\, y_n \in \left[y_n^{\langle s_n \rangle};\, y_n^{\langle s_n+1 \rangle} \right].$$

and

$$\left| \frac{\partial^{M+N} K_r(X,Y)}{\partial x_1 \partial x_2 ... \partial x_M \partial y_1 \partial y_2 ... \partial y_N} \right| \leq \gamma,$$

$$\forall\, x_m \in \left[x_m^{\langle s_m \rangle};\, x_m^{\langle s_m+1 \rangle} \right],\ \forall\, y_n \in \left[y_n^{\langle s_n \rangle};\, y_n^{\langle s_n+1 \rangle} \right]. \quad (16)$$

for some $\gamma > 0$, implying tolerable fluctuations of the hypersurface $K_r(\mathbf{X}, \mathbf{Y})$ on every one of segments

$$\left\{ \left\{ \left\{ \left[x_m^{\langle s_m \rangle};\, x_m^{\langle s_m+1 \rangle} \right] \right\}_{s_m=1}^{S_m^{\langle 1 \rangle}} \right\}_{m=1}^{M}, \left\{ \left\{ \left[y_n^{\langle s_n \rangle};\, y_n^{\langle s_n+1 \rangle} \right] \right\}_{s_n=1}^{S_n^{\langle 2 \rangle}} \right\}_{n=1}^{N} \right\}.$$

The following assertion directs for choosing the numbers (14) and points

$$\left\{ \left\{ \left\{ x_m^{\langle s_m \rangle} \right\}_{s_m=2}^{S_m^{\langle 1 \rangle}} \right\}_{m=1}^{M}, \left\{ \left\{ y_n^{\langle s_n \rangle} \right\}_{s_n=2}^{S_n^{\langle 2 \rangle}} \right\}_{n=1}^{N} \right\} \quad (17)$$

in order to sample PPF under conditions (15) and (16) from the hypercube (4) down to FHCIL $D^{\langle 1 \rangle} \times D^{\langle 2 \rangle}$.

Theorem 1. If local extremums of hypersurfaces $K_1(\mathbf{X}, \mathbf{Y})$ and $K_2(\mathbf{X}, \mathbf{Y})$ are reached at points having only components (17) then, if inequalities (16) hold $\forall\, s_m = \overline{1,\, S_m^{\langle 1 \rangle}}$ and $\forall\, s_n = \overline{1,\, S_n^{\langle 2 \rangle}}$ by $m = \overline{1,\, M}$, $n = \overline{1,\, N}$, $r \in \{1, 2\}$, PPF $\left\{ K_r(\mathbf{X}, \mathbf{Y}) \right\}_{r \in \{1, 2\}}$ are sampled with (8)-(11).

Proof. Since having local extremums only with components (17), neither the hypersurface $K_1(\mathbf{X}, \mathbf{Y})$ nor the hypersurface $K_2(\mathbf{X}, \mathbf{Y})$ have local extremums on every one of intervals

$$\left\{ \left\{ \left\{ \left(x_m^{\langle s_m \rangle};\, x_m^{\langle s_m+1 \rangle} \right) \right\}_{s_m=1}^{S_m^{\langle 1 \rangle}} \right\}_{m=1}^{M}, \left\{ \left\{ \left(y_n^{\langle s_n \rangle};\, y_n^{\langle s_n+1 \rangle} \right) \right\}_{s_n=1}^{S_n^{\langle 2 \rangle}} \right\}_{n=1}^{N} \right\}.$$

Hence, for the differentiable PPF $\left\{ K_r(\mathbf{X}, \mathbf{Y}) \right\}_{r \in \{1, 2\}}$, conditions (15) hold as well. The theorem has been proved.

For conditions (16), parameter γ is pre-assigned on reasoning about the value

$$\gamma \leqslant \lambda \cdot \left(\max_{r \in \{1,2\}} \max_{\mathbf{X} \in H_1} \max_{\mathbf{Y} \in H_2} K_r(\mathbf{X}, \mathbf{Y}) - \min_{r \in \{1,2\}} \min_{\mathbf{X} \in H_1} \min_{\mathbf{Y} \in H_2} K_r(\mathbf{X}, \mathbf{Y}) \right) \quad (18)$$

by, say,

$$\lambda \in \{0.001,\ 0.005,\ 0.01,\ 0.02\}$$

or other practically appropriate values for the scale factor λ. Nevertheless, some conditions below may cause need to resample PPF with the lowered parameter γ. These conditions, telling whether the approximate solution of TSNCG (1) is stable enough, are going to be applied to the finite TSNCG (12) solution. Before stating them, MDM (13) should be represented as ordinary flat matrices, letting solve the finite TSNCG (12) as BMG.

5 Mapping PPF as MDM into ordinary flat matrices

The quadruple (12) is a finite TSNCG but it is not BMG unless $M = N = 1$. Therefore, mapping PPF as MDM (13) into ordinary flat matrices will allow to find the finite game solution with any acceptable methods for solving BMG, including linear programming methods on the basis of algorithm of Lemke — Howson [23] and its modifications [24, 25]. Denote MDM (13) as $(M+N)$-dimensional matrix $P_r(0) = \left[p_J^{\langle r \rangle} \right]_F$ of the format

$$F = \left\{ \underset{m=1}{\overset{M}{\bigtimes}} \left(S_m^{\langle 1 \rangle} + 1 \right) \right\} \times \left\{ \underset{n=1}{\overset{N}{\bigtimes}} \left(S_n^{\langle 2 \rangle} + 1 \right) \right\}, \quad (19)$$

whose $(M+N)$-position indices

$$J = \left\{ j_k \right\}_{k=1}^{M+N}, \ j_m \in \overline{\left\{ 1, \ S_m^{\langle 1 \rangle} + 1 \right\}}, \ j_{M+n} \in \overline{\left\{ 1, \ S_n^{\langle 2 \rangle} + 1 \right\}} \quad (20)$$

determine the matrix element

$$p_J^{\langle r \rangle} = K_r \left(\mathbf{X}, \mathbf{Y} \right), \ x_m = x_m^{\langle j_m \rangle},$$
$$y_n = y_n^{\langle j_{M+n} \rangle}, \ \forall \ m = \overline{1, M}, \ \forall \ n = \overline{1, N}. \quad (21)$$

Then with the following assertion the finite TSNCG (12) is going to be mapped into BMG.

Theorem 2. Retrieved from the finite TSNCG (12), MDM $\mathbf{P}_r(0) = \left[p_J^{\langle r \rangle} \right]_F$ of the format (19) by (21) under indexing (20) is mapped into two-dimensional matrix $\mathbf{G}_r(0) = \left[g_{u_1 u_2}^{\langle r \rangle} \right]_{\mathscr{L}}$ of elements $g_{u_1 u_2}^{\langle r \rangle} = p_J^{\langle r \rangle}$ with ordinary two-positional indexing, whose format is

$$L = \left\{ \prod_{m=1}^{M} \left(S_m^{\langle 1 \rangle} + 1 \right) \right\} \times \left\{ \prod_{n=1}^{N} \left(S_n^{\langle 2 \rangle} + 1 \right) \right\}. \quad (22)$$

The matrix map $\mathbf{P}_r(0) \to \mathbf{G}_r(0)$, realizing this reshaping, is reversible.

Proof. The first M indices in the set (20) of the matrix $\mathbf{P}_r(0) = \left[p_J^{\langle r \rangle} \right]_F$ element (21) correspond to components of the pure strategy of FP, and the last N ones correspond to components of the pure strategy of SP. Therefore, letting the subset of indices $\left\{ j_m \right\}_{m=1}^{M} \subset J$ be convolved into value

$$u_1 = \sum_{m=1}^{M} \left(\prod_{m_1=1}^{m-1} \left(S_{M-m_1+1}^{\langle 1 \rangle} + 1 \right) \right) \cdot \left(j_{M-m+1} - \text{sign}(m-1) \right),$$
$$\quad (23)$$
$$m = \overline{1, M}$$

and letting the subset of indices $\left\{ j_{M+n} \right\}_{n=1}^{N} \subset J$ be

convolved into value

$$u_2 = \sum_{n=1}^{N} \left(\prod_{n_1=1}^{n-1} \left(S_{N-n_1+1}^{\langle 2 \rangle} + 1 \right) \right) \cdot \left(j_{M+N-n+1} - \text{sign}(n-1) \right),$$
$$\quad (24)$$
$$n = \overline{1, N}$$

the values (23) and (24) get integer. Moreover, for $j_m = 1, \ S_m^{\langle 1 \rangle} + 1$ there is

$$u_1 = \overline{1, Q_1(0)}, \ Q_1(0) = \prod_{m=1}^{M} \left(S_m^{\langle 1 \rangle} + 1 \right) \quad (25)$$

and for $j_{M+n} = 1, \ S_n^{\langle 2 \rangle} + 1$ there is

$$u_2 = \overline{1, Q_2(0)}, \ Q_2(0) = \prod_{n=1}^{N} \left(S_n^{\langle 2 \rangle} + 1 \right). \quad (26)$$

Thus $(M+N)$-dimensional matrix $\mathbf{P}_r(0) = \left[p_J^{\langle r \rangle} \right]_F$ of the format (19) by (20) and (21) is reshaped into two-dimensional matrix $\mathbf{G}_r(0) = \left[g_{u_1 u_2}^{\langle r \rangle} \right]_L$ of the format (22), where the set of indices $J = \left\{ j_k \right\}_{k=1}^{M+N}$ is mapped into the set $\left\{ u_1, u_2 \right\}$ by convolutions in (23) and (24). Further, let the function $\rho(a, b)$ by $b \neq 0$ round the fraction $\dfrac{a}{b}$ to the nearest integer towards zero. And let

$$\eta(a, b) = a - b \cdot \rho(a, b).$$

Then the subset of indices $\left\{ j_m \right\}_{m=1}^{M} \subset J$ is restored by the index u_1 after (23):

$$j_M = \eta \left(u_1, S_M^{\langle 1 \rangle} + 1 \right) +$$
$$+ \left(S_M^{\langle 1 \rangle} + 1 \right) \left(1 - \text{sign} \left[\eta \left(u_1, S_M^{\langle 1 \rangle} + 1 \right) \right] \right), \quad (27)$$

$$j_{M-m} = 1 + \eta \left(\frac{u_1 - j_M - \sum\limits_{m_1=1}^{m-1} \left(\prod\limits_{m_2=1}^{m_1} \left(S_{M-m_2+1}^{\langle 1 \rangle} + 1 \right) \right) \cdot \left(j_{M-m_1} - 1 \right)}{\prod\limits_{m_1=1}^{m} \left(S_{M-m_1+1}^{\langle 1 \rangle} + 1 \right)}, \ S_{M-m}^{\langle 1 \rangle} + 1 \right), \ \forall \ m = \overline{1, M-1}. \quad (28)$$

The subset of indices $\left\{ j_{M+n} \right\}_{n=1}^{N} \subset J$ is restored by the index u_2 after (24) similarly:

$$j_{M+N} = \eta \left(u_2, S_N^{\langle 2 \rangle} + 1 \right) + \left(S_N^{\langle 2 \rangle} + 1 \right) \left(1 - \text{sign} \left[\eta \left(u_2, S_N^{\langle 2 \rangle} + 1 \right) \right] \right), \quad (29)$$

$$j_{M+N-n} = 1 + \eta \left(\frac{u_2 - j_{M+N} - \sum_{n_1=1}^{n-1} \left(\prod_{n_2=1}^{n_1} \left(S_{N-n_2+1}^{\langle 2 \rangle} + 1 \right) \right) \cdot \left(j_{M+N-n_1} - 1 \right)}{\prod_{n_1=1}^{n} \left(S_{N-n_1+1}^{\langle 2 \rangle} + 1 \right)}, S_{N-n}^{\langle 2 \rangle} + 1 \right), \ \forall \, n = \overline{1, \, N-1}. \qquad (30)$$

Consequently, the matrix map $\mathbf{P}_r(0) \to \mathbf{G}_r(0)$ is accomplished via (23) and (24), and the matrix map $\mathbf{G}_r(0) \to \mathbf{P}_r(0)$ is accomplished via (27) — (30). The theorem has been proved.

When $M = N = 1$, the finite TSNCG (12) is BMG, and Theorem 2 is useless. When $M \neq 1$ or $N \neq 1$, Theorem 2 allows mapping the finite TSNCG (12) on FHCIL $D^{\langle 1 \rangle} \times D^{\langle 2 \rangle}$ into BMG.

$$\left\langle \left\{ z_{u_1}^{\langle \mathbf{X} \rangle}(0) \right\}_{u_1=1}^{Q_1(0)}, \left\{ z_{u_2}^{\langle \mathbf{Y} \rangle}(0) \right\}_{u_2=1}^{Q_2(0)}, \mathbf{G}_1(0), \mathbf{G}_2(0) \right\rangle \qquad (31)$$

with the pure strategy of FP $z_{u_1}^{\langle \mathbf{X} \rangle}(0)$ corresponding to its strategy $\mathbf{X} = \left[x_m^{\langle j_m \rangle} \right]_{1 \times M} \in D^{\langle 1 \rangle}$ in the initial TSNCG (1) after having sampled under numbers $\left\{ S_m^{\langle 1 \rangle} \right\}_{m=1}^{M}$, and the pure strategy of SP $z_{u_2}^{\langle \mathbf{Y} \rangle}(0)$ corresponding to its strategy $\mathbf{Y} = \left[y_n^{\langle j_{M+n} \rangle} \right]_{1 \times N} \in D^{\langle 2 \rangle}$ in the initial TSNCG (1) after having sampled under numbers $\left\{ S_n^{\langle 2 \rangle} \right\}_{n=1}^{N}$. But before calling BMG (31) the approximation of TSNCG (1), accurateness of the approximation must be ranked.

6 Consistency of the players' equilibrium FSS in BMG

Denote by

$$\left\{ \left\{ p_*(u_1, 0) \right\}_{u_1=1}^{Q_1(0)}, \left\{ q_*(u_2, 0) \right\}_{u_2=1}^{Q_2(0)} \right\} \qquad (32)$$

a Nash equilibrium solution or Pareto efficiency solution or other type equilibrium solution in BMG (31), in which $p_*(u_1, 0)$ is the optimal probability of applying the pure strategy $z_{u_1}^{\langle \mathbf{X} \rangle}(0)$, and $q_*(u_2, 0)$ is the optimal probability of applying the pure strategy $z_{u_2}^{\langle \mathbf{Y} \rangle}(0)$. In ranking the approximation accurateness, the solution (32) should be compared to solutions of other BMG, approximating the initial TSNCG (1). Their formats differ from the format (22) because these BMG are built under the sampling numbers

$$\left\{ \left\{ S_m^{\langle 1 \rangle} + \delta \right\}_{m=1}^{M}, \left\{ S_n^{\langle 2 \rangle} + \delta \right\}_{n=1}^{N} \right\}, \ \delta \in \mathbb{Z} \setminus \{0\} \qquad (33)$$

instead of (14). This is the only way to get comparisons because the genuine solution of the initial TSNCG (1) is often cannot be known. A new BMG is

$$\left\langle \left\{ z_{u_1}^{\langle \mathbf{X} \rangle}(\delta) \right\}_{u_1=1}^{Q_1(\delta)}, \left\{ z_{u_2}^{\langle \mathbf{Y} \rangle}(\delta) \right\}_{u_2=1}^{Q_2(\delta)}, \mathbf{G}_1(\delta), \mathbf{G}_2(\delta) \right\rangle \qquad (34)$$

by

$$Q_1(\delta) = \prod_{m=1}^{M} \left(S_m^{\langle 1 \rangle} + 1 + \delta \right), \ Q_2(\delta) = \prod_{n=1}^{N} \left(S_n^{\langle 2 \rangle} + 1 + \delta \right),$$

and δ-BMG (34) is built under the sampling numbers (33) and re-finding (8), (9), and re-mapping $\mathbf{P}_r(\delta) \to \mathbf{G}_r(\delta)$ with identifications

$$\left\{ S_m^{\langle 1 \rangle} \equiv S_m^{\langle 1 \rangle} + \delta \right\}_{m=1}^{M}, \left\{ S_n^{\langle 2 \rangle} \equiv S_n^{\langle 2 \rangle} + \delta \right\}_{n=1}^{N}, \qquad (35)$$

whereupon the pure strategy of FP $z_{u_1}^{\langle \mathbf{X} \rangle}(\delta)$ corresponds to its strategy $\mathbf{X} = \left[x_m^{\langle j_m \rangle} \right]_{1 \times M}$ in the initial TSNCG (1) after having sampled under numbers $\left\{ S_m^{\langle 1 \rangle} + \delta \right\}_{m=1}^{M}$, and the pure strategy of SP $z_{u_2}^{\langle \mathbf{Y} \rangle}(\delta)$ corresponds to its strategy $\mathbf{Y} = \left[y_n^{\langle j_{M+n} \rangle} \right]_{1 \times N}$ in the initial TSNCG (1) after having sampled under numbers $\left\{ S_n^{\langle 2 \rangle} + \delta \right\}_{n=1}^{N}$. And may there be a convention that the sampling numbers (33) are chosen against the numbers (14) so that density of the sampling points along each dimension by $\delta > 0$ doesn't decrease, and density of the sampling points along each dimension by $\delta < 0$ doesn't increase. That is, for points

$$\left\{ \left\{ \left\{ x_m^{\langle s_m \rangle}(\delta) \right\}_{s_m=1}^{S_m^{\langle 1 \rangle}+1} \right\}_{m=1}^{M}, \left\{ \left\{ y_n^{\langle s_n \rangle}(\delta) \right\}_{s_n=1}^{S_n^{\langle 2 \rangle}+1} \right\}_{n=1}^{N} \right\} \qquad (36)$$

chosen after the sampling numbers (33) with $\delta \in \mathbb{N}$, the inequalities

$$\max_{d_m=1, \, S_m^{\langle 1 \rangle}} \left(x_m^{\langle d_m+1 \rangle} - x_m^{\langle d_m \rangle} \right) \geq \max_{d_m=1, \, S_m^{\langle 1 \rangle}+\delta} \left(x_m^{\langle d_m+1 \rangle}(\delta) - x_m^{\langle d_m \rangle}(\delta) \right)$$

$$(37)$$

$$m = \overline{1, \, M}$$

and

$$\max_{d_n=1, \, S_n^{\langle 2 \rangle}} \left(y_n^{\langle d_n+1 \rangle} - y_n^{\langle d_n \rangle} \right) \geq \max_{d_n=1, \, S_n^{\langle 2 \rangle}+\delta} \left(y_n^{\langle d_n+1 \rangle}(\delta) - y_n^{\langle d_n \rangle}(\delta) \right)$$

$$(38)$$

$$n = \overline{1, \, N}$$

hold.

Formally, BMG (31) is a particular case of BMG (34), taken by $\delta = 0$. Denote the solution of BMG (34) by

$$\left\{ \left\{ p_*(u_1, \delta) \right\}_{u_1=1}^{Q_1(\delta)}, \left\{ q_*(u_2, \delta) \right\}_{u_2=1}^{Q_2(\delta)} \right\} \qquad (39)$$

similarly to denotation (32), in which $p_*\left(u_1, \delta\right)$ is the optimal probability of applying the pure strategy $z_{u_1}^{\langle \mathbf{X} \rangle}\left(\delta\right)$ and $q_*\left(u_2, \delta\right)$ is the optimal probability of applying the pure strategy $z_{u_2}^{\langle \mathbf{Y} \rangle}\left(\delta\right)$. Thus by denoting supports

$$\mathrm{supp}\left\{p_*\left(u_1, \delta\right)\right\}_{u_1=1}^{Q_1(\delta)} = \left\{z_{u_1^*}^{\langle \mathbf{X} \rangle}\left(\delta\right)\right\}_{u_1^* \in U_1(\delta) \subset \overline{\left\{1,\, Q_1(\delta)\right\}}} \tag{40}$$

and

$$\mathrm{supp}\left\{q_*\left(u_2, \delta\right)\right\}_{u_2=1}^{Q_2(\delta)} = \left\{z_{u_2^*}^{\langle \mathbf{Y} \rangle}\left(\delta\right)\right\}_{u_2^* \in U_2(\delta) \subset \overline{\left\{1,\, Q_2(\delta)\right\}}} \tag{41}$$

the r-th player gets payoff

$$v_r^*\left(\delta\right) = \sum_{u_1=1}^{Q_1(\delta)} \sum_{u_2=1}^{Q_2(\delta)} g_{u_1 u_2}^{\langle r \rangle} \cdot p_*\left(u_1, \delta\right) \cdot q_*\left(u_2, \delta\right) =$$
$$= \sum_{u_1^* \in U_1(\delta)} \sum_{u_2^* \in U_2(\delta)} g_{u_1^* u_2^*}^{\langle r \rangle} \cdot p_*\left(u_1^*, \delta\right) \cdot q_*\left(u_2^*, \delta\right) \tag{42}$$

in situation (39), $r \in \{1, 2\}$. Henceforward, BMG (31) can be compared to BMG (34) by $\delta \in \mathbb{Z} \setminus \{0\}$ in two ways: through comparing payoffs $\left\{v_r^*\left(0\right)\right\}_{r \in \{1, 2\}}$ and $\left\{\left\{v_r^*\left(\delta\right)\right\}_{r \in \{1, 2\}}\right\}_{\delta \in \mathbb{Z} \setminus \{0\}}$, and through comparisons among supports (40) and among supports (41). The second comparison way relates to the support cardinality comparisons, and to the support configuration comparisons regarding the hypercube of the player's pure strategies.

The narrowest comparison takes $\delta \in \{-1, 1\}$. Namely, within minimal neighborhood of the sampling numbers (14), the solution of BMG mustn't vary much. And it is clear that the solution (32) can be put for consideration as the approximate solution of the initial TSNCG (1) if

$$\left|U_r(1)\right| \geq \left|U_r(0)\right|, \quad r \in \{1, 2\} \tag{43}$$

and

$$\left|v_r^*\left(0\right) - v_r^*\left(1\right)\right| \leq \left|v_r^*\left(-1\right) - v_r^*\left(0\right)\right|, \quad r \in \{1, 2\}. \tag{44}$$

The inequalities (43) and (44) reflect both the payoff comparison side and the support cardinality comparison side. And the last is strengthened involving $\left(-1\right)$-BMG:

$$\left|U_r(1)\right| \geq \left|U_r(0)\right| \geq \left|U_r(-1)\right|, \quad r \in \{1, 2\}. \tag{45}$$

However, there are no comparisons among the support configurations. These comparisons are really needed because configuration of FSS may differ significantly from the genuine equilibrium strategy support in TSNCG (1) genuine solution. Also it may differ from the configuration of the support, obtained after different sampling. Hence, configuration of the player's FSS mustn't vary much as the sampling numbers change consentaneously.

For seeing the configuration of the players' equilibrium FSS in BMG (31) solution (32), they are going to be represented as piecewise linear hypersurfaces $\left\{h_r\left(u_r, 0\right)\right\}_{r \in \{1, 2\}}$, whose nonzero vertices are those

equilibrium FSS probabilities linearly linked to points on FHCIL not included into the support. The hypersurfaces in δ-BMG (34) are denoted $\left\{h_r\left(u_r, \delta\right)\right\}_{r \in \{1, 2\}}$. Vertices of FP hypersurface $h_1\left(u_1, 0\right)$ are in points

$$\left\{\left\{x_m^{\langle j_m \rangle}\right\}_{m=1}^M,\ p_*\left(u_1, 0\right)\right\}_{u_1=1}^{Q_1(0)} \tag{46}$$

in the space $\mathbb{R}^{M+1}$, and vertices of SP hypersurface $h_2\left(u_2, 0\right)$ are in points

$$\left\{\left\{y_n^{\langle j_{M+n} \rangle}\right\}_{n=1}^N,\ q_*\left(u_2, 0\right)\right\}_{u_2=1}^{Q_2(0)} \tag{47}$$

in the space $\mathbb{R}^{N+1}$.

FP matches the index $u_1^* \in U_1\left(0\right)$ to the point

$$\mathbf{X}_q\left(0\right) = \left[x_m^{\langle q \rangle}\left(0\right)\right]_{1 \times M} = \left[x_m^{\langle j_m(q,\, 0) \rangle}\right]_{1 \times M} \in H_1,$$
$$q = \overline{1,\, Q_1^*\left(0\right)} \tag{48}$$

at $Q_1^*\left(0\right) = \left|U_1\left(0\right)\right|$ through expanding the index u_1^* via (27) and (28) into subset $\left\{j_m\left(q, 0\right)\right\}_{m=1}^M \subset J$. SP matches the index $u_2^* \in U_2\left(0\right)$ to the point

$$\mathbf{Y}_w\left(0\right) = \left[y_n^{\langle w \rangle}\left(0\right)\right]_{1 \times N} = \left[y_n^{\langle j_{M+n}(w,\, 0) \rangle}\right]_{1 \times N} \in H_2,$$
$$w = \overline{1,\, Q_2^*\left(0\right)} \tag{49}$$

at $Q_2^*\left(0\right) = \left|U_2\left(0\right)\right|$ through expanding the index u_2^* via (29) and (30) into subset $\left\{j_{M+n}\left(w, 0\right)\right\}_{n=1}^N \subset J$. Then let the set $\left\{\mathbf{X}_q\left(0\right)\right\}_{q=1}^{Q_1^*(0)}$ of the points (48) be sorted into the set

$$\left\{\bar{\mathbf{X}}_q\left(0\right)\right\}_{q=1}^{Q_1^*(0)} = \left\{\left[x_m^{\langle \bar{j}_m(q,\, 0) \rangle}\right]_{1 \times M}\right\}_{q=1}^{Q_1^*(0)} \cap \left\{\mathbf{X}_q\left(0\right)\right\}_{q=1}^{Q_1^*(0)} =$$
$$= \left\{\mathbf{X}_q\left(0\right)\right\}_{q=1}^{Q_1^*(0)} \subset H_1 \tag{50}$$

so that the value

$$\min_{q_1 \in \overline{\left\{q+1,\, Q_1^*(0)\right\}}} \rho_{\mathbb{R}^M}\left(\bar{\mathbf{X}}_q\left(0\right) - \bar{\mathbf{X}}_{q_1}\left(0\right)\right) =$$
$$= \min_{q_1 \in \overline{\left\{q+1,\, Q_1^*(0)\right\}}} \left\|\bar{\mathbf{X}}_q\left(0\right) - \bar{\mathbf{X}}_{q_1}\left(0\right)\right\| = \tag{51}$$
$$= \min_{q_1 \in \overline{\left\{q+1,\, Q_1^*(0)\right\}}} \sqrt{\sum_{m=1}^M \left(x_m^{\langle \bar{j}_m(q,\, 0) \rangle} - x_m^{\langle \bar{j}_m(q_1,\, 0) \rangle}\right)^2}$$

with the re-sorted subset

$$\left\{\bar{j}_m\left(q, 0\right)\right\}_{m=1}^M \cap \left\{j_m\left(q, 0\right)\right\}_{m=1}^M = \left\{j_m\left(q, 0\right)\right\}_{m=1}^M \subset J \quad \text{is}$$

reached at $q_1 = q+1$ for each $q = \overline{1,\, Q_1^*\left(0\right) - 1}$ by $Q_1^*\left(0\right) < Q_1\left(0\right)$. Similarly, the set $\left\{\mathbf{Y}_w\left(0\right)\right\}_{w=1}^{Q_2^*(0)}$ of the

points (49) is sorted into the set

$$\left\{\overline{\mathbf{Y}}_w(0)\right\}_{w=1}^{Q_2^*(0)} = \left\{\left[y_n^{\langle \overline{j}_{M+n}(w,\,0)\rangle}\right]_{1\times N}\right\}_{w=1}^{Q_2^*(0)} \cap \left\{\mathbf{Y}_w(0)\right\}_{w=1}^{Q_2^*(0)} = \quad , \quad (52)$$
$$= \left\{\mathbf{Y}_w(0)\right\}_{w=1}^{Q_2^*(0)} \subset H_2$$

so that the value

$$\min_{w_1 \in \left\{\overline{w+1,\, Q_2^*(0)}\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(0) - \overline{\mathbf{Y}}_{w_1}(0)\right) =$$
$$= \min_{w_1 \in \left\{\overline{w+1,\, Q_2^*(0)}\right\}} \left\|\overline{\mathbf{Y}}_w(0) - \overline{\mathbf{Y}}_{w_1}(0)\right\| = \quad , \quad (53)$$
$$= \min_{w_1 \in \left\{\overline{w+1,\, Q_2^*(0)}\right\}} \sqrt{\sum_{n=1}^{N}\left(y_n^{\langle \overline{j}_{M+n}(w,\,0)\rangle} - y_n^{\langle \overline{j}_{M+n}(w_1,\,0)\rangle}\right)^2}$$

with the re-sorted subset

$$\left\{\overline{j}_{M+n}(w,\,0)\right\}_{n=1}^{N} \cap \left\{j_{M+n}(w,\,0)\right\}_{n=1}^{N} = $$
$$= \left\{j_{M+n}(w,\,0)\right\}_{n=1}^{N} \subset J \quad (54)$$

is reached at $w_1 = w+1$ for each $w = \overline{1,\,Q_2^*(0)-1}$ by $Q_2^*(0) < Q_2(0)$. Importantly, one ought to be aware of that the result of sorting in (50) and (52) depends on selection of the initial points $\overline{\mathbf{X}}_1(0) \in \left\{\mathbf{X}_q(0)\right\}_{q=1}^{Q_1^*(0)}$ and $\overline{\mathbf{Y}}_1(0) \in \left\{\mathbf{Y}_w(0)\right\}_{w=1}^{Q_2^*(0)}$. In the case of completely mixed strategies, let them be

$$\overline{\mathbf{X}}_q(0) = \mathbf{X}_q(0), \ \forall\, q = \overline{1,\,Q_1^*(0)}, \ Q_1^*(0) = Q_1(0) \quad (55)$$

and

$$\overline{\mathbf{Y}}_w(0) = \mathbf{Y}_w(0), \ \forall\, w = \overline{1,\,Q_2^*(0)}, \ Q_2^*(0) = Q_2(0) \quad (56)$$

for the sake of convenience.

Considering δ-BMG (34), let the hypersurfaces $\left\{h_r(u_r, \delta)\right\}_{r\in\{1,\,2\}}$ and sets $\left\langle \left\{\overline{\mathbf{X}}_q(\delta)\right\}_{q=1}^{Q_1^*(\delta)}, \left\{\overline{\mathbf{Y}}_w(\delta)\right\}_{w=1}^{Q_2^*(\delta)}\right\rangle$ regard built and found with identifications (35) and turning to these sets' description for (46) — (56). Thus, the second comparison way opens for the support configuration comparisons. And then there is a way to learn the rank of accurateness in approximating the initial TSNCG (1) with BMG (31).

Definition 1. The solution (32) of BMG (31) is called weakly consistent for being the approximate solution of TSNCG (1) if the inequalities

$$\max_{q\in\left\{\overline{1,\, Q_1^*(1)-1}\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(1), \overline{\mathbf{X}}_{q+1}(1)\right) \leq$$
$$\leq \max_{q\in\left\{\overline{1,\, Q_1^*(0)-1}\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(0), \overline{\mathbf{X}}_{q+1}(0)\right) \quad , \quad (57)$$

$$\max_{w\in\left\{\overline{1,\, Q_2^*(1)-1}\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(1), \overline{\mathbf{Y}}_{w+1}(1)\right) \leq$$
$$\leq \max_{w\in\left\{\overline{1,\, Q_2^*(0)-1}\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(0), \overline{\mathbf{Y}}_{w+1}(0)\right) \quad , \quad (58)$$

$$\max_{H_r}\left|h_r(u_r, 0) - h_r(u_r, 1)\right| \leq$$
$$\leq \max_{H_r}\left|h_r(u_r, -1) - h_r(u_r, 0)\right| \quad , \quad (59)$$

and

$$\left\|h_r(u_r, 0) - h_r(u_r, 1)\right\| \leq \left\|h_r(u_r, -1) - h_r(u_r, 0)\right\|,$$
$$L_2(H_r), r\in\{1, 2\} \quad (60)$$

are true along with (43) and (44). Then solution (32) of BMG (31) is called weakly 1-consistent. Every strategy and its support in the weakly 1-consistent solution are called weakly consistent or weakly 1-consistent.

Weak 1-consistency of the players' equilibrium FSS in BMG (31) invokes minimal number of δ-BMG, approximating the initial TSNCG (1). This is the most primitive consistency in ranking the approximation accurateness. The primitiveness of Definition 1 is obviated with adding conditions of the sampling minimal loosing.

Definition 2. The weakly consistent solution (32) of BMG (31) is called consistent for being the approximate solution of TSNCG (1) if the inequalities (45) and

$$\max_{q\in\left\{\overline{1,\, Q_1^*(0)-1}\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(0), \overline{\mathbf{X}}_{q+1}(0)\right) \leq$$
$$\leq \max_{q\in\left\{\overline{1,\, Q_1^*(-1)-1}\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(-1), \overline{\mathbf{X}}_{q+1}(-1)\right) \quad , \quad (61)$$

and

$$\max_{w\in\left\{\overline{1,\, Q_2^*(0)-1}\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(0), \overline{\mathbf{Y}}_{w+1}(0)\right) \leq$$
$$\leq \max_{w\in\left\{\overline{1,\, Q_2^*(0)-1}\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(-1), \overline{\mathbf{Y}}_{w+1}(-1)\right) \quad (62)$$

are true. Then solution (32) of BMG (31) is called 1-consistent. Every strategy and its support in the 1-consistent solution are called consistent or 1-consistent.

Inequalities (45), (61), (62), canceling the "weakness" in consistency, mean that the properties of the solution of (-1)-BMG relate to the properties of the solution (32) of BMG (31) as similarly as the properties of the solution (32) of BMG (31) relate to the properties of the solution of 1-BMG. Note that in controlling the players' equilibrium FSS for their weak 1-consistency, there are 10 inequalities (43), (44), and (57) — (60) to be checked. And there are 14 inequalities (44), (45), and (57) — (62) to be checked for controlling the players' equilibrium FSS for their 1-consistency. Below is an opportunity to avoid superfluous computations in checking weak 1-consistency.

Theorem 3. If the solution

$$\left\{\left\{p_*(u_1, 1)\right\}_{u_1=1}^{Q_1(1)}, \left\{q_*(u_2, 1)\right\}_{u_2=1}^{Q_2(1)}\right\} \quad (63)$$

of 1-BMG is completely mixed, then for checking weak 1-

consistency of the solution (32) it is sufficient to check six inequalities (44) and (59), (60).

Proof. Inasmuch as the situation (63) is completely mixed then

$$Q_1^*(1) = Q_1(1) = \prod_{m=1}^{M}\left(S_m^{\langle 1 \rangle}+2\right) > \prod_{m=1}^{M}\left(S_m^{\langle 1 \rangle}+1\right) \geq Q_1^*(0),$$

$$Q_2^*(1) = Q_2(1) = \prod_{n=1}^{N}\left(S_n^{\langle 2 \rangle}+2\right) > \prod_{n=1}^{N}\left(S_n^{\langle 2 \rangle}+1\right) \geq Q_2^*(0),$$

giving us both the inequalities (43), even strictly. Further, as the solution (63) is completely mixed then through the convention (55) and (56) there are the sets

$$\left\{\overline{\mathbf{X}}_q(1)\right\}_{q=1}^{Q_1^*(1)} = \left\{\mathbf{X}_q(1)\right\}_{q=1}^{Q_1(1)}$$

and

$$\left\{\overline{\mathbf{Y}}_w(1)\right\}_{w=1}^{Q_2^*(1)} = \left\{\mathbf{Y}_w(1)\right\}_{w=1}^{Q_2(1)}$$

such that

$$\max_{q\in\left\{1,\, Q_1^*(1)-1\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(1), \overline{\mathbf{X}}_{q+1}(1)\right) =$$
$$= \max_{m=1,\,M}\ \max_{d_m=1,\,S_m^{\langle 1 \rangle}+1}\left(x_m^{\langle d_m+1 \rangle}(1) - x_m^{\langle d_m \rangle}(1)\right) \qquad (64)$$

and

$$\max_{w\in\left\{1,\, Q_2^*(1)-1\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(1), \overline{\mathbf{Y}}_{w+1}(1)\right) =$$
$$= \max_{n=1,\,N}\ \max_{d_n=1,\,S_n^{\langle 2 \rangle}+1}\left(y_n^{\langle d_n+1 \rangle}(1) - y_n^{\langle d_n \rangle}(1)\right) \qquad (65)$$

Then, due to (37) and (38), have

$$\max_{q\in\left\{1,\, Q_1^*(1)-1\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(1), \overline{\mathbf{X}}_{q+1}(1)\right) \leq$$
$$\leq \max_{m=1,\,M}\ \max_{d_m=1,\,S_m^{\langle 1 \rangle}}\left(x_m^{\langle d_m+1 \rangle} - x_m^{\langle d_m \rangle}\right) \leq$$
$$\leq \max_{q\in\left\{1,\, Q_1^*(0)-1\right\}} \sqrt{\sum_{m=1}^{M}\left(x_m^{\langle \overline{j}_m(q+1,\,0) \rangle} - x_m^{\langle \overline{j}_m(q,\,0) \rangle}\right)^2} =$$
$$= \max_{q\in\left\{1,\, Q_1^*(0)-1\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(0), \overline{\mathbf{X}}_{q+1}(0)\right)$$

$$\max_{w\in\left\{1,\, Q_2^*(1)-1\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(1), \overline{\mathbf{Y}}_{w+1}(1)\right) \leq$$
$$\leq \max_{n=1,\,N}\ \max_{d_n=1,\,S_n^{\langle 2 \rangle}}\left(y_n^{\langle d_n+1 \rangle} - y_n^{\langle d_n \rangle}\right) \leq$$
$$\leq \max_{w\in\left\{1,\, Q_2^*(0)-1\right\}} \sqrt{\sum_{n=1}^{N}\left(y_n^{\langle \overline{j}_{M+n}(w+1,\,0) \rangle} - y_n^{\langle \overline{j}_{M+n}(w,\,0) \rangle}\right)^2} =$$
$$= \max_{w\in\left\{1,\, Q_2^*(0)-1\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(0), \overline{\mathbf{Y}}_{w+1}(0)\right)$$

giving us both the inequalities (57) and (58). The theorem has been proved.

Consistency by either Definition 1 or Definition 2 of the player's equilibrium FSS in BMG (31), approximating the player's genuine equilibrium strategy in TSNCG (1), ranks accurateness of the approximation for elementary case. Naturally, the rank conception in the form of (weak) 1-consistency is easily widened to the form of (weak) λ-consistency by $\lambda \in \mathbb{N}$.

7 Approximation of TSNCG (1) in λ-consistency

Definition 3. The solution (32) of BMG (31) is called weakly λ-consistent for being the approximate solution of TSNCG (1) if the inequalities

$$\left|v_r^*(\mu) - v_r^*(\mu+1)\right| \leq \left|v_r^*(\mu+1) - v_r^*(\mu)\right|,\ r\in\{1,\,2\}, \quad (66)$$

$$\left|U_r(\mu+1)\right| \geq \left|U_r(\mu)\right|,\ r\in\{1,\,2\}, \qquad (67)$$

$$\max_{q\in\left\{1,\, Q_1^*(\mu+1)-1\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(\mu+1), \overline{\mathbf{X}}_{q+1}(\mu+1)\right) \leq$$
$$\leq \max_{q\in\left\{1,\, Q_1^*(\mu)-1\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(\mu), \overline{\mathbf{X}}_{q+1}(\mu)\right) \qquad (68)$$

$$\max_{w\in\left\{1,\, Q_2^*(\mu+1)-1\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(\mu+1), \overline{\mathbf{Y}}_{w+1}(\mu+1)\right) \leq$$
$$\leq \max_{w\in\left\{1,\, Q_2^*(\mu)-1\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(\mu), \overline{\mathbf{Y}}_{w+1}(\mu)\right) \qquad (69)$$

$$\max_{H_r}\left|h_r(u_r,\mu) - h_r(u_r,\mu+1)\right| \leq$$
$$\leq \max_{H_r}\left|h_r(u_r,\mu-1) - h_r(u_r,\mu)\right|, \qquad (70)$$

and

$$\left\|h_r(u_r,\mu) - h_r(u_r,\mu+1)\right\| \leq \left\|h_r(u_r,\mu-1) - h_r(u_r,\mu)\right\|,$$
$$L_2(H_r),\ r\in\{1,2\} \qquad (71)$$

are true $\forall\ \mu = \overline{1-\lambda,\ \lambda-1}$ by $\lambda \in \mathbb{N}$. Every strategy and its support in the weakly λ-consistent solution are called weakly λ-consistent.

Definition 4. The weakly λ-consistent solution (32) of BMG (31) is called λ-consistent for being the approximate solution of TSNCG (1) if the inequalities

$$\left|U_r(\mu)\right| \geq \left|U_r(\mu-1)\right|,\ r\in\{1,\,2\} \qquad (72)$$

and

$$\max_{q\in\left\{1,\, Q_1^*(\mu)-1\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(\mu), \overline{\mathbf{X}}_{q+1}(\mu)\right) \leq$$
$$\leq \max_{q\in\left\{1,\, Q_1^*(\mu-1)-1\right\}} \rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q(\mu-1), \overline{\mathbf{X}}_{q+1}(\mu-1)\right) \qquad (73)$$

and

$$\max_{w\in\left\{1,\, Q_2^*(\mu)-1\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(\mu), \overline{\mathbf{Y}}_{w+1}(\mu)\right) \leq$$
$$\leq \max_{w\in\left\{1,\, Q_2^*(\mu-1)-1\right\}} \rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w(\mu-1), \overline{\mathbf{Y}}_{w+1}(\mu-1)\right) \qquad (74)$$

are true $\forall\,\mu=\overline{1-\lambda,\;\lambda-1}$ by $\lambda\in\mathbb{N}$. Every strategy and its support in the λ-consistent solution are called λ-consistent.

For checking λ-consistency of the weakly λ-consistent solution, it is not of necessity to check all $8\lambda-4$ inequalities (72) — (74). It is sufficient to check four inequalities ever.

Theorem 4. If the inequalities

$$\left|U_r\left(1-\lambda\right)\right|\geq\left|U_r\left(-\lambda\right)\right|,\; r\in\left\{1,\,2\right\} \tag{75}$$

and

$$\begin{aligned}&\max_{q\in\left\{\overline{1,\,Q_1^*\left(1-\lambda\right)-1}\right\}}\rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q\left(1-\lambda\right),\overline{\mathbf{X}}_{q+1}\left(1-\lambda\right)\right)\leq\\[4pt]&\leq\max_{q\in\left\{\overline{1,\,Q_1^*\left(-\lambda\right)-1}\right\}}\rho_{\mathbb{R}^M}\left(\overline{\mathbf{X}}_q\left(-\lambda\right),\overline{\mathbf{X}}_{q+1}\left(-\lambda\right)\right)\end{aligned} \tag{76}$$

and

$$\begin{aligned}&\max_{w\in\left\{\overline{1,\,Q_2^*\left(1-\lambda\right)-1}\right\}}\rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w\left(1-\lambda\right),\overline{\mathbf{Y}}_{w+1}\left(1-\lambda\right)\right)\leq\\[4pt]&\leq\max_{w\in\left\{\overline{1,\,Q_2^*\left(-\lambda\right)-1}\right\}}\rho_{\mathbb{R}^N}\left(\overline{\mathbf{Y}}_w\left(-\lambda\right),\overline{\mathbf{Y}}_{w+1}\left(-\lambda\right)\right)\end{aligned} \tag{77}$$

are true for some $\lambda\in\mathbb{N}$ then the weakly λ-consistent solution (32) of BMG (31) is λ-consistent.

Proof. Inasmuch as the inequalities (67) — (69) are true $\forall\,\mu=\overline{1-\lambda,\;\lambda-1}$ then, having added the four inequalities (75) — (77) to them, there are true the inequalities (72) — (74) $\forall\,\mu=\overline{1-\lambda,\;\lambda-1}$ by $\lambda\in\mathbb{N}$. The theorem has been proved.

Apparently, weak $\left(\lambda-1\right)$-consistency follows weak λ-consistency, and $\left(\lambda-1\right)$-consistency follows λ-consistency. Approximation of TSNCG (1) in λ-consistency under the generalizing Definitions 3 and 4 prescribes the monotonic-like properties for $2\lambda+1$ of BMG (34) by $\delta=\overline{-\lambda,\;\lambda}$. The greater λ the wider neighborhood of the sampling is, and the more suitable BMG (31) for being called the approximation of TSNCG (1). In ranking the approximation accurateness, λ-consistency invokes $2\lambda+1$ δ-BMG, approximating the initial TSNCG (1). The greater λ the higher rank of accurateness of the approximation is.

8 Conclusions and possibilities for further work

It is noteworthy to say that neither weakly λ-consistent solution (32) of BMG (31), nor λ-consistent solution (32) of BMG (31) guarantee the faultlessness of the initial TSNCG (1) approximation as BMG (31), whatever $\lambda\in\mathbb{N}$ is. Nonetheless weakly λ-consistent solution being a particular case of λ-consistency forces the equilibrium FSS cardinality nondecreasing as the sampling numbers increase minimally. This is stated with (67), and it is reinforced with (72) for λ-consistency. Secondly, as the sampling numbers increase minimally, both the players' equilibrium payoffs and the players' FSS differentiate no more than at the lesser sampling numbers. This is stated with (66), (70), (71). And thirdly, density of points on FHCIL constituting FSS is forced nondecreasing as the sampling numbers increase

minimally, what is stated with (68) and (69) for weak λ-consistency and is reinforced with (73) and (74) for λ-consistency.

Of course, we could call an equilibrium FSS λ-consistent if it satisfied either the conditions (66) — (71) or (66) — (74), but is its consistency ever followed with the other player's equilibrium FSS? Surely, there is no proof of that. Also there is no proof of that limits

$$\lim_{\delta\to\infty}v_r^*\left(\delta\right),\; r\in\left\{1,\,2\right\} \tag{78}$$

exist and they coincide with the players' genuine equilibrium payoffs in the initial TSNCG (1). Besides, many other equilibrium situations may be in BMG (31) or TSNCG (1), giving diverse payoffs for players [26, 27]. The deficiency of hypersurfaces $\left\{h_r\left(u_r,\delta\right)\right\}_{r\in\left\{1,\,2\right\}}$ is that there is no proof of that limits

$$\lim_{\delta\to\infty}h_r\left(u_r,\delta\right),\; r\in\left\{1,\,2\right\} \tag{79}$$

exist and they coincide with the players' genuine equilibrium strategies in the initial TSNCG (1). These demerits are nonetheless disregarded due to that the suggested dimension-dependent irregular samplings and MDM reshaping allow to solve TSNCG approximately [21, 22, 28] as BMG, controlling the approximation accurateness rank with λ-consistency. Clearly, checking consistency must be started from weak 1-consistency.

The proved items do have their merits. In order to sample PPF under conditions (15) and (16) from the hypercube (4) down to FHCIL $D^{\langle1\rangle}\times D^{\langle2\rangle}$, Theorem 1 determines the choice of the sampling numbers (14) and points (17). When $M\neq1$ or $N\neq1$, Theorem 2 allows mapping the finite TSNCG (12) on FHCIL $D^{\langle1\rangle}\times D^{\langle2\rangle}$ into BMG (31). Superfluous computations in checking weak 1-consistency are avoided with Theorem 3, allowing to check six inequalities instead of 10 inequalities. And Theorem 4 allows to complete checking λ-consistency of the weakly λ-consistent solution on four inequalities (75) — (77).

The suggested approximation of TSNCG (1) is fulfilled in three stages: PPF are sampled, the sampled PPF as MDM are mapped into ordinary flat matrices, and the solution of the corresponding BMG is checked out for its consistency. If the solution (32) is not even weakly 1-consistent, then the sampling numbers (14) should be increased. Partial increment (along some dimensions of the hypercube, but not all of them) is not excluded. If any increment is impossible then FHCIL (10) and (11) must be formed otherwise, accumulating the sets (8) and (9) with some new points (17). Generally, the suggested approximation tool is applicable to both unit-hypercubic infinite TSNCG and games which are isomorphic to unit-hypercubic infinite TSNCG [1, 29].

Further work will be focused on building an efficient sorter for solving the problems (50) — (53). The case with strict consistency, when every sign "greater than or equal" and every sign "less than or equal" appear "greater than" and "less than", ought to be thought over for possible

convergences in (78) and (79). And there are questions waiting for their answers:

1. Shall one player use its equilibrium FSS satisfying conditions of (weakly) λ-consistency if the other player's equilibrium FSS isn't (weakly) λ-consistent? Or if the other player's equilibrium FSS has lower rank of consistency, say, when it is (weakly) $(\lambda - 1)$-consistent?

2. Is it possible to determine (weak) λ-consistency of

the solution (32) if one player's equilibrium FSS satisfies conditions of (weakly) λ-consistency?

3. Are necessarily two different equilibrium situations in BMG λ-consistent if one of them is λ-consistent already?

These questions are motives for continuation of research of approximating infinite TSNCG. For noncooperative games, the suggested approximation approach of consistency is going to fit anywise.

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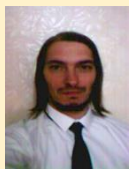
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Data decomposition for formation aggregation values of hypercube in multiprocessor parallel computing systems

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Abstract

In this paper possibilities of aggregational values calculation is considered. Aggregational values are the main element of multidimensional operative analytical processing. The main reason of using parallel computing systems in data processing is to increase productivity level. Although, parallel computing systems cannot be used in processing all data types. Data processing algorithms and processing data should be gradually adapted to parallel computing systems' usage. In this regard, data decomposition for formation aggregational values in parallel computing systems in data operative analyzing is considered in this paper. In order to identify dependence between data during the process of decomposition Bernstein's conditions are used. At the same time implemented course calculation of from 1-dimension to *n*-dimension and parallel computation of course interactions will also be considered.

Keywords: OLAP, multidimensional hypercube, aggregational values, parallel computing, decomposition

1 Introduction

Intensive development of information technologies and their wide range usage in all production spheres requires effective processing of large amounts of information. Accordingly, in order to increase productivity of large amounts of information processing effective multiprocessor parallel computing systems are suggested. Effective usage of high-performance parallel calculation systems requires to solve several important tasks. One of them is to make proved parallel algorithms and data that is being processed by parallel computation system.

Nowadays one of the main directions of information technologies which requires the large amounts of data processing with the help of high-performance computing systems is data operative analytical processing. OLAP (On-Line Analytical Processing) is created in order to perform operative analytical processing of data. This technology is created for working with large amounts of data sources and organizes analytical data as multidimensional hypercube and provides users with required data in the form of hypercube lays. One of the most crucial requirements of operative computation system at certain moment is to quickly calculate, formulate, suggest and store aggregational indexes in huge amounts of data sources. Summing of aggreagtional values is calculated as (sum), average value (avg), minimum value (min), maximum value (max) and e.g. Aggreagtional values size is much more less than original values, therefore request fulfillment of previously computed aggregation data would take less time. Accordingly, data bringing from aggregation increases the rate of demand. Previously computation of aggreagtional values in large amounts of data processing meets operative processing requirements.

Large size of data source which is used in analytical hypercube performance and high quantity of dimensions and dimensional elements which are used in processing, deriving possible aggregational summing require number of operation courses to be performed. In order to do these kind of processes in short time, parallel computations are used in multiprocessor systems. Parallel computing systems usage's opportunities in data operative processing with the help of OLAP are shown in workshops [1-3]. In these workshops decomposition by computation functions is considered. In processing of data parallel computation system data decomposition has to be used as well as decomposition by computation functions.

The main objective of given work is data decomposition for formation aggregational values which are the main element of multidimensional operative analytical processing in multiprocessor parallel computing systems.

2 Decomposition of aggregational values computing operators by data

In decomposition performance aggregation by summing of values and operators of summing would be considered. Summing algorithm and its operators are shown in source [5]. Division of atomic operation groups of independent values and independent operators in order to perform summing parallel is algorithm decomposition. Each of the atomic groups consist of internal groups dependent from each other: operation groups which cannot be used separately or operation groups which cannot be performed separately. Dependence between values and operations groups should be identified in order to divide them into atomic groups.

If large amounts of data is processed by certain atomic algorithm, these kind of data can be divided into separate divisions which can be processed independently from each other and processing would be performed by several performer (processor). Process results can be extracted in this way. That is called decomposition by data. Division for independent parts of numerical values produced by aggregational values in data decompositions will be discussed. The second type of decomposition is division of comuations (operations) through several performers and data identification of certain calculator. That is

called decomposition by computation functions. Decomposition, task division process not always have successful finish. For example, some algorithms work just by one performer (processor). It means that just data parallel processing of atomic divided groups or parallel processing of operations might be performed. Integration to one atomic group of data that cannot be processed separately and operation groups that cannot be performed separately is performed [4].

Fulfillment of certain task consists of activities set and action groups. Each action set can be divided into atomic activities group. If activities are to be parallel performed atomic groups will be performed in several performers simultaneously. In that case they are two performers (processors) in computation system. If output data is taken from input data with similar format at any moment in parallel computing, activities set will be determinant. In opposite way, if different output data is taken from different input data, activities group will be non-determinant. Parallel performance can be used if activities groups are determinant. Bernstein's conditions are used to identify whether program activities determinant or not. Let's try to identify aggregational values calculation determination with Bernstein's condition. Operator is the smallest atomic part of program which includes one or several operands in programming tasks or instructions.

2.1 BERNSTEIN'S CONDITION

They are input and output variableness in activities set of each program. Some activities set might not have such kind of variableness. If there is no any input variableness (data) in aggregational values calculation *NULL* value will be mentioned. Absence of input variableness means that hypercube aggregational values calculation by multidimensional index structure does not have original fact values.

Let's insert notes, activities set in program P, input variableness groups of activities set R(P), (borrowed from "read" in programming), output variableness groups of activities set W(P) (borrowed from "write" in programming). Bernstein's condition will be identified as following for P and Q activities sets [4]:
1) If intersection of W(P) and W(Q) is free group (Ø),
2) If intersection of W(P) and R(Q) is free group (Ø),
3) If intersection of R(P) and W(Q) is free group (Ø).
Performance of P and Q sets will be determinant.

Activities sets being as output data should not use just one variableness in 1-condition.

Variableness used as input data in certain activities sets at the same time should not be used as output data in another activities sets according to the 2 and 3 conditions.

If given conditions are performed P and Q activities sets are not connected with each other. That means atomic groups taken from P and Q activities set are not related. Internal groups of each of the atomic groups might be connected. Thus given sets would be parallel performed if Bernstein condition is enough to identify the determination of activities sets and if it is entirely performed. Certain atomic groups might not be determinant under activities sets consideration, values and operations groups, which are united in atomic groups might be also determinant to one another. Also several processes might be accessed to one atomic group while performance of parallel computing is

happening. Atomic operations groups might be performed separately without being crossed with each other, nevertheless several processes might be accessed to the one atomic data group as mutual resource. These all may create race condition connected with which of the processes accessed to data first which one did it second. In this regard, critical sections will be created in data parallel processing. Critical section is the result of race condition during the performance of program.

Consideration of Bernstein' condition identification of aggregational values computation operations' determination:
S_1, S_2, S_3, ..., S_n, S_{11}, S_{12}, S_{13}, ..., S_{1k_n}, ..., $S_{k_n-1k_n}$, ..., $S_{all_{111...1}}$, $S_{all_{111...2}}$, $S_{all_{111...3}}$, ..., $S_{all_{k_1k_2k_3...k_n}}$ - hypercube aggregational values computing operators. Accordingly, computing operators summing format (1-13 formula) [5]:

$$S_1 = \sum_{i=1}^{j_1} x_i[1], \tag{1}$$

$$S_2 = \sum_{i=1}^{j_2} x_i[2], \tag{2}$$

$$S_3 = \sum_{i=1}^{j_3} x_i[3], \tag{3}$$

$$S_n = \sum_{i=1}^{j_n} x_i[n], \tag{4}$$

$$S_{11} = \sum_{i=1}^{j_{11}} x_i[1][1], \tag{5}$$

$$S_{12} = \sum_{i=1}^{j_{12}} x_i[1][2], \tag{6}$$

$$S_{13} = \sum_{i=1}^{j_{13}} x_i[1][3], \tag{7}$$

$$S_{k_1k_2} = \sum_{i=1}^{j_{k_1k_2}} x_i[k_1][k_2], \tag{8}$$

$$S_{k_n-1k_n} = \sum_{i=1}^{j_{k_n-1k_n}} x_i[k_n-1][k_n], \tag{9}$$

$$S_{all_{111...1}} = \sum_{i=1}^{j_{111...1}} x_i[1][1][1]...[1], \tag{10}$$

$$S_{all_{111...2}} = \sum_{i=1}^{j_{111...2}} x_i[1][1][1]...[2], \tag{11}$$

$$S_{all_{111...3}} = \sum_{i=1}^{j_{111...3}} x_i[1][1][1]...[3], \tag{12}$$

$$S_{all_{k_1 k_2 k_3 \ldots k_n}} = \sum_{i=1}^{j_{k_1 k_2 k_3 \ldots k_n}} x_i[k_1][k_2][k_3]\ldots[k_n] \qquad (13)$$

Lower indexes of summing operators give aggregtional values from 1 and n-dimensional size. If indexes of operators have similar size, they can be dynamically interchanging performed. Dimensions are similar with quantity of dimension performed in lays. Intersection of input and output data of values computing operators can be identified by Bernstein' condition. In order to do this Bernstein' condition will be formulated on computing operators.

Operators are organized as determinant activities groups and they can be performed in pseudo parallel way. According to this, following $S_{all_{111\ldots1}}$, $S_{all_{111\ldots2}}$, $S_{all_{111\ldots3}}$, ..., $S_{all_{k_1 k_2 k_3 \ldots k_n}}$ - if we use original aggregational values compuating operators these operations will be performed dynamically interchanged way. All original aggregational values computing operators do not have connected output and input data. $S_{all_{111\ldots1}}$, $S_{all_{111\ldots2}}$, $S_{all_{111\ldots3}}$, ..., $S_{all_{k_1 k_2 k_3 \ldots k_n}}$ - operators set will be performed in program, but their parallel performance at the same time has to be considered from to point of Bernstein' condition.

There is no connection between all of operators and we can take any two of them in order to test them by Bernstein' condition because they are equal. If $S_{all_{111\ldots1}}$, $S_{all_{111\ldots2}}$ - if two operators are being performed dynamically one by one in (atomic actions set) program

– If the intersection of $W(S_{all_{111\ldots1}})$ and $W(S_{all_{111\ldots2}})$ is free group ($W(S_{all_{111\ldots1}}) \bigcap W(S_{all_{111\ldots2}}) = \varnothing$),

– If the intersection of $W(S_{all_{111\ldots1}})$ and $R(S_{all_{111\ldots2}})$ is free group ($W(S_{all_{111\ldots1}}) \bigcap R(S_{all_{111\ldots2}}) = \varnothing$),

– If the intersection of $R(S_{all_{111\ldots1}})$ and $W(S_{all_{111\ldots2}})$ is free group ($R(S_{all_{111\ldots1}}) \bigcap W(S_{all_{111\ldots2}}) = \varnothing$), operators $S_{all_{111\ldots1}}$, $S_{all_{111\ldots2}}$ might be performed at the same time in different processors in parallel computing system. This parallel computing is common for $S_{all_{111\ldots1}}$, $S_{all_{111\ldots2}}$, $S_{all_{111\ldots3}}$, ..., $S_{all_{k_1 k_2 k_3 \ldots k_n}}$ - all operators.

Disturbing consequence of Bernsten's condition in dynamically performed atomic sets $S_{all_{111\ldots1}}$, $S_{all_{111\ldots2}}$, $S_{all_{111\ldots3}}$, ..., $S_{all_{k_1 k_2 k_3 \ldots k_n}}$ - is considered [6]. Disturbing of the first Bernstein' condition for two operators of dynamically performed one by one program set $S_{all_{111\ldots1}}$, $S_{all_{111\ldots2}}$ is being considered.

– If the intersection of $W(S_{all_{111\ldots1}})$ and $W(S_{all_{111\ldots2}})$ is not free group ($W(S_{all_{111\ldots1}}) \bigcap W(S_{all_{111\ldots2}}) =$ is not free),

– If the intersection of $W(S_{all_{111\ldots1}})$ and $R(S_{all_{111\ldots2}})$ is free group ($W(S_{all_{111\ldots1}}) \bigcap R(S_{all_{111\ldots2}}) = \varphi$),

– If the intersection of $R(S_{all_{111\ldots1}})$ and $W(S_{all_{111\ldots2}})$ is free

group ($R(S_{all_{111\ldots1}}) \bigcap W(S_{all_{111\ldots2}}) = \varphi$),

Performance:

1) $S_{all_{111\ldots1}} = \sum\limits_{i=1}^{j_{111\ldots1}} x_i[1][1][1]\ldots[1]$

2) $S_{all_{111\ldots2}} = \sum\limits_{i=1}^{j_{111\ldots2}} x_i[1][1][1]\ldots[2]$

Case when output results is written down on one variableness. Entering output data into one variablness in program might is used to save the memory. By renaming the similar variableness of output data we can easily solve the problem. For example: $S_{all_{111\ldots1}}$ first output variableness is stayed untouched, accordingly the second one will be mentioned like this: $S_{all_{111\ldots2}}$. Nevertheless, while entering outgoing data into one variableness operators stay interdependent and this is called *output dependence*. Output data dependence will not hinder to perform the task in parallel way, but variableness should be renamed. This dependence is usually mentioned like this: $S_{all_{111\ldots1}} \sigma^o S_{all_{111\ldots2}}$, graphic type like this:
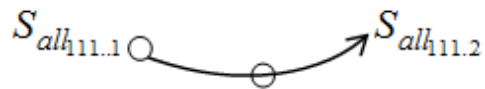

FIGURE 1 Output dependence

The next, disturbing of Bernstein's second condition for two operators (or operators group) $S_{all_{111\ldots1}}$, $S_{all_{111\ldots2}}$ of program set which is performed dynamically one by one is considered.

– If intersection of $W(S_{all_{111\ldots1}})$ and $W(S_{all_{111\ldots2}})$ is free group ($W(S_{all_{111\ldots1}}) \bigcap W(S_{all_{111\ldots2}}) = \varphi$),

– If intersection of $W(S_{all_{111\ldots1}})$ and $R(S_{all_{111\ldots2}})$ is not free group ($W(S_{all_{111\ldots1}}) \bigcap R(S_{all_{111\ldots2}}) =$ not free group),

– If intersection of $R(S_{all_{111\ldots1}})$ and $W(S_{all_{111\ldots2}})$ is free group ($R(S_{all_{111\ldots1}}) \bigcap W(S_{all_{111\ldots2}}) = \varphi$),

Performance:

1) $S_{all_{111\ldots1}} = \sum\limits_{i=1}^{j_{111\ldots1}} x_i[1][1][1]\ldots[1]$

2) $S_{all_{111\ldots2}} = S_{all_{111\ldots1}} + \sum\limits_{i=1}^{j_{111\ldots2}} x_i[1][1][1]\ldots[2]$

Result of $S_{all_{111\ldots1}}$ calculation will be used in $S_{all_{111\ldots2}}$ calculation. If given operators are performed dynamically one by one, they cannot be parallel performed. This kind of dependence is called flow dependence. Flow dependence mark accepted as following $S_{all_{111\ldots1}} \sigma S_{all_{111\ldots2}}$ and Figure 2 shows its graphic format.

FIGURE 2 Flow dependence

The next, disturbing of Bernstein's third condition for

two operators (or operators group) $S_{all_{111...1}}$, $S_{all_{111...2}}$ of program set which is performed dynamically one by one will be considered.

– If intersection of $W(S_{all_{111...1}})$ and $W(S_{all_{111...2}})$ is free group ($W(S_{all_{111...1}}) \bigcap W(S_{all_{111...2}}) = \varphi$),

– If intersection of $W(S_{all_{111...1}})$ and $R(S_{all_{111...2}})$ is free group ($W(S_{all_{111...1}}) \bigcap R(S_{all_{111...2}}) = \varphi$),

– ($R(S_{all_{111...1}}) \bigcap W(S_{all_{111...2}})$ = is not a free group),

Performance:

1) $S_{all_{111...1}} = \sum_{i=1}^{j_{111...1}} x_i[1][1][1]...[1] + S_{all_{111...2}}$

2) $S_{all_{111...2}} = \sum_{i=1}^{j_{111...2}} x_i[1][1][1]...[2]$

Result of $S_{all_{111...1}}$ calculation will be used in $S_{all_{111...2}}$ calculation, $S_{all_{111...2}}$ value will be identified in following calculation. If aggregational values are calculated first time and operators $S_{all_{111...1}}$, $S_{all_{111...2}}$ are performed in set in one performer, in calculation $S_{all_{111...1}}$ value of $S_{all_{111...2}}$ will be equal to 0. In following calculations value of $S_{all_{111...2}}$ value which is taken from one iteration will be used.

If operators $S_{all_{111...1}}$ and $S_{all_{111...2}}$ calculation is performed in different performers, operator $S_{all_{111...1}}$ use the one iteration earlier value of operator $S_{all_{111...2}}$ and in that case parallel performance can be entirely completed. Before using hyppercube formation aggreagtional values taken from atomic activities $S_{all_{111...1}}$, $S_{all_{111...2}}$, $S_{all_{111...3}}$,...., $S_{all_{k_2k_3...k_n}}$ will be equal to 0. Values taken from atomic activities will be identified after each iteration process ends and after iteration all values will be distributed to performers then will be copied to their local memory. Parallel computing will be continued after all this operations end. This type of dependence is called antidependence. Antidependence mark is accepted as following $S_{all_{111...1}} \sigma^{-1} S_{all_{111...2}}$ its graphic format is following (Figure 3):

FIGURE 3 Antidependence

Other types of dependence are used in set program parallel performance except the ones which are mentioned above. They are: connected with condition, by recursion and etc.

2.2 CYCLIC OPERATIONS AND THEIR PARALLEL PERFORMANCE IN CALCULATION OF AGGRE-GATIONAL VALUES HYPERCUBE

Large amounts of data processing perform consistently in number of program. It is the main reason of careful attention on set program parallel performance by data. In aggregational values calculation structure which is characterized above is basically performed in format of massive. Massive should be divided into parts which are processed separately by certain users in parallel performance by data. In massive processing courses are used. It means that courses impact on courses parallel performance of dependence and data massive dependence should be identified.

One simple dimensional and multidimensional completed courses are used in aggregational data calculation. By accordance of indexes taken from original fact data summing of values jointed in one massive are performed like one dimensional loop. All original aggregational values will be jointed into one dimensional massive and processing will be performed by one dimensional course. In formation of certain hypercube loop quantity performed in calculation of original aggregational values is equal to multiplication of all dimensions elements of hypercube or it might be less than them $N_r \leq k_1 \times k_2 \times k_3 \times ... \times k_n$. All one dimensional loops are free from each other. It was discussed above and they can be performed dynamically divided into processors. But iterations of loops might be interdependent. Calculation of original aggreagtional values operators by joining all aggregational values into same multidimensional indexes $S_{all_{111...1}}$, $S_{all_{111...2}}$, $S_{all_{111...3}}$,..., $S_{all_{k_1k_2k_3...k_n}}$ is considered:

1) for (int i = 1; i ≤ $j_{111...1}$; i++)
2) {
3) S_1 : $S_{all_{111...1}} = S_{all_{111...1}}_{i-1} + x_i$;
4) }

For parallel performance of given loop its iterations should be divided into independent parts. In order to identify dependence between iterations loop is considered:

1) S_1^1 : $S_{all_{111...1}}^1 = S_{all_{111...1}} + x_1$;

2) S_1^2 : $S_{all_{111...1}}^2 = S_{all_{111...1}}^1 + x_2$;

3) S_1^3 : $S_{all_{111...1}}^3 = S_{all_{111...1}}^2 + x_3$;

4)....

5) $S_1^{j_{111...1}}$: $S_{all_{111...1}}^{j_{111...1}} = S_{all_{111...1}}^{j_{111...1} +} + x_{j_{111...1}}$;

Operator $S_{all_{111...1}}$ - $S_{a_{l_1 l_{1_{i-1}}}}$ which is calculated one iteration before as incoming value and iteration step value x_i will be considered in each iteration. Marking S_k^i in loop iteration i operator S_k (or operator S_{all_k}) are using for reincarnation. Set operators group data independence can be processed in open loop. Dependence by output data can be easily sorted by renaming variableness. It is mentioned above. Our next step is identification of dependence of input data in loops. If value $S_{all_{111...1}}^i$ is used as output data in one loop iteration in aggregational values calculation it is also used as input data. It shows that dependence which performs summing operations exists in course iteration. If loop

iterations are performed by certain users, Bernstein's condition disturbing will be noted. Input data dependence performance is considered. If iteration variableness values are " $j_{111...1}$ ", λ and κ and if they are equal to $1 \leq \lambda \leq j_{111...1}$, $1 \leq \kappa \leq j_{111...1}$ source of dependence will be the following S_1^{κ} ($S_{all_{111...1}}^{\kappa}$) (massive element – as output variableness), S_1^{λ} ($S_{all_{111...1}}^{\lambda}$) – sink of dependence (massive element – as input variableness). Therefore value $D = \lambda - \kappa$ is being calculated. This value is considered as loop dependence distance [4].

Loop parallel needs the dependence distance to analyzing and division. Dependence distance value gives the opportunity to identify type of dependence between data for performers and to divide iteration space into independent parts.

Dependence distance is identified to given loop iteration parallel performance. For example, iterations S_1^2 and S_1^3 use value $S_{all_{111...1}}^2$. This value is output variableness of iteration S_1^2, source of dependence, but in iteration S_1^3 – it is considered as input variableness, or sink of dependence. Accordingly, $\lambda = 3$, $\kappa = 2$. Dependence distance is $D = \lambda - \kappa = 1$.

If dependence distance is equal to $D > 0$, flow dependence will take place between course iterations. If it is equal to $D > 1$ course will be parallel performed in processors not more than D.

If dependence distance is equal to $D < 0$, antidependence will take place between loop iterations. If course iteration performance has required before input data is copied into performers, each iteration of loop can be performed in parallel performance.

If dependence distance is equal to $D = 0$, dependence between courses will not be identified. Each of iteration of loop makes parallel performance to performers.

It is known that several dimensions are used in hypercube. Multidimensional hypercube is given in the form of multi-dimensional massive, implemented loop types are used in program processing of multidimensional data massive. Implemented loops might consist 2 or more internal loops. Internal loops quantity in aggregational values calculation which are used in each of the implemented loops are connected with dimension quantity in hypercube lays production. Implemented loop for n-dimensional hypercube is considered:

```
1: for ( int i_1 = 1; i ≤ k_1 ; i_1 ++ ) {
2: for ( int i_2 = 1; i ≤ k_2 ; i_2 ++) {
3: for ( int i_3 = 1; i ≤ k_3 ; i_3 ++) {
4: ...
5: for ( int i_n = 1; i ≤ k_n ; i_n ++) {
```

$$6: S_{all_{row}}^{i_1 i_2 i_3 ... i_n} = S_{all_{row}}^{i_1 i_2 i_3 ... i_n - 1} + x[i_1][i_2][i_3]...[i_n];$$

$$7: S_{all_{col}}^{i_n ... i_3 i_2 i_1} = S_{all_{col}}^{i_n ... i_3 i_2 i_1 - 1} + x[i_n]...[i_3][i_2][i_1];$$

```
8: }
9: }
10: }
11: }
```

Each of iterations in n-dimensional implemented loop are identified by all value group i_1 , i_2 , i_3 ,..., i_n of calculators. Value group of calculators which is used in each of the iteration is called n-dimensional vector $I = (i_1, i_2, i_3 ,..., i_n)$, iterational vector. All value groups in iterational vector form iterational space. We can observe the relations order between vectors in iterational space. If $\forall k$, $1 \leq k \leq n$ and $i_k = j_k$, it means that $I = J$, also $\exists s$ $1 \leq s \leq n$, $\forall k$ $1 \leq k \leq s$ and if $i_s < j_s$ is I < J [4, 5].

Space coordination is defined by iterational vectors when hypercube data is offered in multidimensional space. According to multidimensional index structure one aggreagtional value is given to each iteration vector. They are two operators in given loop: for aggreagtional calculation by line and column. In operators calculation process output variableness taken from one course ($S_{all_{row}}^{i_1 i_2 i_3 ... i_n}$) is used as input variableness in next course ($S_{all_{row}}^{i_1 i_2 i_3 ... i_n - 1}$). Disturbing of Bernstein'conditions is shown in this situation. Also, when iterational vectors x[i_1][i_2][i_3]...[i_n] and x [i_n]...[i_3][i_2][i_1] are brought out, they will have common values. It means, operators $S_{all_{row}}^{i_1 i_2 i_3 ... i_n}$ and $S_{all_{col}}^{i_n ... i_3 i_2 i_1}$ are inter-sected by input data, although while using appropriate there is no any order in vectors accessing and no race condition occasion, that is why there is no any interference from iterational vectors in parallel performance. The main task is to divide iteration vectors into private parts in parallel calculation performance. We have to identify dependence distance which is mentioned above, in order to make it in real. Dependence distance for multidimensional courses will be implemented by appropriate indicators of one dimen-sional courses dependence distance. It is called dependence distance of vectors: $D = \Lambda - K$. For each iterational variableness vector following conditions $(1,1,1,...,1) \leq K \leq (k_1, k_2, k_3 ,..., k_n)$, $(1,1,1,...,1) \leq \Lambda \leq (k_1, k_2, k_3 ,..., k_n)$ stay unchangeable.

Hypercube lays are usually taken by two dimensions. Parallel performance opportunities in aggreagtional values calculation which are taken from dimensional elements belonged to each of lays calculation of aggreagtional values in line and column by multidimensional loop are considered. Next, dependence distance of vectors will be defined by two dimensional loops.

```
1: for ( int i_1 = 1; i ≤ k_1 ; i_1 ++ ) {
2: for ( int i_2 = 1; i ≤ k_2 ; i_2 ++) {
```

$$3: S_{all_{row}}^{i_1 i_2} = S_{all_{row}}^{i_1 i_2 - 1} + x[i_1][i_2];$$

$$4: S_{all_{col}}^{i_2 i_1} = S_{all_{col}}^{i_2 i_1 - 1} + x[i_2][i_1];$$

```
5: }
6: }
```

Loop steps are specified in order to identify dependence distance of vectors:

1: $S^{11}_{all_{row}} = S^{11-1}_{all_{row}} + \text{x}[1][1];$

2: $S^{11}_{all_{col}} = S^{11-1}_{all_{col}} + \text{x}[1][1];$

3: $S^{12}_{all_{row}} = S^{11}_{all_{row}} + \text{x}[1][2];$

4: $S^{21}_{all_{col}} = S^{11}_{all_{col}} + \text{x}[2][1];$

5: $S^{13}_{all_{row}} = S^{12}_{all_{row}} + \text{x}[1][3];$

6: $S^{31}_{all_{col}} = S^{21}_{all_{col}} + \text{x}[3][1];$

7: ...

8: $S^{21}_{all_{row}} = S^{21-1}_{all_{row}} + \text{x}[2][1];$

9: $S^{12}_{all_{col}} = S^{12-1}_{all_{col}} + \text{x}[1][2];$

10: $S^{22}_{all_{row}} = S^{21}_{all_{row}} + \text{x}[2][2];$

11: $S^{22}_{all_{col}} = S^{12-1}_{all_{col}} + \text{x}[2][2];$

12: ...

We will identify dependence distance between vectors in order to parallel performance of iteration of given multidimensional course. For example, $I = (1,2)$ and $I = (1,3)$ – vector iterations use $S^{12}_{all_{row}}$ value. This value is output variableness in vector iteration *(1,2)*, dependence source, input variableness in vector iteration*(1,3)* is used as dependence sink. Accordingly, $\Lambda = (1,3)$, $K = (1,2)$. Dependence distance is $D = (0,1)$. Identification of dependence by data and parallel performance by distance of vectors is complicated issue. To find the solution to this issue, we use vector direction. [В.Е. Карпов. Введение в распараллеливание алгоритмов и программ]. Identification of vector directions *d* as following:

$$d_i = \begin{cases} " = ", D_i = 0; \\ " > ", D_i < 0; \\ " < ", D_i > 0. \end{cases} \qquad (14)$$

Vector direction $d = ("=","<")$ is identified by given two dimensional loops [4]. Data dependence might be identified by vector directions. First one is suggested like output value, then it is used as input value in the next iteration of the loop, after all it is jointed to massive element. It is called fact dependence. If the internal course is suggested like whole operator, all dependences will be stayed in this operator, then

parallel performance could be handled by external course iterations. Parallel performance cannot be completed by internal loop and two loops in that case of dependence. If we change internal and external operators and leave calculation unchangeably, dependence distance of vector will be $D = (1,0)$, vector direction will be $d = ("<","=")$. Type of dependence stays without change. In this situation parallel performance by internal loop might be completed. Data dependence by multidimensional loop vector directions types is identified, parallel dependence might be performed by identified dependence.

If multidimensional loop structure consists of vector directions elements "<" and "=". This kind of course can be parallel performed by index number which is appropriate to vector direction component "=" without any limitation. Parallel performance by vector direction component appropriate to index may cause some problems. If multidimensional loop structure consists of vector directions elements ">" and "=". This kind of course can be parallel performed by index number which is appropriate to vector direction component "=" without any limitation. In parallel performance by appropriate indexes to vector direction component ">" input data movement might be required. Before course parallel performance implementation of original structure might be placed in appropriate save places.

If vector direction taken from multidimensional course is $d = ("=",...,"=")$, it will be *loop independent dependence* and dependence type is fact dependence. Parallel performance might be completed by any component of iterational vector. Parallel performance can be completed by changing of implemented course levels.

3 Conclusions

In this paper data decomposition formulation for aggregational values in high-performance parallel computing systems is suggested. Aggregational values are based on data operative analytical analyzing. When decomposition ends algorithm will introduce groups consisted of operations (activities) which are performed by several processors. Group operations brought via decomposition might be performed independently through certain processor. Different operations might be held in each of the group and they can be performed by different user. Parallel performance of implemented courses iteration which is used in program performance of multidimensional data processing is also considered.

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Models and algorithms of testing software on the basis of the basic spesifications

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Abstract

This article discusses the study of software reliability. Define the concept of software reliability. Examines existing software reliability models and their classification. The main stages of the software life cycle.

Keywords: method of proving the correctness of programs, test method for diagnosis, methods of structured programming, reliability of software, testing, verification, validations

1 Introduction

Software reliability issues typically involved only after the completion of software development. This leads to a chronic imbalance in the operation of applications. The survey revealed that most of the errors made during the design phase. Research in the field of software development have formed a set of methods, processes, technologies, models, the use of which allows to achieve specified performance reliability and quality of software. Research on how to improve the reliability of software, showed that the quality assurance and reliability should be given consideration at all stages of the development process. To improve the reliability of software research include methods such as - a method of proving the correctness of programs, methods of test for diagnosis, as well as methods of structured programming [1].

2 Overview of the study area

The main component of the quality of the software is its reliability. *Software reliability* is defined as the ability of the program to operate smoothly certain period of time under certain conditions. *Model of software reliability* - a detailed, formalized definition of reliability. Nowadays developed hundreds of models of software reliability, taking into account the different types of programs and their applications, but there is no common, universal model, applicable to any program. In general, software reliability models are divided into the following groups: **predicting, measuring and evaluation**. These differences are determined at what stage of the life cycle of the program they are used and for what purposes serve. In its turn predictive models include the following: [2]

1. model of Halstead,
2. model of Motley-Brooks.

Measuring models include the following:

1. model without calculation errors,
2. model with calculation errors.

Estimated models are:

1. Moussa model (selection of the data area),
2. model of error's seeding

Most of the developed models of software reliability are based on various assumptions, which seriously limit the scope of their application. In such a situation, model of based on a probabilistic approach more broadly applicable, but the practical value of their use is not great.

3 Adopting relevant technology

Based on the experience of technical diagnostics, developing a model of software reliability, consisting of the basic model, which is the result of the study of a software system, and the diagnostic model, which is constructed on the basis of the base and focused on the the process of ensuring software reliability.

The process of ensuring software reliability should be applied at all stages of the life cycle of programs. Depending on the stage of implementation such a process will vary.

Considering the stages of the software life cycle in terms of features ensure reliable software product produced by each of them.
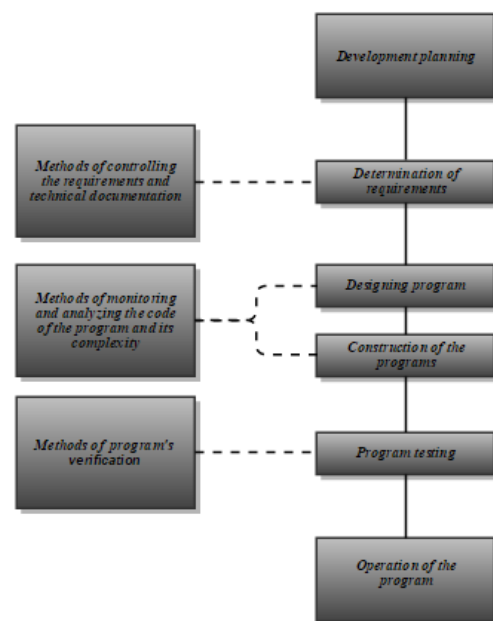

FIGURE 1 The main stages of the software life cycle

Software development process (Figure 1) consists of the following stages:

- planning program development;
- determination of requirements for developing program;
- designing architecture and interfaces;
- construction of (coding) program;
- program testing;
- operation of the program.

Each stage corresponds to its own specific methods and tools for monitoring and ensuring the reliability of the software, as well as the strata of the program description.

Core business of reliability software on the determining step is the *validation* requirements (certification) and *verification* requirements generated.

Core business of reliability software to the software design phase is to *analyze the quality* and *assessment of the program design*.

At the construction stage (coding) software to create a working software product through a combination of coding, verification, unit testing, integration testing, and debugging.

One of the methods of quantify the program code is a code block count code. *Block of code* - is an indivisible sequence of statements executed one after the other.

During the testing phase of software products is subject to various checks compliance behavior of the functions of the working copy of the program specifications as defined in the previous stages of the software life cycle.

4 Testing, verification and validation - differences in terms

Despite the apparent similarity of the terms "*test*", "*verification*" and "*validation*" means different levels of validation work of a software system. To avoid further confusion, clearly define these concepts. (Figure 2)

Software Testing - view of the design associated with the implementation of procedures aimed at the detection of (evidence of) errors (inconsistencies, incompleteness, ambiguity, etc.) in the current definition of the developed software system. The testing process is primarily to verify the correctness of a software implementation of the system, the implementation of compliance requirements, ie, testing - it manages the execution of the program in order to detect inconsistencies of her behavior and requirements.

Software verification - a more general concept than testing. The purpose of verification is to achieve assurance that a verification object (or code requirements) meets the requirements implemented without unintended funktsy and meets design specifications and standards. Verifikatsii process includes inspection, testing, code analysis of test results, the formation and analysis of reports about problems. Thus, it is assumed that the testing process is an integral part of the verification process.

Validation of a software system - a process whose goal is to prove that as a result of the development of the system, we have achieved the goals that were planning to reach thanks to its use. In other words, validation - is to check compliance of the customer's expectations.
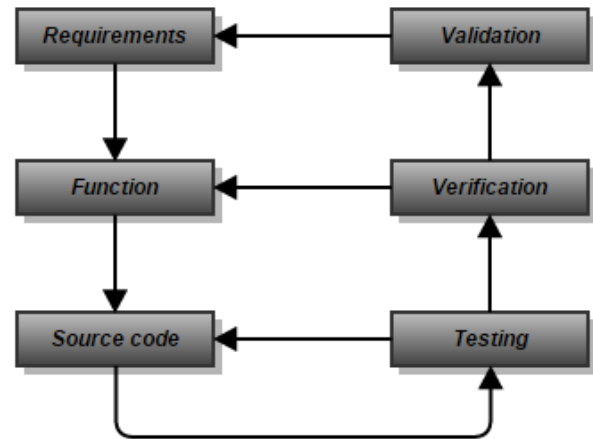

FIGURE 2 Testing, verification and validation

5 Verification

Verification - is the process of determining whether a software tools and components requirements imposed on them in the successive stages of the life cycle of a software system developed.

The main purpose of verification is to confirm that the software meets the requirements. An additional objective is the identification and registration of defects and errors that are made during the development or modification of the program.

Verification is an integral part of the work under the collective development of software systems. In this case, the verification task includes monitoring the results of some developers to transfer them as input to other developers.

To improve the utilization of human resources in the development, verification should be closely integrated with the design, development and maintenance of software systems.

In advance to distinguish between verification and debugging. Both of these processes are aimed at reducing errors in the final software product, but debugging - a process aimed at finding and eliminating errors in the system, and verification - a process aimed at demonstrating the presence of errors and the conditions of their occurrence.

Furthermore, verification - controlled and controllable process. Verification includes an analysis of the causes and consequences of errors that will cause them to fix, planning processes, find errors and their correction, evaluation of the results. All this suggests the verification as a process to ensure a predetermined level of quality in the delivery of a software system.

First, consider the purpose of verification. The main objective of the process - proof that the result meets the design requirements placed thereon. Typically, the verification process is carried out from top to bottom, starting from the general requirements specified in the terms of reference and / or specifications for an information system to all the detailed requirements on the software modules and their interactions. The structure of the tasks of the process includes consistent verification that a software:

- the general requirements for an information system designed for software implementation, correctly processed into high-level requirements specification for complex applications that match the original system requirements;

- high-level requirements correctly processed in software architecture and specification requirements to the functional components of a low level that meet the requirements of a high level;
- specification of requirements for software functional components located between the components of high and low level, meet the requirements of a higher level;
- Software architecture and requirements for low-level components correctly processed in satisfying their source software and information modules;
- source code and the corresponding executable code does not contain errors.

In addition, verification of compliance requirements specification for a specific project software tools are subject to the requirements for technological support lifecycle, as well as requirements for operational and technical documentation.

Purpose software verification are achieved by a combination of sequential execution of inspections of project documentation and analysis of their results, the development of test plans, test and test requirements, test cases and procedures, and follow these procedures. Test scenarios are used to verify internal consistency and completeness of the implementation of the requirements. Run the test procedures shall ensure compliance demonstration test program source requirements.

The choice of effective methods of verification and consistency of their application to the greatest extent influenced by the basic characteristics of the test objects:

- Class set of programs determined by the depth of his connection with the operation of real-time and random effects from the external environment, as well as requirements for the quality of information processing and reliability;
- the complexity or scale (size, dimensions) complex programs and its functional components, is the end result of development;
- prevailing in the program: calculates complex expressions and conversion of measured values or processing logic and character data for the preparation and display solutions.

Defining some concepts and definitions related to the testing process, as part of the verification. Myers gives the following definitions of key terms [3]:

- *Testing* - the process of implementation of the program in order to detect errors.
- *Test data* - inputs that are used to test the system.
- *Test situation (test case)* - Inputs to test the system and the expected outputs, depending on the inputs if the system operates in accordance with its requirements specification.
- *A good test situation* - a situation that has a high probability of detection is still undetected error.
- *A successful test* - a test that detects undetected errors.
- *Error* - programmer action at the design stage, which leads to the fact that the software contains internal defects in the process that the program can lead to incorrect results.
- *Denial* - the unpredictable behavior of the system, leading to unexpected results, which could be caused by defects contained in the system.

Thus, in the process of software testing, as a rule, checking the following:

- To verify that the software meets the requirements for it;
- Verifying that in situations that are not reflected in the requirements, the software behaves adequately, that is not the case of system failure;
- Checking software for common mistakes that make programmers.

6 The life cycle of software development

Collective development, unlike the individual requires careful planning of works and their distribution during the creation of a software system. One way to work is to break the process of developing into separate successive stages, after the passing of which the final product is obtained or a portion thereof. These stages are called software development life cycle of the system. As a rule, the life cycle begins with the formation of a common understanding of the system being developed, and their formalization in the form of a top-level requirements. Completed development life-cycle system start-up. However, it should be understood that the development - just one of the processes associated with the software system, which also has its own life cycle. In contrast to the system development life cycle, life cycle of the system itself ends with the conclusion of its operation and termination of its use.

Software lifecycle - a set of iterative procedures associated with consistent changes in the state of software from the formation of reference to it before the end of its use by the end user.

6.1 THE LIFE CYCLE MODELS

Any stage of the life cycle has a clearly defined start and end criteria. The composition of the phases of the life cycle, as well as the criteria ultimately determine the sequence of stages of the life cycle is determined by a team of developers and / or customer. Currently, there are a few basic life cycle models that can be adapted to real development.

Systems development life cycle (sometimes called a waterfall) is based on a gradual increase in the level of detail describing the whole system being developed. Each increase in the level of detail defines the transition to the next state of development (Figure 3).

V-model of life cycle – as a kind of "work on the bugs" classical cascade model has been applied life cycle model, containing two types of processes - the basic processes of development, similar to the cascade model and verification processes, representing a feedback loop with respect to the basic processes (Figure 4).

Spiral model development system is repeating steps - spirals. Each turn of the spiral - a cascade or V-shaped life cycle. At the end of each turn is obtained a complete version of the system that implements a set of functions. Presented to the user for the next round of transferred all documentation developed at the turn of the previous, and the process repeats.

Thus, the system is developed gradually through constant coordination with the customer. At each turn of the spiral system functionality expands gradually grow to the full.

Life cycle of extreme approach - the maximum shortening of the duration of one stage of the life cycle and close interaction with the customer. In fact, at each stage, the implementation and testing of a system function, which upon completion, the system immediately delivered to the

customer for checking or service.

The main problem with this approach - the interfaces between the modules that implement this feature. If all previous types of life cycle interface is clearly defined at the beginning of development, as are known in advance all the modules, then the extreme approach designed interfaces "on the fly" with the developed modules.

7 Conclusions

Developing basic pattern and diagnostic software has wider

application as compared with existing models. This allows their use in the production cycle of any software, regardless of the model used by the software life cycle and software engineering.

Achieving this goal work the following tasks:
- analysis of existing models of software reliability for the possibility of their use in real production processes;
- development of stratified (base) model software;
- development of diagnostic model of software;
- creation of automated tests to verify the proper functioning of its program specifications.

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Mathematical and Computer Modelling

Approximation of unit-hypercubic infinite two-sided noncooperative game via dimension-dependent irregular samplings and reshaping the multidimensional payoff matrices into flat matrices for solving the corresponding bimatrix game

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The problem of solving unit-hypercubic infinite two-sided noncooperative games is considered. The ultimate goal is to approximate the infinite game with bimatrix game, ranking the approximation accurateness. This is fulfilled in three stages. Primarily the players' payoff functions are sampled under stated conditions of dimension-dependent irregular samplings. Then the sampled payoff functions as multidimensional payoff matrices are mapped into ordinary flat matrices under a reversible matrix map. Finally, after obtaining the solution of the corresponding bimatrix game, equilibrium finite support strategies are checked out for their consistency, being used as the approximation accurateness rank. If consistent, then the bimatrix game can be regarded as the approximation of the initial noncooperative game. For particular cases, conditions of the weakened consistency are stipulated. Different types of consistency ensure the corresponding bimatrix game solution varying reasonably by changing the sampling steps minimally. If the solution is not even weakly consistent by the most primitive consistency in ranking the approximation accurateness, then the sampling intervals should be shortened. If any shortening is impossible then the sampling points must be set otherwise. The suggested approximation tool is fully applicable to games, which are isomorphic to the unit-hypercubic infinite two-sided noncooperative game.

Keywords: two-sided noncooperative games, unit hypercube, approximation, irregular sampling, bimatrix game, multidimensional matrix, equilibrium finite support strategy, approximate solution, equilibrium solution consistency

Data decomposition for formation aggregation values of hypercube in multiprocessor parallel computing systems

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In this paper possibilities of aggregational values calculation is considered. Aggregational values are the main element of multidimensional operative analytical processing. The main reason of using parallel computing systems in data processing is to increase productivity level. Although, parallel computing systems cannot be used in processing all data types. Data processing algorithms and processing data should be gradually adapted to parallel computing systems' usage. In this regard, data decomposition for formation aggregational values in parallel computing systems in data operative analyzing is considered in this paper. In order to identify dependence between data during the process of decomposition Bernstein's conditions are used. At the same time implemented course calculation of from 1-dimension to n-dimension and parallel computation of course interactions will also be considered.

Keywords: OLAP, multidimensional hypercube, aggregational values, parallel computing, decomposition

Models and algorithms of testing software on the basis of the basic specifications

G I Khassenova, S T Amanzholova, N G Khaimuldin

*Computer Modelling & New Technologies 2015 **19**(3A) 24-27*

This article discusses the study of software reliability. Define the concept of software reliability. Examines existing software reliability models and their classification. The main stages of the software life cycle.

Keywords: method of proving the correctness of programs, test method for diagnosis, methods of structured programming, reliability of software, testing, verification, validations

Content B

Research on digital resources integration model in cloud computing environment

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Abstract

This article analyzed the present situation of digital resources integration, expound the content and methods of the digital resources integration, focused on related digital resources integration theory for cloud computing environment, combined with the characteristics of cloud computing, and proposed the application and improvement of the digital resources integration based on cloud computing technology.

Keywords: Cloud Computing, Digital Resources, Resources Integration.

1 Introduction

Before the arising of digital carrier, paper carrier was as the information carrier, supplemented by miniature carrier, laser carrier and carrier magnetic carrier such as a variety of compatible with each other and form a stable structure. Along with the formation of the digital and network environment, digital information has gradually become the mainstream media, information transmission and digital resources organization also became a main research direction in the field of information management and the work content.

According to IDC, also named International Data Corporation. In March 2013, the latest digital universal research report named "Big Data, larger number of figure, the largest growth was in the far east [1]". As the universal application of personal computers, smart phones and other devices and ever growing internet traffic in emerging market, It made the digital universe doubled its quantity within the last two years, an astounding 2.8ZB. IDC predicted that the digital universe would develop with the double the speed every year. Each person would have the possession of 5,247 GB of data on earth, and the digital universe scale would reach 40 ZB till 2020.

Rapid development of digital information, the popularization of 3G and the development of wireless network, had inspired the enthusiasm of using digital information resources through the network. China Internet network information center (CNNIC) issued its 34th report China internet network development state statistic report [2] on July 21, 2014. Up to June 2014, there were 632 million internet users, and Internet penetration rate was 46.9%. Internet development focus shifted from "extensive" to "depth" transformation, various network application profoundly changed Internet life.

The above information indicated that the explosive growth of the digital universe had become the mainstream of the information resources and a variety of heterogeneous digital information. Digital resources presented a partial order, but the overall state was disorder. The application and popularity of cloud computing technology and intelligent terminal had fundamental change of behavior and method to obtain knowledge. The network, especially in wireless networks became the important channel for people to seek for information and knowledge. But digital resource isolated island and digital resources overloads had become the two serious factors to hinder the application of effective digital resources. Cloud computing technology brought new opportunity to digital resources. How to make full use of cloud computing technology to improve the use efficiency of digital resources. To effectively integrate and reorganize the large number of heterogeneous digital resources were the serious problem to solve the current digital resources integration process.

2 Digital resources and digital resources integration

Digital information had become the mainstream of information transferring media, Information resources had a fundamental change ether from the production, storage, or transport and use of digital resources organization. The digital resources organization had become the main research direction and work content in the field of information management.

2.1 DIGITAL RESOURCES AND FEATURES

Digital resources was information resources in the form of digital distribution, processing, through the network access, transfer and the sum of the development and u utilization of information.

In the form of digital distribution, processing, through the network access, transfer and the sum of the development and utilization of information resources is known as digital resources, digital resources includes both traditional information resources digitization, also included the direct production of digital information in digital way. The digital information resources was also the information integration, ordering and facilitation, including text, charts, graphs, images, audio, video, etc. all digital media literature. In the network environment, only the digital information could be the available information for users, the network environment was digital information production, dissemination and use of the main occasions. Digital resources was way of production, distribution, access, transfer and utilization of literature was totally different with traditional carrier, it had a high degree of sharing and partial order, the diversity of types and main

characteristics such as dynamic resources. These characteristics of its organization and integration of digital information put forward the higher request, as the method and technology in digital resources integration and significant changes had taken place in the management model.

2.2 DIGITAL RESOURCES INTEGRATION

Digital resources integration was based on user needs as the guidance, based on the property characteristics of digital resources, according to certain principles and methods. Using the integration technology gathered scattered disorderly, relatively independent heterogeneous resources system integration, and through the technology and methods of knowledge organization, would be the integration of various information resources type, specification and scientifically integration and reorganization, and made its reorganizing a new organic whole, to form a better, more efficient new system of digital resources, in order to offer convenient, fast and efficient [3].

In a cloud environment of digital resource integration would not only concentrated the distributed heterogeneous resources, more important is to the content of the digital resources features and external for ordering and reveal, at the same time, description of the relationship between the digital resources would automate clustering and classification of digital resources and convenient user get on-demand, easy extension information and resources. Secondly, through the virtualization technology integration, a variety of digital resources integration, and the transition of disordered information flow becoming to the orderly flow of information, made the formation of more advanced information products and promote the development process each link of sharing resources, complemented each other, together to create value. Finally, for the integration of information resources indexing information resource cloud formation has greatly helped knowledge service model in digital information resources indexing the transparent interface to provide users with on-demand access to information resources of knowledge service.

2.3 BASIC CONTENT OF DIGITAL RESOURCES INTEGRATION

From different fields of the study concept of digital resource integration, and based on the research field of digital resources integration of the scholars were also different. In a broad sense, the the digital resources integration contented the digital resources optimization selection, analysis, describe and reveal, sorting and storage. The basic preparation of resources integration was selection and analysis of digital information, and its central content was the digital information resources described and reveal and orderly.

Preparation is the basis of resource integration selection and analysis of digital information, is the central content of digital information resources is described and reveal and ordering. And several links of former formed orderly collection of information storage, represented the basic completion of the process of digital resources integration.

2.3.1 Optimal selection of digital resources

Optimal selection was the first step of digital resources integration, and was found in the vast network of digital information ocean and been confirmed to have the function of organizing, sorting out and saving the value information. Due to the digital resources was easy to generate, distribute, reproduce and transmit, in the information generation stage, and the lack of a perfect choice, evaluation system, so the quality and value of digital information was uneven. Therefore, to integrate the digital information could improve the quality of information resources and optimizing choice.

2.3.2 The analysis of the digital resources

Analysis of digital resources was according to certain logical relations, from the semantics, pragmatics and grammar for selection of digital resources, processing and finishing, through calculation, analysis, comparison research, It could create more and more resources and could reveal essence content of activity. It was the premise and foundation of digital resource description and reveal, and one of the indispensable important part of digital resources integration, has a direct impact on the quality of the digital resources integration has a direct impact. Through the analysis and research of digital resources, digital resources had more valuable to use and practical significance.

2.3.3 The description of the digital resources and revealed

Information description and reveal referred to the needs of digital resource integration and information retrieval, the information of the subject content, the form characteristics, such as morphological analysis, selection, record the activities. Information describing was mainly for the description of external characteristic; The content of the information disclosing information revealed the main characteristics. Information description and reveals were the important content of information organization, played an important role in information organization.

2.3.4 Collection and storage of digital resources

Storage of digital resources was arranging the sequence of information and could be processed according to certain order format and stored in a specific carrier, its purpose was to managers and users of digital resources quickly and accurately identify, locate and retrieve information, cd-rom retrieval system, network information retrieval tools was the manner in which information stored. When the information was stored in various retrieval tools meant the end of the process of information organization, also meant the beginning of the information retrieval and information services.

Integration was the optimization of heterogeneous normative and non-normative resources combination, and the creative process of integration and reorganization of resources. Its purpose was to the overall improvement, structure and function of the integrated system, enabled the system to produce digital resources to maximize the function and efficiency. Digital resources integration has the automation, content integration and technical features diversification. As

a comprehensive and systematic project, in the implementation of the digital resources integration should follow the principles of integrity, continuity, hierarchy, targeted.

3 Coulding computing technology

Through the Internet, cloud computing provided the dynamic, expandable and virtualization of resources, was the increase of the related services based on Internet, use and delivery mode [4]. Now the widely accepted was the definition of National Institute of Standards and Technology from the USA. The cloud computing was a kind of pay by usage pattern, this pattern provided the available, convenient, on-demand network access. Entered the configurable computing resources shared pool (resources including network, servers, storage, applications, services). These resources could be quick to provide, just in the management of the very few and or little interaction with service providers. Using cloud computing technology was not only a simple collection of all kinds of resources, but also provided us with a convenient management mechanism, and developers would have transparent freedom of access to resources and the use of resources. Cloud computing provided super computing power for the network application, through certain coordinate scheduling, the cloud computing could provide tens of thousands or even millions of joint between the normal computers to provide a strong.

In the "cloud" service mode, the integration of resources and scheduling would take the user's needs as the starting point and the foothold, with dynamic adaptability to aggregate information resources and services system, the entire guide information, tracking user behavior. Through the use of cloud computing methods and techniques to create different channels, different sources and different carrier of the integration of resources and the polymerization process to form new knowledge, to realize the connotation of knowledge service deepening, support knowledge retrieval, and took the initiative to push service. Cloud computing environment of digital resources integration was to realize from the traditional normative to dynamic, non-normative network resources polymerization of change; from the polymerization to restructuring and integration of information resources. The creative concept of cloud computing service mode and technology, for the digital resources integration and service innovation towards cloud expand the new space for development. Compared with traditional computing, cloud computing key features:

3.1 DYNAMIC RESOURCE ALLOCATION

System dynamic allocation or release different virtual or physical resource depended entirely on the user's demand, when demand increases, the quick matching available resources, to provide users with flexible resources; When users no longer needed the resource, these resources could be quick released, Cloud computing was to provide users with unlimited use of IT resources, and realize the scalability of resources. Cloud computing was to provide users with unlimited use of IT resources, and realize the scalability of resources.

3.2 SELF-SUPPORT SERVICE DEMAND

Cloud computing resources services for the users with the method of self-support, users did not need to interact with suppliers, through the cloud computing system to provide users with a certain application service directory, the user can according to their own needs. Choose a certain service content or project, took a self-service yourself for computing resources ability, and pay of the cost of purchasing service.

3.3 TRANSPARENCY OF THE RESOURCE POOL

For cloud service providers, all of the underlying resources (storage, computing, network, logic, etc.) formed a "pool", it could be unified management and scheduling, the boundary of the various resources was broken, heterogeneity were blocked up; For users on the use of resources, no need to understand the internal structure of the system, based on their own requirements, the needed resources was infinite and transparent.

3.4 NETWORK

Cloud computing services for users was via the Internet by the user through a variety of terminal equipment and standard application to access the Internet everywhere the cloud resource and cloud services.

4 Digital resources intetration under the environment of cloud computing

According to the integration of different requirements, the digital resources integration had a variety of type, level and way, according to the structure of digital resource and the degree of resource integration, resource integration could be divided into data integration, information integration and knowledge integration of three methods for integration. Could Computing has many features, see below:

TABLE 1 Cloud computing features

The basic features of cloud computing	1. Based on the network Distribute based on need, Charge based on volume. 3. Support large amount of information processing 4. Accept Heterogeneous Business System 5. Support resources dynamic scaling and flow 6. Accept heterogeneous resources

The data of the logical or physical merge data integration was the lowest level of resource integration system, and integrated to a certain extent, and solved the problems of data sharing and exchanging the heterogeneous system. But the data integration only showed the resources quantity change, there was no connection between the data. Information integration was based on data integration at an intermediate level of resource integration system and the optimization of the digital resources. At the same time, in the amount of data integrated also revealed the connection between data, but there was still no involved in semantics. Based on data integration and information integration of knowledge integration were at the highest level in the resource integration system, focused on the restructuring of the concepts and relationships, became the ultimate goal of resource integration. In the practice of digital resources integration, generally, it was a kind of integrated way, and with the main function of mixing of other ways to integrate;

They constituted a complete system of digital resources integration. Data integration, information integration and knowledge integration showed cross overlap each other and step by step a progressive process of the development of digital resource integration.

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Information and Computer Technologies

The application of database technology in the network management system

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Abstract

In today's society, the internet was increasingly expanding the scale of the computer network, the structure of the network has become more and more complex, the network management system must have a higher intelligence. A large amount of data had been processed in the network management system, and the application rules on data processing are the two most basic elements, and the database had provided a technical solution to achieve the function of these basic elements. This paper discussed the network management system, the basic function of network protocols and network management MIB databases, the ERC plus method of database design are discussed, and the application example is given. The article also analyzed the adaptability of network management application on database. The design and maintenance of the network system is very useful.

Keywords: Database, Network Management System, Network Management, Protocol Management Information Base, ERC Plus Method

1 Introduction

As a new type database technology, data management of object oriented database system technology has begun to be used deeply in the transaction work areas of enterprise. According to the present application situation of database, data management of object oriented database is more scientific and timely, according to the extension and development of database technology, this paper introduced and analyzed the characteristics of object oriented database and how to establish object oriented database, the author of this paper thought that the data planning, the overall data analysis and the data design should be focused on during the establishment of whole system. A perfect network management system was the guarantee of the computer network reliable and stable operation, also the basis of analysis of network performance. And the network management system used database to store information about network and its operation, of which the database was called MIB, Management Information Base. The implementation of MIB, to a large extent, depended on the object oriented design thought. Each network monitored and controlled resources was marked by the management object, so the MIB became a structured collection of these objects. It is worth to pay attention to these collections MIB, despite of using object-oriented design concept, it was not to say that the object-oriented database management system or object-oriented technology was the must way to implement it. As long as the transfer of information between open system was with the object-oriented design principles. So what kind of database could implemented MIB had become a question worth to discuss. can be discussed. Among the various kinds of database technology, the database depending on its own advantage realized MIB to open the door for connivance.

With the development of computer application and the development of multimedia technology, the large information systems were based on design theory of relational database system. But these database system included hierarchical database, network database and relational database, and no matter what's the difference between the model and technique, but it mainly were for data management and support transaction processing applications. However, with the improvement of the user application requirements, the development of hardware technology and Internet/Intranet to provide colorful multimedia communication, promote the database technology and object-oriented programming technology, network communication technology mutual penetration, in combination with each other. It became the main characteristic of the current database technology development to absorb and make use of these new technologies and continuous efforts to meet the enterprise's information management needs.

2 Database technology application situation

The application of database technology, whether it be a production information system, supply and marketing information system, or information systems asset management information system had been established. Data security, reliability was guaranteed, but the scientific nature data, data processing, feedback and penetration still needed further perfect the combination of science and technology.

2.1 THE CHARACTERISTICS OF THE OBJECT-ORIENTED DATABASE TECHNOLOGY.

Object-oriented database technology was objective to the world, a stable objective existence entity object as the basic elements, and to "class" and "inheritance" to express things have in common and internal relations between them. The related concepts of object-oriented and programming technology, the combination of object-oriented database system could take automatically retrieve the data as object storage and sharing, including the object to complete each database transaction processing instructions, these objects may contain different types of data, including the traditional data and processing, sound, graphics and video signal, object could be shared and reused. Object-oriented database system supported network communication applications and multimedia applications. These applications could combine

different types of data, is very practical and convenient.

2.2 HOW TO BUILD AN OBJECT-ORIENTED DATABASE SYSTEM.

Combined with the status quo analysis of object-oriented database system programming technology application in the actual work. We referred that the production management system, supply and marketing management, asset management system all needed to be a more perfect and convenient operating system, can store data. It can chad reads the data we need, but also to the data, we now created a simple database asset management system (reference source program 1 asset management database system class 1, 2, 3). The system there were two databases needed to collect, at the same time, one was equipment database, the other was a house or a database, so it needed to use an object-oriented database class to achieve the purpose of this database application management procedure. It can put the same data with associated attributed "class" together, the equipment was a kind of object, housing was another kind of object, they are the same interface on the space of two independent individuals, they have their own member variables. That device class could be constructed in the class variables being different, they have the function of public, the public function also had its own member functions, class object using the operator to access define respective member function, does not interfere with each other, Defined after their respective functions, they run in defines the scope of their respective, don't have to call them scope, and these categories are objects of data can be reused to regain, and automatic is this package and class inheritance in object-oriented programming are very common example. It used in an interface, object-oriented different types of different data, not used in a number of interface operation, saved a space resources is also reduced tedious programming provides a great convenience.

The source program 1 asset management database system class 1

4. using namespace zcgl;	16. class building
5. class machine	17. {
6. {	18. private:
7. private:	19. char cName[50];
8. char cName[50];	20.int imj;
9. char ctype[50];	21. float fjz;
10. float fjz;	22. public:
11. public:	23. void Accept();
12. void Accept();	24. void Display()
13. void Display();	25. };

It can be seen clearly above procedure is for the entire database objects do statement, two classes were statement object, is a machine (equipment), the other one is building (housing), and they have a public member function the Accept () and Display (). The definition of their respective member function for the next step is prepared and bedding, they also have their own member variables, that is to say, on the basis of the same to allow the different of each type of data exists.

The source program 1 asset management database system class 2

26. int main()
27. {

28. machine macObj=new machine():
29. building buiOhj=new building();
31. macObj.Accept();
32. buiObj.Accept();
34. macObj.Display();
35. buiObj.Display();
36. return 0;
37. }

The above program 2 began to define their respective class object instance, one was macObj (device class), the other was a buiObj (housing), and their respective member function had been defined, the Accept () function was a member function of a macObj. The Accept (). The other one was buiObj. The Display (), they were all defined as integer variables. Class object applications operator". "to access the respective member function.

The source program 1 asset management database system class 3

39. void maRhine::Accept()
40. {
41. Cout<< "Please enter the name of the device”
42. Cin>>cName;--------” «ENDL;
cout«?Equipment net value
43. coul << “Please enter the name of the device:";
Yes:?<<fjz<<endl;cout<<?Device Number
44. Cin>>ctype; Yes:?<<ctype<<endl;
coul<<?\nDevice Name
45. Cout<< ”Please insert device net
value:”Yes:?<<cName<< endl;>>cName;
46. Cin>>fjz;
47. }
48. void machine::Display()
49 {
50. Cout<<"\n----------Show the device information
51.)

Above procedure 3 analyzed the application of domain decomposition operator "::" the member functions of the public functions were defined, the data in object-oriented database system were not only run in defining its scope. And these data object could also reuse and regain automatically, object-oriented database system was a kind of convenient operation, with a handle to the new data query, database technology.

3 Other database system design technology.

With the aid of network communication technology, distributed database design technology, distributed database management system (see figure 1) was the combination of distributed technology and database technology of database technology. Conceptually, a distributed database was physically dispersed in each node on the computer network, and logically it belonged to the same system of data collection. Distributed data system had the characteristics of: (1) most of the processing was immediately completed; (2) the computer was connected by the associated data communication network; (3), overcame the weakness with a central database, reduced the cost data transmission; (4), improved the reliability of the system, reduced local system fails, the other part still could continue to work; (5), the position of

each database was transparent, convenient system expansion; (6), in order to coordinate the transaction activities of the whole system, the performance of the transaction management expense was still higher.

Distributed was the development direction of computer application in enterprise information, also the actual needs of the database technology application, its application areas: (1) A distributed database system was set up between the departments, and adapt to the distribution of the department organization structure, reduced the communication cost, improved the response speed, and made these departments use database more convenient and economy; (2) When there was something wrong between, a place did not cause the whole system collapse, because failure site users could log in the system through other sites, and other site users could also access path selected by the system automatically to avoid the fault sites, using other data copy operation did not affect the normal operation of the business, so as to improve the reliability and availability of system;(3) when in a large enterprise or department had completed a number of the database, in order to exploit the resources of each other, and develop the global application and develop a distributed database system, it needed to make full use of the database resources; (4) when a department or the field scale need to expand or increase, the structure of distributed database system for the processing capacity of extended system provided a good way: Added a new node in distributed database system to do so than in a centralized system expand the scale of the system was much more convenient, flexible, and economic, so as to achieve a gradual extension processing capacity and the size of the target system. However, the structure of the distributed system, distributed database and its implementation technology, the problem of the current did not achieve the desired goal. Because the information management platform was in the further perfect the process of construction, sharing and network collaborative work had been on the agenda, overcame its implementation technology and the difficulty of hardware and software environment, was the enterprise information management system of modern management of the trend of the times.

4 Conclusion

Our vast database of users were with the hope to get what they need data or information, and the ability to easily accept and use these data or information. The post requirements shall be through hardware and software engineering environment support and high quality database design to achieve; the Last kind of requirement the user improve good user interface and application support to achieve perfect. But it was important to note that any database system, the fundamental problem was the recognition of application in the field of basic data and organization, if can't do this, it was hard to make customer satisfaction and recognition of database system. As a result, the database system construction planning, comprehensive database for application in the field of comprehensive data analysis and design, would be a top priority in the construction of the system.

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Using apache storm for big data

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Abstract

The rapid growth in information technologies has resulted in creating of new concepts, opportunities and challenges. Big Data (BD) is one of them with its tools and techniques. Big data is becoming a metonym for competitive advantage in business. However, majority is not yet familiar on what are or what is meant by "Big Data". In spite its huge benefits, big data has serious challenges and requires some critical thoughts when it comes to analyzing of big data. This study focuses on exploring the meaning of BD, identifying important parts of research on BD and its analysis concepts using sample from Twitter information using the real-time processing software called Apache Storm.

Keywords: Big Data, distributed computing, apache storm, real-time processing.

1 Introduction

Big data has excelled to be one of the most significant technologies that have influenced the way enterprises use information to progress their business models and experiences. Basically it is a combination of data technologies management that has come through some time. Big data enables business to use, store and manage lots of data at the precise time to achieve accuracy and efficiency. The most important feature of BD is that gathered data must be managed in a way so business requirements are kept. There are different ways to collect vast amounts of information to find the hidden patterns, which exists inside that data so it can bring some insights to the business model [1]. Working with big data results require that the base to be set up to back the administration, circulation and flexibility of that data. Therefore, it is essential to put both business and specialized procedure arrangements to utilize this important engineering pattern.

In stream, processing the model of speed is determinant. As a consequence it requires a processing tool, that could operate the new gathered information at a faster pace with guaranteed processing and low latency. Afterwards new instruments are needed to prepare this huge speed of information. "Apache Storm" is the leading real-time processing tool, which delivers the processing of newly gathered information with low latency. Currently the mostly used tool is Hadoop, it is relatively works well, however because Hadoop operates the data in batch it is not most suitable tool for analyzing the cutting edge types of data. Processing the data in real-time is nowadays a usual requirement. This technique is called stream processing; basically it is analysis of real-time data in continues motion. This paper will focus on studying the Big Data analysis and its tools, in particular Apache Storm and will show the comparison of other various tools with Apache Storm.

2 Overview of Big Data and Apache Storm

2.1 ANALYZING OF BIG DATA

"Big Data" has become a catchy term that, for the moment, retains some mystique and persuasive impact in use. The term Big Data is used by different organizations but there is no standard definition of it. On the base of BD is located information; however it's not only significant part of it. Three different attributes such as volume, variety and velocity are combined and linked together to establish Big Data. Real-time information comes from different sources and in various types; for instance it might be content from blog posts, pictures, geolocation, logs and etc. Traditional databases work on homogeneous data structures and cannot process heterogeneous data, therefore are not very compatible to work with BD [2]. The term "real-time" itself can represent two perspectives depending on the context and it is important to be able to recognize them. If it is used related to information, it means transforming the latest available information, operating numbers of data as it is generated. On the other side, if real-time framework is used to detect drifts in Twitter stream, the notion of real-time can be deferred by a couple of seconds. But usually regarding to real-time process's, it means processing the data with very low latency [3]. Stream processing is designed to analyze and act on data, which is generated in real-time, i.e. using "continuous queries" that operate repeatedly over time. This type of processing enables us to analyze the stream i.e. to extract mathematical or statistical information analytics on the runtime within the stream. Stream processing solutions are designed to handle Big Data in real time with a highly scalable, highly available and highly fault tolerant architecture. This enables us to analyze the data in motion [4].

2.2 AVAILABLE TOOLS

Below are listed some open source tools, which are being used for big data analysis:

1. Apache HBase

Apache HBase is a Java based, open-source software,

which enables to store Big Data. It is highly non-relational in nature and provides Google's Bigtable like functionality to store sparse data. HBase is widely used when random and real-time access to Big Data is required and is operates on the top of HDFS [5].

2. Hadoop

The Apache Hadoop project is open source software to process Big Data. The key features of Apache Hadoop are its reliability, scalability and its processing model. It allows processing the large sets of data across clusters of machines using distributed programming paradigm. It operates the information in small batches and uses MapReduce framework to process the data and is called batch processing software [6].

3. Apache Spark

Apache Spark project is open source based for processing fast and large-scale data, which relies on cluster computing system. Like Apache Hadoop it is also designed to operate on batches, but the batch window size is very small. It provides flexibility to develop modules in three different languages Java, Scala and Python. It also provides a rich set of tools that are to process SQL including Spark SQL, for machine learning MLlib, for process graph GraphX, and for stream analysis Spark Streaming [7].

4. Yahoo S4

In October 2010, Yahoo released Yahoo S4. In 2011 it joined Apache Foundation Family and it was given the status of Apache Incubator. Yahoo S4 empowers developer to design applications, which can process real-time streams of data. It is inspired by MapReduce model and process the data in distributed fashion. It supports modular programming model i.e. developer can develop plug and play modules in Java. The modules developed in Yahoo S4 can be consolidate to design more advance real-time processing applications [8].

5. Apache Storm

In December 2010, Nathan Marz came up with an idea to develop a stream processing system that can be presented as a single program. This idea resulted to a new project called Storm. Apache Storm empowers developers to build real-time distributed processing systems, which can process the unbounded streams of data very fast. It is also called Hadoop for real-time data. Apache Storm is highly scalable, easy to use, and offers low latency with guaranteed data processing. It provides a very simple architecture to build applications called Topologies. It enables developer to develop their logic virtually in any programming language, which supports communication over a JSON-based protocol

over stdin/stdout. Apache Storm becomes the part of Apache Family on 17 September 2014.

2.2.1 Architecture

There are three sets of nodes in a Storm cluster and they are Nimbus node, ZooKeeper nodes and Supervisor nodes. Nimbus is the main server where user code has to be uploaded and Nimbus distributes this code among the worker nodes for execution. Also Nimbus keeps track of the progress of the worker nodes so that it can restart the failed computation or move the tasks to other nodes in case of node failures. The set of worker nodes in the Storm cluster runs a daemon called Supervisor. The coordination between supervisor nodes and the Nimbus happens through the ZooKeeper. The message flow in the system is done using ZeroMQ based transport or Netty based transport. The transport layer is pluggable.

2.2.2 Programming Model

Storm does not try to fit a specific programming model like MapReduce on top of streams. Storm programming model provides distributed stream partition among the processing nodes. Each processing element process the input as it processes the whole stream. Storm programming model consists of Spouts, Bolts, Topologies and Streams. The Spouts and Bolts are arranged in a DAG called a Topology. A user submits a topology to a Storm cluster to execute. Stream is a set of tuples and these tuples can be a user-defined type or a system defined type. Spouts are the stream sources for the topology. Bolts consume events and emit events after processing. Storm topology starts with a set of spouts and the rest of the layers of the topology consist of Bolts. User can write the storm spouts and bolts in different programming languages like python, java or clojure. A storm job is configured using the Java programming language as a topology object and the storm client is used to submit the job to the Nimbus.

2.3 COMPARISON OF APACHE STROM WITH OTHER TOOLS

Below Table 1 will compare big data open source tools with Apache Strom [9]:

TABLE 1 Comparison big data open source tools

Other tools	Developer	Type	Difference
HBase	Apache	Batch	Storm provides real time data processing, while HBase (over HDFS) does not process rather offers low-latency reads of processed data for querying later.
Hadoop	Apache	Batch	The main difference is that Storm can do real-time processing of streams of Tuple's (incoming data) while Hadoop do batch processing with MapReduce jobs.
Spark	UC Berkeley AMPLab	Batch	One way to describe the difference is that Apache Spark is a batch processing framework that is capable of doing micro-batching also called Spark Streaming, while Apache Storm is real-time stream processing frameworks that also perform micro-batching also called Storm-Trident. So architecturally they are very different, but have some similarity on the functional side. With micro-batching, one can achieve higher throughput at the cost of increased latency. With Spark, this is unavoidable and with Storm, one can use the core API (spouts and bolts) to do one-at-a- time processing to avoid the inherent latency overhead imposed by micro-batching. And finally, many enterprises use Storm as a mature tool while Spark Streaming is still new.
S4	Yahoo!	Streaming	The main difference is that, storm gives guaranteed processing with high performance and thread programming support.

2.3 WHY APACHE STORM?

Five key attributes, which make Apache Storm as a first choice tool for processing real-time:
- Easy to use fetch the data in real time
- Fast – benchmarked for processing millions byte data per second per node
- Fault-tolerant – keep the track of all worker nodes, whenever a node dies, Apache Storm restart the process on another node
- Reliability –Guaranteed data processing with at least once semantics
- Scalability – process the data in parallel across a cluster of machines.

Below listed are the main criterion, on basis of which one can decide when to use Apache Storm [11].
- Fault tolerance: High fault tolerance
- Latency: Sub Seconds
- Processing Model: Real-time stream processing model
- Programming language dependency: any programming language
- Reliable: each tuple of data should be processed at least once
- Scalability: high scalability

3 Materials and methods

Big data is cutting edge technology that have changed the way world have looked at data and all of methods and principles towards data. Technically speaking, this paper will be using Twitter streaming API to get access to twitter big data as a big data sample. Storm makes it easy to reliably process unbounded streams of data, doing for real-time processing what Hadoop did for batch processing. This experiment will execute 1 scenario with live data and will collect the statistics, which will be used to analyze the processing tool and to draw some conclusion.

4 Results and conclusions

This section illustrates and analysis the data collected for the experiment purpose using twitter streaming API. The study was aimed at analyzing the twitter big data streams using state of art Apache Storm open source tools to recognize particular patterns from huge amount of data. Following scenarios were executed for experiment purpose on live streams of tweets on twitter:
- Top ten words collected during a particular period of time.
- Number of times a particular "word" was being used in tweets, tweeted in a particular period of time.

Scenario-1: Top ten words collected in last 10 minutes Statistics:

- Total time duration=10 minutes (603 seconds).
- The total number of tweets analysed during this time=67271
- The total number of words=482874
- See Table II for top ten words in tabular form.

TABLE 2 Top ten words in last 10 minutes

No.	Word	Frequency
1	Jessie	15585
2	Lady	18543
3	Gaga	18552
4	Rey	23664
5	Lana	23677
6	Del	23690
7	Swift	23881
8	Taylor	24284
9	Coldplay	25330
10	Mtvstars	62726

This study explored for companies to understand the Big Data and its notions. It reviewed for the companies to choose between traditional databases and the big data tools. It is also empowering the developer to understand the use of Storm to analyze and process big data. This study was conducted under some experimental limitations in terms of infrastructure and data. In terms of data approximately 1% of the total tweets were available with Twitter free API. In terms of hardware configuration the experiment was not performed on dedicated Server, rather this study was conducted using laptop ASUS K53SV having corei7 - 2670QM CPU @ 2.20GHz × 8, 4 GB RAM, graphics Intel® Sandybridge Mobile, OS type 64-bit and Linux Ubuntu 14.4. The following scenario was performed:
- Top ten words twitted during last 10 minutes.

The above three mentioned scenario was performed successfully, proving Apache Storm can process real-time streams with very low latency. All the tweets were queued as they were received without any delay and calculations were performed on the tweets using bolts. The programming model was easy to build on own topologies. The execution of the topology can be drawn as a directed graph. Even though Apache is built on Clojure, the topologies were created in Java, so programming can be done in multiple languages. During this experiment, some areas of future development were identified. To install and configure Apache Storm is not easy task. No direct setup is available to install pre-requisites and configure the tool. All the steps have to be performed manually and there is no comprehensive guide available. So for future releases a user friendly installer and configuration module will be of great use for developers. Although Apache Spark provides some key performance indicator's (KPI's) to measure the performance and reliability but it is not enough to call it user friendly. There is no reporting module either. For future releases addition of a reporting module will make the tool the leading open source tool for real-time processing.

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Information and Computer Technologies

Research on digital resources integration model in cloud computing environment

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*Computer Modelling & New Technologies 2015 **19**(3B) 7-10*

This article analyzed the present situation of digital resources integration, expound the content and methods of the digital resources integration, focused on related digital resources integration theory for cloud computing environment, combined with the characteristics of cloud computing, and proposed the application and improvement of the digital resources integration based on cloud computing technology.

Keywords: Cloud Computing, Digital Resources, Resources Integration

The application of database technology in the network management system

Xue-rui Wang

*Computer Modelling & New Technologies 2015 **19**(3B) 11-13*

In today's society, the internet was increasingly expanding the scale of the computer network, the structure of the network has become more and more complex, the network management system must have a higher intelligence. A large amount of data had been processed in the network management system, and the application rules on data processing are the two most basic elements, and the database had provided a technical solution to achieve the function of these basic elements. This paper discussed the network management system, the basic function of network protocols and network management MIB databases, the ERC plus method of database design are discussed, and the application example is given. The article also analyzed the adaptability of network management application on database. The design and maintenance of the network system is very useful.

Keywords: Database, Network Management System, Network Management, Protocol Management Information Base, ERC Plus Method

Using apache storm for big data

S Surshanov

*Computer Modelling & New Technologies 2015 **19**(3B) 14-17*

The rapid growth in information technologies has resulted in creating of new concepts, opportunities and challenges. Big Data (BD) is one of them with its tools and techniques. Big data is becoming a metonym for competitive advantage in business. However, majority is not yet familiar on what are or what is meant by "Big Data". In spite its huge benefits, big data has serious challenges and requires some critical thoughts when it comes to analyzing of big data. This study focuses on exploring the meaning of BD, identifying important parts of research on BD and its analysis concepts using sample from Twitter information using the real-time processing software called Apache Storm.

Keywords: Big Data, distributed computing, apache storm, real-time processing

Content C

Teachers present situation of information literacy for college and university teaching

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Abstract

With the continuous development of the Internet information technology, it had also changed for the colleges and universities education teaching model under this background. And it has become a very important task in today's colleges and universities for the information technology literacy teachers training. In this aspect, many universities and colleges had this problem in this aspect, some even went into a myth, and wasted the manpower and material resources. This article aimed to analysis the current stations of teachers information literacy during the teaching in universities and colleges, and discussed the methods of obtaining teachers information literacy.

Keywords: Education teaching mode, teachers' information literacy, the status quo, method

1 Introduction

With the rapid development of computer technology and Internet and the further accelerated the progress of information technology, the wave of informatization impacted on every aspect of human society, updated the increasing information, and leaded the changes of the amount of information. If teachers were not able to learn new knowledge and technology in time, that teachers could be eliminated by the society. Therefore, to master the latest information in time was to adapt to the inevitable requirement of social development on the information processing ability, and also became the ability. Colleges and universities were the important base for talents in our country, it shouldered on the responsibility of cultivating talents that the society needed. In the information age, the teaching content of higher education was abundant, and was also growing breadth and depth. The teaching resources became more and more rich. There was no national boundaries and geographical restrictions in today's education, innovation and teaching model, teachers' knowledge of channel. While facing these information and content, the teachers shall improve their ability of handling the information and accomplishment.

2 Basic information of literatural and litural literacy

Information literacy was often mentioned in modern society, so, what was information literacy? In fact, information literacy was a new concept, which was pointed out by American Paul Zurkowski in last century in the middle of 70s. Information literacy was the information-processing ability and skills for few tools. While, other scholars of other countries had added some information based on this. Among them, Bruce put forwarder the information literacy should contain the below concept, such as: the idea of the information sources, information process, information technology, knowledge extending, knowledge construction, information control, etc.

And with the further development of society, many generalization and summary had been put forwarder by many experts of information literacy of our country, and the summary of professor An-bang XIE was the most comprehensive and accurate. It has the following several aspects of information literacy of the views and opinions: First, the people should have a correct understanding the characteristics of different information, there was a understand for the desire of the information, and was able to learn computer information technology to the relevant sensitive information. Second, the importance of the work for us was able to correct understanding of the information, and information to be able to solve our problems in study and work to confirm their information needs, and could find all kinds of access to information channels. Third, it shall have keep information moral quality, and take the initiative to safeguard information security.

3 Status Quo analysis of teachers' information literacy during colleges and universities teaching process

Colleges and universities was the important base of fostering talents in our country, the quality of teachers in colleges and universities for the cultivation of the students had very important influence, and the modern teacher's information literacy, the most important qualities of a informatization reform of the teaching of higher education, which required the participation of all the teachers, it required that teachers in colleges and universities have very high information literacy. At present, our country colleges and universities teachers' information literacy was generally low, even they interpret information literacy for the simple use of information tools, it would not be able to play the function of the information technology to the education teaching, so the colleges and universities must improve teachers' information literacy, and then improved their teaching quality.

Through the investigation and analysis, on the basis of the study of teachers' information literacy current problems, and put forward some measures, detailed descriptions below:

Operation Research and Decision Making

3.1 TO STRENGTHEN COLLEGE LEADERSHIP VALUES, MAKE THE TRAINING PLAN.

In order to increase colleges and universities teachers' information literacy, and cultivate teachers' information processing ability, we need to do two aspects. First, to strengthen the leadership, school leadership realized the improvement of teachers' information literacy to the important role of education teaching reform at present stage, at the same time it also determined the level of talent cultivation in colleges and universities, to truly carry out the work and cultivate teachers' information literacy form system. Second, we should establish a scientific and reasonnable training plan, and the training scheme formulated as a subject to study. It needed to learn from domestic and foreign many efficient success. More important, it was combined with the actual situation of their universities, and worked out the solution after a review of relevant departments and organizations, so, the colleges and universities have approved. In the process of implementation, the results of the present scheme for acceptance shall be changed timely to be better.

3.2 INTENSIFY PROPAGANDA, CHANGE TEACHERS' IDEAS

To enhance the information literacy of teachers in colleges and universities, we had colleges and universities to increase the publicity of information technology, and made full use of the school propaganda techniques and tools to promote information technology function, carried out various forms of information skills exchange activities, especially some about the education teaching, scientific research and learning new knowledge exchanges. Get through these different forms of propaganda and change teachers' ideas, teachers should fully realize, for these emerging technologies, the teacher must have new teaching concept and information skills, and learned through propaganda, further changed teachers' ideas and attitude, let them deeply aware that in the face of emerging information technology, if they did not have new teaching ideas and information skills, teaching effect would not be any change and breakthrough, it could cause very serious to the cultivation of talents to adapt to it or not.

4 Cultivation measures for teachers in colleges and universities information literacy

Information literacy goal of teachers in colleges and universities to cultivate goal was that teachers could use the information method and training idea, and then improved their teaching quality. The realization of the information literacy ability mainly relied on information technology. Below was the method for teachers improving the information literacy. Details see below chart:

	Education Degree	Undergraduate course and specialized subject degree of self-study and correspondence
		The graduate degree of information technology education and education technology.
The methods to improve the information literacy of teachers	**Short-time training**	Short-term training in colleges and universities, research departments and other organizations.
		To organize the backbone of the teacher training government organized.
	Same campus training	To organize the Information technology training at leisure time.
		To review the information technology and curriculum integration teaching.
		Read the information technology education related magazines.
	Spontaneous training	To participate in the network BBS topic discussion, exchange experience.
		Actively participate in various seminars

Below was the few method aiming at colleges and universities teachers' information literacy training.

4.1 PAYING ATTENTION TO THE INFORMATION CONCEPT OF TEACHERS CULTIVATION.

To cultivate information literacy of teachers, it must change their traditional teaching idea, and improve their awareness of information technology and sensitivity. Long-term since, our country's education sector and many education workers did not paid enough attention to this, information literacy had been as a method of evaluation of teachers' teaching quality, and the continuous development of modern information technology. The great changes had taken place in colleges and universities teaching method, many teachers at that time could adapt to the need of modern teaching, of course, there were many teachers lacking basic information knowledge and thinking ability, and the use of modern solutions to improve their teaching quality. So, information technology was developing rapidly, information consciousness, information idea, it was particularly important for teachers to strengthen information literacy training.

4.2 TO STRENGTHEN THE INFORMATION TECHNOLOGY OF TRAINING THE NEW TEACHER.

It had been a necessary profession skills for every teacher to master the modern methods of teaching, and this quality of this skill directly affected the quality of information literacy of teachers. At present, with the expansion enrollment of colleges and universities, the demand for teachers in colleges and universities increased year by year. If the modern information technology method were added into the pre-service training of teachers, This effectively improved teachers' information literacy.

4.3 ENHANCING THE CONTINUING EDUCATION WORK IN COLLEGES AND UNIVERSITIES TEACHERS' INFORMATION LITERACY.

During the training of information literacy for teachers in colleges and universities, it was needed to strengthen the continuing education of teachers' information literacy, and take the examine to check the results of the training. It also

needed to arrange the backbone of teachers in colleges and universities to had a short-time training in the higher quailfied colleges and universities. The school also can use holiday or weekends to train teachers for more professional skills. In addition, it also required teachers to cultivate the skills and knowledge of information though the Internet, and reading, to enhance their information literacy.

4.4 ESTABLISHING THE SCIENTIFIC AND REASONABLE EVALUATION SYSTEM.

Institutions of higher learning in the information technology environment had the direct impact on the important condition of training teachers' information literacy level, further strengthened the efforts to teach information literacy training and inspired them to autonomous learning, then improved their information literacy, which was the most direct way. And it was more important to evaluate a teacher's information literacy. It was more stringent to make the evaluation system of requirements, and established the evaluation system, started from the definition of information literacy, set different standards for different levels of personnel. Usually, this evaluation system was divided into two kinds: the teachers' evaluation scale and professional assessment scale.

4.5 SETTING UP THE CORRESPONDING INCENTIVE MECHANISM.

To train the teachers in colleges and universities for information literacy should also be supported by school leaders, and teachers and school leaders should encourage the application of information technology in the teaching process, and should also support new experiment teaching methods for teachers to provide enough time and the necessary funds. The most important thing was that colleges and universities should establish a reasonable incentive mechanism, and improved the enthusiasm of teachers in this respect. We should use modern information technology in the process of teaching teachers shall be rewarded. To master the new information network technology could also carry out some of the information course, excellent course appraisal, etc., improved teachers' information literacy.

4.6 FORMING A GOOD INFORMATION LITERACY TRAINING TEAM.

In colleges and universities teachers' information literacy training in our country started relatively late, various aspects had not done enough to make it perfect, service teachers' information literacy in colleges and universities generally was not high, and the continuous development of society and technology, the teaching work was more and more high to the requirement of teachers' information literacy. And the formation of a high quality team of information literacy training was a very good measures. The local education authorities set up a professional training institution, then set some powerful institutions of further learning to set up an information technology education training center, often of various colleges and universities teachers' information technology training. Institutions should employ excellent teachers for the information technology curriculum guidance, and ensured the quality of classroom teaching and teachers' learning.

5 Conclusion

To sum up, realizing information management of the education teaching was an important method to realize the modernization of education, and was also a major forces for promoting the development of the institutions of higher learning forward. In the information explosion today, the process of informatization was very important to the development of institutions in the future. In recent years, colleges and universities in our country informationization had rapid progressed, the result was more significant in infrastructure construction, information system construction, resource development and integration. The core issue in the development of institutions was the teaching quality of school, and the informationization development of teaching. The teacher was the most important factors that affect the quality of teaching, as in colleges and universities informationization environment, teachers' information literacy could directly affect the teaching quality of a school. Therefore, colleges and universities shall take the improvement of teachers' information literacy as the key of the education teaching work.

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Research on the low carbon packaging of food

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Abstract

Now the food safety issue had become the subject relating people's livelihood, and in which the food packaging issue become more and more important, and had got much attentions. This paper was to research and analysis of the problems of food packaging at present stage, and investigated from the direction of low carbon environment-harmonious food packaging design. Then this study put forward several design ideas, such as: integrated design, simple design, packaging technology and material selection, etc.

Keywords: Packaging of Food, Low Carbon, Environment-harmonious, Research Analysis.

1 Introduction

In today's society, food safety issue had caused extensive concern of government and society. Food packaging was the vital part of food industry, as it could guarantee the stability of food quality, and prevent the damage in transporting. And after the use-up of these food, the food packaging had lost its value, would cause a certain burden to garbage collection. So, the developing mode of food packaging shall be based on the low pollution and low consumption. In the future, the food packaging need to realize the combination of low carbon environmental-harmonious and visual aesthetic. These not only could keep the food packaging beautiful, but also protect the environment. In the food production chain, the food packaging played a very important role.

2 The problem analysis of food packaging

As is known to all, cloth, food, staying and travel was throughout the entire contents of the people's daily life, it meant that the food played an unusual role in our daily life. And the food industry was a very old production industry, and its production was accompanied with certain pollution problem. With the increasing of people's living standard, people were pursuing more and more high requirement of the quality of life. The economy were promoted to be low carbon and environment-harmonious, of which was leading the direction of food packing. And the design requirements of food packaging was to enable most consumers understand the information related product, and distinguish between food brand, companies and the propaganda image. At present, there were a lot of problems of packaging design in our country. As the packaging design was not reasonable, it lead to the waste of resources, and increased the burden of consumers, and also caused certain pollution to the environment, affected the health of human beings. And most of the food packaging just pursued its appearance, with complex design and more packing material and loose structure, while, ignored the low carbon standard for production pack material.

Nowadays, the most typical cases were the packaging of medicine, wine and cigarette. These excessive packaging not only wasted packing material, polluted the environment, but also caused consumers felt been cheated after purchased these products. And a lot of food packaging materials itself had a certain chemical composition and toxic substances. This cause poisoning, and made consumer in a danger condition. a lot of consumers different degrees of damage. A lot of packaging materials were applied on the packaging, such as oiling, waxing. Other packaging material was polystyrene, polyrethane, which could bring a good visual effect, but had threatened people's health. A lot of poisonous packaging materials was disposable. If it cannot be dealt well with or abandon it, it could cause serious pollution to the environment, and food packaging materials also existed some problems in design for safe usage. Now, most of the food packaging material could be plastic, paper, glass, etc. Detailed information was shown Table 1 below:

TABLE 1 Detailed information about food packaging material

Food Packaging Material	Specification	Packaging Purpose	Advantage	Disadvantage
Plastic	The most widely used; security was the most difficult to trace	Edible oil, yogurt cups, packaged beverages, carbonated drink, tea drink juice, mineral water	Good Visibility and Low cost	Food pollution
Metal	Chemical Stability, Can inner coating was the main issue.	Beer, carbonated drinks, non-carbonated drinks	Processing Technology Mature.	Waste resources, low security
Paper	Long history for food packaging, higher technological requirements	Milk box, milk bags, fresh juice	High security	Poor visibility, high cost, difficult to recycle
Glass	Most security, not convenient to transport, the cap and cork were the main issue	Beer, Canned food	High visibility, high security	breakable.

3 Analysis study of low-carbon food packaging

The rapid development of industry has brought serious environmental problems, and food packaging had a very big impact on food safety issues.

3.1 ANALYSIS FROM THE PACKAGING MATERIALS

3.1.1. Edible packaging materials

In recent years, some edible food packaging materials were applied more and more widely. Wafer became the edible food packing materials for packing candy etc., and corn baking packed ice cream, etc. There were a lot of plastic wrap of edible materials, these edible packaging film was made of biological macromolecules such as protein and sugar. The plastic wrap could be interacted into a kind of emulsion through the intermolecular. After certain processing of drying technology, the solvent inside evaporated, then eventually formed a transparent three-dimensional structure film. The film was with a good specification of waterproof and breathable performance, so it was widely applied in the preservation of vegetables and fruits.

3.1.2. Repeatability of packaging materials

The current situation, most of the packaging material could be reused, some alcohol, soy sauce and other daily items were packed in bottles, which could be reused. There were many drinks and bottle contained a lot of polyester which also could be repeated used. These could be repeated use of packaging, not only reduced the production cost of packaging material, but also improved the utilization efficiency of these packaging materials.

3.1.3. Degradability of packaging materials

Packaging materials were developed with the development of science and technology, many modern biodegradable packaging materials were degradable. These not only could realize the product packaging, but also could be degraded through biological photosynthesis into nontoxic substances after the usage. At present, there were a lot of food packing material met our requirement for environment protection and prevented oxygen to come to food interior and achieved the goal of keeping fresh. So, polyethylene plastic film used now would be replaced by a lot of new materials in the future, these new materials followed the state advocated development of low-carbon economy, would be used as the main material of food packaging design in the future.

3.2 ANALYSIS FROM THE PERSPECTIVE OF PACKING DESIGN

The above study had analyzed the low carbon of packaging material, from the perspective of packaging design. For food packaging design, if company wanted to have a good effect, there were two factors must be considered, first was the innovative packaging design, which fully considered the visual perception of consumer, and consumers had a feeling of new and fresh. Second was packaging design

should obey the requirement of low carbon environmental protection, a scientific design could fully reflect the quality of products, also could reduce the use of packaging materials, and conveyed to the consumer the brand characteristics of an enterprise. This made the products of enterprises be successful in the fierce market competition, and brought huge economic benefits for the enterprise.

To sum up, on food packaging design, our manufacturers should have the concept of low carbon environmental protection, and used some of the low carbon environmental protection material for packaging. This not only could improve the efficiency recycling of packaging materials, but also reduced the cost of enterprise and carbon emissions, and protected our ecological environment.

4 Concrete design method analysis of food low carbon packaging

In general, what we told the food packaging design refers to the process of people using the words, picture and some other design method to convey basic information of the food. But, nowadays, many food enterprises did not accurately set the social status of their products, and not reasonable at packaging design. This unreasonable food packing cannot convey the basic information of the enterprise products to customers. And the design was not beautiful, and somehow it was rough, and some material were also in low quality. These factors would have the significant impact on company's food packing design. With the deepening of the low carbon and environment harmonious concept being popularizing, the innovative design method of low carbon environment protection became very important.

4.1 SIMPLE METHOD

Simple method was widely used in the food packaging design, as the purpose of the simple method is to maximally decrease of the packaging material, through the expression elements and color packaging material. So this could had the artistic effect that complex and profound design could not do. Most people thought the simple design was simply contracted. The fact was not like that, simple design method not only keeping people's life taste, but also promising the fashion, healthy, reasonable consumption concept. It give a person the sense with simple and fashionable. Simple method was a very practical design methods, which obeyed the advocated national low carbon economy requirement for food packaging. The purpose of using this design method was to avoid unnecessary waste of material and resources, and improve the repeated usage of packing materials, and then reduce the design cost of packaging materials and environmental protection. The cost and waste of resources, improve the repeated use of packaging materials, reduce the design cost of packaging materials, environmental protection. Simple design method not only could improve the economic efficiency of enterprises, but also could reflect the cultural values of an enterprise.

4.2 SYNTHESIS METHOD

In the design of food packaging, there was another method called synthesis. Literally, we could know that this was a comprehensive and integrated design method. This design method could be accepted by most consumers, at the same time, it also reflected in many aspects of the product. From product design to production, every step had the synthesis method. The emergence of this kind of design method was created in order to ensure that products meet the requirement of most consumers. The food packaging design was a comprehensive field, which combined the packaging materials, packaging technology, process design, food science, etc. So, the packaging design need to combined with many fields, and integrated a number of factors for innovative design. Integrated design method not only need to consider most consumers requirement, but also need to consider consumers occupation, desire and shopping sites. This could guarantee our food packaging be accepted by consumers, and improve the quality of life of consumers.

4.3 MATERIAL METHOD

For the success or failure of a packaging design, the key reason was to see the quality of the selected packaging materials, and it also would cause certain influence to the whole market. An environmental harmonious materials packaging design would stimulate consumption. Therefore, the food packaging materials was very important, the life cycle of a material could cause certain influence on the ecological environment. From the view of environmental protection, it need to be sure to choose low carbon environment protection material on food packaging design, and make the concept of low carbon environment protection throughout the packaging material in the whole process of design and usage, and fully realized the low carbonation of food packaging. At present, we had found and investigated a lot of low carbon materials, such as: light-pollution prevention packing material, nanometer packing material, special functional packaging material, edible packaging material, degerming packaging material, controlled biodegradable packaging material, water soluble packaging material, etc. So, food enterprises could choose the suitable low carbon packaging material based on nature of their products. This not only obeyed the national requirement for low carbon packaging, but also protected our ecological environment.

4.4 PROCESS METHOD

In food packaging design, there was a kind of design named packaging process method. Because the packing process had important implications for food packaging, which related to the quality and effect of food packaging. A very good packaging technology would have very strong visual impact on consumers, and aroused people's purchasing desire. Process method was the design for the packaging process method. On the one hand, this method met the needs of social development and the market, and conformed the state advocated concept of low carbon environmental protection. So, this method could solve many problems. First, the food safety shall be took into consideration, the applied packaging material would not cause pollution, and affected the health of consumers. Secondly, it was the food preservation, a reasonable effective packaging technology could extend the shelf life of food. Third, it was the packaging usage issue. The packaging designed shall be easy to open for consumer. Generally, when consumers choose the food, they would choose the food packaging which were beautiful and simple. Therefore, if enterprise wanted to win in the fierce market competition, the innovation process is a must in the process of food packaging design and never-stopping process method.

4.5 THE ENGINEERING DESIGN METHOD

In above information, food packaging design was a comprehensive discipline, which determined its design must be combined with a variety of subjects. Art design was the inevitable result of the continuous development of science, it not only was determined by the single factor of a variety of domains, but also developed with the advance of science technology and the further development of productivity. Human as the main body of the society, in certain social practice, there would be some production rule and the free creation, and the form of aesthetic ability in the natural life activities. Art design had a very close relationship with all of these factors, which was the perfect unification of these factors. When making packaging design, the packaging materials selected must be conformed obey the science and technology guidelines and its use function. So, it needed to evaluate food packaging art design from each aspect and different angles. And engineering was the science relating to the person himself. It mainly studied some mental and physical aspect under particular environment factors, and the mutual relationship between people and environment, and the safety and comfort issue of people's working and life. The human engineering disciplines provided the certain scientific basis for food packaging design, and enabled the design of packaging more scientific and reasonable, comfortable and safe. So for food packaging design, it need to study and analysis the human body engineering for consumers, which involved the production, sale and operation, cost, material, technology, recycling, shape, color and other various factors.

5 Conclusion

To sum up, in the fierce market competition, food low-carbon packaging could directly affect the reputation of the enterprise, so each of food companies should pay much attention to its product packaging design and reputation. Food packaging not only must meet the psychological needs of consumers, but also should coordinate with the requirement of low carbon economy, let more consumers feel the scientific progress brings them convenience. Research on food low carbon packaging not only need to have certain systematic point of view, and also need to combine with certain emotional factors. Food packaging design should not just be based on the specific procedures and steps, instead, it shall steam from food packaging design to grasp the influence of various factors, only in such a path of low carbon design could find the right direction.

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Operation Research and Decision Making

Discussing to the application of virtual reality technology in competitive sports for simulation training

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Abstract

The application of virtual reality technology in competitive sports for simulation training can be used to movement' analyses, evaluate, arrange and innovation. This technology improves the technological content of sports training. Therefore, it makes athletes to grasp sports technique quickly and keeps in good form. The paper describes research status and development trend of the technology of virtual reality and physical stimulate and its application in sports training. And it discusses the function and system of virtual reality technology in simulative training.

Keywords: Virtual Reality, Competitive Sports, Simulative Training

1 Introduction

With the popularization of "technology Olympics", "Digital Olympics" and "Humanistic Olympics" concept in 2008 and the rapid development of computer technology, Modern science and technology has penetrated into all fields of sports with its powerful affinity, especially plays a tremendous role in sports training. The rapid development of virtual reality technology provides wide space application in competitive sports field. To our country's advantage projects - diving, gymnastics, trampoline, sailing, windsurfing and other projects in the 2008 Beijing Olympic Games, they used virtual reality technology for simulation training in order to realize the sports training methods transformation from traditional human observation to capture and motion analysis of high precision measuring method of human, from approaches based on experience to human motion modeling and Simulation of human motion analysis method. Therefore, this improves the training level and athletic level of our country faster and more effectively in these projects, to ensure that these projects can impact more gold medals in the Beijing Olympic Games and realize China's glory plan in 2008 Olympic Games.

2 Summarize virtual reality technology and sports stimulation system

2.1 VIRTUAL REALITY TECHNOLOGY

Virtual reality, which also can be abbreviated to VR, stimulates the world of human sense generated by computer. Sometimes are called the virtual environment. VR technology embodies the characteristics of multi-subjects, and is a multi-disciplinary complex art accompanying fast development of computer technology, computer graphics, computer network technique, picture processing, pattern recognition, Intelligent interface technology, physiology, multi sensor technology, speech processing and audio technology and so on. The operator can produce be personally on the scene through the visual, auditory, olfactory, tactile and interaction, which can provide new media for human-computer interaction. Nowadays, VR technology has been widely used in military simulation, fire simulation, entertainment, games, medicine, remote control robot, virtual design, virtual manufacturing and other fields.

2.2 SPORTS STIMULATION SYSTEM

Sports stimulation system is interdisciplinary including comprehensive sociology, management, sports training, computer science, graphics, prediction, psychology, math and so on. It is an integrated experimental science with the method of system simulation research on sports issues. It analyzes the problems in sports field through the method of system analysis, and uses related knowledge about math, graph theory, gray theory, operational research, control theory, information theory and so on to establish simulation pattern, then conducts real time, super real-time, under real-time simulation demonstration by using computer technology and connecting graphics, film and video BA and psychology. Finally, it is a typical multi- subjects, multi-factor analysis and comprehensive integration of the disciplines comprehensive disciplines and evaluated, planned, decision-made by experts. It reproduces the training experience and intention of the coach, organization schemes of the managers and the training process of athletes by computer simulation technology to explain, analyze, predict, organization and evaluate sports education system. In that way, it is a strategic technology to promote sports progress. Athletes need many feel in sports training (visual, auditory, tactile and olfactory etc.) and the simulation of virtual reality technology emphasizes a variety of perceptions, interaction and immersion. Therefore, with the further development of virtual reality technology, the simulation training with virtual reality technology will be widely used in the field of sports.

3 Sports systematic simulation based on VR

3.1 SPORTS SIMULATION SYSTEM BASED ON VR

Sports simulation system based on VR uses VR technology to do simulative training of competitive sports. It provides effective training tools for new coach and athletes, not only

to rapidly improve the effect of exercise training and technology content, but also expend the scope of application of the system simulation, and promote the rapid development of VR technology. Therefore, VR has promising prospect in sports simulative training, and that depend on traits of VR. VR system has variety output form (picture, sound, character and so on). The ability of dealing with a variety of input devices can perform collision detection, real-time interaction, viewpoint control and complex behavioral modeling. In sports training, the use of VR technology can use many kinds of perception to present coach's training intention or athlete's training process, and the coaches and athletes can naturally interact with this simulation system. Application of this kind of physical simulation system based on VR will further improve the scientific training level of sports.

3.2 DEVELOPMENT STATUS OF COMPETITIVE SPORTS SYSTEM SIMULATION BASED ON VR

Development status of competitive sports system simulation based on VR, VR has been widely used in the military simulation, fire simulation, medical and many other fields, its purpose is in certain circumstances (hostage negotiation, parachute, fire-fighting etc.) and simulative training on students. This training allows the wrong, but not brings any risk and harm to the practitioners. Compared with other methods of training, sports training simulation based on VR have a variety of perception, therefore it can enhance the ability of athletes and sports simulation system for interactive, improve the effect of exercise training. At present, the virtual environment has less application study in competitive sports training, this is mainly because the requirements of competitive sports training to the performance of the VR system are higher than the virtual game, such as the requirements for user friendly interactive, real-time, high precision and strong sense of immersion, in addition to the virtual reality software, hardware technology. Conditions (such as virtual reality special interaction is more expensive equipment, the existing interaction is not convenient and flexible system), real time and accuracy are to be improved; application and popularization of these constraints limit the VR technology in the field of competitive sports training simulation. U.Y. Yang et al. realized an immersive training system based on virtual reality technology, whose core idea is a metaphor for "intuitionist ghost based on interactive method ", being called "Just Follow Me". In the training process, trainer action is real-time visualization, and the visualization image training is equivalent to the ghost out of trainee' body through intuitionist ghost metaphor. To observe the trainee's movement from different point of view, the trainees (or as quickly as possible) follow the ghost master (trainers'). SeongmhiBaek et al. give reference movement for any trainee adjustment, and provide reference motion effect analysis for trainee and take swordsman training as an example to verify the arithmetic. Nowadays, Also it has made a number of research results in simulation and analysis of 3D human motion in China, has successfully developed a VHTrampdineJ71 software system of computer aided trampoline sports scientific training to prepare for the Beijing Olympic Games. The software is different from the color image analysis based on physical training software, which is based on the digital 3-D human motion

simulation technology, human biomechanics data and real human motion data, the 3D simulation, design, analysis and action, therefore, practice has stronger directive significance to sports training.

Based on the development status of VR in competitive sports simulation, VR technology has the specific scope of application in competitive sports simulation are as follows: the scientific monitoring sports training; sports training information collection, analysis system; advanced training technology application demonstration; training and equipment, a variety of gymnastics editing. These research results will be applied widely in trampoline, diving, gymnastics and other competitive sports training. So competitive sports simulation based on VR has a broad development prospect.

3.3 FUNCTION OF COMPETITIVE SPORTS SYSTEM STIMULATION BASED ON VR

3.3.1 Structure training scene and equipment

According to specific requirements of the specific sports on training scenario building virtual training scenarios, such as, sailing and windsurfing training time is subject to certain conditions (for instance, the appropriate wind speed, wave height and weather) , this system constructs realistic training environment field data the system through collecting a variety of sensors and mathematical models of real driving 3D visual, and meets the non-training condition in this environment (such as no waves without wind conditions) to complete the training mission. It also can make the virtual training and simulation human, such as, gymnastics athletes can be invited to connect virtual gymnasium in virtual instruments and see how to change the shape of the gymnastics equipment. This technique not only can be used in daily training, but also in the adjustment period before the game to make the athletes play out of their own level in the race.

3.3.2 Capture exercise date

Through the sensor tracking equipment, it is directly recorded motion data and used to generate computational motorized painting. The biggest advantage of this method is able to capture the athletes (including training apparatus) real exercise data. Due to the generation of movement is basically movement "copy" of a player (instruments), the effect is very generally real. According to the captured motion data, it can edit, modify, design new action, let the coaches to design their own mind "ideal" action, in order to ensure the scientific training. This function can be used wildly in weightlifting, gymnastics, trampoline, narrow water project.

3.3.3 Collecting physiology and biochemistry and mental date

Physiological, biochemical and physical index is an important indicator of the State Sports. According to different athletes, the biochemical, physiological and psychological data of athletes can be collected through a variety of sensors and intelligent instrument. The collection of physiology includes mainly obtaining pulse, blood pressure and so on which is human metabolism index , all

sorts of organ and system function index. According to the collection index, coach can rearrange and redesign action to meet function and characteristics of this project. And coach can pick out action which need arrange with the intention, therefore, coach choose the best arrangement to make sure scientific and reasonable training methods.

3.3.4 Repeat the performance and show the movement

Movement reappearing is the key function of sports simulation system. Traditional camera shooting can't realize it in some condition. When study on the innovation of new movements in gymnastics project, athletes can realistically and accurately reproduce the gymnastics athletes with a variety of action sports simulation system with its 3D virtual gymnastics to help assistant trainers and athletes innovate action, improve the technical level.

3.3.5 System composition

The sports simulation system has three parts: input system, output system, virtual environment generator. The input system includes date glove, location orientation tracker, converter, and glove input converter etc. Virtual environment generator has custom system, simulation supervisor, three-dimension processor, high performance computer, graphic card, three-dimension model date, touch and force sense feedback device and HD ports etc. The output system contains signal converter and effect converter, so that the user can feel more real and natural of the stereo vision, stereo sound, and completely immersed in the virtual environment, like be personally on the scene.
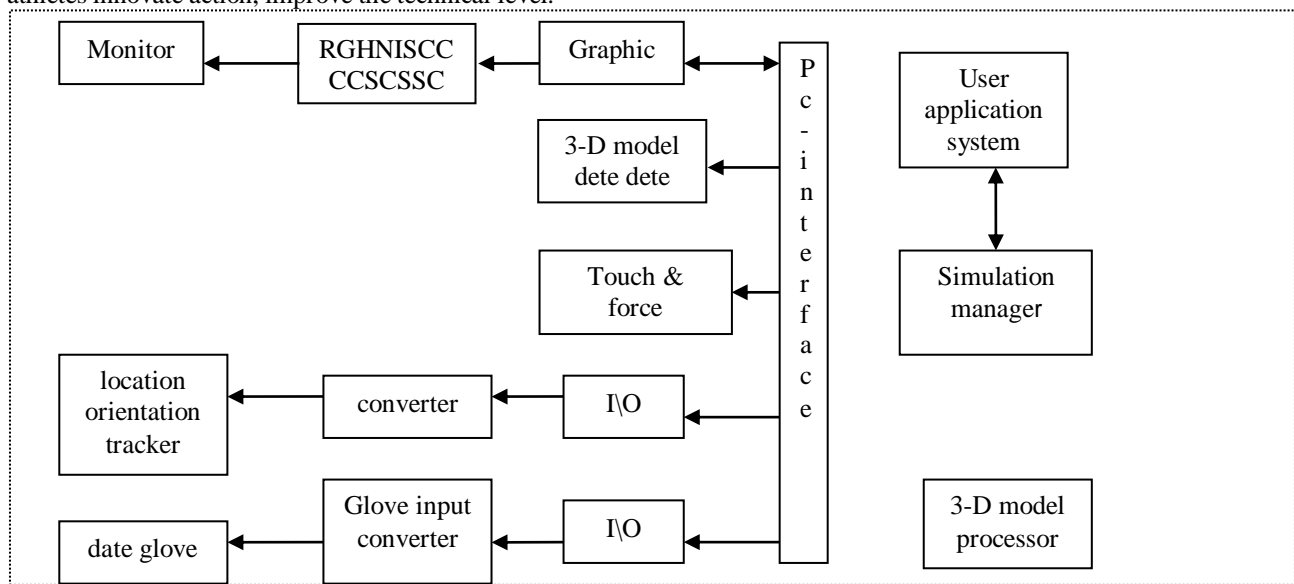
4 Conclusion

With the 2008 Olympic Games held in Beijing, it will promote China's in-depth study of competitive sports simulation technology based on VR. Along the development of virtual reality technology in competitive sports in the simulation of widely used will further enhance the technology content of the sports athletics level and the

training process. Through the analysis, simulation technology will play an increasingly important role based on VR in sports training, competition, recovery, material process and competition environment. Therefore, the development of dynamic and trace of VR technology, is of great practical significance to study the development of VR technology in competitive sports.

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Study on intelligent stadium operation management assisted by computer

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Abstract

With the emergence of intelligent constructions, the designs of stadium which act as the venue for sports events also develop rapidly to the direction of intelligence. Computer technology is not only able to help the venue manager to finish various tasks but also be able to realize the information exchange of all systems. The control technology can realize the automatic manipulation over all kinds of equipment. Currently, the intelligent system of stadium is able to realize the share of resource and information, to enhance the equipment utilization and to save energy, providing a safe, comfortable and convenient environment for users.

Keywords: computer assistance, stadium, intelligent construction, operation management.

1 Introduction

With the flourishing development of the sports career and the success of the Olympic Games in Beijing, in 2008, different kinds of stadium have been built increasingly all over the nation, becoming the main venue of recreation for people. However, during the process of construction of some specialized stadium, the extent of intelligence has reduces due to various reasons, thus affecting people's demand for intelligent buildings. Therefore, according to the need of stadium construction, the national construction industry, begin to stipulate the relevant standards in the area of intelligent construction combined with the latest development of information $ technology, thus providing technical guide for the intelligent construction and design of stadium, perfecting and optimizing intelligent system and realizing the intelligent design of stadium.

1.1 THE CHARACTERISTICS OF STADIUM

Due to the multiple functions and the great number of speculators, the cover of area is usually big, approximately ranging from 200 000 m to 1 100 000 HI in most of the case. A small portion of the area of stadiums is shown in Table 1.

TABLE 1 Part of the summery of the covering area of stadium in China

Stadium	Covering area	Building area
Shanghai Stadium	18	17
Guangzhou New Stadium	24	10
Nanjing Olympic centre	40	29.5
Suzhou sports centre	21	11.4

1.2 THE GENERAL INVESTMENT IS HUGE

Due to the large area, the demand for capital investment is huge in the process of construction. For the relatively small stadium, hundreds of millions should be invested; for the relatively large stadium, almost one billion is needed. During the process of intelligent construction, the expenditure on the construction of intelligent system consists of 4%~5% of the investment in the whole construction. Moreover, the daily expenditure is also considerable.

TABLE 2 Stadium investment and operational cost

Stadium	Total investment(hundred million, RMB)	Operational cost(RMB/hour)
Shanghai Stadium	13	3150
Guangzhou New Stadium	12	5682
Nanjing Olympic center	22.2	13860
Suzhou sports centre	7	5040

1.3 A LARGE FLOW OF CROWD

In the case of competition or performance in stadium, the large flow of crowd and the busy traffic have placed the potential risk to safety. So a more comprehensive video surveillance system is highly needed to control the situation around and therefore, the issues can be found timely and be dealt with on the spot. Then the security of the speculators and stadium are guaranteed.

2 The conception of intelligent stadium system

Intelligent buildings, according to the standards in China, can be defined: "it is a set of facilities with the characteristics of safety, comfort and convenience, including various kinds of electrical equipment, office environment and communication system via optimizing construction structure, system management and service quality". The stadium intelligent system, which also has the function of warmness and ventilation, is a part of intelligent buildings. Moreover, it also

possesses the necessary equipment of construction structure and electrical equipment. Intelligent design can provide venue and other services for athletic training and competition, including information services, network communications services and presentation services, etc.

3 The current situation of intelligent stadium system

3.1 THE CURRENT SITUATION OF INTELLIGENT STADIUM SYSTEM IN ABROAD

In abroad, the conception of intelligent construction has already been applied in the whole life circle of intelligent buildings. Especially, the functioning systems, in the early and mid-stage operation, are able to have a better effect on saving energy by optimizing design, enhancing controllability and exploiting the potential of original products and design fully. In contrast with European countries, the conception of intelligent construction in China is relatively narrow, thus being likely to limit our mindset.

Currently, the energy-saving idea, which is one of the goals in intelligent construction, is a large concept system and is closely related with the preliminary design & simulation, the realization of control function and the later management. The energy-saving can really realize only by viewing the problem of intelligent construction from a large concept system. However, the energy-saving idea has already deeply rooted in people's heart without a clear definition on the large system. The specific implementation has not been taken into systematic consideration, but start only from a limited perspective with a view to realizing energy-saving by utilizing automatic system under simplistic thought. Moreover, when considering the design of system, saving electricity, such as the application of ice storage system on air-conditioning equipment, can also be adopted etc. The construction of intelligent building control system in China is on a certain level, however, in contrast with developed countries, we still fall behind. In fact, the connection of automatic system, the performance of preliminary function, controllability optimization, which aim at making system operation reach design goal and develop the domestic building control system with its own characteristics, is the trilogy of BAS system. Most of the control systems that we used are foreign brands. It is a long journey for the development of building control system.

3.2 DEVELOPMENT SITUATION OF DOMESTIC STADIUMS INTELLIGENT SYSTEM

3.2.1 The climax of stadiums intelligent systems construction

With the ceaseless improvement of living standards and material level, higher demand in life is needed, including the sports & leisure activities. In our sports venues, per capita rate is far below the level of developed countries. Moreover, the existing stadiums are very dilapidated due to the long time span, sometimes; the existing stadiums have been closed, being unable to satisfy the need for physical exercise due to the poor exploitation. The successful holding of The Olympic Games in 2008 in Beijing provided a good opportunity for the emergence of stadium. The new 11 competition venues, 11 stadiums by alteration and

9 temporary stadiums are to be built. The stadium building also has peaked in many cities and provinces in China under such a circumstance. The National Sports Center in Nanjing is built for the 10th National Games. Jinan Olympic Sports Center, where the National Eleventh sports meeting will be held, has also been under construction. Zhuzhou City Sports Center, is now fully completed where the 10th National Games were held in September. Suffice to say, the stadium construction has peeked in China.

In the previous years, the intelligent system was rarely taken into consideration. However, with the development of intelligent construction and the deeper understanding to intelligent system in recent years, the intelligent system plays a more and more important role in the competition and becomes an important part in the stadium construction. Suffice to say it is the extension and expansion during the whole process. The extent of intelligent system construction usually determines the level of the stadium. Stadium intelligent system has become an indispensible component in the stadium construction.

3.2.2 The project of stadium intelligent system is to be improved

The rate of penetration and application increases gradually and so does the experience of project design, planning and management. Project management model also transitions from the simple one-way contract to intelligent systems engineering contract. Nevertheless, the intelligent buildings in China are on the way of development: the low level of engineering construction, the unsatisfactory project quality, the incomplete intelligent systems, and the dysfunctional operation. What is worse, some intelligent projects are unable to be handed in, thus causing investment waste. The actual implementation of the project construction management of intelligent systems in the construction of stadiums also exist many problems. In the planning and design stage, the specialized designers are rare due to the less demand in engineering design, thus making the demand for stadium blurry. In the early period, the comprehensive design and plan is rare: conversely, the adjustments and corrections are simultaneous with the construction. During the implementation phase of the project, the construction team of intelligent systems usually works late and the cooperation with civil engineering, air conditioning, and lighting is rather difficult. Intelligent systems usually cannot integrate well with the stadium construction, usually separately. In the final stage, the lack of criteria on intelligent system has made the inspection work blocked, without reference. And the quality problem appears naturally. In routine maintenance, due to the limited level of property management companies, coupled with the incomplete intelligent system design, some intelligent system has become a decoration, being unable to function well.

3.2.3 The lack of experience for stadium intelligent construction

Since the experience for stadium intelligent construction is limited, we have no mature stadium intelligent construction criteria to be referred to. By the end of 2002, in the field of national standards, the Chinese national standard directory,

sports standards only account for less than 1%. [2] Since the late development of sports equipment standardization, the specialized sports equipment criteria is absent. So the need of stipulating scientific, regular and advanced stadium is urgent. Country General Administration of Sports facilities and standard office, acting as standard in sports facility industry and implement unit, is planning to start building intelligent systems standard formulation, expecting to act as guidance and reference for management, planning, design and construction of stadium intelligent systems.

3.2.4 Daily stadiums intelligent management system is limited

The main function of stadium is to carry out sports competition. However, the time is less. So the problem of how to better utilize stadium to make it play a greater role in daily life and to reach better operational result is the priority for the developers and designers. In particular, the intelligent system design must take the dual functions (competition and daily use) into consideration.

Despite the completion of intelligent system in many stadiums, the management of property companies is far from the criteria due to the poor trained technicians and fast personnel changes etc. So the system put into practice is in high failure rate which is caused by improper use. Even some high-tech systems (such as building self-control system) are paralyzed and cannot be used for long time.

4 The characteristics of stadium intelligent system

4.1 HIGHLY SPECIALIZED ENGINEERING TECHNOLOGY

Due to the specific nature of sport stadiums, in contrast with other civil intelligent systems, it is highly professional. Since the whole construction serves for competition and training, then the intelligence design should also revolves closely around the all kinds of demands. Then the designers are required to familiarize with the traits & regulations of competition and the various demands of athletes, coaches, referees, news reporters, spectators and distinguished guest etc. These professional requirements in other intelligent building are rare, not so stringent.

4.2 THE DIFFERENCES OF EMPHASIS COMPARED WITH OTHER COMMON INTELLIGENT CONSTRUCTION

In the intelligent system design of ordinary intelligent mansion, building automation system occupies a very prominent position, which is the key in realizing building comfort and energy efficiency. And in the stadium intelligent system design, computer networks, integrated

Wiring, site lighting control, big venue screen, grades system which is directly related with sports competition, television systems, athlete registration system, the news release system etc. become more important. This is the different focus on construction. The ordinary intelligent mansion emphasizes the inner building equipment management; however, stadium emphasizes the system related with competition.

The stadium intelligent system should stick to the principle of importance protrusion, conciseness, reality and people-orientation, avoiding the unnecessary technology accumulation outside the practical needs.

4.3 THE CONSTRUCTION GOES WITH MULTIPLE MAJORS AND COMPLEX TECHNOLOGIES

Stadiums intelligent system generally consists of more than two dozen subsystems. Since stadiums are generally in the form of building construction, including the stadium, stadium, and swimming pool composition; each intelligent system of each venue is relatively separate, but are also interdependent and information-sharing with other buildings. Design should consist with the specific characteristics and usage. Different stadiums are also disparate in design and equipment. The integral design, systematic coloration and the interrelation also should be taken into consideration in order to guarantee the design is nor out of the date. Furthermore, the intelligent system, as the integral part of the building, also should coordinate with other relevant majors, such as mechanical and electrical equipment professional, civil engineering professional, renovation professional, craft professional sports, etc. Intelligent construction, the component of building, not only cooperates with other majors but also calls for the coordination of other majors. Since the demand for cooperation is high, it is a must to have good communication and coordination with each major.

The stadium intelligent system design coves various areas with Technical complexity and High-tech, such as computer professional, professional control, electric Sub-professional, professional acoustics, optics professionals, systems integration expertise, network information professionals etc. This is also the difficulty and peculiarity of stadiums intelligent construction, calling for the joint effort of different majors, help from each other and learning from others. So the challenge of design is imaginable.

4.4 COMPLEX GAME INTEGRATED PIPELINE

The symbol of stadium is the sports supporting system, including timing and scoring system, TV Broadcast systems, personnel registration system card system, query results system, news release system etc. All kinds of reserved pipeline demanded by these systems should be given sufficient reserve space in the preliminary design in order to meet the demands of wirings supported by technology in various sports meeting.

5 The significance of stadiums intelligent systems research

With the arrival of the Olympic project construction boom, China's sports venue construction has entered a new and unprecedented stage. Currently Beijing National Stadium (Bird's Nest) has begun to take shape, many domestic provinces and cities have built stadium one after another. Moreover, Shandong, which won the right to host the 2009 Eleventh National Games, has already devoted in Jinan Olympic construction. Design and implementation of intelligent systems is also an important component in stadium

construction which can ensure the smooth proceeding of sports, provide comfortable and safe environment for people and improve the management level of property personnel.

Nowadays, such a huge market is both opportunity and challenge for each intelligent system integrators. The intelligent system design, planning, research for China is on the initial stage and many problems are to be dealt with in the process. In this thesis, we have set Zhuzhou intelligent system for example. Through practical summary about the existence of problems concerning intelligent system plan, design and project management etc., we have found out the resolutions and summarized relevant experience, hoping to be beneficial to the later stadium intelligent system and to provide reference for the criteria stipulated by government.

6 Stadiums intelligent system
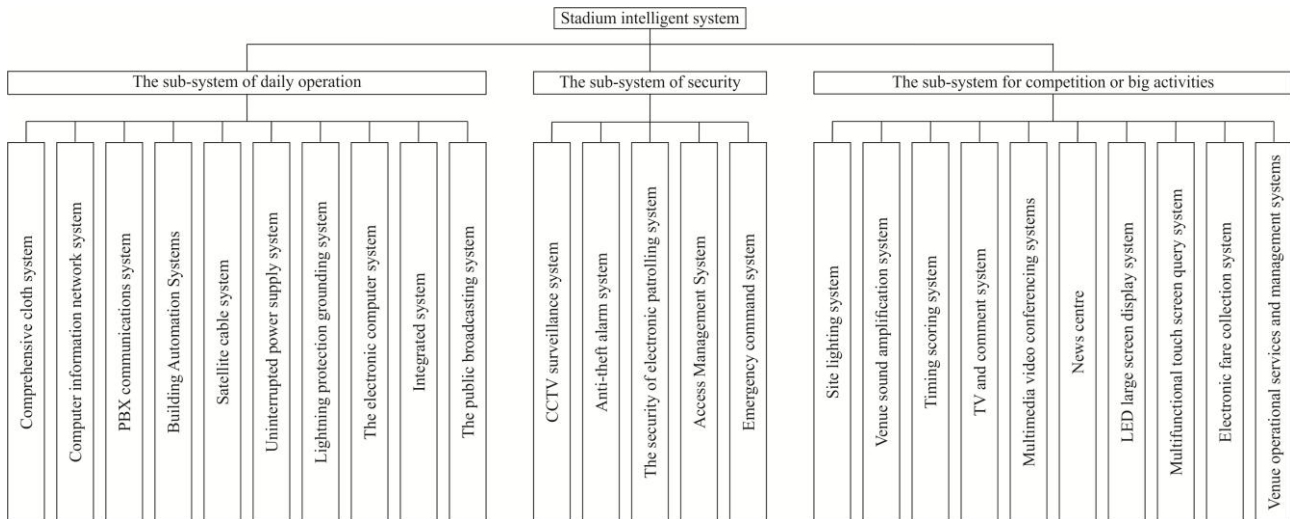
FIGURE 1 Stadium intelligent system

6.1 INTELLIGENT POWER DISTRIBUTION SYSTEM

Currently, stadiums have assumed various kinds of sports competition and performances and the extent of openness is on the rise. Meanwhile, the demand for stadium is becoming higher. Therefore, for the intelligent stadium construction, electrical distribution system usually applies intelligent design to improve the reliability of electrical distribution system. Accumulate the data in each system by light of sensor technology, and then transfer data to computer and tackle comes last. Calculation results can be visually displayed on the screen; meanwhile, power distribution system operation can be manipulated. Since the computer can be programmed, it is valid to realize automation and enhance working efficiency.

6.2 INTELLIGENT LIGHTING SYSTEM

Lighting System is critical for competition; moreover, light Illumination mode should also change accordingly in differrent cases. And an intelligent system is needed. At present, intelligent lighting system can design hierarchically to realize different functions through the communication network platform. Then control the lights and detect the lamp use automatically by light of compute and the malfunctions can be found and excluded timely, thus ensuring the normal function. In addition, you also need to consider emergency lighting design to prevent accidents from happening.

6.3 INTELLIGENT SECURITY MONITORING SYSTEM

When holding competition or activities in stadium, for the venue managers, top priority is to ensure the safety of all the people entering the stadium. Therefore, there is a need to control the site during competition or activities, including the scope of venues and venues around. The surroundings around the venue mainly apply closed-circuit TV monitoring system, and exit and entrance of venue is camera in order to confirm the emergency timely. Once unforeseen circumstances happened, security personnel can arrive at the site immediately, thus enhancing the ability of tackling emergency. In addition, the door in the internal access is installed with FI detectors in order to prevent the illegal entrance.

6.4 SMART DISPLAY SYSTEM

When holding sports competition, the real-time situation or game screen should be presented to the spectators directly in order to be convenient to watch the game. In the intelligent stadium, every part of the game is set with cameras. Then, transmit the screen to L E D display on top of the stadium via network platform. The display screen is able to present the competition process from various perspectives. Then process the data by light of integrated circuits, and spectators can watch the highlights of the replay camera.

6.5 CABLING SYSTEM

In the process of stadium intelligent system construction, cabling is an effective platform for information and data transfer. In order to save costs and facilitate management, cabling must be designed according to stadium function and plan. Try to choose a more optimal solution; meanwhile, future development plan of network equipment and the reservation for power should also be taken into consideration. The system uses a star structure and is designed based on the standards of non-shielded Category 6 which can meet the use of fast Ethernet, Gigabit Gigabit Ethernet and other network.

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Operation Research and Decision Making

21

Operation Research and Decision Making

Teachers present situation of information literacy for college and university teaching

Zheng Xu

*Computer Modelling & New Technologies 2015 **19**(3C) 7-9*

With the continuous development of the Internet information technology, it had also changed for the colleges and universities education teaching model under this background. And it has become a very important task in today's colleges and universities for the information technology literacy teachers training. In this aspect, many universities and colleges had this problem in this aspect, some even went into a myth, and wasted the manpower and material resources. This article aimed to analysis the current stations of teachers information literacy during the teaching in universities and colleges, and discussed the methods of obtaining teachers information literacy.

Keywords: Education teaching mode, teachers' information literacy, the status quo, method

Research on the low carbon packaging of food

Yan-qi Liu

*Computer Modelling & New Technologies 2015 **19**(3C) 10-13*

Now the food safety issue had become the subject relating people's livelihood, and in which the food packaging issue become more and more important, and had got much attentions. This paper was to research and analysis of the problems of food packaging at present stage, and investigated from the direction of low carbon environment-harmonious food packaging design. Then this study put forward several design ideas, such as: integrated design, simple design, packaging technology and material selection, etc.

Keywords: Packaging of Food, Low Carbon, Environment-harmonious, Research Analysis

Discussing to the application of virtual reality technology in competitive sports for simulation training

You Sheng

*Computer Modelling & New Technologies 2015 **19**(3C) 14-16*

The application of virtual reality technology in competitive sports for simulation training can be used to movement' analyses, evaluate, arrange and innovation. This technology improves the technological content of sports training. Therefore, it makes athletes to grasp sports technique quickly and keeps in good form. The paper describes research status and development trend of the technology of virtual reality and physical stimulate and its application in sports training. And it discusses the function and system of virtual reality technology in simulative training.

Keywords: Virtual Reality, Competitive Sports, Simulative Training

Study on intelligent stadium operation management assisted by computer

Xiying Zuo

*Computer Modelling & New Technologies 2015 **19**(3C) 17-21*

With the emergence of intelligent constructions, the designs of stadium which act as the venue for sports events also develop rapidly to the direction of intelligence. Computer technology is not only able to help the venue manager to finish various tasks but also be able to realize the information exchange of all systems. The control technology can realize the automatic manipulation over all kinds of equipment. Currently, the intelligent system of stadium is able to realize the share of resource and information, to enhance the equipment utilization and to save energy, providing a safe, comfortable and convenient environment for users.

Keywords: computer assistance, stadium, intelligent construction, operation management

Content

Numerical simulation of deposited behaviours of Al particle on Mg substrate in supersonic particles deposition

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Abstract

ANSYS/LS-DYNA is used to simulate supersonic particles deposition process of Al particle impinging on Mg substrate. Critical velocities of particle at different spraying temperatures and deformation, highest temperatures, stress and strain of particle/substrate are studied. The results show that with the increasing of spraying temperatures, the critical velocities experience a small amplitude decrease. For the two aspects of single particle and two-particle impingements, the highest temperature rises with the increasing of initial temperature and the deformation morphology and stress and strain of particle/substrate vary with/without tamping effect. Upon the effect of tamping, the flatten ratio of pre-deposit particle is bigger than the particle without the tamping effect at the same velocity. The values of maximum stress and strain of two-particle with tamping effect are both higher than single particle impinging. The change gradient of stress without tamping effect is much steeper in comparison of two-particle impinging with the velocity increasing while the change curve tendency of maximum strain is similar to the flatten ratio.

Keywords: supersonic particles deposition, simulation, tamping effect, critical velocities, stress and strain

1 Introduction

Supersonic particles deposition (hereafter referred to as SPD) is based on the cold spray technique and develops rapidly as a new spraying process [1-3]. Cold spray was initially developed in the mid-1980s at the Institute for Theoretical and Applied mechanics of the Siberian Division of the Russian Academy of Science in Novosibirsk [4-6]. The compressed gases, generally nitrogen, helium and air, or their mixtures, are used in cold spray process. The feedstock powders are injected into a de-Laval type nozzle by the gases and accelerated to a supersonic velocity, these particles impinge on the substrate and form the coating [7-9]. In the impinging process, the impact behaviours can bring high plastic deformation, contact stress and plastic strain. A continued flux of impinging particles may result in a continuously impinging through high velocity impacts between particles arriving at the substrate and those already deposited. The occurrence of bonding on particle impact is widely regarded to be related to the occurrence of shear instabilities at the inter-particle boundaries, due to high strain rate deformation [10].

The impinging process between the feedstock powders and the substrate finishes in a very short time period, usually less than 0.1ms. With a transient process, the colliding and deformation of the particle/substrate cannot be observed by experiments easily in the SPD process [11, 12]. M. Grujicic [13] proposed that jet-like metals might produce interfacial roll-ups and vortices under the Kelvin-Helmholtz effect in this rapidly process, which results in a mechanically combine on a substrate of particles. B. Gyuyeol [14] studied the deformation and the critical velocities of single particle impinging on substrate with different hardness of materials using computational methods. ZHOU [15] studied the deposition behaviour of multi-particle impact of Cu coating, tamping effect of continuous particles was proposed.

The light metals (such as Al, Mg) are so active that they are inappropriate to prepare by high temperature spraying processing, and SPD technique provides an effective method to tackle the defects of melt, oxidation and the phase transition of materials, which exists mostly in traditional thermal spraying. In this article, the deformation behaviours and tamping effects of Al particles and Mg substrate are investigated by computational methods. Meanwhile, the flatten ratio, maximum stress and strain of single particle and two-particle impinging behaviours are studied.

2 Numerical modeling

2.1 FINITE-ELEMENT METHODOLOGY

The impinging behaviours of particles on the substrate in SPD are analyzed using the finite-element program ANSYS/LS-DYNA. The particle is assumed to impact the substrate vertically, a schematic of computational domain vertical collision of spherical particle and cylindrical substrate is given in Figure 1. The finite element model and grid meshes of single particle impinging on substrate are shown in Figure 1(a), which is referred to without tamping effect; and the two-particle impinging in Figure 1(b) can be seen as with tamping effect, correspondingly. The size of particle is 50μm average and the cylindrical substrate is adequate for particles and substrate deformation, the impacting domain is two twice than the particle size [16]. Four-node bilinear shell elements, hourglass control and two-dimensional automatic single surface contact are used in the simulation process.

a) single particle without tamping effect
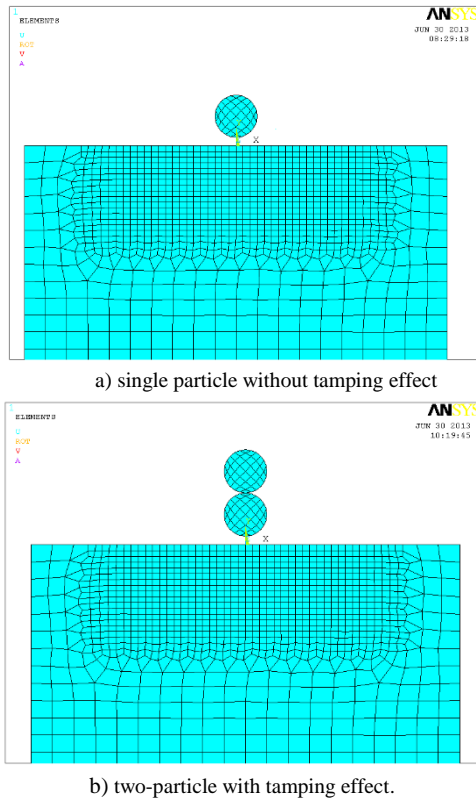

b) two-particle with tamping effect.

FIGURE 1 2-D finite element models and grid meshes of impinging

a. Boundary conditions.

The boundary condition of underside of substrate is wall-boundary, and the other faces are deemed as freedom boundaries. In these models, the interaction of

particle/substrate is assumed to be an adiabatic process, the shear friction of particles on substrate is viewed as a negligible quantity. The initial temperature and pressure of spraying process are set to 300K and 0.65MPa respectively.

b. Material models.

Both particles and substrate are set as strain-hardening, strain-rate sensitive and thermal-softening materials, and the materials are assumed to comply with Johnson-Cook plasticity model [17], the equivalent normal plastic deformation resistance σ is written as in Equation (1).

$$\sigma = [A + B\varepsilon_p^n][1 + C\ln(\varepsilon^*)][1 - (T^*)^m] , \tag{1}$$

where ε_p^n is the equivalent normal plastic strain, ε^* the equivalent plastic strain rate normalized with respect to a reference strain rate, constants A, B, n, m and C are determined by material properties, and T^* the temperature which can be denoted by initial and the melting temperature, respectively[17-18]. The materials may lose effectiveness at the colliding process, so we adopt the losing-effectiveness modeling of material based on Johnson-Cook plasticity model, the accumulation damage law is as follows in Equation (2).

$$D = \sum (\Delta\varepsilon / \varepsilon_f) \tag{2}$$

where $\Delta\varepsilon$ is the increasing of effective plastic strain, ε_f the losing effectiveness strain, it is a function of effective strain, plastic strain rate and temperature [17, 18]. Then some material properties of Al and Mg alloy are shown in Table 1.

TABLE 1 Some material properties of feedstock and substrate

	Materials	Young's modulus (GPa)	Density (g/cm³)	Poisson's ratio	Specific heat capacity (J/kg·K)	T^*(K)
Feedstock	Al	68.9	2.7	0.33	904	1189
Substrate	Mg	44.8	1.8	0.35	10.4	986

3 Results and discussion

3.1 CRITICAL VELOCITY OF PARTICLE

The particle velocity is one of the dominant factors in the process of coating forming. It has been shown that the sign of an adequate degree erosion deforming on the substrate surface of spraying particle is adiabatic shear instabilities formation, which means that the critical velocity is as a particular minimum particle velocity to form a coating on the substrate surface [13, 19-20]. In the simulation process, Al particles with different spraying temperatures exist different critical velocities, the spraying temperatures play a more significant role in promoting velocities than other parameters.

The input of temperature parameters is by a little program which is inserted into the ANSYS main programs and the algorithm of the temperature program is based on the principle of Thermo-Solid Coupling, while the other parameters such as spraying pressure, particle size, distance to exit of nozzle, the radial position are set as constants in this paper. The critical velocities at different spraying

temperatures are shown in Table 2. The results show that the critical condition of successful deposit of particles onto substrate is of dependence on implementation by increasing spraying temperatures.

TABLE 2 Critical velocity of Al-alloy powder at process pressure 0.65MPa

Spraying temperature (K)	Critical velocity (m/s)
300	720
400	714
500	678
600	653
700	631
800	616
900	588

3.2 DEFORMATION BEHAVIOURS OF PARTICLE AND SUBSTRATE

Figure 2 shows the simulated deformation morphologies and value of strain of single particle and two-particles on substrate at different moments at the critical velocity of

720m/s (temperature=300K, pressure=0.65MPa).

It is obvious that the deformation is severe and the strain is intense, the particles become flat and craters take place on the substrate (Figure 2). With the contact time increasing, a jet-type flow of the materials at the interface generates on both impinging aspects. The jets flow occurs only in the substrate at 20ns, the metallic jets are discovered on the interface of particle and substrate at 40ns. In Figure 2c, 2d we can detect that the pre-deposited particle is flatter than single particle impinging (Figure 2a, 2b)) at the same moment, and the deformation of subsequent particle is also intense because they are same materials and deform easily of consubstantial solid material.

The maximum strain takes place at the interface of particle and substrate, and locates at the side of substrate, we can infer that at these places the deformation is severe and the temperature may be sufficient to melting point of the materials. The specific heat capacity of Mg is much lower than Al (Table 1), the capacity of heat dissipation of Mg is weaker and the temperature can be raised to its melting point more easily than Al, so the maximum of strain is on Mg substrate [8]. And the continuous particles improves the kinetic energy of pre-deposited particle, which results in promotion of converting to internal energy, so the value of strain of the interface with tamping effect are higher than the interface without tamping effect in Figure 2.

a) single particle at 20ns

b) single particle at 40ns

c) two-particles at 20ns

d) two-particles at 40ns 40ns
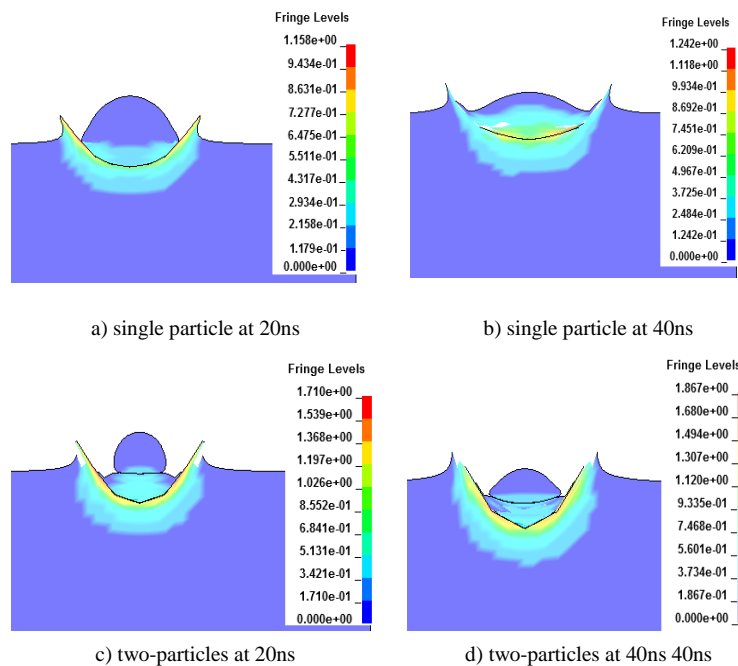
FIGURE 2 Deformation morphology and value of strain of particles at 750m/s

The initial temperatures generate a profound influence on the deformation of solid particles as well. The highest temperature of the impinging process is located on tangent edge of the Mg substrate and the maximum value of temperature increases with the growing of the initial value, the results of the influence of initial temperature on the highest temperature are shown in Figure 3. From the curves, we can infer that the highest temperatures of single particle impinging process at different initial temperatures are all a little smaller compared with the two-particle impinging process. The highest temperature reaches to nearly 900K which is proximity to the melting point of Mg substrate when the input data of initial temperature is 700K, that is to say, the substrate will probably melt if there is a continuing increase of the initial temperature. This situation should be avoided in our experiments because the coating in SPD melts barely in the spraying process. So the preheat temperatures in our experiments are practically lower than 400K so that we can achieve the champion coatings.
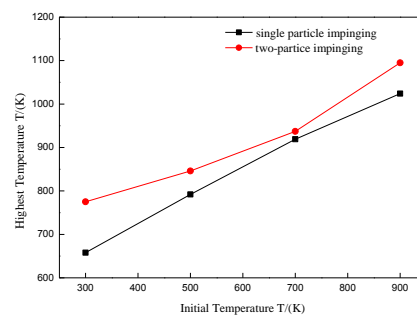
FIGURE 3 Influence of initial temperatures on highest temperatures in impinging process

Flattening ratio which is defined as the ratio of the diameter of deformed particle to that of a spherical particle of the same volume, is often used to estimate the deformation of impinging particles. In the impinging process, the subsequent particle breeds a tamping action on the pre-deposited particle [21], which results in different aspects of deformation, the ratios of single particle (without tamping effect) and multi-particle (with tamping effect) on the Mg substrate at different velocities are shown in Figure 4.

As can be seen from the linear fit of the measured data in Figure 4, the flattening ratios do not increase remarkably with the critical particle velocities, however, the flattening ratios of particles with tamping effect increase partly at the same critical velocity comparing with single particles. Therefore, the tamping action on pre-deposited particle by subsequent particle plays a vital role in particle deformation and shaping of coatings.
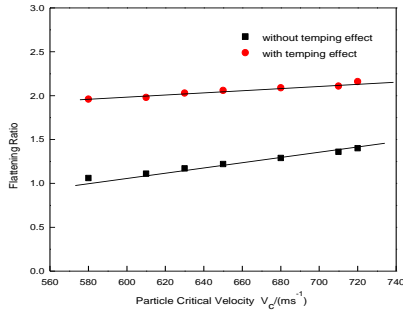

FIGURE 4 Influence of tamping effect on the particle flatten ratios

3.3 STRESS AND STRAIN DISTRIBUTION

The relationships between maximum stress, strain and impinging moment of pre-deposited particle are shown in Figure 5. It can be easily obtained that strain and stress of pre-deposited particle are both mutant at about 10ns, the strain remains constant in contrast with the occurrence of stress fluctuation as shown in Figure 5. The maximum value of strain is at the interaction edge and the strain curve states that the thermal-softening effect is superior to strain-rate hardening characteristics of Mg substrate, which results in the plastic flow and the adiabatic shear instability at 5~10ns. Meanwhile, the maximum strain remains 1.325 with increasing of contact time. Similarly, the stress curve states the plastic deformation increases rapidly in initial colliding process. The flow stress fluctuations are investigated at 20-35ns and 40-50ns. At 20-35ns, high-rate visco-plastic deformation occurs at the interface and interior of materials where the adiabatic shear instability takes place. At this occasion, the metallic jets release the stress while the visco-plastic deformation stores stress at the same time, so the stress presents fluctuations at this stage. At 40-50ns, the kinetic energy of particles transfers to internal energy of substrate and particles and the instantaneous stress of particles which produced by impinging also transmits to substrate. The stress in substrate dissipates most then the stress reduces to 1000MPa rapidly. Besides dissipation, the stress grows as the contact time increases so the fluctuation is founded at this time interval.
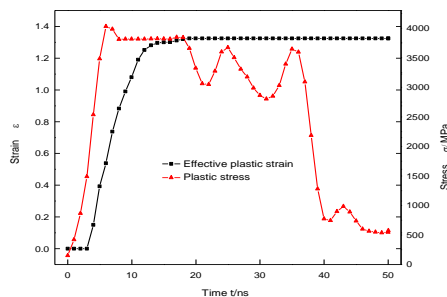
FIGURE 5 Simulated temporal developments of stress and strain of particle with tamping effect

The influences of particle critical velocities with/without tamping effect on maximum stress, strain are shown in Figure 6. As we can see that the maximum stress of particle increases with the soaring of critical velocities whether the tamping effect exists (Figure 6a), but the maximum stress with tamping effect is higher than that without tamping effect obviously. With the tamping effect, the maximum value is approximately 3 times than the particle deposit without tamping effect at the velocity of 580m/s, so we can presume the maximum value of pre-deposited particle is located at the interface of pre-deposited particle and the follow-up particle. At the velocity of 720m/s, the deformation of particle is adequate and similar, so the maximum stress value increases slowly. The changes of strain of particles with different deposit aspects are similar to the flattening ratio (Figure 6b), since the changes of strain are synchronous with the deformation of particle with the increasing of time, the degree of craters of substrate and flattening ratio of particle is associated with the tendency of the effective plastic strain of particle.
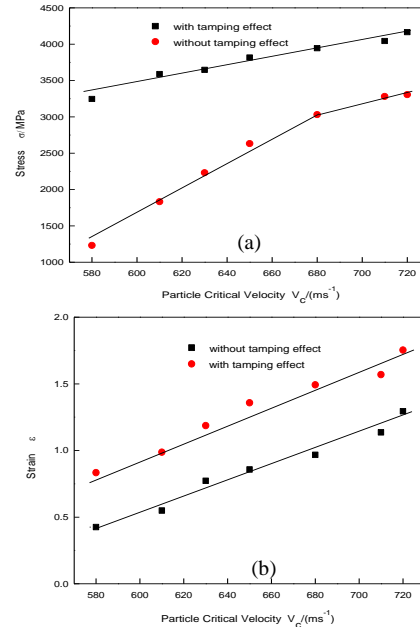
FIGURE 6 Stress and strain distribution at different critical velocity:
(a) stress distribution (b) strain distribution

4 Conclusions

1) The critical velocity of particle decreases with the rising of spraying temperature, so in the actual spraying process, the extra cost of increment gas pressure to increase particle velocity can be cut down by increasing the spraying temperature, and the spraying efficiency is souped-up.
2) Under the tamping effect, the flatten ratio of particle and the crater depth of substrate are greater than the particle/substrate without tamping effect, which states that the deformation of two-particle is more severe and the interlock of the interface is closeness.
3) The preheat temperature in experiments should be lower than 400K to avoid the excessive high temperature which will probably results in the melting of substrate material. The maximum stress of particle/substrate is concussion with an increase of impinging time while the strain tends to a

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stable maximum value at 720m/s of two-particle impinging onto substrate. With the critical velocity increasing, both of the stress and strain increase partly, and the maximum value of stress and strain are higher with tamping effect compared with the single particle impacting without tamping effect.

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Study on supported perovskite-type catalysts for catalytic combustion of volatile organic compounds

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Abstract

$La_xCe_{1-x}M_yN_{1-y}O_3$ was supported on γ-Al_2O_3 by equal volume impregnation method. The effects of loading amount, calcination temperature, element type and element ratio in the A-site and B-site on catalytic combustion of toluene were investigated. Then the catalysts were characterized by XRD, BET and SEM. The results showed that the optimum preparation condition of the catalyst was the loading amount of 12%, the calcination temperature of 750°C, and the catalyst form was $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$/$\gamma$-$Al_2O_3$. Under the action of this catalyst, the ignition temperature T_{50} and complete conversion temperature T_{90} of toluene were 243°C and 303°C, respectively. The supported perovskite catalyst maintained perfect perovskite structure and dispersed uniformly. Its surface area and porosity were greatly increased. The whole structure was fluffy and conductive to practical application.

Keywords: volatile organic compounds, catalytic combustion, perovskite, support

1 Introduction

Volatile organic compounds (VOCs) are the major components in air pollutants, which are organic compounds with the boiling points in the range of 50~260°C and saturated vapor pressure at room temperature for more than 133.3 Pa. Currently there are more than 300 kinds of VOCs having been identified, of which the most common are benzene, toluene, xylene, styrene, trichlorethylene, etc. VOCs have attracted great concern all over the world because of their toxicity to human health and the environment [1]. The main approaches for treatment of VOCs include adsorption [2, 3], membrane separation [4], biodegradation [5, 6], photocatalytic degradation [7], corona method [8] and catalytic combustion technology. Catalytic combustion technology [9] is one of the most effective methods for the elimination of VOCs due to its simple equipment, low energy consumption and high removal efficiency.

Selecting suitable catalysts is the most important thing of the catalytic combustion reaction. There are three types of VOCs removal catalysts, including noble metal catalysts, transition metal oxides and composite metal oxides. Each type has its own advantages and practical limitations. Noble metal catalysts, especially palladium-based catalyst, can exhibit outstanding catalytic behavior at low temperatures. However, they are expensive and easy to be deactivated by poisoning. Non-noble metal catalysts have been more and more attractive due to the lower cost and relatively abundant resources, while they always need a high ignition temperature and the structure is not stable enough [10]. The activity of mixed metal oxides is higher than the single metal oxides due to the interaction of the structure and electronic modulation. Perovskite is one of mixed metal oxides, which is represented by the general formula ABO_3. The A- and/or B-site of ABO_3 can be substituted by many foreign metal cations without destroying the matrix structure, as long as the tolerance factor is in the range of 0.7~1.1 [11, 12]. The partial substitution of A and/or B by another metal ions may improve the stability or enhance the activity of the catalyst. In recent years, perovskite catalyst has been widely investigated by researchers because of its advantages of low price, high activity, high temperature stability and good chemical stability. Jiguang Deng et al. [13] removed toluene and ethyl acetate by $LaCoO_3$/SBA-15. Hisahiro Einaga et al. [14] investigated the cation A doping of $LaMnO_3$ for catalytic combustion of toluene, and found that the doped catalyst activity was affected by the calcination temperature. Pecchi et al. [15] prepared $LaFe_{1-y}Ni_yO_3$ by sol-gel method to remove ethanol and ethyl acetate. Zhai et al. [16] prepared $LaMnO_3$ by co-precipitation method, sol-gel method and spray pyrolysis method, investigating the relationship of different preparation method and the catalytic activity of methane combustion. Most of the studies focus on the element substitution in the A or B cation individually, while little research is about the substitution in both the A and B cations. Therefore, this paper aimed at preparing a series of $La_xCe_{1-x}M_yN_{1-y}O_3$ catalysts supported on γ-Al_2O_3 by impregnation method, investigating the influence of preparation conditions on catalytic activity of toluene and emphatically analyzing the effect of the element substitution in the A and B cations.

2 Experimental

2.1 CATALYSTS PREPARATION

The carrier Al_2O_3 was obtained from Aluminum Corporation of Shandong, China with particle diameter of 1~2 mm. First, Al_2O_3 was put into muffle furnace and calcined at 550°C for 4 hours. Specific amount of $La(NO_3)_3 \cdot 6H_2O$, $Ce(NO_3)_3 \cdot 6H_2O$, $M(NO_3)_x \cdot yH_2O$ and $N(NO_3)_x \cdot yH_2O$ were weighed according to molar ratios and dissolved into anhydrous ethanol (M, N were Fe, Co, respectively. When M was Ti, then $Ti(C_4H_9O)_4$ was used.). The solution was stirred vigorously. Then, specific amount

of γ-Al$_2$O$_3$ was immersed into the solution by equal volume impregnation method for 12 h, followed by drying at 80°C for 12 h, and finally calcined in a muffle furnace at 750°C for 6 h.

2.2 ACTIVITY TESTS

Catalytic activity tests were conducted in a fixed-bed flow reactor at atmospheric pressure. Schematic representation of the experimental system was shown in Figure 1. It was comprised by the gas generating system and the catalytic combustion system. The concentration of toluene was controlled by adjusting the air flow rate and toluene flow rate. The reactor was a stainless steel tubular reactor with diameter of 20 mm and length of 550 mm, which provided uniform heating of the catalyst bed. Typically, 10 ml of catalyst was packed between the layers of quartz sand. The temperature of catalyst bed was monitored and controlled by temperature controller and the temperature was measured by a type-K thermocouple. The inlet and outlet concentrations of toluene were analyzed by gas chromatograph (VARIAN CP-3800) equipped with FID.
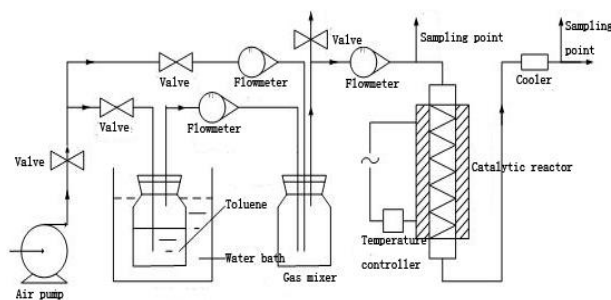
FIGURE 1 Schematic diagram of the experimental catalytic combustion process

2.3 CHARACTERIZATION

The crystal structure of sample was examined by the X-ray powder diffraction (XRD) method, using an X' Pert Pro MPD powder diffractometer made in Netherlands. Measurement of surface area was carried out by the BET nitrogen adsorption method on Micromeritics ASAP2010 automatic adsorption instrument made in America. Scanning electron microscopy (SEM) images were acquired with an S-4800 electron microscope made in Japan to observe surface topography of catalyst.

3 Results and discussion

3.1 CATALYTIC ACTIVITY OF LA$_X$CE$_{1-X}$TIO$_3$

3.1.1 Effect of loading amount of active component on catalytic activity

La$_{0.8}$Ce$_{0.2}$TiO$_3$/γ-Al$_2$O$_3$ catalyst was prepared in this part. Figure 2 shows the catalytic activities of the five perovskites for toluene oxidation. The specific surface area of the catalyst prepared by conventional method with high calcination temperature is usually less than $5m^2 \cdot g^{-1}$.

Although the specific surface area of the non-supported catalyst prepared in this study increases to $8m^2 \cdot g^{-1}$, its activity is still poor. In order to increase the activity, the catalyst must be supported on a carrier so as to reduce the particle size and improve its dispersity. A control test of γ-Al$_2$O$_3$ without loading La$_{0.8}$Ce$_{0.2}$TiO$_3$ is performed under the same conditions. The conversion rate of toluene is very low in the control test. With the increase of temperature, the conversion rate rises slowly, and only reaches to 36% at 410°C. The loading of La$_{0.8}$Ce$_{0.2}$TiO$_3$ significantly improves the catalytic activity of the catalyst. It is identified from Figure 2 that the activity increases by raising the amount of La$_{0.8}$Ce$_{0.2}$TiO$_3$ loading. When the loading amount reaches to 12%, the catalyst is the most active. The ignition temperature T50 and complete conversion temperature T90 of toluene are the lowest. However, when the loading amount is 15%, the catalytic activity decreases. The probably reason is that the active center is not enough at low loading amount, resulting in low activity. Catalytic activity increases with the increase of loading amount. But when loading amount is too high, the active center is covered by metal, resulting in a decreasing activity. Besides, metal is easy to aggregate and lead to some inactivation in reaction of high temperature.
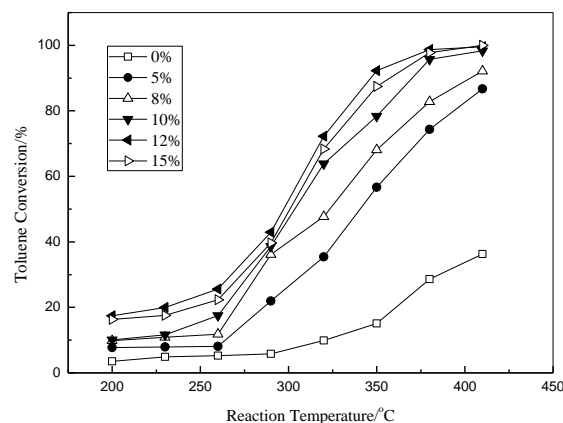

FIGURE 2 Effect of different loading amount of active component on catalytic activity

3.1.2 Impact of calcination temperature on catalytic activity

Figure 3 shows the catalytic activity results obtained for oxidation of toluene over the catalyst La$_{0.8}$Ce$_{0.2}$TiO$_3$/γ-Al$_2$O$_3$ calcined between 600°C and 1100°C. The catalytic activity shows in general a maximum for the sample calcined at 750°C. With calcination temperature continuing to rise, the conversion rate of toluene under the same reaction temperature reduced gradually at 750°C or more. The calcination temperature has great impact on catalytic activity. Perovskite structure is formed as a single phase upon calcination at T>700°C. However, as the calcination temperature rises continuously, the grain of La$_{0.8}$Ce$_{0.2}$TiO$_3$ is sintered, leading to smaller specific surface area and lower activity [17]. T90 of toluene over the catalyst calcined at 1100°C is 70°C higher than the one calcined at 750°C, indicating that the thermal stability of the catalyst is not very good.
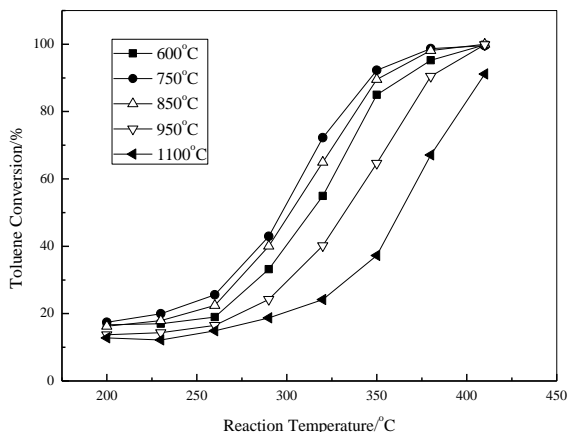
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FIGURE 3 Effect of different calcination temperature on catalytic activity

3.1.3 Impact of element ratio of La, Ce on catalytic activity

Figure 4 presents the catalytic activities of the $La_xCe_{1-x}TiO_3/\gamma$-Al_2O_3 (x=0, 0.2, 0.4, 0.5, 0.6, 0.8, 1.0) catalysts for toluene oxidation. The substitution of La^{3+} by other rare earth metal ions favors the creation of structural defects, accelerates oxygen diffusion, and induces more surface active oxygen species [18]. Also, it is known that the materials with Ce have high oxygen mobility. Ce^{3+}/Ce^{4+} ions cause an exchange of oxygen with the gas phase, resulting in oxygen mobility and therefore higher oxidation activity [19]. Among the catalysts investigated, La-Ce-Ti three-component mixed oxide catalysts show better activity than La-Ti catalyst. When some crystal lattice of the perovskite is substituted by Ce, oxygen vacancies are formed in order to maintain electrical neutrality, and specific surface area of the catalyst changes. The joint action of the oxygen vacancies and specific surface area makes $La_{0.8}Ce_{0.2}TiO_3$ the most active.
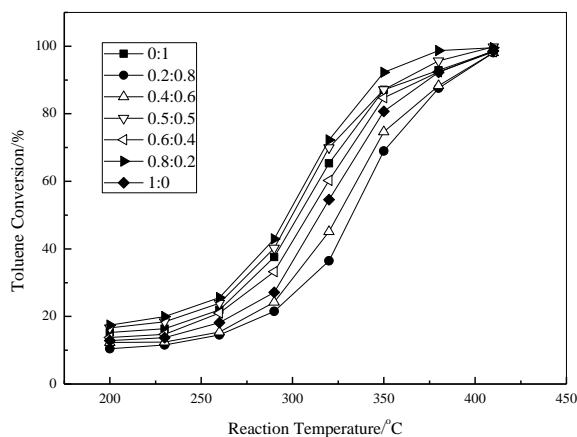
FIGURE 4 Effect of different ratio of La, Ce elements on catalytic activity

3.2 CATALYTIC ACTIVITY OF $LA_{0.8}CE_{0.2}TI_YM_{1-Y}O_3$

3.2.1 Impact of element type of M on catalytic activity

The knowledge of structural chemistry shows that the elements in the B cation play a key role on the activity of perovskite catalyst. So $La_{0.8}Ce_{0.2}Ti_{0.8}M_{0.2}O_3/\gamma$-$Al_2O_3$ (M=Fe, Mn, Co) catalysts were prepared in this part. The catalytic activity of the three samples is plotted in Figure 5. It has

been reported that the catalytic activity of perovskite type $AB_xB'_{1-x}O_3$ is related to the metal-oxygen bond and the free energy of reduction of the cations at B and B′ sites [15, 20]. Substitution modifies the surface structure of the catalysts by greatly increasing the oxygen valances in the surface regions, which results in better performance of catalytic activity. Figure 5 shows that the catalyst doped with Mn in the B cation has better activity than the other two samples.
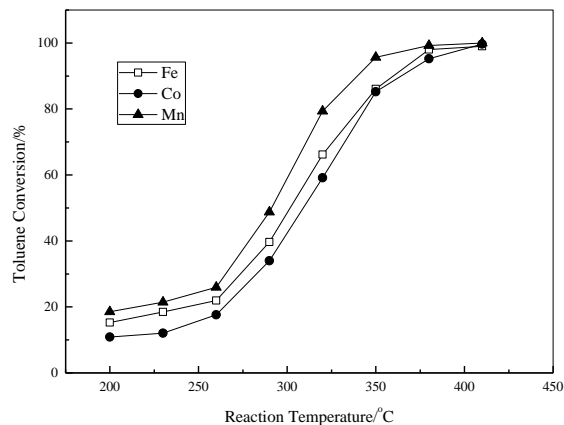

FIGURE 5 Effect of different type of element M in the B cation on catalytic activity

3.2.2 Impact of element ratio of Ti, Mn on catalytic activity

Figure 6 presents the catalytic activities of the $La_{0.8}Ce_{0.2}Ti_yMn_{1-y}O_3/\gamma$-$Al_2O_3$ (y=0, 0.2, 0.4, 0.5, 0.6, 0.8, 1.0) catalysts for toluene oxidation. The catalytic activity is greatly affected by the M doping amount. When y=0, the ignition temperature T50 and the complete conversion temperature T90 of toluene are 257°C and 315°C, respectively, significantly lower than the other six cases. It indicates that $La_{0.8}Ce_{0.2}MnO_3/\gamma$-$Al_2O_3$ exhibits much higher activity than other samples. The possible reason is that Mn has a variety of oxidation states, the modulation between different valences produces lattice defects, thereby improving the catalytic activity [21].
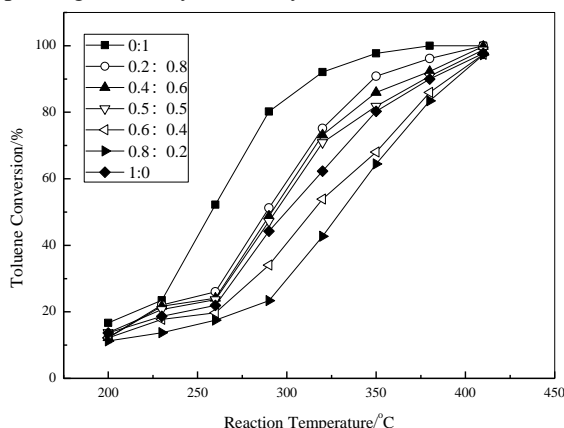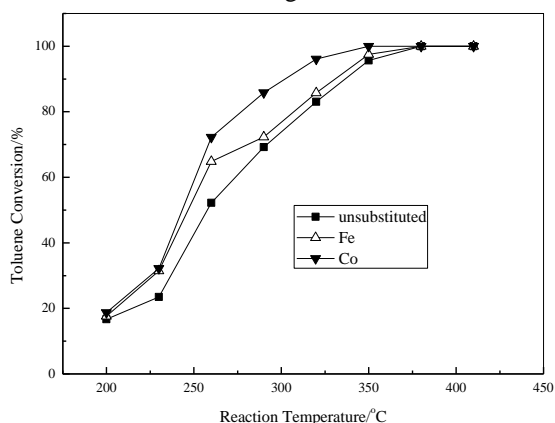

FIGURE 6 Effect of different ratio of Ti, Mn elements on catalytic activity

3.3 CATALYTIC ACTIVITY OF $LA_{0.8}CE_{0.2}MN_YN_{1-Y}O_3$

3.3.1 Impact of element type of N on catalytic activity

The studies above show that the substitution with Mn in the

B cation is more effective. So $La_{0.8}Ce_{0.2}Mn_{0.8}N_{0.2}O_3/\gamma$-$Al_2O_3$ (N= Fe, Co) catalysts are investigated in the following study. It is known from Figure 7 that the substitution with other transition metal is effective. $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3/\gamma$-$Al_2O_3$ performs best. T50 and T90 of toluene are 243°C and 303°C over this catalyst. There are different ionic radius and valence state among Fe^{3+}, Co^{2+} and Mn^{3+}. The partial substitution of Mn by Fe and Co results in more lattice defects and oxygen vacancies, which promote the adsorption and desorption of oxygen molecules on the catalyst and improve the catalytic reaction proceeds [22]. As the difference of ionic radius between Mn^{3+} and Co^{2+} is larger, there are more lattice defects in $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$. This is the reason why the activity of $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$ is higher.

FIGURE 7 Effect of different type of element N in the B cation on catalytic activity

3.3.2 Impact of element ratio of Mn, Co on catalytic activity

The results of catalytic activity of the $La_{0.8}Ce_{0.2}Mn_yN_{1-y}O_3/\gamma$-$Al_2O_3$ (y=0, 0.2, 0.4, 0.5, 0.6, 0.8, 1.0) catalysts in the toluene combustion reaction are shown in Figure 8. The Mn content has a great impact on the activity of the catalyst. When y=0.8, the T50 and T90 of toluene are 243°C and 303°C, respectively, significantly lower than the other six cases. With lower Mn content, fewer lattice defects and less space for oxygen conductivity are produced, which leads to low activity. But when Mn content is too high, the larger ion radius of Mn induces larger cell volume and decreasing surface area, also resulting in low activity [23].
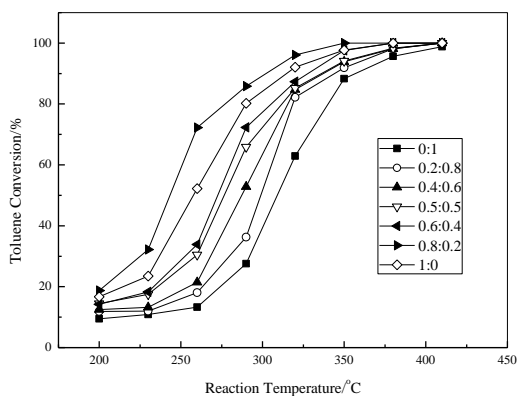

FIGURE 8 Effect of different ratio of Mn, Co elements on catalytic activity

3.4 CATALYST CHARACTERIZATION

3.4.1 XRD characterization

Figure 9 presents the XRD patterns of $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$, $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3/\gamma$-$Al_2O_3$ and γ-Al_2O_3, respectively. In Figure 9a, despite the presence of the diffraction lines of $La(OH)_3$, there are a few strong XRD peaks of perovskite. Figure 9b shows a few observable perovskite diffraction peaks of the investigated catalyst $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3/\gamma$-$Al_2O_3$. It is indicated that after being loaded on γ-Al_2O_3, there is little change in the crystal structure of perovskite active group. $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$ and γ-Al_2O_3 are well combined，which is more conducive to its practical application.
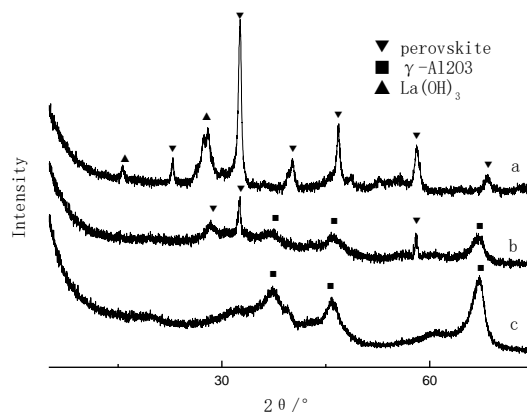
FIGURE 9 XRD Patterns of catalyst samples: a) $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$; b) $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3/\gamma$-$Al_2O_3$; c) γ-Al_2O_3

3.4.2 BET characterization

The BET analysis data of these samples are summarized in Table 1. The specific surface area of $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$ is only 8.0375 $m^2 \cdot g^{-1}$, while increasing to 116.0388 $m^2 \cdot g^{-1}$ after being loaded on γ-Al_2O_3. Although some of the pores are blocked after loading, perovskite can be dispersed more uniformly, thereby increasing the number of active centers. There is also a large variation in the pore size of the catalyst before and after loading. The pore size decreases from 19 nm to 11 nm. The decreasing of pore size produces more active points, which are more conducive to the improvement of activity.

TABLE 1 S_{BET} of catalysts

Catalysts	Surface area /$m^2 \cdot g^{-1}$	Pore volume /$cm^3 \cdot g^{-1}$	Pore size /nm
$La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$	8.0375	0.0387	19.2599
γ-Al_2O_3	170.2937	0.4586	10.7717
$La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3/$ γ-Al_2O_3	116.0388	0.3280	11.3074

3.4.3 SEM characterization

Figure 10 shows the SEM images of three samples. As can be seen in the figure, γ-Al_2O_3 shows puffy porous and loose structure, while the structure of $La_{0.8}Sr_{0.2}Mn_{0.8}Co_{0.2}O_3$ is dense and flaky. The supported $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$ is

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dispersed more uniformly by γ-Al_2O_3. The sample is fluffy and the fine pores increase significantly, which is in good agreement with BET analysis data. It is indicated that perovskite and γ-Al_2O_3 are organically combined, enhancing the activity of catalyst.
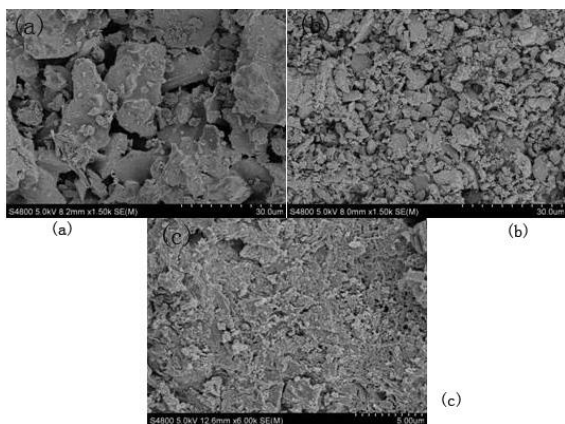

FIGURE 10 SEM images of catalyst samples (a) γ-Al_2O_3; (b) $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3/\gamma$-$Al_2O_3$; (c) $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3$

4 Conclusions

The effects of preparation conditions of supported perovskite catalysts were emphatically investigated. A series of $La_xCe_{1-x}M_yN_{1-y}O_3/\gamma$-$Al_2O_3$ catalysts were prepared by equal volume impregnation method. The catalytic activity for combustion reaction of toluene was investigated of these samples. $La_{0.8}Ce_{0.2}Mn_{0.8}Co_{0.2}O_3/\gamma$-$Al_2O_3$ with loading amount of 12% and calcination temperature of 750 $^\circ$C preformed best. The element substitution in the A and B cation of perovskite changed the oxidation state of the metal ions, which leading to the improvement of catalytic activity. There was little change in the crystal structure of perovskite after loading. Perovskite was dispersed uniformly over the surface of γ-Al_2O_3 and organically combined with it.

Acknowledgments

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Nursing on maternity anesthesia surgery

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Abstract

Objective: Analysis to strengthen the effect of nursing in gynecology and obstetrics anesthesia surgery. Method: This study had select the 100 cases of patients with the treatment of anesthesia surgery of obstetrics and gynecology in our hospital from July 2012 to July 2014, in which, there were 60 cases of patients for full term care on perianesthsia care period, and 40 cases of patients (the control group) whom were only given general nursing. This paper compared the nursing effect of the two group. Results: recover fineness rates of anesthesia care group was 96.7%, patients satisfaction rate was 96.7%, the incidence rate of complications was 7%; recover fineness rates of control anesthesia was 87.5%, the patient satisfaction rate 85.0%, and the complication rate was 7.5%; The anesthesia care group effect was more promising (P<0.05). Conclusion: the full term perianesthsia care could significantly improve the anesthesia effect during the maternity anesthesia, and worth clinical extensive application.

Keywords: Gynecology and obstetrics surgery, anesthesia, nursing

1 Introduction

Obstetrics and gynecology surgical anesthesia would directly affect the operation effect, with the continuous improvement of operation requirements for obstetrics and gynecology operation effect, and the improvement of anesthesia effect has become an important goal of clinical anesthesia work. Before the operation, according to the situation of the patients, this study had chose reasonable anesthesia methods, narcotic drugs and dosage, and reasonable adjusted during the anesthesia, and made sure to maximize the safety of anesthesia, at the same time, tried to improve the operation of sedation and muscle relaxant effect, could effectively improve the effect of anesthesia. At the same time, the reasonable care during the anesthesia was the important guarantee for clinical surgery to obtain ideal anesthesia effect. This article had presented the analysis of gynecology and obstetrics anesthesia surgery nursing situation, detailed reports as below.

2 Basic information and method

2.1 BASIC INFORMATION

This study had selected 100 cases of patients for the treatment of anesthesia surgery in the obstetrics and gynecology department of our hospital from July 2012 to July 2014. All were for downlink laparoscopic surgery through waist hard joint anesthesia. According to the difference of anesthesia care and the 100 cases of patients were divided into two groups. 60 cases (care group) aged 18-61 years old, and the average age was 42.6±7.4 years old. 40 cases (control group) aged 20-62 years old, the average age was 42.3±7.2 years old. Among the 100 cases

of patients, 21 cases of patients were with ovarian tumor, 47 cases of patients were with uterine fibroids, 12 patients had hysterectomy, 14 patients were suffering from ectopic pregnancy surgery, the other 6 cases of patients were with other diseases of obstetrics and gynecology. All patients were without obvious pathological changes for cardiopulmonary organs, liver and kidney. In clinical basic situation, the two groups did not have significant difference (p<0.05) for every examined organ function indexes.

2.2 ANESTHESIA

Both groups had applied the waist hard joint anesthesia, and depending on the type of surgery and the patient condition and the overall physical condition, etc., then decided to choose a reasonable way of anesthesia, the anesthetic, anesthetic dose and concentration in order to maintain a reasonable time facilitate the operation of anesthetic drugs to maintain a reasonable time.

2.3 CARE TREATMENT

The nursing groups: full term care treatment of perianesthesia care period. Control group: only given general nursing.

3 Perianesthesia care treatment

3.1 CARE BEFORE ANESTHESIA

3.1.1 Psychological nursing intervention

Before anesthesia, patients usually had different degrees of stress, negative psychological emotions such as fear and anxiety, nursing staff should take full consideration to care

for patients, and a comprehensive grasp of specific mental patients, and targeted to take nursing intervention. Nursing staff shall inform the full detailed operation instruction to patients, especially on safety and success rate of surgery for patients in order to eliminate worries. At the same time, it also need to pay attention to explain the successful operation which had done before, and let surgery patients enhance with confidence and courage; In addition, the opponent preoperative severe anxiety in patients, when facing this patients, nursing stall should focus on strengthening the psychological counseling, and the anesthesiologists visit patients several days before the surgery, and communicate directly with the patient. Before anesthesia, nursing stall also could introduce some light and soothing music to relax the mood of patients; when it was necessary to use the right amount of stability and imidazole stability, etc., to stabilize the patient's emotions.

3.1.2 Basic nursing.

Before anesthesia, it needed to carefully check the basic information of patients to prevent a phenomenon of irrational use of drugs. At the same time, within the certain time, instructed patient to fast, in case the aspiration or vomiting happened during the anesthesia.

3.1.3 Nutrition care before anesthesia

Before anesthesia, nursing staff shall pay attention to adjust the nutritional status of patients, such as vitamin and protein deficient. Patients with anesthesia tolerance tends to be affected, the poor nutritional status of patients shall give appropriate nutritional support before fasting. It should be more than adjust the diet, increase dietary protein and vitamin content. For patients who failed to eat needed to inject hydrolysis of vitamin and protein supplement [1].

3.2 CARING DURING ANESTHESIA

3.2.1 Basic nursing

It needed to monitor on patients' vital signs, the blood pressure, blood oxygen saturation, such as breathing, and ECG monitoring, assisted patients breathing oxygen, at the same time, to ensure that patients in the stable state.

3.2.2 Establish vein channels

According to the patient's specific surgical site, it has to select the reasonable position of vein puncture, and expansion treatment; After being successful punctured, immediately applied 500 ml equilibrium liquid, in case the happen of lower blood pressure after anesthesia. And should keep patients with venous patency after anesthesia, and timely adjust the speed of infusion.

3.2.3 Anaesthetic puncture nursing

In anaesthetic puncture, nursing staff should be standing in the ventral patients, and observe the patient's vital signs,

and assist patients to keep good anesthetic position; At the same time, in order to reduce the patient's nervous psychology, nursing staff should tenderly shake hands with patients, etc., and comfort patients, and help patients to fully relax and help keep a good state of muscle relaxant. After successful anesthesia, ccording to the demand of the anesthesiologist, nursing staff should adjust the patient's bed in order to achieve the ideal anesthesia plane.

3.3 CARE AFTER ANESTHESIA

3.3.1 Basic nursing

After anesthesia, nursing stall shall continue patients' vital signs. Once appeared the abnormal situation, it shall promptly report to the physician, dealing with patients with body position nursing care, and to keep the patients' head to one side, and let the patient head lie to one side, and keep lying posture, in order to prevent aspiration and vomiting. In addition, it shall pay attention to keep respiratory tract nursing care of patients, and keep the respiratory tract smooth to breath, in order to prevent the occurrence of asphyxia by blocking etc.

3.3.2 Abdominal nursing

It needs to pay close attention on the nursing for patients with abdominal signs, and carefully examine the area between the belly button and pubic bones. Once found blood oozing, and immediately use the corset for pressurized and hemostatic treatment; In addition, Once patients had uncontrolled hemorrhagic shock signs, nursing shall consider if it was due to abdominal cavity hemorrhage, and assist the physician during the process in a timely manner.

3.3.3 Nursing for anesthesia adverse reactions

(1) Chills. During anesthesia, patients may have low body temperature, or chills. Attentions shall be paid to maintain an appropriate temperature, advisable temperature was 22-25°C, and offer the proper heat preservation measures to help patients after anesthesia. It needs to pay attention to change the pad frequently; when using the blunt lotion or infusion, it needs to do the proper heating. In addition once fund that patients with chills, should use drugs such as tramadol intravenous administration in order to ease as soon as possible.
(2) Respiratory depression. Patients with lumbar anesthesia, after the application of anesthetic drug, it will quickly spread within the intra-spinal canal, the anesthesia plane was more difficult with a reasonable control of the height, for example, when anesthesia plane was too high, its easy to cause respiratory depression, so nursing stall should strictly obey the doctor's advice, and properly adjust the angle and position of the surgical bed, when patients had dyspnea phenomenon, it needed to immediately wear mask and give oxygen.
(3) Low blood pressure. Patients usually have low blood pressure in the following 20 minutes after the anesthetic drug application, more common in women; few patients may have the low heart rate, and the symptom, and

symptom such as vomiting and nausea; After anesthesia nursing staff shall strictly monitor patients' blood pressure, Once the symptoms of low blood pressure, need to assist physicians give full oxygen and support and add proper blood volume, etc. [2].

3.4 EVALUATION METHOD

Nursing effect of the two groups had been compared for the evaluation index, included: the rate of good anesthesia, patient's satisfaction and complications. Among them, the anesthesia effect was optimal, analgesia and muscle relaxant effect was good, hemodynamic was stable, patients were in quiet state during anesthesia. There were no obvious complications; the analgesia and muscle relaxant effect was good, hemodynamics was stable, during anesthesia in patients with no obvious complications [3]. Questionnaire survey had done among patients for the postoperative satisfaction evaluation after the former.

3.5 STATISTICAL METHODS

Statistical methods: using SPSS16.0 software for statistical data processing for this article, all counted data had been tested by X2, and took results $P<0.05$ for significant differences between them.

4 Results

Among the two groups of anesthesia, nursing care group had the anesthesia evaluation rate 96.7%, patients satisfaction rate was 96.7%, 1.7% for incidence of complications, 1 patients had chills; In control group, the anesthesia excellent rate was 87.5%, patients satisfaction rate was 85.0%, 7.5% for incidence of complications, 2 patients had chills, 1 cases of patients had low blood pressure; effect of nursing group was more ideal ($P<0.05$). See Table 1.

TABLE 1 Effect of two groups of nursing comparative evaluation n (%)

Group	Case Quantity	Anesthesia Excellent Rate	Patients satisfaction Rate	Incidence of Complications
Nursing Group	60	58(96.7)	58(96.7)	1(1.7)
Control group	40	35(87.5)	34(85.0)	3(7.5)

5 Discussions

Maternity reasonable anesthesia care had took during the operation to ensure the intraoperative good analgesia and muscle relaxant effect, as well as the stable vital signs for patients, it prompted the operation smoothly, and had positive function to reduce complications. Reasonable anesthesia care was conducive to the improvement of the operation effect and improves patient satisfaction.

Perianesthesia of gynecology and obstetrics surgery in patients with the full-term nursing could help patients with stable psychological mood, and ensure the vital signs in a stable state, and to ensure that the nutrition support anesthesia tolerance, etc. Strengthen the life condition monitoring during anesthesia, help patients' reasonable establishing venous channel, and complete the good

anesthestic puncture.

At the same time, the basic nursing for abdomen anesthesia with this article 60 patients (nursing care group) around the time of anesthesia care, in the whole process, the 40 cases (control group) were only given general nursing, comparison results show that: in nursing care group, the anesthesia excellent rate was 96.7%, 96.7% for patients satisfaction rate, 1.7% for complications; In the control group, the anesthesia excellent rate was 87.5%, patients satisfaction rate was 85.0%, the incidence of complications rate was 7.5%; The anesthesia effect was more ideal in nursing care group ($P<0.05$).

In a conclusion, gynecology and obstetrics anesthesia for peri-anesthesia in the operation of the whole nursing, it could significantly improve anesthesia effect, and worth the clinical extensive application.

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Perioperative nursing on patients undergoing gynecologic laparoscopic surgery

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Abstract

Investigate on perioperative nursing on patients undergoing gynecologic laparoscopic surgery. Methods: There were 121 cases of obstetrics and gynecology patients who were selected in our hospital, they were required to laparoscopic surgery and were randomly divided into control group, 61 cases in this group, they were given routine care, there were 60 cases in observation group, they were given Psychological Nursing care on the bases of routine care which the same as control group. Compare the sedative effect, psychological reactions, clinical signs and SAS score to evaluate the effect of psychological care. Results: compared to the control group, the anxiety cases of observation group was of significantly less (P<0.05); compared with admission, SAS scores in observation group on the preoperative and 1 day after decreased significantly(P<0.05). Compared with the control group, the observation group at each time point was significantly lower in the depth of sedation score (P<0.05); the differences in the systolic blood pressure and heart rate after break five minutes between two groups were significant (P<0.05). Conclusion: compared with obstetrics and gynecology laparoscopic surgery patients in the periaesthesia give regular care to give psychological care to patients with depression, education sentiment mitigation, sedation enhancement surgery.

Keywords: Laparoscopy, Obstetrics and gynecology, Perianesthesia, Psychological care.

1 Introduction

For the gynecology and obstetrics surgery, the majority of middle-aged women. Since most patients have few knowledge for gynaecologic disease, and very easy to have the negative emotions such as tension, anxiety, fear, panic, etc.The clinically reports had indicated that patients' psychological status and emotional mood has very significant influence on anesthesia effect, now the clinical field are paying more and more attention to nursing results. Medical workers are more focusing on the psychological nursing of patients than before [1, 2]. In this paper, the study had selected 121 patients going to our hospital for treatment with gynecology and obstetrics disease, and all needed to have laparoscipic surgery. Then randomly divided the 121 patients into two groups: observation group for 60 patients and control group of 61 patients. This study gave observation group patients routine care and psychological care, while, and gave control group routine care only.

2 Basic information and method

2.1 BASIC INFORMATION

This study had selected 121patients suffering from gynecology and obstetrics disease, and went to our hospital for treatment since July 2012 to July 2013. And all needed to have laparoscopic surgery, the youngest one was 23 years old, and the eldest one is 52 years old, average age was 42.6±7.3 years old. According to condition of disease, among the 121 patients, there were 29 case of patients for uterine fibroids rejecting operation, 53 case of patients for fallopian tube retrograde drainage operation, 16 case of patients for tubal embryos extraction surgery, 13 cases of patients for electric coagulation drilling operation, 10 case of patients for ovarian cyst elimination surgery. All patients were randomly divided into control group, control group 61 cases, observation group 60 cases. In the general information through statistical analysis for the two groups of patients, there were no statistically significant difference (P>0.05).

2.2 METHOD

First, the patients in control group were given routine nursing during peri-anesthesia. Second, patients in observation group were not only given routine care, but also psychological nursing during perianesthesia. Detailed information as follows: (1) before surgery, nursing staff may need explain how was the anesthesia and surgery, and made sure patients could full understand the safety of the surgery and matters which needed to pay attention to during surgery. More importantly, needed to inform patients that emotions could significantly affect the anesthesia effect and prognosis, in order to make the patients significantly relief the negative emotion for the anesthesia and surgery[3]; (2) according to different

disease which patients were suffering from, nursing staff shall explain to patients for the knowledge relating disease, and do the health education content in order to enable patients understand the cause of the disease, a variety of possible influencing factors and so on. And enable patients to correct the misunderstanding of disease, and could easily cooperate with medical staff for the treatment of disease in a positive attitude; (3) in the treatment of disease, the proper application of psychological knowledge, so that we could make the patients emotion in a unstressed relaxed situation, nervous tension was significantly reduced, the psychological treatment was 4 times/day, 30 minutes/time, the training time was 3 days and continue to achieve the best clinical effect; (4) if the patients were for general anesthesia, the therapy for relaxed mood could be used; (5) nursing staff need wait besides the patients after the surgery until the awakening of patients, for all kinds of postoperative complications shall be handled in a timely manner. After patients waking up, nursing staff took timely communication with patients, and encourage patients, and make sure get a eliminate anxiety.

2.3 OBSERVE INDEX

First, psychological reaction: patients reaction were divided into normal, worry, anxiety, including normal emotional aspect, have a good mood and normal signs; between normal and anxiety, nervousness, nervous and larger problems worry about; which the aspects such as the heart and breathing speed up performance, helpless and the nervous feeling, appear even aggressive mood of anxiety such as crying. Second, the level of anxiety in the patients using SAS scores, including patients after hospitalization, 1 day before surgery, and 1 day after surgery. Third, sedative effect: using for four times for depth of sedation scores was compared. Including before anesthesia and

surgery, beginning of anesthesia, and 60 minutes after the beginning of surgery and the end of surgery, depth of sedation score was divided into five ranking points. 5 points were for calling patients in a normal tone, patients have very sensitive reaction speed; 4 points for calling patients in a normal tone, while, patients were with slow reaction; 3 points for calling patients aloud or repeat, then patients could have response; 2 points for patients have no reaction when be called aloud, and patients have reaction when been gently pushed or shaken; 1 points for patients don't have response when been gently pushed or shaken or have mild pain. Forth, clinical signs: monitoring patient blood pressure and heart rate, monitoring time shall be the 1 day before surgery, and 5 minutes after entering operation room.

2.4 STATISTICAL ANALYSIS

Using SPSS 13.0 statistical analysis software package for study data analysis processing, measurement data represented as mean ± standard deviation $(x \pm s)$ difference between groups using analysis of variance, t test, using X2 test for categorical data, comparing the differences between groups, difference of $P<0.05$ was statistically significant.

3 Results

3.1 TWO GROUP OF PATIENTS WITH EMOTIONAL CONDITION COMPARISON

Emotional condition of observation group and control group were compared, the patients with anxiety mood in observation group were obviously less than in control group, and its difference has statistical significance (x2=5.17, P<0.05). See Table 1.

TABLE 1 Emotional condition comparison

Group	Case of patients	Normal	Worry	Anxiety
Observation Group	60	31	20	9
Control Group	61	20	23	18

3.2 TWO GROUPS OF PATIENTS WITH SAS SCORES COMPARISON

Data from Table 2 has below information, there was no significant difference of SAS scores (t=0.52, P>0.05) in the two groups after hospitalization; Compared with the patients' data after admission, 1 day before or after

surgery, the observation group obviously had the reduced score, and has statistically significant difference (t=2.79, 3.75, P<0.05); 1 day before or after surgery, the SAS scores in the control group had obviously increased compared with after admission, the difference was statistically significant (t=5.36, 4.92, P<0.05).

TABLE 2 Comparison of SAS scores of two groups of patient $(x \pm s)$

Group	Case of patients	After admission	Before surgery	1 day after surgery
Observation Group	60	44.86 ± 6.14	42.52 ± 5.33	41.07 ± 5.28
Control Group	61	44.73 ± 6.39	56.28 ± 7.49	52.30 ± 6.96

3.3 THE SEDATIVE EFFECTS OF COMPARISON BETWEEN THE TWO GROUPS OF PATIENTS.

Data can be obtained from Table 3, compared with the control group, before surgery, at the beginning of surgery,

60 minutes after the beginning, end of surgery, the depth of sedation scores of the observation group was significantly lower, the difference was statistically significant (P<0.05).

TABLE 3 The sedative effects of comparison two groups of patients (x ± s)

Item	Cases of patient	Sedative effect			
		Before patents	Beginning of surgery	The 60th minutes in surgery	Finalized of surgery
Observation group	60	3.49±0.62	2.71±0.43	3.30±0.55	3.53±0.58
Control group	61	3.75±0.79	3.18±0.64	3.72±0.47	3.86±0.61
t score		2.73	3.36	3.01	2.95
P		<0.05	<0.05	<0.05	<0.05

3.4 COMPARISON OF BLOOD PRESSURE AND HEART RATE OF THE TWO GROUP

Observation group and control group had small differences of preoperative systolic blood pressure and heart rate of 1 day before operation (P>0.05). 5 minutes after entering

operation theater, the systolic blood pressure and heart rate difference between the two groups was statistically significant (P<0.05), detailed information in Table 4. Results suggested that control group were with more severe tension than observation group of psychological nursing.

TABLE 4 Compared of two group patient's blood pressure and heart good contrast($\bar{x}$ ±s)

Item	Case of Patients	1 day before surgery		5 minutes after entering operation theater	
		Systolic blood pressure (mm Hg)	Heart rate (times/min)	Systolic blood pressure (mm Hg)	Heart rate (times /min)
Observation Group	60	117.6±12.5	77.2±8.1	128.9±10.2	93.5±10.1
Control Group	61	119.2±10.3	78.0±9.7	147.2±12.9	112.8±9.6
t score		1.51	0.97	3.27	3.56
P		>0.05	>0.05	<0.05	<0.05

4 Discussions

With the rapid development of economy and people's rising material and cultural level, people continuously increased the requirement of nursing work, so the idea of patient with medical activities and nursing activities should be given the full embodiment. Clinical surgery would have a lot of factors in anaesthesia and the prognosis of how to impact the quality of anesthesia effect and its operation. These would be affected by patients' emotional and psychological tension, one of the most serious affect was the anesthetic effect [7]. Either in anesthesia induction period or in awakening period, patients with health care workers besides was needed to actively cooperate closely, if the patient appeared excessive negative emotions such as anxiety, fear. In the process of anesthesia, some factors would cause serious influence of quality, if a patient can't cooperate with accurately, medical staff would not be able to make accurate judgment [8].

The results showed that, compared with the control group, the observation group patients were significantly with less anxiety and fear (P < 0.05). The anxiety score had little difference after admission. But the observation group patients were given routine care, but also preoperative psychological nursing and practice relaxation therapy on the patients. Time was for 3 days and needed to be continuous, in the process, patients had a certain

understand of some of diseases knowledge and a variety of possible influencing factors, then the doubts were lifted and anxiety been eliminated; In the process of psychological nursing, medical staff especially explain to patients the detail operation scheme, security, and the prognosis of the disease, and increased confidence of patients to conquer the disease, and significantly reduced the fear and tension. Through relaxation therapy, patients not only relaxed body, but also relaxed the mood. At the same time, patients' anxiety score was measured before the surgery, compared with the condition when patients was on admission, the improvement degree of the observation group was more obvious. Due to the control group patients were not given psychological care, the negative emotion, such as anxiety, tension and fear increased whiles the approaching of operation. Above suggested that perianesthesia implement psychological nursing could make patients more correctly understanding disease in patients with gynecological laparoscopic surgery, reduced the panic of the surgery, and enhanced confidence in the treatment of surgery. The depth of sedation significance was very important in the normal conduct of the operation [9].

The results of research had showed that, compared with the control group, the observation group patients had the significantly lower preoperative sedation scores (P<0.05). Results suggested the sedation depth of observation group was obviously better, which indicated the importance of

preoperative psychological nursing for preoperative sedation. In anesthetic sedative drugs in patients with the same situation, its sedative effect is better. After 5 minutes of entering operation room, the systolic blood pressure and heart rate difference between the two groups is significant (P<0.05), the results hinted the observation group psychological nursing than that in of the control group patients have more severe tension. Implementation of psychological nursing on the patients also had certain improvement effect on the systolic blood pressure and heart rate.

To sum up, the foundation of a successful surgery is a well-done anesthesia, and guarantee of a successful surgery is accurate and mutual cooperation between medical staff and patients during the perianesthesia time. In perianesthesia period, it's needed to give patients with gynecological laparoscopic surgery the corresponding psychological nursing, which could reduce the negative mood. In the process of treatment, patients could remain a relatively relaxed and peace mind, which became the effective guarantee to make the anesthesia and surgery successfully.

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Using laser scanning technology to 3D Imaging and study on volume measurement

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Abstract

Based on the necessary of large volume fast measurement of material stack, this article introduced the principle of laser scanning technology in achieving 3D imaging and volume measurement, and the method of establishing 3D surface model with coordinate conversion and image processing effectively, in order to improve the accuracy of volume measurement in material stack. Experimental result shows good characteristic of speediness, accuracy and short periodic.

Keywords: coordinate conversion, image processing, surface model, volume measurement

1 Introduction

Because of its high measuring speed, moderate accuracy, low cost and robustness in the industrialfield, 3D laser scanning has been widely used in a variety of applications [1]. The laser scanning method allows the non-destructive generation of 3D point clouds representing the spatial structures directly. Applied in forests, fruit tree crops and vineyards parameters like leaf area, stem height, stem volume and biomass were also deduced [2]. These simple 2D representations might provide sufficient accuracy to measure seedlings of cereals or vegetables and rosette plants [3]. Because of the feasibility of scanning from multiple positions around the object, this technique provides a new scale of resolution making possible a m ore specific analysis of the complex morphological 3D structure of older cereal plants, as well as for specific organs [4]. A further contribution to the development of three-dimensional acquisition systems is given by the remarkable possibilities offered by today's three-dimensional visualization and 3D modelling：the widespread that 3D is taking in areas of daily life with the progressive development and diffusion of products such as virtual reality or augmented reality means that the stimulus in the search for new methods of acquiring competitive, low-cost and thus increasingly accessible to many is truly remarkable[5].

Structured light 3D laser scanning has been studied over the past several decades [6]. It offers a number of advantages, including noncontact measurement, fast measuring speed, a simple optical arrangement, moderate accuracy, low cost and easy extraction of the light stripe image information [7-9]. Range Sensors have been used for 3D object acquisition, the efficiency and accuracy of the technique has been demonstrated using indoor objects [10-13]. Traditionally, a large dynamic range of scene radiances is acquired by combining several varying exposures of the scene [14, 15].

In real life, it's very important to carry out volume measurement of the large material stack, including coal, grain, fertilizer and building materials. For example, coal storage and daily consumption of coal yard is an important metrics of thermal power plants, coal mines and other units. Most significant part goes down to measure the size of irregular coal heap, while it becomes a vital factor that affects the economics of power plants and management level on measuring quickly, accurately and effectively.

Speaking of coal, the traditional methods of measurement was using bulldozers to shape the coal, and heaping up as trapezoid artificially before the manual measurement, or calculated through the section plane of the coal pile. It required flat bottom surface, lots of manpower and material resources. This method remained a low measuring accuracy (about >5% error) and efficiency. The workload was about three to four days.

The same problem was found in food and other ecological research. As we can see, measurement of irregular shape grain size would directly influence the management of food storage. The volume determination of crown would increase the fitting accuracy of component biomass model and estimate. It is also an important part in the ecological environment.

As far as all above, it is very market valuable to design a program to determining irregular volume precisely and rapidly. Combining with 3D laser scanning technology, and short time, dense and high-precise laser scanning, an irregular solid surface under Puslar apparatus and Starsurvey3d instrument is used to generates the respective point cloud(3D coordinates).Then it will be image processed, and simulate the real dimensions of the whole solid surface in a 3D surface model. Finally, its volume would be calculated by a particular program. The advantage of whole operation is automatic, fast, accurate, high-precision, economic-saving, and low testing period and will be very beneficial to scientific management in factory. This measurement can help enterprise arrange the quantity of vehicles, as long as the accurate data of storage capacity in order to make the regulation more scientific.

2 Relative work

With the development of measurement technology, foreign measurements mainly include binocular photogrammetry, 2D laser scanners measurements, and 3D laser scanners measurements.

Binocular Stereo Vision is an important form of machine vision. Based on the principle of parallax, using the imaging equipment to get two image of detected objects from different locations. It obtains the 3D geometric information by calculating the position deviation between the corresponding points of the image. However, in terms of large scale stock yard, it is not good using binocular stereo vision for volume measuring because of its large area .Besides, it will causes the poor robustness problem by using self-calibration of camera.

The 2D laser scanning technology is using 2D laser scanners to determine the section of two-dimensional coordinates. Displacement sensors and angular sensors are used to achieve the orientation of the 3rd coordinate. Combining with two data sets, it shows a large number of discrete coordinate points in the entire field. So we can calculate the volume of coal pile with the TIN triangulation algorithms. In other words, firstly coal pile surface point in the projection surface can get a large number of discrete point coordinates of the bottom surface, that is, three dimensional coordinate system turned into a two dimensional coordinate system. Secondly, the two-dimensional coordinates points of bottom turn into triangular meshes. The last, we connect the points of surface and the points of bottom longitudinal, hence we will attain a lot of straight triangular prism. All three prisms accumulated can be derived the volume value of material. All three prisms are disjoint and adjacent to each other, so the accumulated value can be expressed as below:

$$V = V_1 + V_2 + V_3 + ... + V_i + ... + V_n = \sum_{1=0}^{n} V_i \qquad (1)$$

In the Equation, the most important step is calculating the volume of the triangular prisms. Every triangular prism can be divided into a regular triangular prism and a tetrahedron by using an accurate algorithm, that is to say, the volume of target is the summation of the regular triangular prism and the tetrahedron, making it easy to calculate the volume. However, it is hard to calculate the volume of irregular tetrahedral. The Euler equations, matrix and vector was used as well as costing great workload and very inconvenient.

3 The measurement of B-spline

In the process of laser scanning, it is difficult to obtain all data in the same point. The measuring instrument is moved, known as moving stations. After moving stations, the measured data is different because of the changing location. At this time, all of the data should be integrated into the same coordinate system.

3.1 OBTAINING THE COORDINATE OF CONTROL POINT

We use two coordinate systems before moving as an example. In Figure 1, O_1 is used as a measuring instrument before moving in coordinate systems, and O_2 as a measuring instrument after. The origin vector of O_1 and O_2 is (a, b, c).
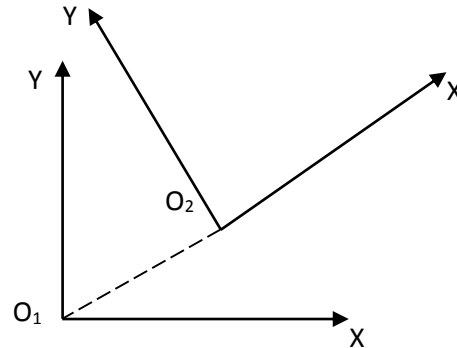

FIGURE 1 Moving station before and after

In each coordinate system, there is a positive direction in the x axis. Direction angle anticlockwise starts from the north direction, and ends in the angle of direction. These angles in two coordinate systems can be calculated through all direction angles. In Figure 2, the Φ is the angle between two coordinate systems.
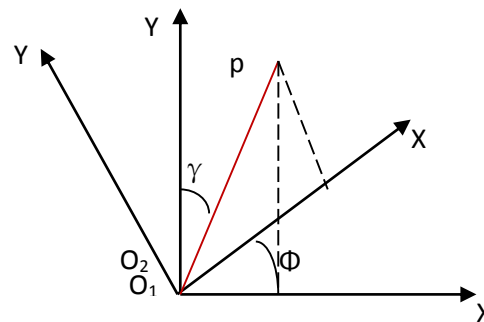

FIGURE 2 Coordinates conversion map

The angle of γ can be calculated by the x-axis orientation in O_1 coordinate system, or by the x-axis angle in O_2 coordinate system with the angle in the direction of the P point. Setting the coordinate of P as (Px1, Py1, Pz1) in the coordinate system. Then we can obtain:

$$Px1 = OP \cdot \sin \gamma , \qquad (2)$$

$$Py1 = OP \cdot \cos\gamma . \qquad (3)$$

Setting the coordinate of P is (Px2, Py2, Pz2). Then we can obtain:

$$Px2 = OP \cdot \cos(\frac{\pi}{2} - \lambda - \phi) , \qquad (4)$$

$$Py2 = OP \cdot \sin(\frac{\pi}{2} - \lambda - \phi) . \qquad (5)$$

Thus, the conversion of P is derived in two coordinate system:

$$Px2 = Px1 \cdot \frac{\sin(\gamma + \phi)}{\sin \gamma} + a \,, \qquad (6)$$

$$Py2 = Py1 \cdot \frac{\cos(\gamma + \phi)}{\cos \gamma} + b \,, \qquad (7)$$

$$Pz2 = Pz1 + c \,. \qquad (8)$$

3.2 THE MEASUREMENT OF B-SPLINE CURVE

The Equation of B-spline curve is defined as:

$$P(t) = \sum_{i=0}^{n} P_i N_{i,k}(t), \quad (t_{\min} \le t \le t_{\max}, \; 2 \le k \le n+1) \qquad (9)$$

In this Equation, P_i (i=0,1,…,n) control (n+1) vertex in polygon, and $N_{i,k}(t)$ (i=0,1,…n) is called B-spline basis function of k-order(k-1 th).The range of parameters t depends on other parameter selection of B-spline. K is a first-order parameters and order parameters can be assigned to any integer from 2 to n+1.In fact, it can also be set to 1, but it happens to be the control point itself. Local control of B-spline can be expressed by the mixture functions which are defined in the range of t.

The mixture of b-spline basis function is defined by the recursive of deBoor - Cox:

$$N_{i,1}(t) = \begin{cases} 1 \,, & t_i < t < t_{i+1} \\ 0 \,, & \text{Otherwise} \end{cases} , \qquad (10)$$

$$N_{i,k}(t) = \frac{t - t_i}{t_{i+k-1} - t_i} N_{i,k-1}(t) + \frac{t_{i+k} - t}{t_{i+k} - t_{i+1}} N_{i+1,k-1}(t) \,, \qquad (11)$$

B-splines can be designed as a curve by changing the number of control points without number of polynomial. You can also add or modify the number of control points to control the shape of the curve.

B-spline surface is made up of two B-spline curve in the direction of intersecting grid with the Equation:

$$P(u,v) = \sum_{k_u=0}^{n_u} \sum_{k_v=0}^{n_v} P_{k_u k_v} \cdot B_{k_u k_v}(u) \cdot B_{k_u k_v}(v) \,. \qquad (12)$$

In the formula, the vector $P_{k_u k_v}$ specifies the location of the control point $(n_u + 1) \cdot (n_v + 1)$. B-spline surface has the same property compared with B-spline curves. The value of the selected parameter d_u and d_v determine the times of polynomial number d_u-1 and d_v-1. Choosing the knot vector for each surface parameters u and v, it was used to determine the range of mixed function parameters.

4 Comparative analyses of the traditional method and B-spline curves

In this work, the polar axis is converted to space rectangular coordinate system through obtaining azimuth and distance between target point and the station by laser scanning. The reference frame is used to find the basic laws of moving station. Then using B-spline surfaces which have higher degree of fitting to simulate practical model of coal pile. Finally, using the differential principle to get volume of the coal. There will be some errors, but the results were amended so that error is acceptable.

TABLE 1 Comparative analysis of the traditional method and B-spline curves

	Advantages	Disadvantages
Binocular Photogrammetry	High precision, Fast operation, Device structure is simple	Difficult to measure large objects, Poor robustness
Two-dimensional laser scanning	Applies only to regular objects	Complex calculation to irregular volume
B-spline curves	Economic and rapidly, High precision, High surface fitting	B-spline is more complex than Bezier splines, Devices require high performance

By comparison, we can see that B-spline curves used for volume measurement has a higher fitting degree. Besides, it can also measure large or irregularly objects. In conclusion, application of B-spline curve is more extensive.

5 Experiment simulation

Though the experiment simulation, we will better to understand how the B-spline curves work .

5.1 B-SPLINE SURFACE MODELING EXPERIMENT

There are three coordinates for each control point, X, Y, Z, it builds a class based on the coordinates:

```
class Point3D
{
public:
    double x, y, z;
public:
    Point3D(double thisx, double thisy, double thisz)
    {
        x=thisx;  y=thisy;
        z=thisz;
    }
};
```

In order to facilitate the description of the experimental process, we can input the experimental data to test the results, and the control point is stored as a three dimensional array.

TABLE 2 Control points

Points			
(0,1,80)	(0,20,60)	(0,40,40)	(0,60,20)
(0.87,0.5,80)	(17.4,10,55)	(34.8,20,35)	(52.2,30,15)
(0.87,-0.5,75)	(17.4,-10,60)	(34.8,-20,40)	(52.2,-30,20)
(0,-1,80)	(0,-20,55)	(0,-40,35)	(0,-60,15)
(-0.87,-0.5,75)	(-17.4,-10,60)	(-34.8,-20,-40)	(-52.2,-30,20)
(-0.87,-0.5,75)	(-17.4,10,55)	(-34.8,20,35)	(-52.2,-30,15)
(0,1,80)	(0,20,60)	(0,40,40)	(0,60,20)

The total control points are:

$$(n_u + 1) \cdot n_v + 1) = (3+1) \cdot 6 + 1), \quad n_u = 3, \; n_v = 6.$$

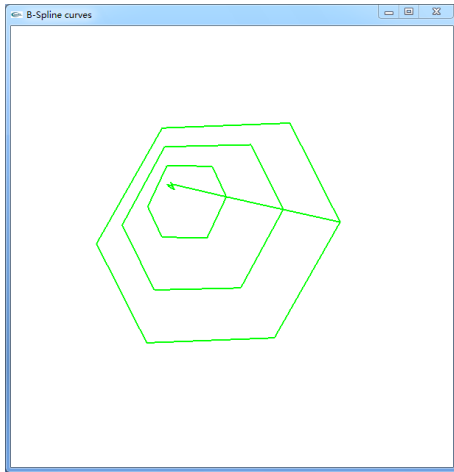In the platform of OPENGL, the drawings of control points are shown in Figure 3. It mainly lies on four surfaces:

FIGURE 3 Control point of the drawing

Setting $d_u=d_v=3$, the number of vector nodes in u direction is $n_u+d_u+1=7$ and the number of vector nodes in v direction is $n_v+d_v+1=10$. Control points have formed a closed curve. Set the knot vector for uniform B-spline curve, and nodes at both ends are repeat, and in the middle the node spacing is uniform.

By programming the B-spline surface, the simulation results are shown in Figure 4:
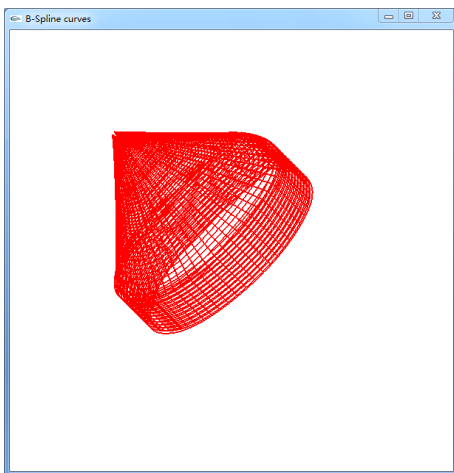

FIGURE 4 Control point on the simulate surfaces

In order to research deeply, we rotate the image, that shown in Figure 3 and Figure 4 above.

5.2 CALCULATION THEORY AND EXPERIMENT

Through the B-spline surfaces, we can attain the points on the surface. We'll also regard the coal volumes as the sum of tiny elongated cube by using the ideas of calculus.

The coordinates of each point on the surface was calculated in the programming process is as follows:

```
Point3D calPuv(double u, double v)
{
  Point3D puv  = Point3D(0,0,0);
  for (int ku = 0; ku <= nu+1; ku++)
  {
    for (int kv = 0; kv <= nv+1; kv++)
    {
      puv.x += ctrlPts[ku][kv].x
           * Bfunction(ku, du, u, uarray)
```

```
           * Bfunction(kv, dv, v, varray);
      puv.y += ctrlPts[ku][kv].y
           * Bfunction(ku, du, u, uarray)
           * Bfunction(kv, dv, v, varray);
      puv.z += ctrlPts[ku][kv].z
           * Bfunction(ku, du, u, uarray)
           * Bfunction(kv, dv, v, varray);
    }
  }
  return puv;
}
```

Bfunction () is the function of B-spline curves and surfaces, it uses a recursive formula called the deBoor-Cox to calculate.

Using the experimental data in the previous section, the total volume is 466619.888415.
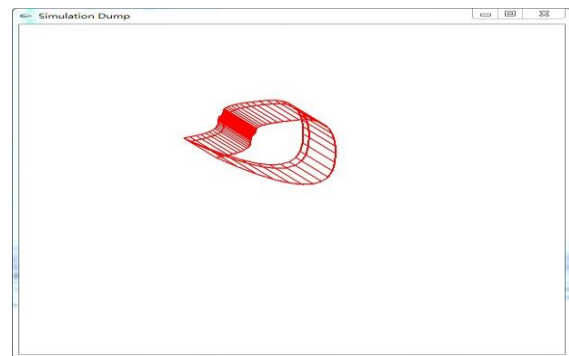

FIGURE 5 The interface of image simulation

6 Conclusions

This paper introduces the working principle of using laser scanning technology to achieve 3D imaging and volume measurement. In order to get a proper fitting surfaces, this paper uses the B-spline method. Compared with the traditional method of calculating, this method is more convenient for them. Meanwhile, using differential method to calculate the volumes, which have higher accuracy in the system.

FIGURE 6 3D laser scanner

This simulation results demonstrate the feasibility of the experiment. Meanwhile, through this experiment, we have concluded that measurement errors come from the location of control points in the system. Therefore, the working direction in the future is mainly to the control point selection, in order to make more realistic shapes of 3D imaging, and then the accuracy of volume measurement will also improve.

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NATURE PHENOMENA AND INNOVATIVE ENGINEERING

Numerical simulation of deposited behaviours of Al particle on Mg substrate in supersonic particles deposition

J K Yao, X M Wang, Y X Liu

*Computer Modelling & New Technologies 2015 **19**(3D) 7-11*

ANSYS/LS-DYNA is used to simulate supersonic particles deposition process of Al particle impinging on Mg substrate. Critical velocities of particle at different spraying temperatures and deformation, highest temperatures, stress and strain of particle/substrate are studied. The results show that with the increasing of spraying temperatures, the critical velocities experience a small amplitude decrease. For the two aspects of single particle and two-particle impingements, the highest temperature rises with the increasing of initial temperature and the deformation morphology and stress and strain of particle/substrate vary with/without tamping effect. Upon the effect of tamping, the flatten ratio of pre-deposit particle is bigger than the particle without the tamping effect at the same velocity. The values of maximum stress and strain of two-particle with tamping effect are both higher than single particle impinging. The change gradient of stress without tamping effect is much steeper in comparison of two-particle impinging with the velocity increasing while the change curve tendency of maximum strain is similar to the flatten ratio.

Keywords: supersonic particles deposition, simulation, tamping effect, critical velocities, stress and strain

Study on supported perovskite-type catalysts for catalytic combustion of volatile organic compounds

Chaocheng Zhao, Xiuxin Xu, Yongqiang Wang, Lin Li

*Computer Modelling & New Technologies 2015 **19**(3D) 12-17*

$LaxCe1-xMyN1-yO3$ was supported on $\gamma-Al2O3$ by equal volume impregnation method. The effects of loading amount, calcination temperature, element type and element ratio in the A-site and B-site on catalytic combustion of toluene were investigated. Then the catalysts were characterized by XRD, BET and SEM. The results showed that the optimum preparation condition of the catalyst was the loading amount of 12%, the calcination temperature of 750°C, and the catalyst form was $La0.8Ce0.2Mn0.8Co0.2O3/\gamma-Al2O3$. Under the action of this catalyst, the ignition temperature T50 and complete conversion temperature T90 of toluene were 243°C and 303°C, respectively. The supported perovskite catalyst maintained perfect perovskite structure and dispersed uniformly. Its surface area and porosity were greatly increased. The whole structure was fluffy and conductive to practical application.

Keywords: volatile organic compounds, catalytic combustion, perovskite, support

Nursing on maternity anesthesia surgery

Ji Zhang, Lei Fan, Ruilian Cheng, Jimin Yu, Jiping Liu

*Computer Modelling & New Technologies 2015 **19**(3D) 18-21*

Objective: Analysis to strengthen the effect of nursing in gynecology and obstetrics anesthesia surgery. Method: This study had select the 100 cases of patients with the treatment of anesthesia surgery of obstetrics and gynecology in our hospital from July 2012 to July 2014, in which, there were 60 cases of patients for full term care on perianesthsia care period, and 40 cases of patients (the control group) whom were only given general nursing. This paper compared the nursing effect of the two group. Results: recover fineness rates of anesthesia care group was 96.7%, patients satisfaction rate was 96.7%, the incidence rate of complications was 7%; recover fineness rates of control anesthesia was 87.5%, the patient satisfaction rate 85.0%, and the complication rate was 7.5%; The anesthesia care group effect was more promising (P<0.05). Conclusion: the full term perianesthsia care could significantly improve the anesthesia effect during the maternity anesthesia, and worth clinical extensive application.

Keywords: Gynecology and obstetrics surgery, anesthesia, nursing

Perioperative nursing on patients undergoing gynecologic laparoscopic surgery

Ji Zhang, Lei Fan, Ruilian Cheng, Jimin Yu, Jiping Liu

*Computer Modelling & New Technologies 2015 **19**(3D) 22-25*

Investigate on perioperative nursing on patients undergoing gynecologic laparoscopic surgery. Methods: There were 121 cases of obstetrics and gynecology patients who were selected in our hospital, they were required to laparoscopic surgery and were randomly divided into control group, 61 cases in this group, they were given routine care, there were 60 cases in observation group, they were given Psychological Nursing care on the bases of routine care which the same as control group. Compare the sedative effect, psychological reactions, clinical signs and SAS score to evaluate the effect of psychological care. Results: compared to the control group, the anxiety cases of observation group was of significantly less (P<0.05); compared with admission, SAS scores in observation group on the preoperative and 1 day after decreased significantly(P<0.05). Compared with the control group, the observation group at each time point was significantly lower in the depth of sedation score (P<0.05); the differences in the systolic blood pressure and heart rate after break five minutes between two groups were significant (P<0.05). Conclusion: compared with obstetrics and gynecology laparoscopic surgery patients in the periaesthesia give regular care to give psychological care to patients with depression, education sentiment mitigation, sedation enhancement surgery.

Keywords: Laparoscopy, Obstetrics and gynecology, Perianesthesia, Psychological care

Using laser scanning technology to 3D Imaging and study on volume measurement

Xianjie Yang, Gang Du, Zehui Cheng, Dongxia Zhang

*Computer Modelling & New Technologies 2015 **19**(3D) 26-30*

Based on the necessary of large volume fast measurement of material stack, this article introduced the principle of laser scanning technology in achieving 3D imaging and volume measurement, and the method of establishing 3D surface model with coordinate conversion and image processing effectively, in order to improve the accuracy of volume measurement in material stack. Experimental result shows good characteristic of speediness, accuracy and short periodic.

Keywords: coordinate conversion, image processing, surface model, volume measurement