COMPUTER MODELLING
AND
NEW TECHNOLOGIES

Editors' Remarks

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Endless Time

by Rabindranath Tagore

Time is endless in thy hands, my lord.
There is none to count thy minutes.
Days and nights pass and ages bloom and
fade like flowers.

Thou knowest how to wait.
Thy centuries follow each other perfecting a
small wild flower.

We have no time to lose,
and having no time we must scramble for a
chance.

We are too poor to be late.

And thus it is that time goes by
while I give it to every querulous man
who claims it,
and thine altar is empty of all offerings to
the last.
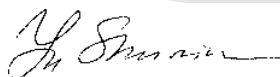
At the end of the day I hasten in fear lest
thy gate be shut;
but I find that yet there is time.

Rabindranath Tagore (1861-1941)♣

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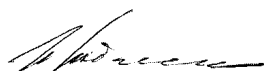
This 19th volume No.5 consists of four topical parts, namely, **Part A: Mathematical and Computer Modelling**, **Part B: Computer and Information Technologies**, **Part C: Operation Research and Decision Making** and **Part D: Nature Phenomena and Innovative Engineering**. These parts have a particular 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**(5C) 7-22) We are planning to expand CMNT topics within the scope of its scientific interests.

Our journal policy is directed to fundamental and applied scientific researches, innovative technologies and industry, which is the fundamentals of the full-scale multi-disciplinary modelling and simulation. This edition is the continuation of our publishing activities. We hope our journal will be of interest for research community and professionals. We are open for collaboration both in the research field and publishing. We hope that the journal's contributors will consider collaboration with the Editorial Board as useful and constructive.

EDITORS

Yuri Shunin

Igor Kabashkin

♣ **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

Classified Image Enhancement Method Based on Histogram Characteristics in YCbCr Color Space

Lijing Tong[1]*, Jingzhong Wang[1], Sam Li[2], Ke Xiao[1], Quanyao Peng[3]

[1]College of Information Engineering, North China University of Technology, Beijing, China

[2]Palo Alto Networks Incorporation, Santa Clara, California, USA

[3]Beijing 58 Information Technology Co., Ltd, Beijing, China

*Corresponding author's e-mail: tong_lijing@163.com

Abstract

Color image enhancement in YCbCr space is an important task since most of the color image signals captured from the embedded camera or the professional video device are YCbCr image signals. Prior classical color image enhancement methods like linear transforms such as binarization, piecewise-line transform, and gray-level slicing, or non-linear transforms such as logarithm transform, index transform, and power-law transform did not consider possible histogram characteristics, and thus their enhancement performance on different image types would be degraded in some cases. In this paper, a novel classified image enhancement method based on CbCr and Y histograms is proposed to address the aforementioned problem. First, captured images are divided into two types, document image and scene image, according to the normalized chrominance histogram characteristic. For the document image, a filter is applied in space domain to get a better foreground and background. For the scene image, three different types are divided by the normalized luminance histogram characteristics. Then, three different processing schemes are applied to the three types of scene images respectively. Experimental results on different images with a variety of variations verify the effectiveness and robustness of the proposed method.

Keywords: Image processing, Image enhancement, Characteristic classification, YCbCr color space, Normalized Histogram

1 Introduction

Over the last few years, more and more embedded devices with small cameras emerged in our daily life. The signals captured from the embedded cameras, also most of the professional video devices, are YCbCr image signals. Because of camera performance, shooting environment, human vision and other reasons, the quality of the image cannot satisfy the user very well sometimes. To get a better visual experience, the image needs to be processed by the enhancement method.

For example, we developed an intelligent reader, which can read the document image out and zoom in the captured image for sight impaired in Figure 1. The image signal from the embedded camera is the YCbCr signal. YCbCr image enhancement is a key step for the entire processing flow.

FIGURE 1 Intelligent reader developed by us

YCbCr image can be enhanced in RGB color space also. However, it is difficult for luminance and saturation control in RGB color space. Hence, direct enhancing the YCbCr image signals in its own YCbCr color space is a better choice. For enhancement method in YCbCr color space, some methods have been proposed.

Gwanggil J proposed a near infrared (NIR) image enhancing method with the help of a high resolution RGB image [1]. However, this method is effective mainly for the low resolution NIR image.

Yang S and Liu W proposed a color fusion method of low-level-light and infrared images to render multiband image to a comparative realistic color appearance in YCbCr color space [2]. However, this method is proposed to solve the problems of the low-level light image intensifiers and thermal infrared cameras.

Zolfaghari, Mohammad and Yazdi, Mehran offered an efficient edge-preserving algorithm for color contrast enhancement [3]. However, through comparisons, this method can get a better performance in CIE Lu'v' color space, not the YCbCr color space.

Wang J, Wang C, and Lee J proposed an image enhancing and processing method in YCbCr color space to remove the remaining background around the hand [4]. However, this method is mainly suitable for compact hand image.

Jiang D, Li M, and Mao J proposed an effective method of combining histogram manipulation and moving objects region enhancement for nighttime video enhancement [5]. However, this method enhances only the chrominance signal in YCbCr color space.

Chiang J, Hsia C, Peng H, Lien C, Li H proposed a saturation adjustment method based on human vision with YCbCr color model characteristic sand luminance changes [6]. However, this method is mainly for the scene image, not including the document image.

Zhang W, Wang Z, and Li Y proposed a method, which can enhance driver video image quality [7, 8]. However, this method enhanced only the Y component,

not including the saturation.

Lee S, Kwak Y, Youn J Ki, SeHyeok P, Jaehyun K proposed a chroma enhancement algorithm using the YCbCr signals by predicting the amounts of lama change needed to compensate for the lightness change induced by chroma enhancement [9]. However, the image contrast is preserved unchanged.

Yin W, Lin X, and Sun Y described a novel framework for low-light color image enhancement and denoising [10]. However, only the noise reducing is processed in the YCbCr color space based on noise characteristics in low-light images.

Bonghyup K, Changwon J, David K H, Hanseok K proposed an Adaptive Height-Modified Histogram Equalization (AHMHE) algorithm as a compensation technique for backlight images [11]. However, the histogram equalization algorithm is not suitable for all kinds of images, especially the document images.

Some of these proposed methods are mainly for some special images, for example, the near infrared (NIR) image, the low-level light image, the thermal infrared image, and so on. Some of these proposed methods are mainly for some special applications, for example, the hand, the face, and so on. The other proposed methods did not consider the different types of the captured images.

This paper proposes a classified enhancement method using histogram characteristics in YCbCr color space. First, the normalized chrominance histogram characteristic is used to distinguishthe document image and the scene image. Then for the document image, a spatial filtering is performed to eliminate possible shading and enhance the background and the foreground. For the scene document, some further different types are identified by the normalized luminance histogram characteristics and different enhancement schemes are applied to them.

2 Image classification based on normalized chrominance histogram characteristic

The signal Y of the YCbCr is the luminance signal. Its range is in $[0, 255]$. The signal Cb and Cr are the chrominance signals. Their ranges are both in $[-128, 128]$. The relationship between YCbCr and RGB can be represented as Equation (1).

$$\begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix} = \begin{bmatrix} 0.2990 & 0.5870 & 0.1140 \\ -0.1687 & -0.3313 & 0.5000 \\ 0.5000 & -0.4187 & -0.0813 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (1)$$

The main content of the document image is the text characters, for example, Figure 2. The main content of the scene image normally is portraits, objects, landscapes, and so on, for example, Figure 3.
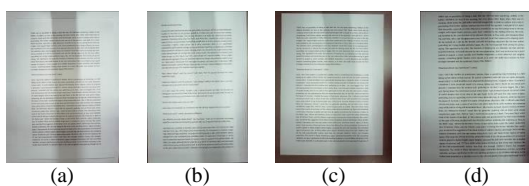
FIGURE 2 Some examples of document images

(a) (b) (c) (d)
FIGURE 3 Some examples of scene images

Normalized chrominance histogram is used to identify the document and scene images. The normalized chrominance histogram is a 2-dimension normalized histogram. The horizontal plane is composed by Cb and Cr axes. The vertical axis is P_{CbCr}, which is the probability of (Cb, Cr). The normalized chrominance histogram is shown in Figure 4(a). And the P_{CbCr} is calculated as Equation (2).

$$P_{CbCr} = \frac{N_{CbCr}}{H \times W},$$
$$Cb = -128, -127, \cdots, 0, \cdots, 127, 128 \quad (2)$$
$$Cr = -128, -127, \cdots, 0, \cdots, 127, 128$$

Normally, most of pixels in the document image have lower saturation than the scene image. Hence, a threshold, T_L, for the value of Cb and Cr in the normalized chrominance histogram can be set, for example, 10% of the 128. The region, which the maximum value of Cb and Cr is less than the threshold is called threshold region. The threshold region is shown in Figure 4(b).
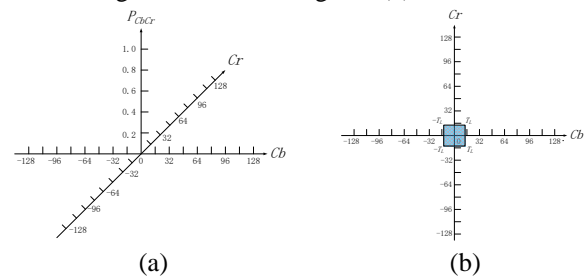
(a) (b)
FIGURE 4 (a) Normalized chrominance histogram; (b) Low saturation region

Normally, the possibility sum in the threshold region of the document image is very high. This normalized chrominance histogram characteristic can be used to identify the types of the image. For example, if the possibility sum in the threshold region, SP_{CbCr}, is more than 75%, the image can be identified as the document image. The SP_{CbCr} is calculated as Equation (3).

$$SP_{CbCr} = \sum_{Cr=-T_L}^{T_L} \sum_{Cb=-T_L}^{T_L} P_{CbCr} \quad (3)$$

In fact, the SP_{CbCr} of Figure 2(a)~(d) are 98.5%, 96.2%, 90.0%, and 94.0%. And the SP_{CbCr} of Figure 3(a)~(d) are 66.9%, 72.6%, 28.6%, and 65.9%.

3 Document image enhancement method based on spatial domain filtering

3.1 IMAGE FILTERING IN SPATIAL DOMAIN

Figure 5 is the normalized luminance histogram of Figure 2(a). The P_Y in the histogram is the possibility of the

pixels which has luminance Y. P_Y is calculated as Equation (4).
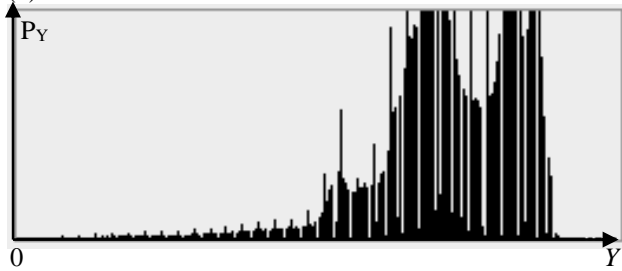
FIGURE 5 Luminance histogram of Figure 2(a)

$$P_Y = \frac{N_Y}{H \times W} \quad Y = 1, 2, \ldots\ldots, 255 \tag{4}$$

In order to degrade the shading in the document image, for the luminance value of pixel (x, y), i.e. $f(x, y)$, the spatial filtering is calculated as Equation (5).

$$h(x,y) = \begin{cases} e^{\ln 80 + \ln f(x,y) - LPF(\ln f(x,y))}, & e^{\ln 80 + \ln f(x,y) - LPF(\ln f(x,y))} \leq 255 \\ 255, & e^{\ln 80 + \ln f(x,y) - LPF(\ln f(x,y))} > 255 \end{cases} \tag{5}$$

Here, $h(x, y)$ is the filtering result. The LPF is a low-pass filtering. The low-pass filtering is fulfilled by a convolution $f(x, y) * m(x, y)$. $m(x, y)$ is the convolution mask. For the position (x, y) in the mask, the mask coefficients are calculated by Equation (6).

$$T(tx, ty) = \frac{1}{2\pi\sigma^2} e^{-(tx^2 + ty^2)/(2\sigma^2)} \tag{6}$$

Figure 6 is the normalized luminance histogram of Figure 2(a) after spatial filtering.
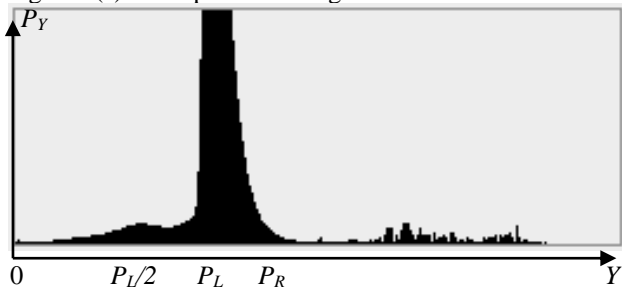
FIGURE 6 Luminance histogram after spatial filtering

3.2 LINEAR DYNAMIC RANGE ADJUSTMENT

After spatial filtering, most of the luminance values are relatively low. So a linear dynamic range adjustment is performed. Here, two variables in the luminance histogram after spatial filtering are defined. One is P_L, the first luminance value which probability is more than $\frac{1}{255}$. The other is P_R, the last luminance value which probability is more than $\frac{1}{255}$. For example, for the Figure 2(a), the P_L and P_R in Figure 6 are about 77 and 100.

Most of the background pixels should be in $[P_L, P_R]$. The pixels in the range $[P_R, 255]$ then can be identified

as 255. The pixels in the range $[0, P_L]$ should be the foreground. For the robust reason, the pixels in the range $[0, \frac{P_R}{2}]$ can be identified as 0.

For the pixels in the range $[\frac{P_R}{2}, P_L]$, a linear function is applied to their luminance values as Equation (7). The histogram after the processing of Equation (7) is shown in Figure 7.

$$l(x,y) = \begin{cases} 0, & h(x,y) \leq \frac{P_L}{2} \\ \dfrac{510h(x,y) - 255P_L}{2P_R - P_L}, & \frac{P_L}{2} < h(x,y) < P_R \\ 255, & h(x,y) \geq P_R \end{cases} \tag{7}$$
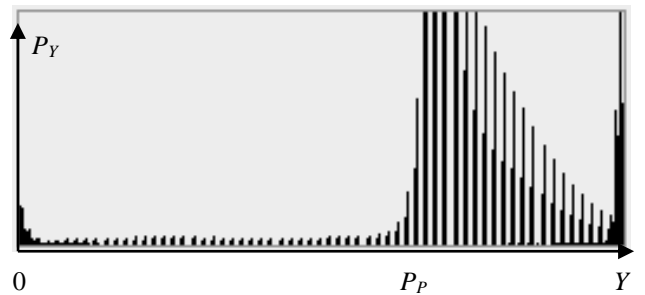
FIGURE 7 Luminance histogram after dynamic range adjustment

3.2 PEAK VALUE POSITION ADJUSTMENT

Considering most of the pixels in the document image should be the background pixels, the peak value position, for example 176 in Figure 7, then should be the back ground color. So the peak value position in the figure of the luminance histogram after dynamic range adjustment can be adjusted further to 255. Supposing the peak value position P_P, the pixels in the range $[0, P_P]$ should be adjusted to $[0, 255]$ also. The whole peak value position adjustment equation can be summarized in Equation (8).

$$p(x,y) = \begin{cases} \dfrac{255l(x,y)}{P_P}, & l(x,y) \leq P_P \\ 255, & l(x,y) \geq P_P \end{cases} \tag{8}$$

After peak value position adjustment, the histogram in Figure 7 can be changed to Figure 8. From Figure 8, we can see that a lot of pixels are distributed in 0 or 255. The pixels in the range of (0, 255) also have a good distribution.
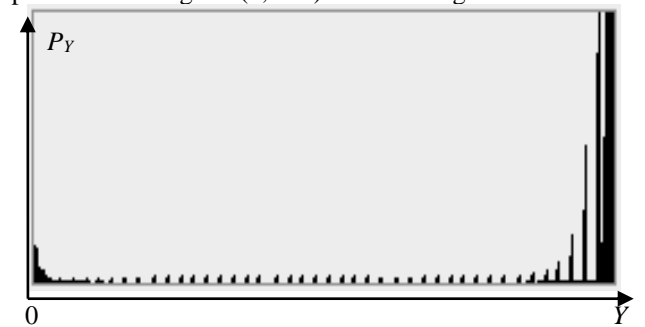
FIGURE 8 Luminance histogram after peak value position adjustment

4 Scene image enhancement method based on normalized luminance histogram characteristics

4.1 SCENE IMAGE CLASSIFICATION

For the P_L, the first luminance value which probability is more than $\frac{1}{255}$, and P_R, the last luminance value which probability is more than $\frac{1}{255}$, their average value, i.e. P_M, can be calculated as Equation (9).

$$P_M = \frac{P_L + P_R}{2} \tag{9}$$

Then the probability sum of the left side of the P_M, i.e. SP_L, and the probability sum of the right side of the P_M, i.e. SP_R, can be calculated as Equation (10) and Equation (11). At last, the absolute value of the SP_L and SP_R, i.e. ΔSP, is calculated as Equation (12).

$$SP_L = \sum_{Y=0}^{P_M} P_Y \tag{10}$$

$$SP_R = \sum_{Y=P_M}^{255} P_Y \tag{11}$$

$$\Delta SP = |SP_L - SP_R| \tag{12}$$

If the absolute value ΔSP is smaller than a threshold, for example, 15%, normally the distribution ratio of the foreground pixels and the background pixels are nearly balanced. The scene images belonging to this category are called class I scene image here. For the class I scene image, the luminance histogram equalization algorithm is performed.

On the contrary, if the absolute value ΔSP is bigger than the threshold, normally the distribution ratio of the foreground pixels and the background pixels are much different. One is for the scene image which probability sum of the left side in the luminance histogram is more than the right side. This kind of scene image is called class II scene image here. The other is for the scene image which probability sum of the right side in the luminance histogram is more than the left side. This kind of scene image is called class III scene image. Two non-linear transformations are used to enhance them.

4.2 SCENE IMAGE LUMINANCE ENHANCEMENT

For the class I scene image, the luminance histogram equalization algorithm is performed. For every luminance value in the luminance histogram, i.e. Y, and its probability, i.e. P_y, its probability sum, i.e. SP_y, is calculated as Equation (13).

$$SP_Y = \sum_{i=0}^{Y} P_i \tag{13}$$

Then, for the original luminance value, i.e. Y, the enha-nced luminance value, i.e. $m(Y)$ is calculated as Equation (14).

$$m(Y) = 255 SP_Y \tag{14}$$

Supposing the original luminance value is $l(x,y)$ for every pixel which coordinates is (x, y) in the class II scene image, its enhanced luminance value, i.e., $P(x, y)$ is calculated as Equation (15). Its transformation curve is presented in Figure 9(a).

$$p(x, y) = 255 \sin \frac{\pi l(x, y)}{510} \tag{15}$$

Supposing the original luminance value is $l(x, y)$ for every pixel which coordinates is (x, y) in the class III scene image, its enhanced luminance value, i.e. $p(x, y)$, is calculated as Equation (16). Its transformation curve is presented in Figure 9(b).

$$p(x, y) = 2l(x, y) - 255 \sin \frac{\pi l(x, y)}{510} \tag{16}$$

(a)   (b)
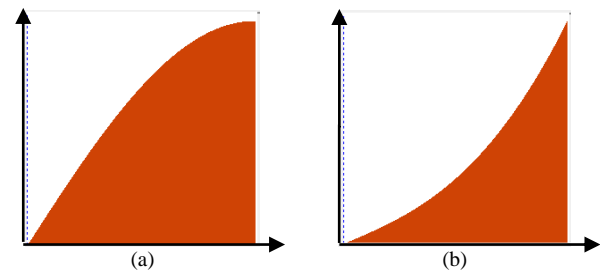
FIGURE 9 (a) Luminance enhancement curve for class II scene image; (b) Luminance enhancement curve for class III scene image

4.3 SCENE IMAGE SATURATION ENHANCEMENT

In order to enhance the color saturation under the condition of keeping the hue unchanged, normally the YCbCr color space should be transformed to RGB color space as Equation (17). Then the RGB color space can be transformed to HSI color space as Equations (18) ~ (21). The S value of HSI color space can be increased then. At last, the new HSI signals should be transformed back to RGB color space again. However, that scene image saturation enhancement method is a little bit complicated.

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 & 0 & 1.403 \\ 1 & -0.344 & -0.714 \\ 1 & 1.773 & 0 \end{bmatrix} \begin{bmatrix} Y \\ Cb \\ Cr \end{bmatrix}, \tag{17}$$

$$S = 1 - \frac{3}{(R+G+B)} \left[\min(R,G,B) \right], \tag{18}$$

$$H = \begin{cases} \theta & \text{if } B \le G \\ 360 - \theta & \text{if } B > G \end{cases}, \tag{19}$$

$$\theta = \cos^{-1} \left\{ \frac{\frac{1}{2}[(R-G)+(R-B)]}{\left[(R-G)^2 + (R-B)(G-B) \right]^{\frac{1}{2}}} \right\}, \tag{20}$$

$$I = \frac{1}{3}(R+G+B). \tag{21}$$

In order to enhance the scene image saturation with YCbCr color space signals directly, let us consider the condition of Equation (22). Here, both *Cb* and *Cr* are increased the same magnification, i.e. $\beta(\beta > 1)$. Then the new differences of *R, G* and *B* are also increased the same magnification, i.e. β, because of Equation (23) which is deduced from Equation (17).

$$\begin{cases} Cb' = \beta Cb \\ Cr' = \beta Cr \end{cases},\qquad(22)$$

$$\begin{cases} R\text{-}G = \ \ \ 0.344Cb + 0.689Cr \\ R - B = -1.773Cb + 1.403Cr \ \ . \\ G - B = -2.117Cb - 0.714Cr \end{cases}\qquad(23)$$

Hence the θ in Equation (20) can be kept unchanged because the new differences of *R, G* and *B* is increased the same magnification. That means the *H* is unchanged because of Equation (19). Also through some algebraical deductions, the scene image's saturation *S* in Equation (18) is increased under the condition Equation (22) when $\beta > 1$.

For every (*Cb, Cr*), the increasing magnification, i.e. β, is limited in a range because the *R, G* and *B* should be limited in the range of [0, 255] in Equation (17). Supposing the maximum increasing magnification is β_{max}, the new adjusted value of (*Cb, Cr*), i.e. *Cb', Cr'*, can be calculated as Equation (24). Here the α is a coefficient for saturation adjustment which range is [0, 1]. User can set the α according to his personal preferences for the saturation of the current scene image.

$$\begin{cases} Cb' = \alpha\beta_{max}Cb \\ Cr' = \alpha\beta_{max}Cr \end{cases}\qquad(24)$$

5 Experimental results and analyses

We made the programs for the proposed method of this paper in Windows operating system in our personal computer. The programming environment is the Microsoft Visual C++ 2005. A lot of images' testing demonstrated that this method can effectively enhance not only the document image but also the scene image.

Figure 10 and Figure 11 shows the enhanced document images from Figure 2 processed by the SSR and MSR. The document images of Figure 2 come from the famous novel of "*Jane Eyre*" by English writer Charlotte Brontë [12]. Figs. 12 shows the enhanced images from Figure 2 processed by the proposed method.
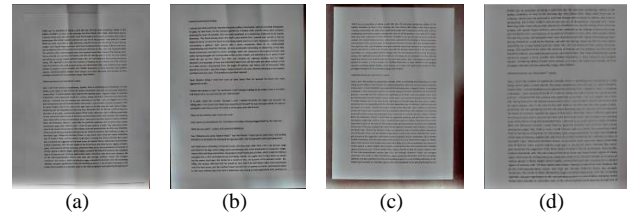
FIGURE 10 Document images enhanced by the SSR method
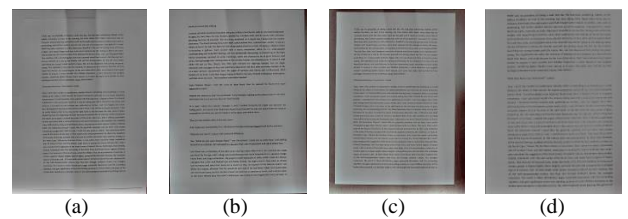
FIGURE 11 Document images enhanced by the MSR method
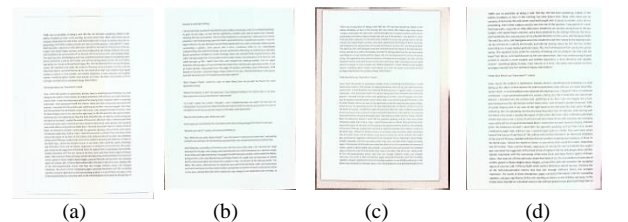
FIGURE 12 Document images enhanced by the proposed method

The average of the chrominance, chrominance standard deviation, and chrominance contrast are counted in Table 1. The chrominance contrast is calculated by Equation (24) through the 8 neighbourhood method.

$$C = \frac{\sum_{y=1}^{H\text{-}2}\sum_{x=1}^{W\text{-}2} \begin{matrix}(f(x,y) - f(x\text{-}1, y+1))^2 + (f(x,y) - f(x,y+1))^2 + \\ (f(x,y) - f(x+1, y+1))^2 + (f(x,y) - f(x-1,y))^2 + \\ (f(x,y) - f(x+1,y))^2 + (f(x,y) - f(x-1,y\text{-}1))^2 + \\ (f(x,y) - f(x,y\text{-}1))^2 + (f(x,y) - f(x+1,y\text{-}1))^2 \end{matrix}}{(H\text{-}2)\times(W\text{-}2)} .\qquad(24)$$

From Table 1, we can see that the chrominance average values, chrominance standard deviations, and chrominance contrast of the enhanced document images with the proposed method are 46%, 32%, and 70% higher than the SSR and MSR method on average.

Figure 13 and Figure 14 show the enhanced scene images from Figure 3 processed by the SSR and MSR. Figure 3 is selected from the book of "Digital Image Processing, 3rd ed." by Gonzalez and Woods [13]. Figure 15 shows the enhanced images processed by the proposed method. Here, the coefficient in Equation (24) is taken can be taken a less value to deduce the color saturations.

TABLE 1 Document image enhancement result comparison

Me ē thod	Name	Y Avg.	Y Std. Dev.	Contrast
Orig. Image	Fig. 2(a)	181.13	33.15	215.98
	Fig. 2(b)	188.97	31.39	206.46
	Fig. 2(c)	159.82	51.24	253.24
	Fig. 2(d)	155.14	49.43	767.02
	Average	171.27	41.30	360.68
SSR	Fig. 10(a)	128.95	30.61	282.56
	Fig. 10(b)	128.95	30.94	295.45
	Fig. 10(c)	127.97	38.52	279.50
	Fig. 10(d)	129.48	30.62	490.03
	Average	128.84	32.67	336.89
MSR	Fig. 11(a)	128.98	28.76	349.18
	Fig.11(b)	129.03	29.34	363.99
	Fig. 11(c)	128.24	36.27	390.64
	Fig. 11(d)	129.62	30.32	528.70
	Average	128.97	31.17	408.13
Proposed Method	Fig. 12(a)	242.05	43.67	1054.85
	Fig. 12(b)	240.58	41.81	954.10
	Fig. 12(c)	235.23	48.14	1167.53
	Fig. 12(d)	236.76	54.89	1930.10
	Average	238.66	47.13	1276.65

(a)   (b)   (c)   (d)

FIGURE 13 Scene images enhanced by the SSR method

(a)   (b)   (c)   (d)

FIGURE 14 Scene images enhanced by the MSR method

(a)   (b)   (c)   (d)
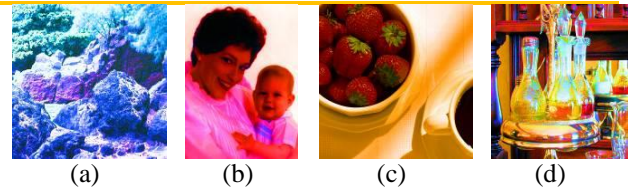
FIGURE 15 Scene images enhanced by the proposed method

The standard deviations of the RGB, chrominance contrast, and color saturation are counted in Table 2.

TABLE 2 Scene image enhancement result comparison

Method	Name	R. Std. Dev.	G. Std. Dev.	B. Std. Dev.	Con-trast	Sat.
Orig. Image	Fig. 3(a)	19.62	23.78	28.42	79.71	0.27
	Fig. 3(b)	66.66	67.52	68.36	14.35	0.07
	Fig. 3(c)	59.99	82.02	75.35	150.86	0.27
	Fig. 3(d)	61.83	64.85	68.14	197.62	0.21
	Average	52.03	59.54	60.07	110.64	0.21
SSR	Fig. 13(a)	40.39	39.73	46.41	229.78	0.08
	Fig. 13(b)	43.58	41.95	41.87	8.34	0.06
	Fig. 13(c)	37.27	44.96	37.95	127.90	0.13
	Fig. 13(d)	41.74	42.35	43.25	85.86	0.07
	Average	40.75	42.25	42.37	112.97	0.09
MSR	Fig. 14(a)	40.30	38.97	46.12	359.84	0.10
	Fig. 14(b)	43.42	41.97	41.92	15.07	0.06
	Fig. 14(c)	36.53	45.37	37.01	231.74	0.13
	Fig. 14(d)	41.11	41.94	43.71	150.38	0.08
	Average	40.34	42.06	42.19	189.26	0.09
Proposed Method	Fig. 13(a)	93.94	75.99	75.41	681.71	0.54
	Fig. 15(b)	88.38	88.17	100.97	25.64	0.55
	Fig. 15(c)	80.85	84.64	76.84	131.58	0.77
	Fig. 15(d)	85.05	85.89	105.08	223.44	0.63
	Average	87.06	83.67	89.58	265.59	0.62

The standard deviations of the RGB, chrominance contrast, and color saturation of the enhanced scene images with the proposed method are 53%, 50%, 53%, 43%, and 85% higher than the SSR and MSR method on average.

6 Conclusions

This paper proposes an image enhancement method based on image classification by histogram characteristics for YCbCr color space signals. Firstly, the images are divided into document image and scene image according to the normalized CbCr histogram characteristic. For the scene

image, three types are identified by the normalized Y histogram characteristics. For different types of images, different enhancement scheme is applied. Experimental results showed that the proposed method can enhance not only the contrast for the document image, but also both the contrast and saturation for the scene image effectively.

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Authors

Lijing Tong, 1972, Anhui Province, PRC

Current position, grades: Associate Professor, PhD
University studies: Institute of Software, Chinese Academy of Sciences (ISCAS)
Scientific interest: Computer Vision, Computer Graphics
Publications: More than 30 papers published in various conferences and journals.
Experience: Teaching experience of 7 years, 5 scientific research projects

Jingzhong Wang, 1962, Inner Mongolia, PRC

Current position, grades: Dean of the School of Information Engineering, North China University, Professor
University studies: Inner Mongolia University
Scientific interest: Pattern Recognition, Signal Processing
Publications: More than 60 papers published in various conferences and journals
Experience: More than 20 year teaching experience, more than 10 scientific research projects

Sam Li, born in May, 1971, Hainan Province, PRC

Current position, grades: Senior Engineer, Bachelor Degree of Computer Science and Technology
University studies: University of Science and Technology Beijing (USTB)
Scientific interest: Image Processing, Multimedia Network
Publications: Several papers published in various journals
Experience: More than 20 year computer technology development and research experience

Ke Xiao, born on June, 1980, Jilin Province, PRC

Current position, grades: Associate Professor, PhD
University studies: Beijing University of Posts and Telecommunications
Scientific interest: Digital Image Processing, Signal Processing
Publications: More than 10 papers published in various conferences and journals
Experience: Teaching experience of 6 years, 5 scientific research projects

Quanyao Peng, 1986, Jiangxi Province, PRC

Current position, grades: Engineer, Master Degree
University studies: North China University of Technology (NCUT)
Scientific interest: Image Processing, Computer Graphics
Publications: Several papers published in various conferences and journals
Experience: More than 3 year research experience

Modelling and simulation of CNTs- and GNRs-based nanocomposites for nanosensor devices

Y Shunin[1, 4]*, S Bellucci[2], Y Zhukovskii[1], T Lobanova-Shunina[3], N Burlutskaya[4], V Gopeyenko[4]

[1]*Institute of Solid State Physics, University of Latvia, Kengaraga Str. 8, LV-1063 Riga, Latvia*

[2]*INFN-Laboratori Nazionali di Frascati, Via Enrico Fermi 40, I-00044, Frascati-Rome, Italy*

[3]*Riga Technical University, Institute of Avionics, 1 Lomonosov Str., Bld V, LV-1019, Riga, Latvia*

[4]*ISMA University, 1 Lomonosov Str., Bld 6, LV-1019, Riga, Latvia*

*Corresponding author's e-mail: yu_shunin@inbox.lv

Abstract

The main objective of the current study is to demonstrate the implementation of advanced simulation models providing a proper description of the electronic properties, electrical conductivity, electromagnetic and electromechanical phenomena of functionalized CNT- and GNR-based nanostructures of different morphologies and their interconnects for nanosensor and nanomemory systems. The sensitivity of the local electronic density of states to external influences (mechanical, chemical, magnetic, etc) on the fundamental electromagnetic properties of CNTs, GNRs and their metal interconnects have been analyzed from the point of view of nanosensor applications. Nanoporous systems are considered as complicated ensembles of basic nanocarbon interconnected elements (e.g., CNTs or GNRs with possible defects and dangling boundary bonds) within the effective media type environment. The model of nanocomposite materials based on carbon nanocluster suspension (CNTs and GNRs) in dielectric polymer environments (e.g., epoxy resins) is regarded as a disordered system of fragments of nanocarbon inclusions with different morphologies (chirality and geometry) in relation to a high electrical conductivity in a continuous dielectric environment. The electrical conductivity of a nanocomposite material depends on the concentration of nanocarbon inclusions (in fact, carbon macromolecules). Various nanocomposite morphologies are considered and computer simulation results are discussed.

Keywords: carbon-based nanocomposites pressure nanosensors hopping conductivity

1 Introduction

We develop a set of prospective models of nanocarbon-based nanomaterials and nanodevices based on the various interconnects and interfaces (see Figure 1). In particular, nanoporous systems are considered as complicated ensembles of basic nanocarbon interconnected elements (e.g., CNTs or GNRs with possible defects and dangling boundary bonds) within the effective media type environment (Figure 1a,1b). Interconnects are essentially local quantum objects and are evaluated in the framework of the developed cluster approach based on the multiple scattering theory formalism as well as effective medium approximation [1-3].

In cases when nanocarbon clusters are embedded in high resistance media (instead of vacuum) we come to nanocomposite material. Talking about carbon based nanocomposites, the formation of direct nanocarbon interconnects may not be mandatory (see, Figure 1e).

The utilization of polymeric composite materials (e.g., epoxy resins) supplemented with various morphological nanocarbon groups of carbon nanotube-type (CNTs) and graphene nanoribbons (GNRs) allows us to create effective pressure and temperature sensors. Application of such nanocomposites as coatings can provide continuous monitoring of the mechanical strains in piping systems (for example, in aircraft or automotive applications), when the critical pressure values can indicate malfunctions of the engine. Such an ongoing monitoring is essential for the development of intelligent engine management and cooling systems.

a)   b)   c)

d)   e)
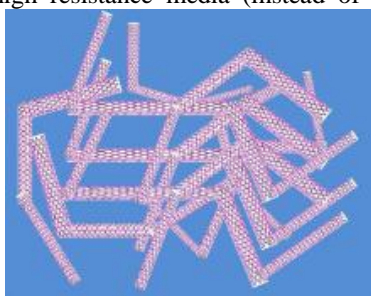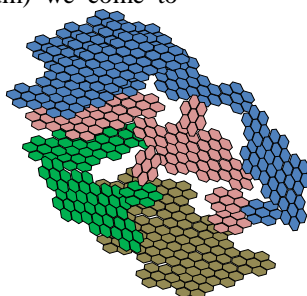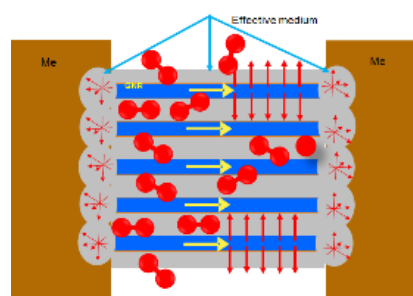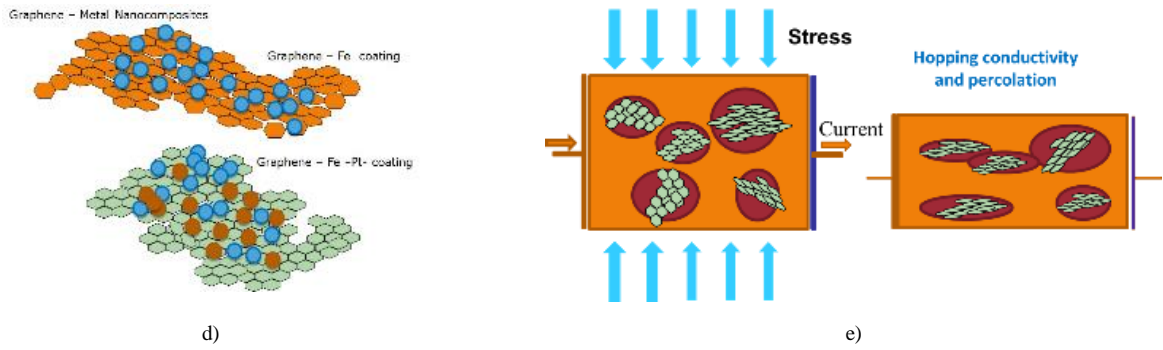
FIGURE 1 A set of simulation models: a) Structural model of CNTBA; b) Structural model of GBA; c) GNRs-based gas nanosensor device;
d) Graphene-metal nanocomposites- Fe and Fe-Pt coatings; e) model of nanocomposite based pressure and temperature sensor

The interest in the CNTs and GNRs based polymer nanocomposites as prospective pressure nanosensor materials is based on the observed electric percolation phenomena via the nanocarbon inclusions concentration. In particular, the electrical conductivity of a nanocomposite increases with the increasing CNT loading till a critical filler concentration, where a dramatic increase in conductivity is observed. This critical filler concentration is called electrical percolation threshold concentration. [4, 5]. At percolation threshold concentration, a filler forms a three-dimensional conductive network within the matrix, hence electron can tunnel from one filler to another, and in doing so it overcomes the high resistance offered by insulating polymer matrix.

It is worth mentioning some experience in the creation of CNTs-based experimental prototypes of pressure nanosensors [6-8].

External stresses applied to nanocarbon based nanocomposites lead to a relative volume decrease and, as a result, to nanocarbon concentration increase. This process explains the trends in conductivity increase under the stress growth for improving percolation conditions.

2 Models CNTs- and GNRs-based nanocomposites

Consider the model of composite material with carbon nanocluster inclusions of CNTs- and GNRs- types. The host material – is a flexible dielectric medium of epoxy resin-type with high resistance [3, 9]. However, low concentration of nanocarbon inclusions cannot change the mechanical properties of the host material. At the same time, high electrical conductivity of CNTs- and GNRs incorporated in the host material can significantly affect the total conductivity of the nanocomposite material. According to our model, the mechanism of these changes is related to the effects of percolation through the hopping conductivity.

Thus, the model of nanocomposite materials based on carbon nanocluster suspension (CNTs and GNRs) in dielectric polymer environments (e.g., epoxy resins) is considered as a disordered system of fragments of nanocarbon inclusions with different morphology (chirality and geometry) in relation to a high electrical conductivity in a continuous dielectric environment. Presumably, the electrical conductivity of a nanocomposite material will depend on the concentration of nanocarbon inclusions (in fact, carbon macromolecules). Isolated nanocarbon inclusions will provide conductivity due to the hopping conductivity mechanism through dangling bonds up to the percolation threshold, when at high concentrations (some mass %) a sustainable ballistic regime appears, which is

characteristic of pure carbon systems. The hopping mechanism is regulated by the hopping of electron between 'nanocarbon macromolecules' [10]:

$$\sigma_{IC} = \sigma_0 \cdot \exp\left(-\frac{4}{3}\left(\frac{4\alpha r_{IC}}{a}\right)^{3/4}\left(\frac{W_0}{kT}\right)^{1/4}\right) , \qquad (1)$$

where r_{IC} is the length of the tunnel 'jump' of the electron equal to the distance between 'nanocarbon' clusters, σ_0 - normalization constant, which means the conductivity of monolithic dielectric medium [10]. Added to this is the effect of intrinsic nanocarbon cluster conductivity, which is dependent on its morphology. The electric conductivity will also depend on the spatial orientation of nanocarbon inclusions. It will be greater for the longitudinal electric field orientations and lower for the transverse ones. Of course, any spatial orientations are technologically possible.

If we introduce the volume part as an indicator of the nanocarbon inclusions concentaration:

$$\eta = \left(\frac{R_0}{R_0 + R}\right)^3 ,$$

where R_0 is the average nanocarbon macromolecule radius, R is, as earlier, the width of the potential barrier between the nearest nanoclusters, which is responsible for percolation ability of the model nanocomposite. We should also diminish the hopping phenomena and percolation probability taking into account the nanocarbon macromolecule orientation within a hypothetical sphere embedded into high resistance dielectric medium.

Based on this definition, we can obtain a contribution of potential nanocarbon clusers to nanocomposite conductivity as follows (see also Figures 2, 3):

$$\ln\left(\frac{\sigma_{IC}}{\sigma_0}\right) = -\frac{4}{3}\left(\frac{4\alpha}{a} R_0 (\eta^{-1/3} - 1)\right)^{3/4}\left(\frac{W}{kT}\right)^{1/4} \qquad (2)$$

The overall conductivity of nanocomposite material is [9, 11]:

$$\Sigma \approx \Sigma_D + \Sigma_{NC} , \qquad (3)$$

where $\Sigma_{NC} = \sum_i^N (R_i)^{-1}$,

$$R_i = A\sum_{k=1}^{N_i}(\sigma_{nano,i.k}^{-1} + \sum_{k=0}^{N_i}(N_{eff,i,k}\,\sigma_{IC,i,k})^{-1}) ,$$

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where N - is the number of conductivity channels, N_i – is the number of nanocarbon clusters in the conductivity channel, N_{eff} is the number of effective bonds of tunneling bonds including the contact region, $\sum_D = (R_D)^{-1}$ is the conductance of dielectric medium, σ_{nano} is the conductivity nanocluster, σ_{IC} - is the hopping conductivity of the effective bond, which creates interconnect for large nanocarbon inclusion concentrations.
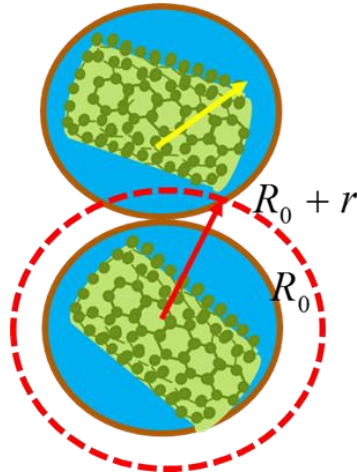
FIGURE 2 Nanocomposite conductivity via volume concentration of nanocarbon inclusions [3]
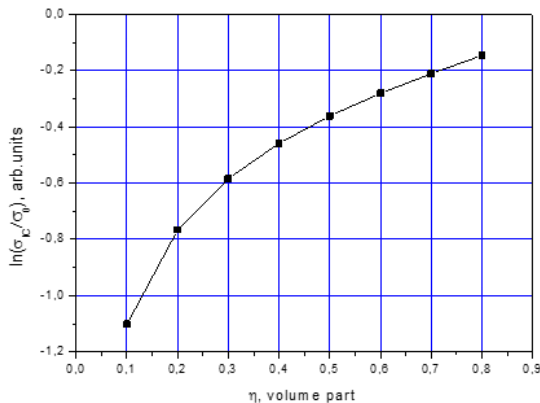
FIGURE 3 The hopping conductivity correlation via the average nanocarbon macromolecules volume part within continuous dielectric medium

3 Simulation of stress-induced resistance of carbon-based nanocomposite sensors

The overall configuration of the sample for the model calculations is presented in Figure 4. The basic dimensions of nanocarbon clusters (CNTs and GNRs) are as follows: the diameter of the CNT - 5 nm, the height - 10 nm, the width of the expanded CNT, ie, the width of the GNR = $\pi \cdot 5 \approx 15,6 nm$.
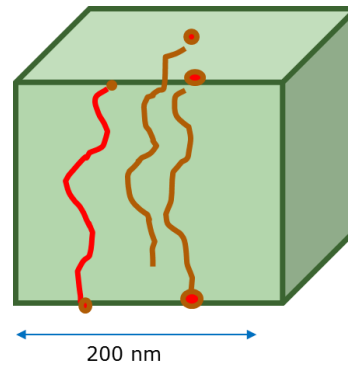
FIGURE 4 Nanocomposite sample with a probabilistic percolation way of the electric current

The average statistical distance between nanocarbon clusters is - 5 nm. This is the key distance for the mechanism of hopping conductivity (see Figure 5). Nanocarbon cluster is considered as a potential well with a typical size 2a. Neighboring potential wells are separated by a distance r_{IC}. These two parameters are ultimately determine the morphology of the nanocomposite material.
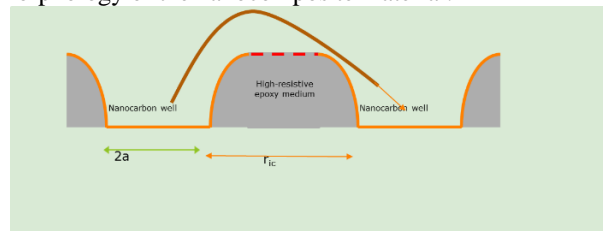
FIGURE 5 Jumping between neighboring nanocarbon potential wells

The proposed model of hopping conductivity for current percolation in carbon-based epoxy-resin nanocomposite [4] takes into account basically the percolations along the nanocluster sets which are located along the stress direction. Interactions between the neighbouring sets are not considered for a low general concentration of nanocarbon inclusions [11].

Figure 6 demonstrates resistances correlations via static stresses for ideal morphologies of a nanocomposite when CNTs and GNRs are oriented pure longitudinally or pure transversely.

From the technological point of view, it is not so simple to provide such ideal orientations for host polymer materials similar to epoxy resins. The first problem of the nanocomposite morphology is the selection of CNTs and GNRs with identical parameters. The second problem is the polymer-nanocarbon mixture creation when we evidently should expect a homogenous random distribution of nanocarbon orientations.

Figure 7 demonstrates the marginal rotational disordering of CNTs inclusions from 'ideal' longtitudinal orientation. Deviations of orientations give the characteristic intercluster distances of 3.82 and 7.02 nm taking into account basic 5 nm in the ideal case.

Figure 8 presents the full-scale simulation of CNTs orientation deviations within a host material. The results show various sensitivity of the model nanocomposite as a potential pressure nanosensor in dependence of its morphology. Configurations of the 4th type (see Figure 8) are more sensitive and, evidently, more practically preferable.

Shunin Y, Bellucci S, Zhukovskii Y, Lobanova-Shunina T, Burlutskaya N, Gopeyenko V
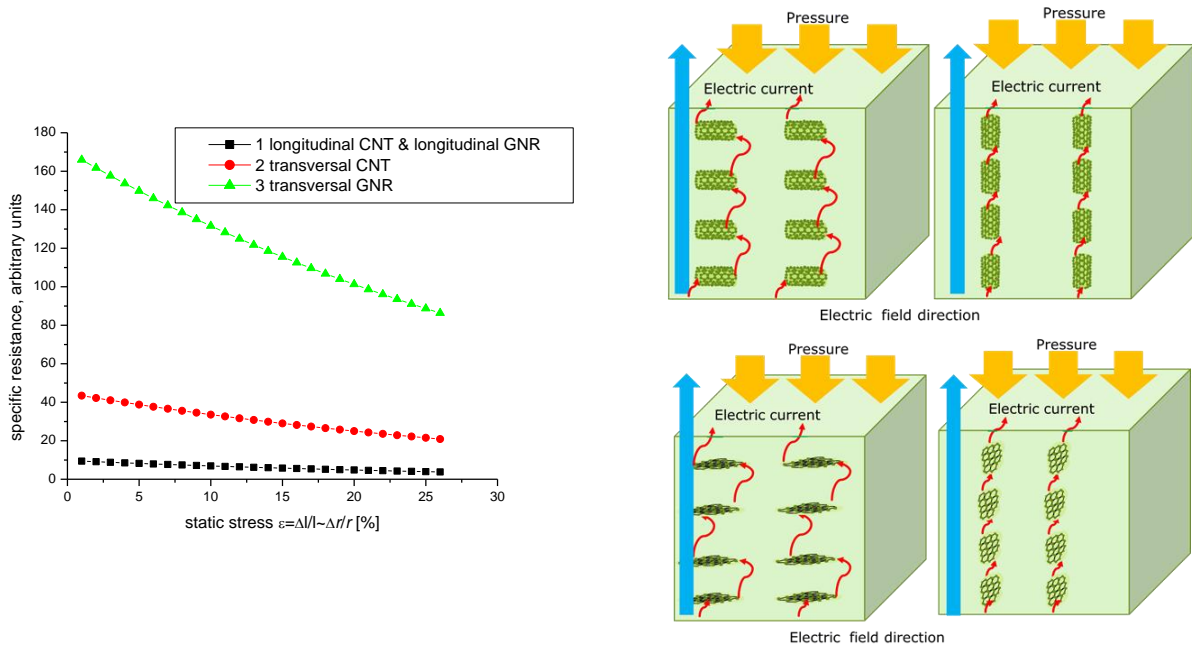
FIGURE 6 Specific resistance of CNTs and GNRs based nanocomposite (epoxy resin) via static stress. To the right – variants of morphological orientations of nanocarbon inclusions
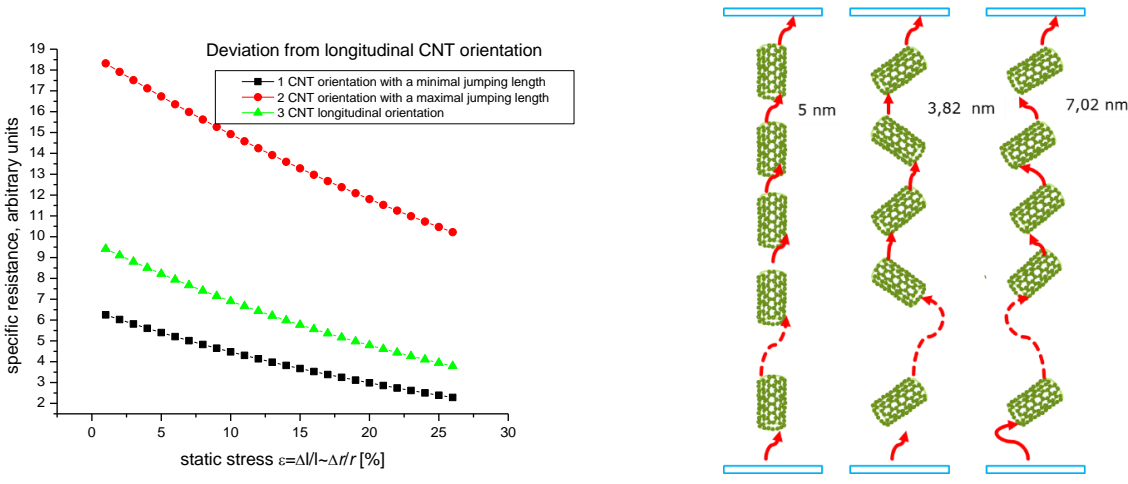
FIGURE 7 Rotational disordering of nanocarbon inclusions: longitudinal case. To the right – morphological variants of CNTs orientations
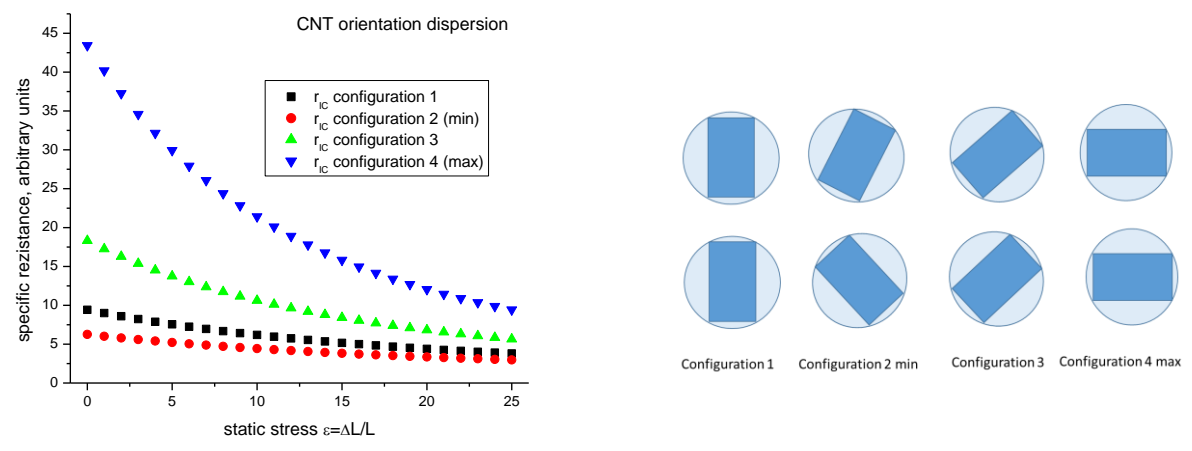
FIGURE 8 Resistances of CNTs based nanocomposites via static stress for various marginal morphologies

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Burlutskaya N, Gopeyenko V**

The model uses morphologically compatible carbon nano configurations with the same number of carbon atoms, the same surface area of model CNTs and GNRs, and the same chirality. In this way, the model CNTs and GNRs are interconnected by a simple topological transformation from a cylinder to a rectangular fragment. Monte-Carlo simulations of orientation deviations for CNTs and GNRs morphologies are presented on Figures 9 and 10.
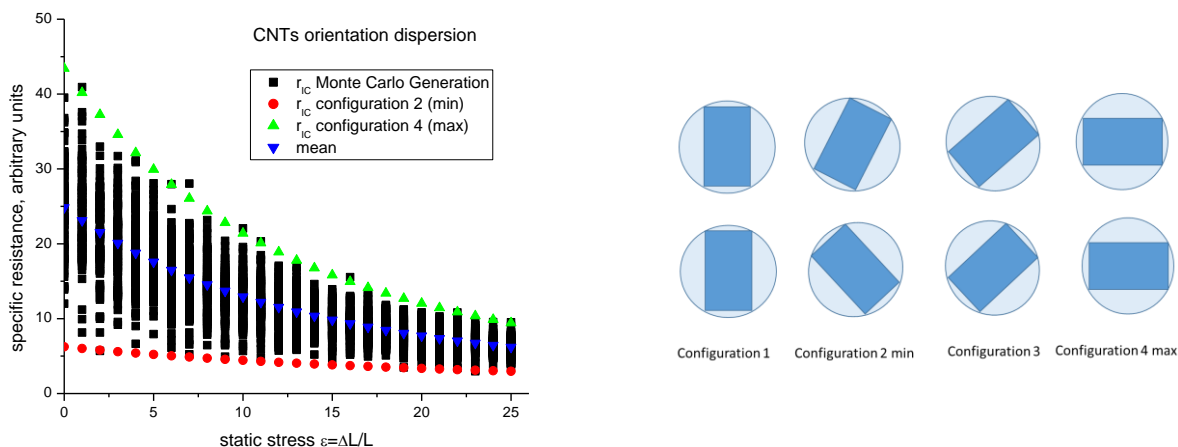
FIGURE 9 Resistances of CNTs based nanocomposites via static stress for Monte-Carlo varied morphologies. To the right – marginal orientations of CNTs within a host polymer material
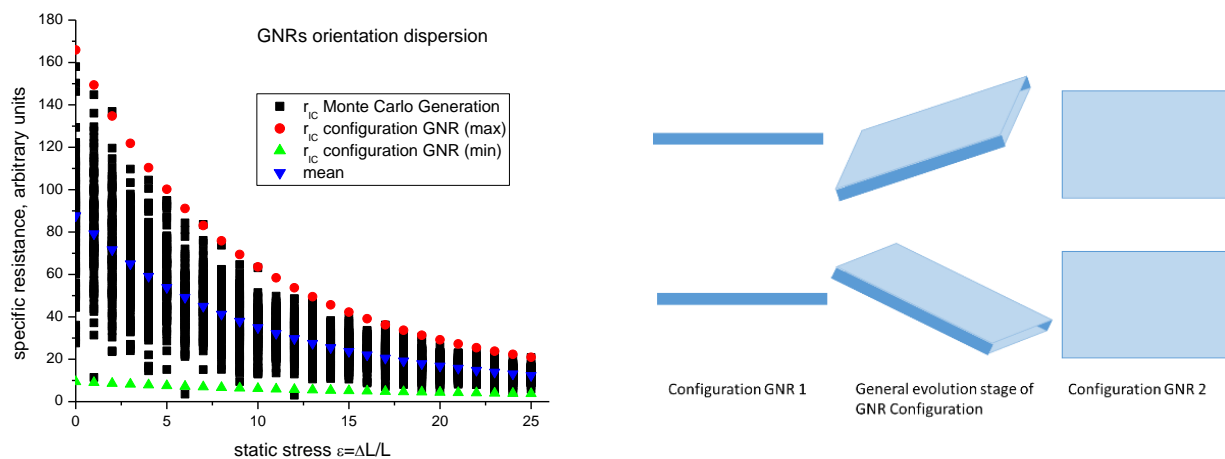
FIGURE 10 Resistances of GNRs based nanocomposites via static stress for Monte-Carlo varied morphologies. To the right – marginal orientations of GNRs within host polymer material

The middle curves of resistances via the static stress (Fig. 9, 10) characterize the main phenomenon trend for the expected pressure CNTs and GNRs-based nanosensor prototypes.

4 Conclusions

A nanocomposite pressure nanosensor prototype has been simulated. The hopping conductivity mechanism gives the adequate description of possible nanosensor qualilities.

An important problem of manufacturing sensors based on CNTs is nanotube orientation, which determines the electrical properties of the future sensor.

A temperature nanosensor prototype needs a host medium with a high heat conductivity and low electrical conductivity. Epoxy resin parameters do not answer these requirements.

Acknowledgments

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Authors

Yuri N Shunin

Current position, grades: Professor and Vice-Rector on academic issues at Information Systems Management University and a leading researcher at the Institute of Solid State Physics, University of Latvia.
University studies: PhD (physics and maths, solid state physics, 1982) at the Physics Institute of Latvian Academy of Sciences and Dr. Sc. Habil. (physics and maths, solid state physics, 1992) at Saint-Petersburg Physical Technical Institute (Russia).
Scientific interests: His current research activities concern nanophysics, nanoelectronics, nanodevices, nanomaterials, nanotechnologies, nanorisks, nanoeducation, and nanothinking
Publications: over 470, 1 book with Springer
Experience: director of NATO ARW "Nanodevices and Nanomaterials for Ecological Security," Riga, Latvia, 2011, a visiting researcher at Gesellschaft für Schwerionenforschung mbH, Darmstadt, Germany (1995), INFN—Laboratori Nazionali di Frascati, Frascati-Roma, Italy (2010 to 2015), participation in EU FP7 Projects CATHERINE (2008 to 2011) and CACOMEL (2010 to 2014), education practitioner in Higher Education from 1975 till nowadays

Stefano Bellucci

Current position, grades: PhD, Professor, currently coordinates all theoretical physics activities at INFN Laboratori Nazionali di Frascati (Italy).
Universisty studies: April 1982: Laurea in Physics (Magna cum Laude), University of Rome "La Sapienza" July 1984: Master in Physics of Elementary Particles, SISSA and University of Trieste, PhD in physics of elementary particles in 1986 at SISSA, Trieste, Italy.
Publications: over 400 papers in peer-reviewed journals (with h = 40), and more than 10 invited book chapters, the editor of ten books with Springer
Scientific interests: research interests include theoretical physics, condensed matter, nanoscience and nanotechnology, nanocarbon-based composites, and biomedical applications.
Experience: Worked as a visiting researcher at theBrandeis University, Waltham, MA, USA (1983 to 1985); at the M.I.T., Cambridge, MA, USA (1985 to 1986); the University of Maryland, USA (1986 to 1987); at the University of California at Davis, USA (1987 to 1988). Editorial board member of the Springer Lecture Notes in Nanoscale Science and Technology, as well as the editorial board member of the Global Journal of Physics Express and the Journal of Physics & Astronomy

Yuri Zhukovskii

Current position, grades: Dr.Chem., Head of Laboratory of Computer Modeling of Electronic Structure of Solids, Institute of Solid State Physics (University of Latvia).
Publications: He is the author of over 120 regular and review papers in international scientific journals. His Hirsch index is 16.
Experience: From 1977 until 1995 a researcher at the Institute of Inorganic Chemistry, Latvian Academy of Sciences. Since 1995 a leading researcher at the Institute of Solid State Physics, University of Latvia. Within the last 20 years he has been granted several fellowships for collaboration, visiting activities and positions at seven universities and scientific centers of Canada, Finland, Germany, United Kingdom, and the United States. Actively engaged in developing active collaboration with some scientific groups in Belarus, Italy, Russia, and Sweden. Simultaneously, a contact person and participant in a number of collaboration projects under support of European Commission. His current research activities concern theoretical simulations on the atomic and electronic structure of crystalline solids (with 3D, 2D and 1D dimensionalities).

Victor Gopeyenko

Current position, grades: professor, Dr.Sc.Eng Vice-Rector on scientific issues at Information System Management University and the director of ISMU Computer Technologies Institute.
University studies: Riga Civil Aviation Engineering Institute (Latvia) obtained his doctor's degree (Dr. Sc. Eng., 1987) at Riga Civil Aviation Engineering Institute (Latvia).
Scientific interests: current research activities concern nanophysics, nanoelectronics, nanodevices, and nanotechnologies in the EU FP7 Project CACOMEL (2010 to 2014). His special interests concern carbon nanotubes and graphene systems applications and modeling.
Publications: 80 regular papers in international scientific journals
Experience: Was the member of local organizing committee of NATO ARW "Nanodevices and Nanomaterials for Ecological Security," Riga, Latvia, 2011, the editor-in-chief of the journal 'Information Technologies, Management and Society' and editorial board member of the journal 'Innovative Information Technologies'**.**

Nataly Burlutskaya

Current position, grades: a researcher at the Information Systems Management University and the Institute of Solid State Physics, University of Latvia
University studies: Master degree in computer systems (2011) at Information Systems Management University, Riga, Latvia.
Scientific interests: current research activities concern theoretical simulations of the electronic and electrical properties of carbon nanotubes and graphene nanoribbons in the EU FP7 Project CACOMEL (2010 to 2014).
Publications: 30 regular papers
Experience: the secretary of organizing committee of NATO ARW "Nanodevices and Nanomaterials for Ecological Security," Riga, Latvia, 2011.

Tamara Lobanova-Shunina

Current position, grades: Associate Professor at Riga Technical University, Aeronautics Institute, PhD, Dr.edu
University studies: University of Latvia, She obtained her PhD (2009) on innovative education at South-Ukrainian National University
Scientific interests: current research activities concern nanotechnologies, nanomanagement, nanoeducation, nanorisks, and nanothinking in the EU FP7 Project CACOMEL (2010 to 2014), special interests are connected with the systemic approach to nanosystems applications.
Publications: 53 regular papers
Experience: a member of the NATO ARW Local Organizing Committee 'Nanodevices and Nanomaterials for Ecological Security', Riga, Latvia, 2011. A visiting researcher at INFN-Laboratori Nazionali di Frascati, Frascati-Roma, Italy (2010 to 2015). The Head of International Business Communications Department, Director of the study programme 'International Business Communications' at Information Systems Management University (till 2013). The Editorial Board member of the journal 'Innovative Information Technologies'.

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Mathematical and Computer Modelling

Classified Image Enhancement Method Based on Histogram Characteristics in YCbCr Color Space

Lijing Tong, Jingzhong Wang, Sam Li, Ke Xiao, Quanyao Peng

*Computer Modelling & New Technologies 2015 **19**(5A) 7-13*

Color image enhancement in YCbCr space is an important task since most of the color image signals captured from the embedded camera or the professional video device are YCbCr image signals. Prior classical color image enhancement methods like linear transforms such as binarization, piecewise-line transform, and gray-level slicing, or non-linear transforms such as logarithm transform, index transform, and power-law transform did not consider possible histogram characteristics, and thus their enhancement performance on different image types would be degraded in some cases. In this paper, a novel classified image enhancement method based on CbCr and Y histograms is proposed to address the aforementioned problem. First, captured images are divided into two types, document image and scene image, according to the normalized chrominance histogram characteristic. For the document image, a filter is applied in space domain to get a better foreground and background. For the scene image, three different types are divided by the normalized luminance histogram characteristics. Then, three different processing schemes are applied to the three types of scene images respectively. Experimental results on different images with a variety of variations verify the effectiveness and robustness of the proposed method.

Keywords: Image processing, Image enhancement, Characteristic classification, YCbCr color space, Normalized Histogram

Modelling and simulation of CNTs- and GNRs-based nanocomposites for nanosensor devices

Yu Shunin, S Bellucci, Yu Zhukovskii, T Lobanova-Shunina, N Burlutskaya, V Gopeyenko

*Computer Modelling & New Technologies 2015 **19**(5A) 14-20*

The main objective of the current study is to demonstrate the implementation of advanced simulation models providing a proper description of the electronic properties, electrical conductivity, electromagnetic and electromechanical phenomena of functionalized CNT- and GNR-based nanostructures of different morphologies and their interconnects for nanosensor and nanomemory systems. The sensitivity of the local electronic density of states to external influences (mechanical, chemical, magnetic, etc) on the fundamental electromagnetic properties of CNTs, GNRs and their metal interconnects have been analyzed from the point of view of nanosensor applications. Nanoporous systems are considered as complicated ensembles of basic nanocarbon interconnected elements (e.g., CNTs or GNRs with possible defects and dangling boundary bonds) within the effective media type environment. The model of nanocomposite materials based on carbon nanocluster suspension (CNTs and GNRs) in dielectric polymer environments (e.g., epoxy resins) is regarded as a disordered system of fragments of nanocarbon inclusions with different morphologies (chirality and geometry) in relation to a high electrical conductivity in a continuous dielectric environment. The electrical conductivity of a nanocomposite material depends on the concentration of nanocarbon inclusions (in fact, carbon macromolecules). Various nanocomposite morphologies are considered and computer simulation results are discussed.

Content B

Maximum of load database of GPS service with recovery

Victor Boicov

Department of Electronics and Telecommunications, Riga Technical University, Riga, Latvia

*Corresponding author's e-mail: viktor.boicov@inbox.lv

Abstract

The paper analyses the database global position system (GPS) services load with recovery. A mathematical model of the interaction with the database services is developed. On the basis of mathematical modelling procedures for the exchange services, the possible delays and the presence of large queues to services are defined. Suggestions to improve the exchange of services are developed. Development of an integrated transport management system enables to solve a local task of reducing the "order-delivery" cycle and creating a positive image for the company in the eyes of the clients due to accurate execution of undertaken obligations related with order execution terms, minimization of the delivery failure risk and the opportunity of creating a flexible feedback system

Keywords: Heterogeneous services, client and server requests, network queuing systems, heterogeneity

1 Introduction

The main purpose of any database is to provide efficient services to users. One of the fundamental works on relational databases [1] identifies four main types of database services: "Projection", "Intersection", "Selection" and "Union" and four types of special services: "Subtraction", "Descartes product", "Connection" and "Division". All these services are independent from each other, although special services can be expressed in terms of the basic relational operators. Each of the services in the database is processed during the period of time determined by the type of query. This indicates the presence of heterogeneity in database network queries processing.

2 The mathematical model of the database services interaction without recovery

In [2] a mathematical model of the interaction between the workstation and the server is presented, one that takes into account the presence of two types of services. However, it was noted above that for the exchange of data in a database the number of services may be of more than eight types. To account for these factors, a mathematical model of the interaction of the services with the network database is presented below. The general scheme of interaction of clients and the database server can be represented as a closed network queuing system (QS). The scheme of such a network is shown in Figure 1.
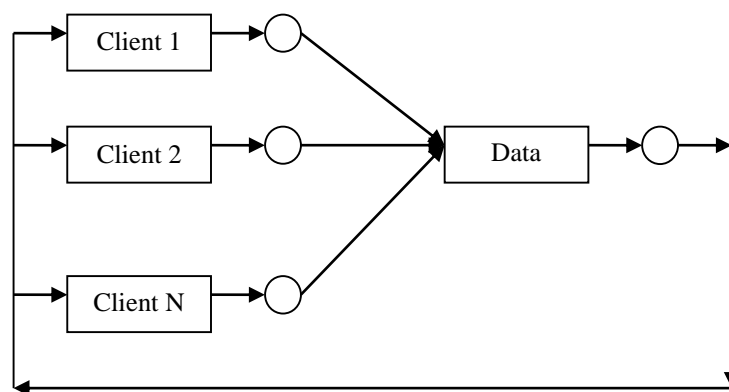
FIGURE 1 Schematic portrayal of the interaction of the client and server queues.

Each client program sends a request to the database. This request may be of any length. In general, the length of this request is random. Each client's request lengths depend on many random factors. This randomness is manifested in servicing these requests by the database. The database is required to respond to each client request. Furthermore the database itself can generate queries. The times of occurrence of these requests are random, and the length of these requests is random as well. In each case, the client must respond to the query of the database server. Thus, a closed loop of interaction between the database programs and the client emerges. Client work can be interpreted with the help of QS models. In Figure 1, each QS of the client is marked with its own rectangle with the name 'Client' and the corresponding number of the client. Transitions of requests from the client to the server and from the server to the client are marked with arrows. These transitions are probabilistic in nature. The times of servicing requests by both the server and the client also random. Client service time is homogenous because this time is determined by the time of

the implementation of the programs of one client. The time of servicing requests by the server is heterogeneous. A study of QS networks with heterogeneous service laws is presented in [3]. However, in our case, the network QS is mixed, since it contains both homogeneous and heterogeneous queries. In [4] an expression was obtained that estimates of mean number of customers in one particular QS network node with heterogeneity. This expression has the following form:

$$N_{(R)} = \sum_{i=1}^{R} \lambda_i / \mu_i + (\sum_{i=1}^{R} \lambda_i) \left[(\sum_{i=1}^{R} \lambda_i / \mu_i^2) / (1 - \sum_{i=1}^{R} \lambda_i / \mu_i) \right]. \quad (1)$$

Here λ_i - the average intensity of entry into the system of the i - the type queries, μ_i - average service rate of these requests, R – the number of service types, $N_{(R)}$ - the number of requests that are in the queue and serviced by the heterodyne QS.

In the particular case when R = 1, we turn to the homogeneous service. Average number of demands in a homogeneous QS for this case is determined by the following expression:

$$N = \lambda / \mu + \lambda^2 / \mu^2 / [(1 - \lambda / \mu)]. \quad (2)$$

Equation (1) yields the average queue length for a database server, and using the relation (2) we can find the average queue length on the client side. These relationships make it possible to assess the effectiveness of the database without taking into account the emergence of its failure and recovery.

3 The mathematical model of interaction of database services with recovery

All questions related to data recovery are defined by restoration procedures and failure rate. Various algorithms are used to ensure recovery; they are implemented in the program as special points of rollback, control and data recovery. For the implementation of the recovery model, we assume that the occurrence of failure is instantaneous. Creating control points, the time of data recovery and service requests are distributed along the time axis in the form of appropriate actions that are shown in Figure 2.
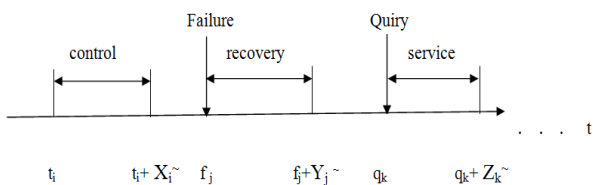
FIGURE 2

Here, $X_i^{\sim}$ indicates the time of the i- th control request, $Y_i^{\sim}$ - recovery time of the j- th failure and $Z_k^{\sim}$ - service time for the k- th order.

That said, the instants of occurrence of queries and the moments of occurrence of errors may take place during the processes of control, repair and service. We can assume that two or more operations cannot be executed simultaneously by the database server. Because of this assumption, and in accordance with the analogous assumptions that have been

made in a number of works on the restoration of databases [4, 5] that arise in the course of requests' servicing, we can assume that failures and moments of queries in the database take place in accordance with the laws of Poisson. The average service time of requests can be accepted as exponentially distributed [6]. I must say that this assumption may well be justified, more so because the estimations of the load in the databases which are exploring the performance in reality almost always take the critical value. Let us now turn to the assumptions regarding the timing control. Stationary probability distribution for the database monitoring system can be obtained using the generating function, which has many generations [7]. Figure 3 shows the distribution of the steady-state control over time, which consists of at least two generations of requests - service requests and requests for control.
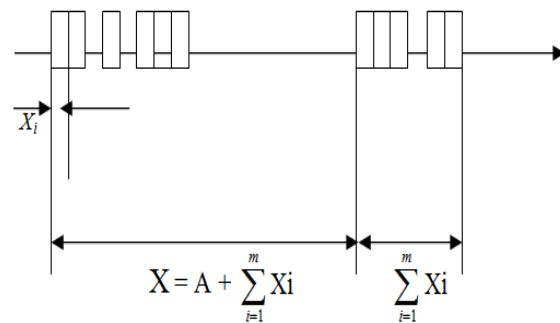
FIGURE 3

In Figure 3, X denotes the time between the control moments in a single monitoring session, A – the time interval between the moment of closure of the previous control session and the start of the next, X_i – the time of treatment for commands executed in a single control point, m – the number of control points in the session.

The generating function of the first generation is the function with respect to the duration of the monitoring process:

$$Q^{(1)}(s) = \exp(-X + X * s). \quad (3)$$

The generating function of the second generation is a function that is determined by the probability parameter p - the probability of controlling with a single control point:

$$Q^{(2)}(s) = \sum_{j=1}^{\infty} p * [(1-p) * Q^{(1)}(s)]^{j-1}. \quad (4)$$

Substituting 3 in 4, we find that:

$$Q^{(2)}(s) = p / [1 - \exp(-X + X * s) + p * \exp(-X + X * s)] \quad (5)$$

The obtained expressions (4) and (5) make it possible to determine the average number of queries to the database for a single control session and monitoring of requests by the server. For overall assessment, a general model of requests service is considered below. A graph of the general model for incoming requests and their service by the database server is shown in Figure 4.
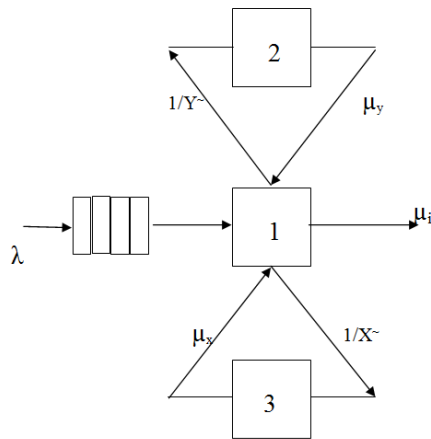
FIGURE 4

Here $Y^\sim$ is the average time of occurrence of failures, $X^\sim$ average time of control.

The system of differential equations describing the behaviour of the process of Scheme 4 is as follows:

$$d\big(p(0,1,t)\big)/d\,t = \mu_i\, p(1,1,t) - (\lambda + Y^\sim + X^\sim)\, p(0,1,t)\,;$$

$$d\big(p(n,1,t)\big)/d\,t = \mu_i\, p(n+1,1,t) + \mu_x\, p(1,3,t) +$$
$$\mu_y\, p(1,2,t) + \lambda\, p(n-1,1,t) - (\lambda + Y^\sim + X^\sim)\, p(n,1,t), n \geq 1\;;$$

$$d\big(p(0,2,t)\big)/d\,t = \mu_y\, p(1,2,t) - Y^\sim p(0,2,t)\,;$$

$$d\big(p(n,\,2,\,t)\big)/d\,t = \mu_y\, p(n+1,2,t) +$$
$$+Y^\sim p(n+1,1,t) - (Y^\sim + \mu_y)\, p(n,2,t)\, n \geq 1\;;$$

$$d\big(p(0,3,t)\big)/d\,t = \mu_x\, p(1,3,t) - X^\sim p(0,3,t)\,;$$

$$d\big(p(n,3,t)\big)/d\,t = \mu_i\, p(n+1,3,t) +$$
$$X^\sim p(n+1,1,t) - (\mu_i + X^\sim)\, p(n,3,t),\, n \geq 1\;.$$

From the resulting system of equations, one can find the distribution of stationary probabilities of states $P(n,k)\big(n=0,\infty,\, k=1,2,3\big)$. Here, n is the number of requests in the system. The solution of this system can be found by using the method of substitution or by using the following generating function :

$$G_k(s) = \sum_{n=0}^{\infty} P(n,k)s^n, k = 1,2,3 \qquad (6)$$

The values of the stationary probabilities $P(n,k)\big(n=0,\infty, k=1,2,3\big)$ determine the length of the queue to the server. By solving the above system of differential equations, and simplifying and taking into account the heterogeneity of services in accordance with the expression (1), we establish the following expression for the mean queue length on the server:

$$N^\sim_{servser} = \Big[\lambda / \sum_{i=1}^{R}(\mu_i + 1/X^\sim + 1/Y^\sim)\Big]\Big/\Big[1 - \big(\lambda / \sum_{i=1}^{R}(\mu_i + 1/X^\sim + 1/Y^\sim)\big)\Big]\,. \qquad (7)$$

5 Evaluation of database service downloads

Expression (7) makes it possible to estimate the average utilization of services in a client - server database in the presence of failures and recoveries. From the point of view of the efficiency of use of these devices, the important features are the dependencies of the queue lengths on the amount of client requests, that is, their work intensity. To account for these possibilities, in evaluating the performance of queuing systems, one typically introduces the concept of system load. Queuing system load is the ratio of the intensity of the incoming requests to the system to the intensity of their service. For our case - when the servicing system of a database server is used - this ratio takes the following form:

$$\rho = \lambda / \sum_{i=1}^{R}(\mu_i + 1/X^\sim + 1/Y^\sim)\,. \qquad (8)$$

Using the obtained expression (7) and the designation (8), we can construct a graph of how the length of the queue depends on the system load for the server and client parts of the database. These dependences - for different mixtures of requests in the server database - are shown in Figures 5 and 6.

On the graphs, the mixtures of requests to the server are related to the different types of queries. According to

database theory, proposed by (Codd E.F 1970), the main types of queries are "Projection", "Intersection", "Selection" and "Union" queries. These are the most time-consuming ones from the point of view of their treatment by database management systems. On the presented graphs, the types of mixtures of requests are scaled in relation to the "Selection" type of query and are defined as follows.

The first type:

$$X^\sim = 0,3, Y^\sim = 0,4, \sum_{i=1}^{R}\mu_i = 0,5\,,$$

The second type:

$$X^\sim = 0,2, Y^\sim = 0,1, \sum_{i=1}^{R}\mu_i = 0,8\,,$$

The third type:

$$X^\sim = 0,1, Y^\sim = 0,08, \sum_{i=1}^{R}\mu_i = 1\,,$$

The fourth type:

$$X^\sim = 0,08, Y^\sim = 0,05, \sum_{i=1}^{R}\mu_i = 1,8\,.$$
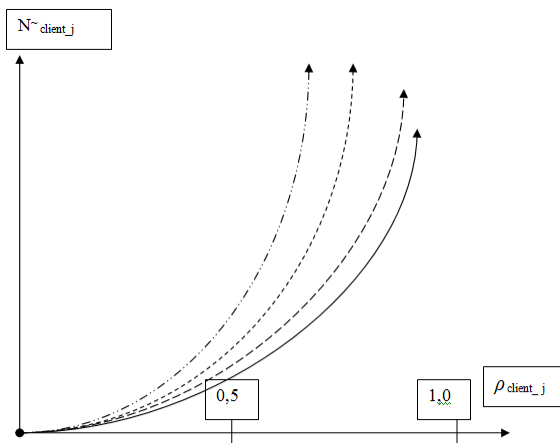
FIGURE 5 The dependence of the length of client service queues on the load
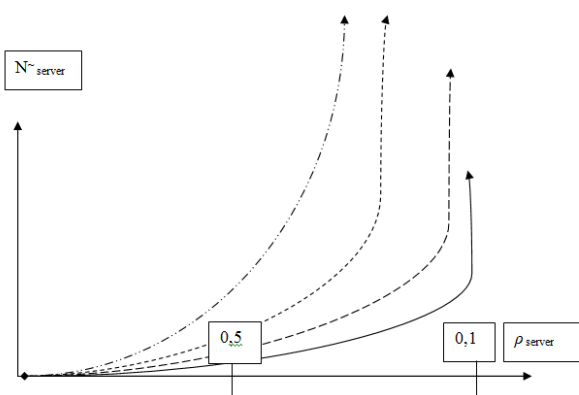
FIGURE 6 Dependences of the length of server service queues on the load

The first type of mixture is calculated based on the fact that the request pertains only to the "Projection". The second type includes "Intersections" requests. The third type includes "Selection" and the fourth type pertains to "Union".

The graphs show that the greatest load on the server comes from "Projection" type requests. When client - server systems are at a load around $0,8 - 0,9$, variations in service delay time increase tenfold compared to a load of $0,1$.

According to queuing theory [8], the length of the queue in the QS can be significantly reduced if the service discipline is changed. In our case, a rational change in the discipline of servicing is to apply heterogeneous services. The alignment of services in the queue can be changed, for example, by using the ORACLE database management system's utility QUEUE_SIZE. In [6], it is shown that, given the prioritising of query service, it is most advantageous to assign a higher priority to the shortest queries. To implement such a service discipline in the database server, one must insert a service type estimation block and a request service length estimation block. Then, using the utility QUEUE_SIZE, the service priority is assigned according to its minimum assign data length. Thus, it is possible to reduce the average queue length in a database server to 20 %.

6 New opportunities

Regular research carried out in Riga Technical University [9-11] present gradual criteria changes according to which the

GPS service is selected. Low price and high quality of goods are undoubtedly the most important ones on the list; however, those are not desired characteristics, but rather the mandatory standard of a competitive service instead. Nowadays consumers pay more attention to additional criteria, such as time of delivery, possibility of getting ordered goods in the determined period as well as high-quality information maintenance of order delivery process.

Nowadays not all companies are able to offer delivery of goods to their clients on the day of order receipt (common practice is delivery on the following day). However, it is evident that presently service standards tend to become stricter and a company's position in the market depends on the ability to meet these standards.

Dispatcher services using the abovementioned modern systems obtain the following options for managing motor vehicles:
- analyse information and take decisions based on the data shown on the scalable electronic map;
- store data on the movement and status of the objects under control and prepare reports based on this information, including the data visualised on an electronic map;
- receive detailed reports about non-routing and emergency situations requiring operative response.

Furthermore, in case of an incoming call from a client the dispatcher has complete information about the status of the order at the present moment and is able to answer any questions, including the estimated time of arrival (this information can also be shown online, thus clients can get free access to it).

As a consequence the efficiency of vehicle use increases, transport logistics improve; transport management is carried out, strict control is implemented over improper vehicle use and the number of failed deliveries decreases which enables the company to reduce the "order-delivery" cycle and improve the level of services provided to the clients accordingly.

7 Problems with Evaluating Efficiency of motor Vehicle Monitor Monitoring System by using GPS

One of the main problems in improving the efficiency of GPS use in the motor vehicles is the problem related to evaluation of efficiency of such systems. Efficiency of these systems can be evaluated by mathematical calculations using queuing systems. The vehicle GPS signal receivers as such can be interpreted as separate systems of queuing which receive queries about their locations from the system dispatcher. GPS signal receivers can generate queries to the system dispatcher. Management of queries received from GPS receivers is shown in Fig. 7 as a schematic image from the perspective of queuing. Each queuing system shown in Fig. 7 is a device that manages the GPS queries. Queries are managed on a first in, first out basis in rotation and return from GPS receiver to a dispatcher, then they are transferred back to GPS receivers from a dispatcher. One of the characteristics of this query management scheme is the availability of different rules on query management by GPS receivers. This diversity on one part can be explained by diversity of queries and the diversity of the receivers' characteristics. Unfortunately, in terms of applying queuing

systems, the network device diversity is recorded extremely rarely or considered if there is a correlation between the rules on query behaviour when queuing for service and the diversity or with other queues [10–12].

As to GPS efficiency evaluation, cases should be taken into consideration when the types of queries do not depend on the status of query in the queue. Therefore this research suggests characteristics calculation method for GPS systems on the basis of the assumption that management in the network nodes is subordinated to management rules.

Approbation for use of this method for corporate computer network analysis is reflected in various works of the authors [8 - 10]. Along with analytical researches presented below, the authors carried out the experimental methods of GPS system assessment [13] and the researches based on simulation modelling methods [14]. This research suggests selecting the mathematical tool of queuing stochastic networks as a basis for studies of the characteristics of GPS receiver network consisting of several nodes. In these networks, queries can select a network node for management randomly. It is suggested to perform the analysis of computer networks first based on the fundamental queuing system with the hyper-exponential management law and the superposition of Poisson query stream acting at the system input and then a transition to a stochastic network of queuing systems takes place. This method enables studying the networks with hierarchical organisation of the structure where subnets can be used as service units.
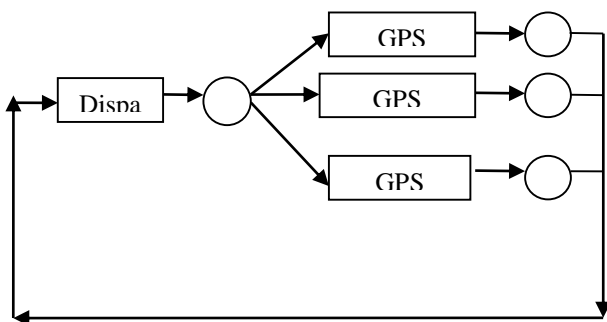
FIGURE 7 GPS receivers

The closing system mentioned above, may have peak periods in which traffic is very heavy, so that queues build up which, however, are taken care of later in the system. We may then be interested in total throughput or in peak like maximum queue length. In all those examples the only way to interested in the steady state response of an on-line computers networks can we chose between replicating run and continuing one long run. We feel that in practical studies steady state, off-line computer networks are an exception, where as in theoretical studies such systems prevail.

If we replicate runs and new set of random numbers for each run then each run yields one independent observation, e. g. the average waiting time in run "1", then:

$$x_i = \sum_{j=1}^{m} w_{ij} / m \ , \tag{9}$$

where w_{ij} denotes the waiting time of customs j in run

(I=1,2…n).

Traditional techniques can be applied to estimate the standard deviation of the response:

$$Z_x = \sqrt{\sum_{j}^{n} (x - x) / (n - 1)} \ . \tag{10}$$

In this equation we forget how x_i was composed individual observation w_{ij}

As initial conditions for on-line computer networks we simple take the nature.

Al conditions:

- Replicated runs yield independent observations so the analysis problem, problem standee-state behavior and problem off-line computer networks simulation.
- The practical problem is to detect whether the system one is simulating has such renewal states. There are also some diagnostically and statistical estimation problems, since the point confidence intervals are not using straightforward formulas like equations (10).
- For a single prolonged run we distinguish 2 approaches: the measurement extractor and the analysis tools.

7 The Measurement Extractor

The goal of this tool is an on -line collect of information in the Operations Systems computer networks. A listing might be received with a monitoring in the computer networks. Statistics we can be gathered at three levels:

The user job level - here we can measure the programs called for job step: compilation, execution, lines printed etc., the run time option selected and called diagnostics;

The system level – here we measure job traffic, service time, resource allocation, job and task queue lengths;

The I/O level – here we measure channel and I/O equipment activities.

They are suggested from analytical and simulation models of the on-line and off-line computer networks and of workstations and console lights and from reflection on what parameters are likely to be important. The general approach is essentially that of a diagnostic there is a transfer of control to a routine, which collects data and stores it for later analysis. The sampling rate and amount of data collected must be low enough so that the overhead due to the monitoring is acceptable. We distinguish two types of monitoring computer networks: system accounting programs and periodically run or to obtain information off packages programs. The accounting programs and peri-odically run must be some special problem.

The normal accounting information which cam users and is collected in computer network for billing is an extremely rich source of data for monitoring process. But the information from billing source is not full. An accounting programs cam a very detailed profile of user job with rude precessions.

Most of equation (10) observable can by means of

packaged software monitoring, but at greater cost in time. The problem software monitoring it is operating employing program in the same option operation system of on-line and off-line computer networks. The software monitoring is not yet used regularly and it must be installations by loading important program modules. Several kinds of collect subroutines are considered, we give below the list collects programmed in the current version.

A. Evaluation of the load workstation: operator dialog; batch processing commands; primary and secondary commands; steps accounting; supervisor calls.
B. Evaluation of the files manipulation: logical input-output; opens and closes of files.
C. Evaluation of the task management: workstation queues; system task activity; utilities and command for workstation activity and queues in the system activity.
D. Evaluation of the computer utilization: CPU occupation; peripheral and channel occupation and core memory occupation.
E. Evaluation of the system reliability: system error; server's errors; user aborts and various value overly.

8 The Measurement Extractor

A measurement off-line and on-line computer networks accompanied of analysis. The analysis tools importance was often undervalued. These essential problems of analysis measurement in off-line and on-line computer networks are:

- Probability, in order to perform analysis on different computer or network systems;
- Easy modification, because results of a first analysis may conduct to modify several parameters for the next analysis;
- Easy utilization, because this tool is used on various centres.

The detecting system will be assumed in the standard monitoring mode. The monitoring mode may be described as follows on Fig. 8.

It is assumed that requests for monitoring and failures occur according to two processes. The time sharing those processes shout of the Figure 9. One process it is independent failures Poisson process of rate $\lambda=1/Y$. Y it is average time of y=a+b. Second process it is monitoring process. A monitoring process may be assumed from Geometrical process of rate p=1/x. X it is average time from equation (9).

The date base system under monitoring mode of operation can be considered as a server to request for monitoring system (for example in server of Oracle).
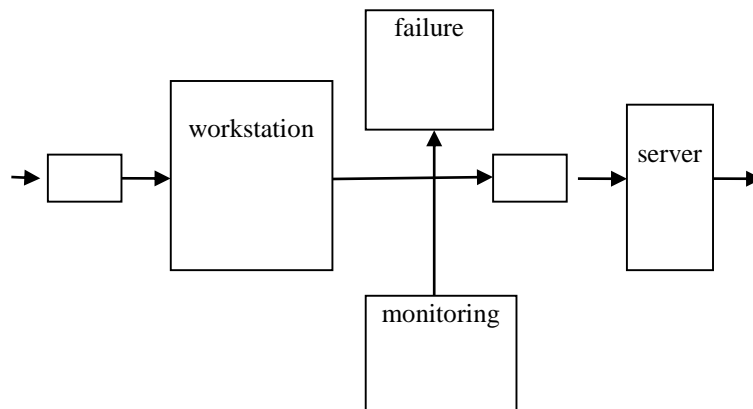
FIGURE 8 Described monitoring mode

The stationary probability distribution for the data base monitoring system can be obtain for generating function which has many generation. For Figure 9 stationary probability can be obtain for generating function which has two generations.
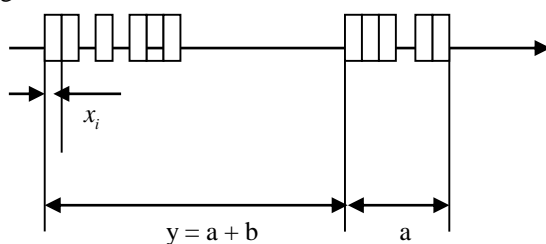
FIGURE 9 Generating function which has two generations

First generation function it is generation function from failure process. This is function can be obtain of equation:

$$Q^{(1)}(a) = \exp(-\lambda + \lambda * a). \tag{11}$$

The generation function for monitoring process it is function of second generation. For geometrical distribution this is function has equation:

$$Q^{(2)}(b) = \sum_{j=1}^{\infty} p * [(1-p) * Q^{(1)}(b)]^{j-1}. \tag{12}$$

This is equation it is geometrical progression from which we will give expression for general function of monitoring process:

$$Q^{(2)}(b) = p / [1 - \exp(-\lambda + \lambda * b) + p * \exp(-\lambda + \lambda * b)]. \tag{13}$$

This is result give become equation from arrival number measurement for one monitoring séance.

From equation (13) describing state transitions and distribution stationary probability f the system measurement, bet we showing the becoming the arrival number measurement and standard deviation for this number. The described the arrival number measurement for one séance measurement can be becoming from first derivative equation (13) for s=1. From this transformation we have:

$$\alpha_{(s=1)} = dQ^{(2)}(s)/d(s) =$$
$$d\{p/[1-\exp(-\lambda+\lambda*s)++p*(-\lambda+\lambda*s)]\}/d(s) = \quad .(14)$$
$$= [(p-p^2)*\exp(-\lambda+\lambda*s)*\lambda]/[1-\exp(-\lambda+$$
$$\lambda*s)+p*\exp(-\lambda+\lambda*s)] = [(1-p)*\lambda]/p$$

For described the standard deviation can be becoming from second derivative equation (13) for s=1.

Skip the operations of derivative we have:

$$\psi_{(s=1)} = d^2 Q^{(2)}(s)/d(s)^2$$
$$= [(1-p)*\lambda*(2-p)]/p^2$$

The different of measurement system have different values and have the different parameters, bat the different characteristics this system can be design in statistical terminology for equation (13) and (14). In this paper we discuss selected analysis and measurement that seem of practical use in the design and diagnostic off-line and on-line computer network in general. The equation (14) given use compare several off-line and on-line computer networks.

9 Summary

The organisation which is focused on the long-term business activity and the quality of its processes must follow development trends in the information technologies, make progress in this area and react timely to the changes in this area in order to optimize its processes and increase the overall work efficiency.

During the last few years organisations have had huge amounts of unstructured content, including documents, e-mail messages, video clips, instant messages, web-sites and many others. This information is often in disorder which prevents the organisation from using these valuable assets efficiently in order to share knowledge, improve relations with its clients and increase efficiency of processes.

Many companies currently have the following widespread issues:

- processing of and search for documents is not efficient and requires too much time;
- business processes are not managed efficiently;
- lack of an integrated information source or its insufficient activity;
- increase of costs related with compilation, copying, sharing and storage, as a consequence, the company suffers from the inefficient work organisation.

Implementation of a GPS system in a company is a complicated and time-consuming process requiring a tedious analysis, studies and thorough preparation.

Eventual risks should be precisely assessed during implementation of automation systems as it is in any management process. Risk evaluation is an important stage of work. Adequate selection of the system, implementation terms, costs and further use of the selected system by personnel depends on this stage. Apart from the eventual risk evaluation the manager should calculate risk probability and severity and elaborate a plan for minimizing all of assessed risks.

This research also demonstrates risk management in case of GPS system implementation as a case study of a particular organisation. For instance, the risks that are ranked as medium status "Improper GPS system, strategy" and "Work interruption" have the following indicators: 0.08 and 0.10 accordingly.

Implementation of a new company content management system has also revealed the necessity to upgrade the employees' qualification. This matter can be solved by organizing special trainings. Moreover, various levels of motivation, such as salary revision, payment of bonuses, bonus system and free education are offered in order to increase responsibility of the company's employees and willingness to master the new system faster and with a serious attitude

As a result of studies of the offers in the GPS system market, individual needs of the company, risk analysis and evaluation and proposed measures to minimize them, experts' evaluation of the organisation's maturity level and necessary optimization calculations, the decision was made to use web-sites for the project implementation. The expert group acquired the following result when evaluating the significance of the most important advantages as per the degree of their significance:

- reduction of the time spent by employees - 94%;
- business process optimization - 84%;
- improvement of the employees' work quality - 81%.

Determinant choice criteria were (as per the degree of significance, according to the evaluation of the expert group): project payback rate - 93%, low maintenance costs - 78% and functional characteristics of the system - 77%.

Implementation of GPS system provides significant advantages; however, this process is rather complicated, as various factors have to be taken into consideration. Further effect is mostly determined by the adequate choice of the system and the realization of the implementation process. If the system is selected correctly and the implementation process is carried out successfully, the employees of the organisation are able to use their working time more efficiently and do more work thanks to the reduction of time for routing operations. The systems also enable optimizing activities of particular departments and the organisation as such and obtain analytical information which is used for making various important managerial decisions.

10 Conclusion

This paper presents a study of database load. A service interactions model is developed. Expressions for estimating the load of the database server are derived both for working conditions without and with failure recovery. It is shown

that services have properties of varying degrees of load of the nodes in the network, i.e. the properties of heterogeneity. Constructing mathematical models allowed us to make the calculations of average services' queue length to the database. These calculations showed that the database server can function catastrophically badly if run with a load of close to 0,9. Improving the efficiency of services can be achieved using heterogeneous service disciplines. The performed calculations have shown that the expected time gain in using services by network servers through the selecting the optimal load of network nodes and application of heterogeneous services can exceed 20% .

The polls carried out show that the use of modern positioning systems for transport and motor vehicle control

systems is economically feasible.

Thus, it is evident that the economic effect from their implementation in large companies performing thousands of deliveries every day will definitely exceed the costs for its purchase, implementation and maintenance. Furthermore, it will be much easier to manage the transportation company.

Development of an integrated transport management system enables to solve a local task of reducing the "order-delivery" cycle and creating a positive image for the company in the eyes of the clients due to accurate execution of undertaken obligations related with order execution terms, minimization of the delivery failure risk and the opportunity of creating a flexible feedback system.

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Author

Victor Boicov, Riga, Latvia

Current position, grades: Professor-researcher of Department Electronics and Telecommunication Riga Technical University; professor of Department of Computer Technologies and Natural Sciences Information Systems Management Institute
Scientific interest: Computer Technologies, digital Networks and Telecommunication, Specification and Verification of probabilistic and stochastic systems and model checking
Experience: Expert in queuing theory of real computer networks structure and physical processes in electronic devices. In last decade, obtained significant results in the field of database systems and electronics.
Publications: many papers in recent years and more than ten of them were included in the international Engineering Index (EI)

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Maximum of Load Database of GPS Service with Recovery

V Boicov

The paper analyzes the database global position system (GPS) services load with recovery. A mathematical model of the interaction with the database services is developed. On the basis of mathematical modelling procedures for the exchange services, the possible delays and the presence of large queues to services are defined. Suggestions to improve the exchange of services are developed. Development of an integrated transport management system enables to solve a local task of reducing the "order-delivery" cycle and creating a positive image for the company in the eyes of the clients due to accurate execution of undertaken obligations related with order execution terms, minimization of the delivery failure risk and the opportunity of creating a flexible feedback system

Content C

Solving problems of geriatric care in the Republic of Kazakhstan based on new ICT trends

R Muhamedyev[1], E Muhamedyeva[1], A Mansharipova[2], V Chaykovska[3]

[1] IITU, Kazakhstan

[2] KRMU, Kazakhstan

[3]KNMU, Kazakhstan, Institute of Gerontology of NAMS of the Ukraine, Ukraine

[*]Corresponding author's e-mail: muhamedijeva@gmail.com

Abstract

In recent years, the measures to improve geriatric care of the population are taken in the Republic of Kazakhstan. Relevance of this issue is determined by a population aging on the one hand, and by RK humanization policy on the other hand. Consideration of these issues is impossible without corresponding data support, which is necessary for organizational tasks and for the entire cycle of medical data processing, starting from data collection, through a comprehensive analysis and issue of recommendation. Using modern software, communication and intelligent technologies promises not only improving of geriatric care quality but reducing the cost and obtain social-economic benefits. The article introduces the problem of geriatric care in Kazakhstan and offers an approach to the solution based on the new trends in the field of ICT.

Keywords: Geriatric care ICT Ambient Assi Living machine learning broadband network Machine-to-Machine big data

1 Introduction

Importance of gerontological research in the world is associated with accelerated aging of the population in developed countries [1 - 4] and with corresponding increase in health care costs [4] (Figure 1).
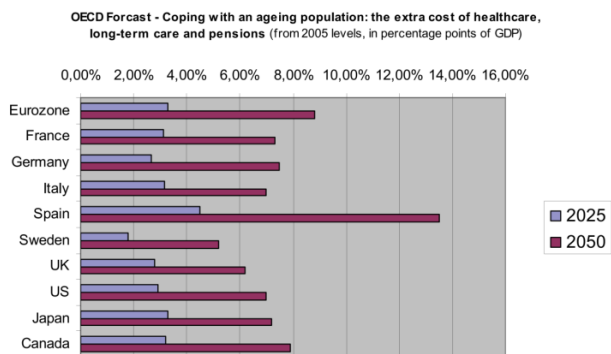
FIGURE 1 Forecast of costs' growth for health care, pensions and social services in percents of gross domestic product (GDP) (http://www.capsil.org/files/Ageing%20Well%20Background.pdf)

Major portion of the elderly people is in need of intensive medical care, single elderly people require special attention from medical and social services. In this regard, the developed countries have taken measures to prevent social isolation of elderly people; conditions for active lifestyle maintenance and participation of elderly people in the labor market are created. These are both appropriate measures of health maintenance, and initiatives in the field of business, employment, and reduction of health care and elderly patients care spending [8 - 10].

Modern ICT's provide a set of tools and techniques that reduce the costs and improve geriatric care quality, and also implement proactive medical and social measures to reduce the costs and improve geriatric care quality. Implementation of the system geriatric care includes use of modern ICTs in a heterogeneous distributed system that provides not only heterogeneous data collection, but also its intellectual analysis. The complexity of processes require special researches with the aim to find the appropriate models, methods and solutions that provide of intelligent support not only older persons but also geriatric system as whole.

2 General

World Health Organization (WHO) predicts that the share of people aged 60 and older in Kazakhstan from 11% in 2014 will reach 25% in 2050. With increase of duration of life health care expenses inevitably rise (Figure 2) [13]. Therefore, improvement of medical assistance for elderly people, complex solution of biomedical, social and psychological problems defined by one of the priorities of the State program "Salamatty Kazakhstan" 2011-2015, approved by the Presidential Decree №1113 from 29.11.2010. In recent years, the formation of the gerontology service is taken place in the Republic of Kazakhstan [11], laws and policies aimed to improvement of geriatric care to the population were adopted [12]. In the President's message it is stated: "According to international estimates, about 5 percent of the population with basic types of diseases use about 70 percent of all health care services. Well-organized prevention activities could prevent diseases at early stages".

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Per capita total expenditure on health ($)
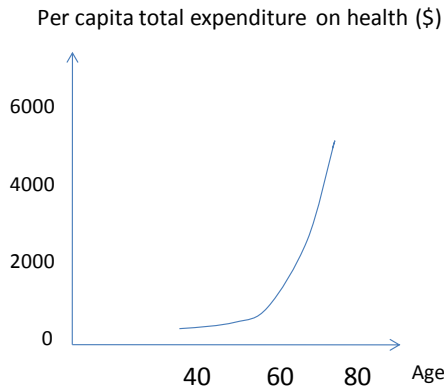
FIGURE 2 The average cost of "healthy" life maintenance at different ages [13]

Timely diagnostics and disease prevention will significantly reduce the costs of out-patient treatment and in-patient treatment, and also will help to preserve mental and physical performance of elderly people. Initiatives in this area are associated with use of information and communication technologies (ICT) [4-7]. It is time to bring into scientific discourse the term "data-based (electronic) gerontology and to consider aspects of ICT use in science and practical applications associated with aging within its scope. In this domain a large number of international programs, projects, communities and academic institutions [33-42] are working, particularly the consolidated program on creation of living support environment of - AAL (Ambient Assisted Living Joint program) (http: //www.aal-europe .eu /), bringing together 123 projects with the total fund of 700 million euro.

However, up to now there are no electronic data systems that can address comprehensively the problem of medical and social services for elderly population. It is necessary to search for new ways and technologies that could reduce the costs during with rise of the services quality standard.

In the Republic of Kazakhstan in the earlier study related to this topic, there was developed the web-portal "Active Longevity" (http://100let.kz/), which provides information, data collection and preliminary analysis of screening information about the elderly population of Kazakhstan [14, 15].
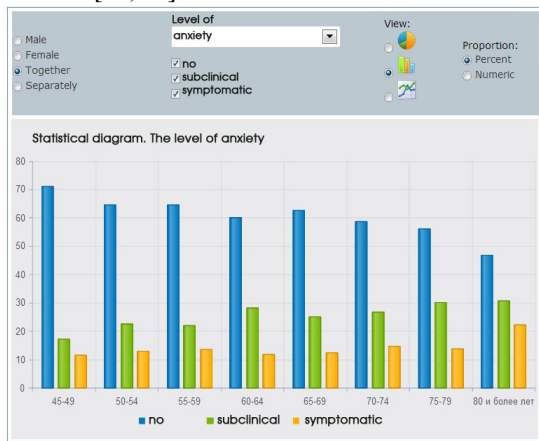
FIGURE 3 Anxiety level by age group

The portal allowed to collect, process and visualize significant amount of information about 4000 elderly residents of the Republic of Kazakhstan (Figure 3, 4), assess the risks of major diseases, screening research boundaries and self-diagnostics [14, 15]. There were obtained important data for design of gerontological electronic system. It was displayed that efficiency of solving medical problems such as prevention, diagnstics, rehabilitation and forecasting will depend on integration of not only clinical, but also personal and social characteristics of patients in the information system and the lack of information can lead to errors in management of the health care service.

FIGURE 4 Visualization of screening data on the web-portal "Active Longevity"

ICT development trends offer the possibility for solving the problem of efficiency of RK gerontology services. The key aspect is the use of new generation of ICT for screening of the medical and social situation, needs assessment and provision of timely assistance especially with a view of the large territory and low population density of RK.

ICT are moving to a new level, improving the resources of data-processing systems, or Clouds, a communication medium or network (Pipe) and Devices (Figure 5).
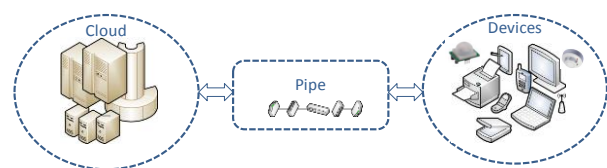
FIGURE 5 Major ICT domains

Combining wireless sensor network, inter-machine communication systems (Machine-to-Machine (M2M)) [16, 17], the broadband network access based on the new communication protocols [18] and other technologies [19-23] are the development basis of the effective medical information systems. These technologies provide a high level of reliability and small delays in remote monitoring and data transfer of different volumes [24, 15].

The functioning of the new communication and screening systems on the basis of new communication protocols involves generation of large amount of data [25], or Big Data, with special processing requirements [26, 27].

In the health monitoring systems the focus is shifted to the development of intelligent algorithms for identification

of consistency patterns with the use of machine learning methods [28]. At the same time there are resolved such problems as identification of abnormal conditions, diagnostics, forecasting, recommendations and visualization of big data for human decision-making [23, 30].

The general scheme of machine learning methods application is shown in the Figure 6 [29].
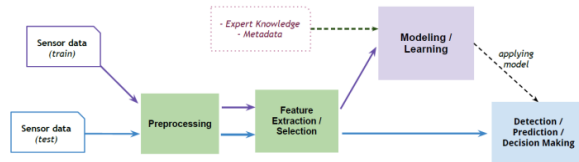
FIGURE 6 Generic architecture of the main data mining approach for sensor data

The functional of the electronic system predicts existence of Training and Qualification section that will improve the quality of service operations and of the related to its units [31, 32].

The mentioned above information gives ground to state that ICT development trends have clearly expressed technological and scientific background to support the gerontological service and to organize its work on a new level.

3 Offered solution

Based on a new ICT development trends a multi-level distributed personified electronic system is offered. The system will provide support, monitoring, detection and prediction, and support for comprehensive geriatric services for the population. Multi-layer architecture of the system is illustrated in the Figure 7.
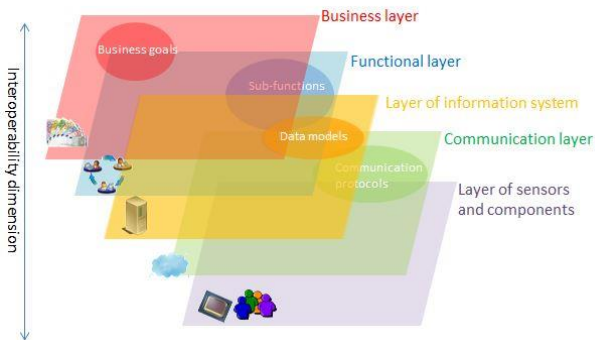
FIGURE 7 Main system layers

To reach the goal it is necessary to solve a number of technological and systemic issues related to selection of necessary technologies, algorithms and software in the core domains of the system.

The main efforts should be focused on research in the field of communications (Network Domain), information systems (IS Domain), user interaction with the system (User Domain). The sensory level (M2M domain) need to be partially affected. This choice is due to the fact that, firstly, in other areas could be used the achieved significant results, partly brought to the technology level, and secondly, exactly in the development field of the appropriate IS applications of machine learning methods, and the processing of large

amounts of data today are the most relevant [28].

4 Economic benefits

Solution of this task will bring a social effect expressed in improvement of the quality of medical services and slowdown in growth of their costs, and totally, in improvement of the quality of life for older persons.

Economic benefits will consist of three aspects.

Firstly, the project will contribute to emerging of a new market of services, with the estimated volume of 3-5 mlrd. Euro (similarly to European markets of services for elderly people (300 milliards) and with consideration of a lower level of life and less (approximately by 30 times) population of the Republic of Kazakhstan)

Secondly, the system will aid to extend the healthy period of life that will bring both economic and social benefits. For instance, in conditions of Kazakhstan increase of the number of working people for 85 thousand people can lead to growth of gross domestic product for 1% or for 102 milliards of USD.

Thirdly, the system will contribute to increase of the state healthcare spending for older persons (till 70% of all healthcare spendings).

5 Conclusion

New communications and computational technologies offer good opportunities into the solving one of the greatest World problem - the problem of accelerated aging of the population. This problem concerns not only developed countries but developing countries. In RK the special portal was developed as the first step on the way. The next step is design and develop complex of geriatric services based on modern concepts and technologies. The complexity and diversity of the processes require appropriate research, development and approval of the system model that requires to : 1) Analyze data acquisition systems, human-machine interfaces and machine-to-machine interaction, intelligent methods applied in the health care system; 2) Develop a system model for elderly patients' services with help of modern ICT's and in view of the health care system development; 3) Develop models, methods and algorithms of data consistency patterns retrieval system for intelligent system of gerontology services' maintenance.

Realization such project will bring a social effect for every senior person as well as economic benefits in the scale of country.

The developed system model should be focused on working with the components of a new e-government generation, including medical e-cards, social services and insurance system. The task realization will contribute to the emergence in the Republic of Kazakhstan of a new services market, its estimated amount is 3-5 billion euro, and to the increase the labor force participation of elderly people, which will lead to the increase in the number of working people and growth of gross domestic product.

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Authors

Ravil Muhamedyev, Kazakhstan, Almaty

Current position, grades: Head of Department CSSE&T, professor, International IT University, Almaty, Kazakhstan
University studies: International IT University, Almaty, Kazakhstan
Scientific interest: stochastic simulation, machine learning, simulation of anisochronous systems
Publications: 160 papers, 5 books

Operation Research and Decision Making

Elena Muhamedyeva, Latvia, Riga

Current position, grades: Senior lector of Department CSSE&T, master of computer science, International IT University, Almaty, Kazakhstan.
University studies: International IT University, Almaty, Kazakhstan
Scientific interest: machine learning, data mining
Publications: 30 papers**.**

Almagul Mansharipova, Kazakhstan, Almaty

Current position, grades: Head of Department science KRMU, professor, member of Association aksam, Almaty, Kazakhstan
University studies: Kazakh Russian medical university
Scientific interest: Research in the field of medicine, cell biology, bioinformatics.
Publications: 150 papers, 3 patents.

Vera Chaykovska, Ukraine, Kiev

Current position, grades: Kazakhstan a professor of Gerontology and Geriatrics Department, Almaty, Kazakhstan
University studies: Kazakh National Medical University
Scientific interest: Organization of gerontological research and geriatric population assistance
Publications: 200 papers,4 monographs (as a co-author), 2 teaching guides

Decision making in ITSM processes risk assessment

V Grekul*, N Korovkina, K Korneva

National Research University Higher School of Economics, 20 Myasnitskaya Ulitsa, Moscow, 101000, Russia

Corresponding author's e-mail: grekoul@hse.ru

Abstract

This article is dedicated to enterprise risk management, specifically the problem of subjectivity of decisions made on different phases of risk management process, risk assessment in particular. Quality of decisions strongly affects the effectiveness of risk management process as a whole; at the same time, standards regulating risk management do not provide any instruments to support the decision-making process.

The main objective of this study is to decrease the subjectivity of decisions made during the risk management process by integrating decision theory tools into the risk assessment phase. As a result, an approach to risk assessment using Analytical Hierarchy Process is introduced; the approach is then implemented to IT Service Management processes.

Keywords: risk assessment subjectivity decision making AHP ITSM

1 Introduction

Effective IT Services management (ITSM) proves to be impossible without managing inherent risks of ITSM processes.

Each company despite of its size and specifics encounters the need to manage various types of risk. Experience of largest international enterprises demonstrates that the company cannot reach stability and increase its efficiency when risk management process is not embedded into the management system of the company [1].

The key part of risk management is a decision making – efficiency of risk management process is directly dependent on ability of decision makers to make informed decisions [2]. But people tend to make wrong decisions. According to D.Hubbard [3], human errors related to subjectivity in decision making are one of ten main causes of ineffective risk management [3].

Thus finding risk management tools that would eliminate possible subjectivity of decisions to be made becomes an important issue. It seems appropriate to focus on risk assessment. During risk assessment, current threats and their impacts are identified, then identified risks are prioritized. Company management decides on risk response strategies based on risk assessment results, that is why well-informed decisions made during risk assessment are vital for efficiency of risk management process as a whole.

2 Approaches to risk assessment

There are a number of standards and methodologies designed to assist company management in developing risk management systems. The most widespread and universal standards are FERMA, ISO 31000:2009 and COSO II.

Despite of versatility, each of the documents is aimed at a specific goal, which causes the difference in types of risks and risk management tools described by them. However, one can identify similarities in risk assessment processes described by standards. Analysis of risk assessment approaches defined by COSO II, FERMA, ISO 31000 (Figure1) revealed that there are three basic tasks to be completed during risk assessment; those are risk identification, measurement and prioritization. Each task requires decision making – whether it is choosing a method for risk identification and measurement or ranging the identified risks. Choosing risk identification and measurement methods is a very particular problem as selection criteria strongly depend on company profile. As a result, methodologies and standards do not describe definite tools for choosing a method but provide general recommendations. On the contrary, there is a widespread tool used for risk prioritization offered by each of the documents listed above – that is a risk matrix. Columns of risk matrix describe the likelihood of risk occurrence and rows present the consequences - possible impact of risk occurrence. Impact assessment criteria can include financial, reputational, operational, compliance and other consequences. Companies typically define impact using a combination of these consequences given that different risks may have different impacts on the company (see an example of impact assessment scale in Table 1). However, usage of risk matrix has its disadvantages. L.A.Cox states that usage of risk matrix for risk evaluation has several limitations [4]:

- Typical risk matrices can correctly compare a small fraction (less than 10%) of randomly selected pairs of hazards;
- Effective resource allocation for risk countermeasures cannot be based on categories provided by risk;
- Risk matrices can mistakenly assign higher (or lower) qualitative ratings to quantitatively lower (or higher);
- Ratings derived from risk matrices may be subjective and dependent on judgements of a decision-maker.
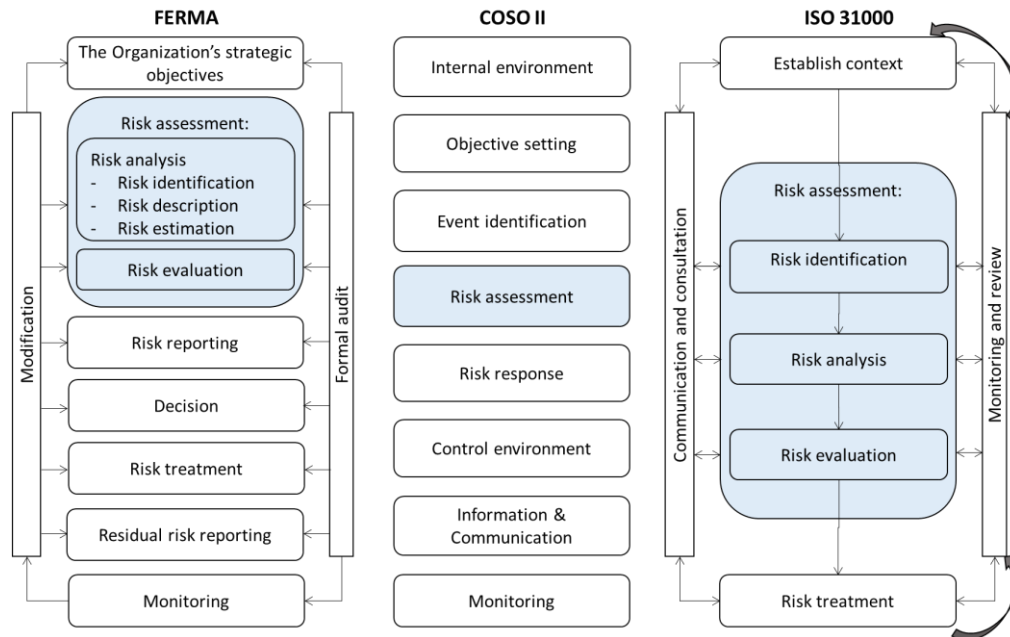
Figure 1 Risk management process in COSO II, FERMA, ISO 31000

The last two limitations listed above strongly affect the quality of decisions made by company management. They can be surpassed by developing a highly detailed risk assessment scale and by using risk measurement methods effectively. However, companies tend to develop risk matrices based on subjective judgements due to limited time and human resources (which is a quite common situation).

Obviously, standards and best practices in risk management do not suggest tools and methods to decrease subjectivity of decisions made during risk assessment. Nevertheless, such tools are well known in decision theory that offers a reasonable approach to decision-making under uncertainty, when the result depends solely on the preferences of the responsible person.

3 Decision making techniques for risk assessment

As consequences of risk occurrence affect various aspects of the company (and IT Service Management in particular), it is reasonable to use multicriteria decision-making methods for risk ranging. These methods would allow us to avoid usage of risk matrices and enable to range risks based on decision maker judgments.

Researches dedicated to decision making methods indicate that such methods (ELECTRE, TOPSIS, PROMETHEE, AHP, etc.) provide similar evaluation of alternatives being considered [5, 6]. So choosing a decision-making method entirely depends on the type of the problem faced by decision maker.

TABLE 1 Illustrative impact scale for risk assessment

Rating	Descriptor	Definition
5	Extreme	• Financial loss of $X million or more • International long-term negative media coverage; game-changing loss of market share • Significant prosecution and fines, litigation including class actions • Significant injuries or fatalities to employees or third parties, such as customers or vendors • Multiple seniors leaders leave
4	Major	• Financial loss of $X million up to $X million • National long-term negative media coverage; significant loss of market share • Report to regulator requiring major project for corrective action • Limited in-patient care required for employees or third parties, such as customers or vendors • Some senior managers leave, high turnover of experienced staff, not perceived as employer of choice
3	Moderate	• Financial loss of $X million up to $X million • National short-term negative media coverage • Report of breach to regulator with immediate correction to be implemented • Out-patient medical treatment required for employees or third parties, such as customers or vendors • Widespread staff morale problems and high turnover
2	Minor	• Financial loss of $X million up to $X million • Local reputational damage • Reportable incident to regulator, no follow up • No or minor injuries to employees or third parties, such as customers or vendors • General staff morale problems and increase in turnover
1	Incidental	• Financial loss up to $X million • Local media attention quickly remedied • Not reportable to regulator • No injuries to employees or third parties, such as customers or vendors • Isolated staff dissatisfaction

In order to select a decision-making method to support a risk prioritization process, we used quite general criteria for comparative evaluation of methods [7]:

- Possibility to use both qualitative and quantitative information about preferences of decision maker;
- Ability to quantitatively rank the alternatives to ensure clarity of the results and ease of interpretation;
- Ability to check the consistency of received decisions;
- Availability of mechanism to define a scale of evaluation criteria;
- Relative ease of use – there should be no need to

involve experts or have a specific knowledge to apply the method.

We performed a comparative evaluation of methods for compliance with the selected criteria based on the analysis of studies on practical applications of multicriteria decision-making methods [5][6][8][9][10]. As a result we decided to apply AHP for risk assessment as it fully complies with evaluation criteria (see the results of evaluation in Table 2).

In this research we used AHP to assess the influence of risks on different aspects of IT Service Management.

TABLE 2 Decision making techniques for risk assessment

Criteria	AHP	ELECTRE	PROMETHEE	TOPSIS	MAUT
Quantitative and qualitative information					
Quantitative ranking of alternatives		×	(not all methods of the family)		
Consistency check				×	
Mechanism to define a scale of evaluation criteria		×	×	×	×
Ease of use		×			×

4 Applying AHP to ITSM processes risk assessment

Risk assessment model using AHP is applied to the results of IT control environment assessment project performed for a large company engaged in development and support of customized software, IT outsource and IT consulting. During the project compliance of internal control system to requirements of Sarbanes-Oxley Act was assessed. General methodology of control environment assessment was based on COSO II requirements to internal control system. As risk is an event preventing the process from achieving its goal,

IT goals in accordance with Cobit 5 documents were used for risk identification.

As an interim result of control environment assessment project a register of risks inherent to the company was developed. For current research we chose to analyze risks in ITSM processes; in Cobit 5 documents these processes are described in "Deliver, Service and Suport" (DSS) domain. Risk assessment is performed only for those risks in DSS domain that were not mitigated by relevant control procedures at the time of the project and for which a risk response strategy is to be developed (see a list of risks in Table 3).

TABLE 3 Unmitigated risks in ITSM processes mapped to Cobit 5

Cobit 5 process	Risk #	Risk description
DSS01 Manage operations	IT.R2	Inability or delay in recovery of information systems due to inability to maintain recovery procedures or improper recovery.
DSS02 Manage service requests and incidents	IT.R3	Incomplete or untimely resolution of incidents and service requests due to incomplete registration of incidents and\or untimely processing of requests (including violation of SLA).
DSS03 Manage problems	IT.R3	Incomplete or untimely resolution of incidents and service requests due to incomplete registration of incidents and\or untimely processing of requests (including violation of SLA).
DSS05 Manage continuity	IT.R5	Unauthorized usage of information resources of the Company including introduction of changes to financial data due to granting unauthorized access or extended privileges.
DSS06 Manage business process controls	IT.R7	Incorrect operation of information systems due to (1) implementation of unauthorized or not fully tested changes to information systems; or (2) incorrect implementation of the change management cycle to newly developed systems.

Risks in ITSM processes are the alternatives to be ranked based on developed evaluation criteria. We used financial, reputational, operational and compliance consequences of risks as such criteria. Those are often used when developing a risk matrix and happen to be the most widespread. However, AHP does not limit a number of

criteria to be used for assessment – one can evaluate a risk impact on a greater number of consequences if needed.

Problem of risk ranking in ITSM processes is shown as a hierarchical structure of objectives, criteria and alternatives in Figure 2.
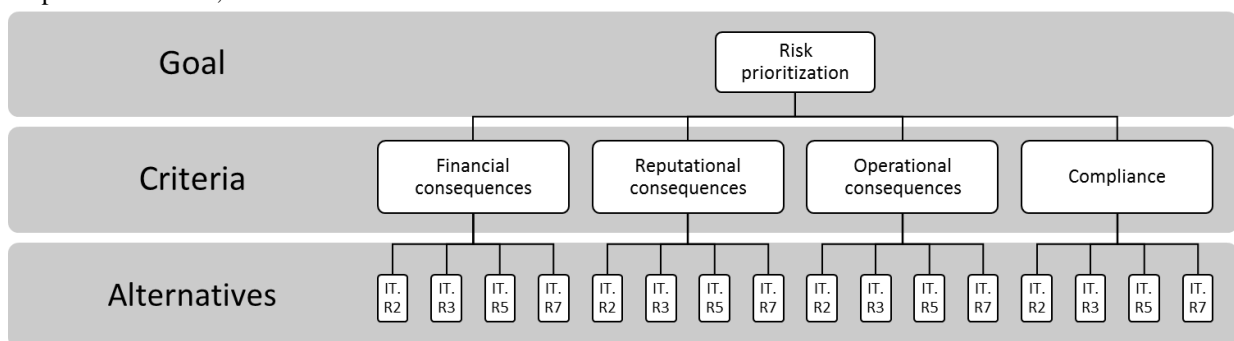

Figure 2 AHP risk assessment hierarchy

In our research the decision maker is a Head of IT Department in a company where control environment was assessed and unmitigated risks in ITSM processes were identified. Pairwise comparison matrix for defined criteria is developed based on judgements of the decision maker; it is worth to mention that priority of criteria is defined according to the impact on IT Department performance and not the performance of the whole company. Determining of global priorities of criteria through calculation of normalized principal eigenvector is performed using MATLAB R2014a (Version 8.3). Results of calculation are shown in Table 4.

TABLE 4 Pairwise comparison of risk assessment criteria

Criteria	Financial consequences	Reputational consequences	Operational consequences	Compliance	Weight of criteria
Financial consequences	1	4	2	1/3	24%
Reputational consequences	1/4	1	1/3	1/4	7.58%
Operational consequences	1/2	3	1	1/5	14.24%
Compliance	3	4	5	1	54.18%

Usage of pairwise comparison matrix provided us with a quantitative representation of decision maker's subjective judgements regarding importance of given criteria when assessing consequences of risk realization. Consistency index of the matrix is 7% which is an acceptable level (less than 10%) meaning that judgements of the decision maker are consistent and can be used in assessment.

Next step is making a pairwise comparison of alternatives (risks in ITSM processes) in context of developed criteria; this comparison is also based on decision maker's opinion and provides us with risk weights regarding specific criterion. Example of pairwise risk comparison in context of financial consequences is shown in Table 5; same comparisons were made regarding other criteria as well.

TABLE 5 Pairwise comparison of risks in context of financial consequences

	IT.R2	IT.R3	IT.R5	IT.R7	Risk weight
IT.R2	13%	26%	34%	7%	**13%**
IT.R3	5%	19%	13%	6%	**8%**
IT.R5	56%	6%	5%	59%	**46%**
IT.R7	26%	50%	48%	29%	**32%**

After determining risk weights with respect to each criterion we performed a comparison of risks based on global priorities of criteria shown in Table 4 and calculated composite risk weights (see Table 6 for results). As seen from Table 6, ranking of risks in ITSM processes after applying AHP to risk assessment is the following: firstly, risk response strategy has to be developed for risk IT.R5 as it has the biggest weight and thus the biggest influence on business activity of the company. Then risk response has to be developed for risk IT.R7; after that risks IT.R2 and IT.R3 need to be considered.

TABLE 6 Pairwise comparison of risk impacts on evaluation criteria

	Financial consequences	Reputational consequences	Operational consequences	Compliance	Composite risk weight
Weight of criteria	*24%*	*8%*	*14%*	*54%*	
IT.R2	13%	26%	34%	7%	**13%**
IT.R3	5%	19%	13%	6%	**8%**
IT.R5	56%	6%	5%	59%	**46%**
IT.R7	26%	50%	48%	29%	**32%**

5 Conclusion

Evaluating the results of applying a decision-making method is a nontrivial and hardly feasible task. Decision-making methods are applied in cases when there obviously cannot be a clear answer; these methods are designed to help a decision maker systematize his judgements and formalize the decision-making process. Thus, applicability of the concrete method is also decided by a decision maker based on ease of use, transparency and consistency of the method with natural course of thinking. AHP has several advantages – first of all, AHP enables a decision maker to take into account the human factor in a decision making process, including those cases when decision is made not by one person but a group of people. Secondly, AHP allows to quantitatively express the preference of one option over another. This, in turn, allows to fully identify preferences of the decision maker, and consistency check shows whether we can trust the results. The method is general-purpose as it can be applied to the task from any field. Thanks to hierarchical representation of the problem suggested by AHP, the decision maker can divide the problem into separate tasks and delegate them to several experts. Therefore, it can reduce the complexity of data preparation and the difficulty of application of the method which occurs when a large number of criteria and alternatives is assessed (in this case, the number of pairwise comparisons to be carried out increases drastically).

One way to develop our research is to revise evaluation criteria. As we stated earlier, risk is an event preventing the process from achieving its goal. Obviously, achievement of different goals brings different value to the company. AHP allows using multiple levels of criteria, so it seems useful to

define the relative importance of each goal and consequences influencing achievement of this goal, and the assess the risks. Moreover, it seems appropriate to automate the method and create a system that would interpret the results of the method in understandable terms. Currently, results obtained after applying AHP can be easily interpreted if we assess a relatively small number of criteria and alternatives; when assessing a bigger number of factors interpretation of the results with respect to each criterion becomes more complex.

Developed approach to risk assessment was reviewed at Enterprise Risk Services department of international company providing audit and consulting services. Peer review confirmed that currently experts use risk matrices for risk prioritization when developing risk management systems in the companies of different profiles. Risk evaluation is often carried out by voting of client's senior management regarding importance of different risks based on the prescribed scale. It was noted that using AHP for risk assessment would help to decrease the subjectivity of estimates and check the consistency of judgements of senior management. The approach was applied to results of finished projects; the approach was said to be adequate and recommended for usage in future projects on developing risk management system and assessing company risks.

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Authors

Vladimir Grekul, 1949, Sakhalin, Russia

Current position, grades: professor, National Research University Higher School of Economics, Moscow, PhD
University studies: Kiev Higher Engineer Aviation Training School of the Air Force
Scientific interest: IT management
Publications: 90
Experience: has 40 years experience in design and implementation of information systems, has been working at NRU HSE since 2001 as Professor.

Nina Korovkina, 1947, Moscow, Russia

Current position, grades: Associate professor for the Information Systems and Digital Infrastructure Management department, National research university – Higher school of economics (Moscow, Russia)
University studies: Moscow institute of railway transport, engineer-mathematician specialization majoring in "Mathematical and computing devices"
Scientific interest: Design and implementation of information systems, IT project management
Publications: 39
Experience: worked in the Central economics institute for economics and mathematics (division of the Academy of sciences, Moscow, USSR) as well as in the Main computer centre of State planning committee. Since 1994 has been working in the National research university - Higher school of economics, took part in the projects carried out for the Ministry of Education, Ministry of Economic Development and Trade, Ministry of Information Technologies and Communications

Ksenia Korneva, 1993, Moscow, Russia

Current position, grades: Consultant, Deloitte & Touche CIS, ERS
University studies: Master of Business Informatics, National Research University – Higher School of Economics (Moscow, Russia)
Scientific interest: Risk management, internal control system review
Publications: 1
Experience: in 2012 Intern at Enterprise Risk Services, Deloitte & Touche CIS. Currently is a Consultant with three years of experience in projects related to Audit Support (IT audit), SOX-compliance and development of internal control system.

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Operation Research and Decision Making

Solving problems of geriatric care in the Republic of Kazakhstan based on new ICT trends
R Muhamedyev, E Muhamedyeva, A Mansharipova, V Chaykovska
Computer Modelling & New Technologies 2015 **19***(5C) 7-11*

In recent years, the measures to improve geriatric care of the population are taken in the Republic of Kazakhstan. Relevance of this issue is determined by a population aging on the one hand, and by RK humanization policy on the other hand. Consideration of these issues is impossible without corresponding data support, which is necessary for organizational tasks and for the entire cycle of medical data processing, starting from data collection, through a comprehensive analysis and issue of recommendation. Using modern software, communication and intelligent technologies promises not only improving of geriatric care quality but reducing the cost and obtain social-economic benefits. The article introduces the problem of geriatric care in Kazakhstan and offers an approach to the solution based on the new trends in the field of ICT.

Keywords: Geriatric care, ICT, Ambient Assisted Living, machine learning, broadband network, Machine-to-Machine, big data

Decision making in ITSM processes risk assessment
V Grekul, N Korovkina, K Korneva
Computer Modelling & New Technologies 2015 **19***(5C) 12-16*

This article is dedicated to enterprise risk management, specifically the problem of subjectivity of decisions made on different phases of risk management process, risk assessment in particular. Quality of decisions strongly affects the effectiveness of risk management process as a whole; at the same time, standards regulating risk management do not provide any instruments to support the decision-making process.

The main objective of this study is to decrease the subjectivity of decisions made during the risk management process by integrating decision theory tools into the risk assessment phase. As a result, an approach to risk assessment using Analytical Hierarchy Process is introduced; the approach is then implemented to IT Service Management processes.

Keywords: risk assessment, subjectivity, decision making, AHP, ITSM

Content D

Computer-mediated environment as a new technological real virtuality triggering virtual identity development

T Lobanova-Shunina[1*], Y Shunin[2]

[1]*Riga Technical University, Faculty of Mechanical Engineering, Transport and Aeronautics, Latvia*

[2]*Institute of Solid State Physics, University of Latvia, ISMA University, Latvia*

Corresponding author's e-mail: busus@inbox.lv

Abstract

In contemporary higher education, it has become a commonplace to emphasize that our globalized world is undergoing an identity crisis. The signs of this crisis particularly in social and cultural spheres are abundantly increasing as we go through the global, postmodern and information era in which the concept of identity turns out to be more complex than ever before.

This paper explores significant trends in contemporary higher citizenship education including a specific focus on the role of ITs and communication technologies, as well as new emerging technologies on the development of new emerging identities, particularly, virtual identity.

The purpose of this paper is to bring together various elements that represent the complex conceptuality of virtual identity within technological society. It engages into a research of what awareness young people are now getting of new information and communication technologies and how global media may possess the potential to transform their identity and in what way educational institutions should understand and respond to this evolving virtual reality.

In this paper, we address these issues both from a quantitative and qualitative standpoint. The key issues under research include the Systemic approach to identity formation as a synergy of information and communication technology (ICT) and virtual reality in citizenship education at Riga Technical University, Faculty of Mechanical engineering, Transport and Aeronautics (Riga, Latvia). The Sociometry method and Optimization theory are the factors that integrate all the elements.

The research results have demonstrated that the Tree-model of identity development offers a methodology for identity construction by evaluating virtual reality as the potential for the development of a creative personality. Implementation of the obtained research results can contribute to the working out of a scientifically grounded concept providing recommendations for the efficient strategy of identity formation in a computer-mediated global environment.

Keywords: identity crisis virtual reality virtual identity synergy of information and communication technology (ICT) and virtual reality new emerging identities global media

1 Identity: static and sustainable or developing and transforming?

Within the historical evolution of humans, history can be divided into three segments: pre-literacy, modern and post-modern societies. The movement between segments is characterized by transitions that our sensibilities undergo as technological advancements are made and as the tools are incorporated into everyday life. The printing press divided the pre-literacy and modern societies; the computer divides the modern and the post-modern societies. In the move from pre-literate to modern society, there were few technological advances and the speed of mechanical devices entering people's life was slow, which insured that individual and societal reactions to innovation were absorbed over a considerable amount of time. People were able to develop new competencies as changes in life occurred gradually.

This is not the case in the move from modern to post-modern society. New advanced technologies demand that we extend our capabilities in a flash within the global network. Action and reaction times occur simultaneously and there are many more 'smart' tools available.

Undoubtedly, the concept of identity has undergone its evolutionary path as well. Still, there is a paradoxical dichotomy when it comes to the concept of identity, where there are two common, but opposite, approaches to the questions of what identity means and how it is constructed ranging from a prevalent and traditional approach when identity is defined as a constitution based on the recognition of familiar and shared derivations including but not limited to ethnic, linguistic, religious, historical, territorial, cultural and political attributes with other people, groups or ideals (Hall, 1994, 1996) to philosophically specific conceptualizations.

The concepts of *familiarity* and *share* in the traditional approach are closely associated with the meanings of *sameness*, *belongingness* and *unity*. From this perspective, identity is a 'one, common, shared culture', a kind of collective 'one real self,' which people with a shared ancestry and history hold in common. According to Grossberg (1996), the problematic factor in this analysis is that there is some intrinsic and essential content to any identity which is characterized by either a common origin or a common structure of experience or both. One can be

deemed to be born along with his or her identity that appears to act as the sign of an identical biology. In this regard, identity is determined more likely as a naturalistic and static formation that could always be sustained. This conventional view sees individual as a unique, stable and whole entity.

On the other hand, nowadays, a number of scholars point out that human self-conceptions have a history and are constantly changing. Weinreich [1] gives the definition of a person's identity 'as the totality of one's self-construal in which how one construes oneself in the present expresses the continuity between how one construes oneself as one was in the past and how one construes oneself as one aspires to be in the future' [1]. Ideas of human nature and, ultimately, identity have always been shaped by the integrated concepts of education, science, philosophy, and technology as a never completed process, logged in contingency. It is always in the process of *becoming* rather than *being*, therefore, it is constantly changing and transforming within the historical, social and cultural developments and practices such as globalization, mobility, and new innovations in technology. It is not something to have or to be, yet a resource to use and an action to do.

Furthermore, the entity of the process, the unity of education and a person's identity development constitutes the main methodological principle of citizenship education, which is especially topical at present. A person's identity relates to self-image, self-esteem, and individuality. According to this constructionists and discursive view, an individual is a socio-historical and socio-cultural product and identity is not biologically pre-determined, instead, a person develops and constructs it, and more importantly, this construction may include various and multiple identities at different points of time and contexts.

In social and cultural studies, this debate refers to a tension between essentialists (Descartes, Karl and Husserl) and constructionists/anti-essentialists (Hume, Nietzsche and Sartre) or in recent discussions, a transformation from the conception of modern identity to postmodern identity. This is how Bauman (2006) explains this transformation: 'If the *modern* problem of identity was how to construct an identity and keep it solid and stable, the *postmodern* problem of identity is primarily how to avoid fixation and keep the options open. In the case of identity, as in other cases, the catchword of modernity was creation; the catchword of postmodernity is recycling'.

2 Technological advancements and their consequences altering identity

Throughout human existence, changes in technology have significantly affected human life. Modern identity has been strongly influenced and shaped by new emerging technologies firmly entering the life of every citizen of the global community. In their turn, new technologies have shaped new theories enabling a deeper insight into the concept of identity and its construction. How a person communicates who he/she is to others is given multiple possibilities with the advent of the Internet and computer-mediated environments. Technological advancements dissolve national boundaries and open cultures to a wide and diverse unity, enabling globalization to occur. It can interconnect the world, provide

information availability and assist in developing a global communication network, thus, providing a means for information sharing, self-representation in the global context supporting multiple identity through socialization and, ultimately, triggering off the development of virtual identity.

People in different parts of the world can now get together and experience the same things at the same time. They can choose any community to interact with and not obligatory the territory they are physically bound up with. What is being created – is a new electronic cultural space – a 'placeless' geography – a world in which space and time horizons have become collapsed. The concept of 'shrinking world' inherent to the process of 'time-space compression'.

Accordingly, there seems to be a fundamental transition from the values of family, community, nation, culture and country to those of global media, technological networks and virtuality.

Assuming that personal identity is a complexity of identities compiled of multiple identities, it seems no longer possible to just report the technological advancements of our society and remain neutral to their consequences. Social, technological and cultural changes are arising from a rapidly advancing technology, altering at the same time our perception of identity. Whether or not these changes are crucial, the question still focuses on how best we can come to understanding of our globalized, technologized world, ourselves, and our place in it under rapidly transforming technological conditions.

In fact, contemporary identity being greatly facilitated and shaped by ICTs and new advanced technologies that have been moving us as 'homosapiens' along the evolutionary path to an interactive and reciprocating relationship with the computer has brought about a new 'derivative' – 'composapiens'. Computer seems to have become an integral part of our life, our indispensable 'right hand' and a major personal consultant.

Therefore, identity theory today must take into consideration computer-mediated communication theory and research indicating the four major ways in which identity is affected by technology. First, there is a difference between a person's true identity and his/her virtual identity represented to the online world. Second, there are two reciprocating ways of interaction with the Internet - it can provide both protective anonymity to those who seek it and publicity to those who need it. Third, there is a mutually reverse impact that virtual identity has on the practice of communication and the impact that communication has on the practice of representing one's self. Fourth, there are varuious ways in which a user pursues both reflective virtual life and role-play with multiple identities.

Thus, once restricted to face-to-face communication, human interaction in the technologized world can be initiated, cultivated and sustained totally through computer-mediated communication, contending that identity in a modern electronic world is rooted in communication and virtual reality.

3 Virtual reality and virtual identity

Modern information and communications technology can affect changes in identities in a way that has not been experienced before in the history of humankind. Techno-

logy convinces us in being 'superhuman' since it allows us to fly, to manipulate huge and heavy objects in space and in the ocean depths, to perform surgery on the nucleus of a cell, to write by handling individual atoms, to see planets orbiting distant stars, to quickly access a vast amount of information and to communicate not only aurally but also visually in a global scale.

Social changes and identities are determined by technological innovations that can expeditiously convey information and embody social and cultural dimensions decisively shaping culture through a new communication system. Thereby, a new culture is emerging – the *culture of real virtuality* in which reality itself is fully immersed in a virtual context on the screen through which communication occurs becoming a real experience promoting the emergence of virtual identity.

There are numerous definitions given to the notions of virtual reality and virtual identity. We have adopted those given by Webster's Third New International Dictionary [2]. The notion of virtual reality comes, naturally, from the definitions for both 'virtual' and 'reality'. The definition of 'virtual' is near and reality is what we experience as human beings. So the term 'virtual reality' basically means 'near-reality'. It usually refers to a specific type of reality imitation.

Virtual reality (VR) – is the computer mediated simulation of a three-dimensional electronic environment (objects and subjects) that can be interacted, communicated with and visualized by means of computers and highly advanced technologies (such as a helmet with a screen inside or gloves fitted with sensors).

Virtual identity (VI) – is a social identity, the manifestation of one's 'self' in the computer-mediated globalized world of online communities, social networks, websites, and virtual worlds.

According to Myers (2007), the self is the most researched topic in psychology. 'Our sense of self organizes our thoughts, feelings and actions' (Myers, 2007, p. 25). When you complete the sentence, 'I am _____'you are essentially defining or describing your *identity*, how you see yourself. You could fill in the blank to describe an element of your personal identity, for example, 'I am cheerful' or 'I am athletic' or you could use terms to describe your social identity, such as, 'I am Latvian' or 'I am nationalistic'. Junglas, Johnson, Steel, Abraham, and Loughlin (2007) suggest that identity formation includes two processes: exploration and commitment. Exploration is the time period where someone questions or searches for their beliefs and goals, while commitment is when a person decides and invests in the beliefs and goals (Junglas et. al, 2007). More understanding of how and where individuals explore their identities is beginning to emerge, with the focus turning from real world to virtual worlds.

Cabiria (2008), in his research compared participants' real world experiences to their virtual world experiences. Part of his findings suggest that the structure and design of virtual worlds allow its users to freely explore many facets of their personalities in ways that are not easily available to them in real life. 'One reason for this freedom of exploration can be attributed to the anonymity that virtual worlds provide. It gives the individual the ability to be free from social norms, family pressures or expectations they may face in their personal real world lives' (Junglas et. al, 2007).

The Internet helps us to be where we want to be, to see what we want to see, hear what we want to hear, read what we want to read, feel what we want to feel and of course to be who we want to be in the freedom of anonymity.

However, with this anonymity, other consequences come into play when we look at the commitment aspect of identity formation. For example, if an individual creates a virtual identity that is different from their real identity, it can take a lot of psychological effort to maintain the false identity. In addition, one of the two options might occur: the identities may converge into one, making the virtual and real identities more true; or the individual may simply toss out the virtual identity, and start over with a new one (Junglas et. al, 2007).

The element of anonymity within virtual worlds, may provide individuals with a safe and private arena to explore their identity. However, anonymity also presents a problem for others who engage in virtual worlds, and that problem is trust. Anonymity can leave you scratching your head wondering how much, if any, of an individual's virtual identity, is really - real.

'In regards to the formation of an individual's identity in virtual worlds, we have inferred that exploration, which motivates such formation, may play a more dominant role than it does in the real world. (Junglas et. al, 2007. p. 94)

These days it seems hard to tell which is the real 'you', your real identity or your *virtual identity*, but when you have the opportunity to be who you want to be you do not really care. Some people are fine with their reality but there are also those who prefer their virtual identity, which is easier to have control over.

4 Latvian social media landscape in the European environment

Latvia is one of the Baltic states along with Lithuania and Estonia. It is an Eastern European country with a population of about 2 million [3]. About 62% of inhabitants are Latvians, and Russian-speaking population makes up the second largest multicultural group (38%) (Veģis, 2012). Because of the existence of the two ethnic-linguistic groups, the Latvian media landscape is also divided into parts - Latvian- and Russian-language editions.

Latvian media are pluralistic in terms of opinions expressed, which also includes some hostility toward the officially recognized basic principles of the state (Skudra, Šulmane, & Dreijere, 2014). Social media platforms have become very popular online venues where individuals communicate and collaborate while creating, discussing, and sharing media content. The spread of information through social media enables an emergent practice of information consumption, where users get information in their online social networks rather than actively seeking it out by regularly visiting a handful of external information and entertainment sources (Newman, Levy, & Nielsen 2015).

The use of the Internet has risen steadily over the last decades. In 2014, 76% of the Latvian population used the

Internet, and 61% used it every day. This is a bit lower than the average among the European Union countries, which was 78% and 66%, respectively (Seybert & Reinecke, 2014), but higher than the average among Eastern and Central European countries - 71% and 57%, respectively.

In line with global trends (Alexa, 2015), the most popular online services are Web search, e-mail, social networking, video, and news sites (TNS, 2014a). At the same time, traditional media retain relatively large audiences (Eurobarometer, 2013).

Similar trends can be observed in social media use. For example, in 2012, 51% of Latvians used the Internet for social networking, and by 2013, the number of social media users reached 53% (TNS, 2014). On average, social networking sites are used by 52% of Europeans (Eurobarometer, 2013), which correlates very well with the Latvian figures.

Regardless of their popularity on the Internet, many traditional media entities still have considerably large audiences. According to Eurobarometer (2013), around 92% of the Latvian population watch television and 78% listen to the radio at least once a week. These results are similar to European averages, which are 95% and 74%, respectively. While the circulation of print media, especially newspapers, has fallen dramatically in many markets (Meyer, 2009), 65% of the Latvian population still read print media at least once a week. The European average also is 65% (Eurobarometer, 2013).

5 How Latvian students' interests in social networking correlate with those of Europeans

The increasing popularity of social networking services can best be demonstrated by the growing number of their users. Facebook, the most popular social networking site in the world, has about 890 million daily active users (Facebook, 2015). The Latvian social networking site - Draugiem.lv - is one of the few among Facebook's local rivals that still dominates its home market (Aptauja.lv, 2014; Linsell, 2011). It has about 382,000 daily users (TNS, 2014b), but the number of monthly users is above 700,000 (Aptauja.lv, 2014), which is around half of all Internet users in Latvia (see Figure 1).
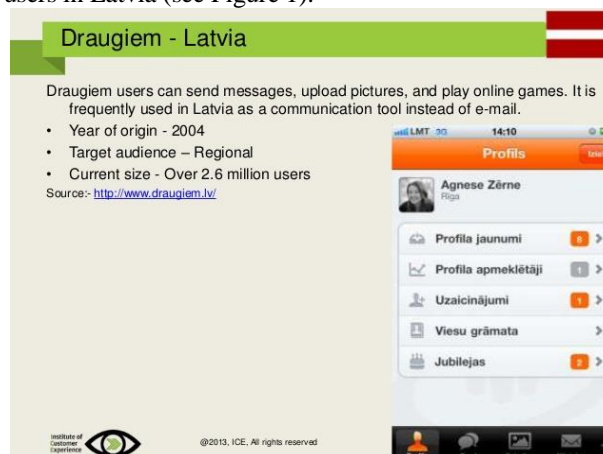
FIGURE 1 Screenshot of the Latvian social networking site - Draugiem.lv

Social media are increasingly employed not only to follow current events and find relevant information but to establish interpersonal contacts (see Table 1).

The most popular websites in Latvia (TNS, 2014) are the Google search engine (average daily audience is 43.2% of all users), Inbox.lv e-mail and entertainment service (28.6%), social networking site Draugiem.lv (25.3%), video site YouTube (25.1%), and news site Delfi (22.7%).

TABLE 1 The most popular websites in Latvia

Website	Average daily audience (thousands)	Average daily audience (%)
Google	886	43.2
Inbox.lv (e-mail and entertainment service; Latvian- and Russian-language versions)	586	28.6
Draugiem.lv (social networking service)	520	25.3
YouTube	516	25.1
Delfi (news site; Latvian- and Russian-language versions)	467	22.7
TVNET (news site; Latvian- and Russian-language versions)	353	17.2
Facebook	315	15.3

To get a deeper insight into the phenomenon of identity construction in times of computer-mediated global environment, we launched a pilot research to explore identity formation as a synergy of information and communication technology (ICT) and virtual reality in citizenship education at Riga Technical University, Faculty of Mechanical Engineering, Transport and Aeronautics (Riga, Latvia). Our research confirms that today's Latvian students are using a wide range of media technologies, with usage patterns growing steadily over the last few years.

We asked the 1-st and 3-rd year students (N=48; N=44 respectively) about five specific types of media use and compared these with the European tendencies:
- Watching television
- Listening to the radio

- Reading the written press
- Going on the Internet
- Use online social networks

The survey respondents were asked a series of questions regarding their use of the particular social networking site, their media consumption, what activities they use the Internet for, and how often. Descriptive statistics demonstrated the frequency of each answer, and correlation analysis was used to determine the participants' preferences for media they use.

First, the participants in the survey were asked to state how often they used any of the kinds of media on the list—every day, several times a week, once a week, several times a month, less often, or never (see Table 2).

TABLE 2 Survey results: To what extent do you watch television via the Internet?

Education	Every/Almost every day	2-3 times a week	2-3 times a month	Never	No access to this medium
Average in Europe	17%	23%	21%	36%	0%
Latvian students aged 18-20	14%	26%	34%	25%	1%
aged 21-25 +	15%	16%	21%	48%	0%
	Men – 27%		Women – 21%		

Television is the preferred medium of Europeans: 86% watch it every day or almost every day. Although Europeans are far less likely to watch television over the Internet, this practice continues to gain ground: 20% of Europeans watch television online at least once a week (Eurobarometer, 2013).

When it comes to watching television via the Internet at least once a week, the differences between categories of Latvian students are slightly more pronounced:
- This practice is more widespread among boys (27%) than among girls (21%);
- Students in the 18-20 age group are the most likely to watch television via the Internet: 34% do so at least once a week. We note that the proportion of respon-

dent who watch television via the Internet decreases gradually with age: 21% of 21-25 year-olds watch television via the Internet at least once a week.

Radio - is the second most widely used medium by Europeans (76% use it almost every day). But there are significant differences in listening habits between Member States (see Table 3).

Two-thirds or more of the population listen to it every day or almost every day in Germany (69%). In contrast, this practice is far less widespread in Bulgaria (29%) – which is the country where respondents are the most likely to watch television. (Romania (34%) and Portugal (34%) (Eurobarometer, 2013).

TABLE 3 Radio listening: to what extent do you listen to the radio?

Education	Every/Almost every day	2-3 times a week	2-3 times a month	Never	No access to this medium
Average in Europe	37%	30%	18%	15%	0%
Latvian students aged 18-20	49%	27%	13%	9%	2%
aged 21-25 +	56%	28%	11%	5%	0%

About half of the Latvian participants listen to the radio every day or almost every day. In our talk after the survey the students admitted that they listened to the radio in the car while going to university in the morning or going home in the evening from work.

The written press is read by a third of Europeans at

least once a week (see Table 4). In reading the written press, a national analysis reveals significant differences between countries: in Finland (94%) and Sweden (93%), more than nine out of ten people read the written press at least once a week. In contrast, this practice is less widespread in Greece (34%) and Romania (38%).

TABLE 4 Written press: To what extent do you read the written press?

Education	Every/Almost every day	2-3 times a week	2-3 times a month	Never	No access to this medium
Average in Europe	30%	32%	24%	13%	1%
Latvian students aged 18-20	24%	27%	31%	18%	0%
aged 21-25 +	34%	31%	24%	11%	0%

TABLE 5 Internet using: To what extent do you use the Internet?

Education	Every/Almost every day	2-3 times a week	2-3 times a month	Never	No access to this medium
Average in Europe	93%	5%	2%	0%	0%
Latvian students aged 18-20	92%	7%	1%	0%	0%
aged 21-25 +	97%	3%	0%	0%	0%

Men are more likely than women to read the written press at least once a week (69% versus 62%). Our next purpose was to find out how often our students surf the Internet (see Table 5).

More than nine out of ten young Latvian students now use the Internet on a daily or near daily basis. It is dependent on the educational attainment and age. In the age group of 18-25 it is used by 95% on a regular basis as well

as 100% of all pupils and students. The use of the Internet on a daily or near-daily basis is more widespread among men (59%) than among women (41%).

The participants were also asked to report how many hours a day they spend on the Internet and on the social networking site (see Table 6). They chose from a set of answers that included various time intervals – for example, one hour or less, two to four hours, five to eight hours.

TABLE 6 Intensity of Internet use

Internet use	N=92
Amount of time in a 'typical day'	
More than 5 hours	39%
More than 4 hours –3 hours	26%
More than 3 hours –2 hours	27%
30 minutes – 1 hour	6%
≥30 minutes	2%
0 minutes	0%

The analysis has shown that the average time the students spend online daily is about 6 hours (SD = 2.75), and the average time they spend on a particular social networking site is about 2 hours (SD=2.25).

If to add the time needed for sleep – 7-8 hours and the time spent at university/work – 8 hours and the picture appears dramatic!

Notable differences in how boys and girls used the Internet emerged: girls were more likely to endorse social networking sites, emailing, instant messaging, and listening to music whereas boys were more likely to endorse playing games, surfing the web, and buying or looking at price on websites as their most common online activities.

It is the use of online social networks that has increased the most perceptibly in recent years: more than a third of Europeans use social networks every day or almost every day and 47% of Europeans now use them at least once a week (see Table 7).

TABLE 7 Social networks using: To what extent do you use online social networks?

Education	Every/Almost every day	2-3 times a week	2-3 times a month	Never	No access to this medium
Average in Europe	75%	16%	4%	5%	0%
Latvian students aged 18-20	78%	14%	3%	5%	0%
aged 21-25 +	59%	15%	11%	15%	0%

There are over 1 million active users of social media networks in Latvia and the growth rate is high. The use of social media among Latvian students is high, placing the country in the second place among European countries after the Netherlands.

The data on time spent on the Internet were correlated with students' answers to how regularly they consume different types of social networking site. FaceBook and Google continue their dominant position among students surveyed, with 76 of 92 students having a membership in FaceBook. At present, FaceBook remains the social media place to be and to connect with students. Twelve students listed Google+ membership. Four students noted that they were not members of any social media web site. No student listed Instagram, SnapChat, or other 'new social media' options that are seeing strong growth in other markets (see Table 8).

TABLE 8 Comparative analysis: To what extent different types of media are used (except 'never' users)

Education	TV via the Internet	Radio	The written press	Internet	Social networks
Average in Europe	68%	85%	87%	100%	95%
Latvian students aged 18-20	75%	91%	82%	100%	95%
aged 21-25 +	52%	95%	89%	100%	85%

The comparative analysis shows that both in Europe and in Latvia the situation is very similar – with the Internet occupying the leading position and very closely followed by social networks.

6 The reasons for escaping from reality and their consequences

The question arises: why do young people start spending more and more time in virtual worlds trying to escape from reality? The major problem the students reported is just that they feel bored when staying alone.

One of the reasons why they feel bored when staying in silence, away from everyone, may be 'existential emptiness'. This emptiness is formed when a person has no interests, hobbies, small pleasures, reflections, dreams, desires and conscious will.

The negative consequences of being addicted to social networks result in:
- alienation,
- reduced intelligence,
- fast fatigue and stress,
- boredom – one of the main causes of many human problems leading to:
  - frequent nervous tension,
  - alcohol / drug dependency (because of boredom many people cannot stop drinking / smoking, and even if they do it, it is only for a while, then come back to bad habits again),
  - inability to withstand long trips, meetings,

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even the rest,
- inability to concentrate,
- inability to relax, chronic fatigue,
- painful desire for purchases, shopping,
- congestion of the brain by lots of problems, 'information garbage',
- the feeling of anxiety,
- apathy, depression.

As a result, the wrong choices in life, loss of opportunities, false goals and aspirations, misery and inability to get the full enjoyment of life.

How to get rid of boredom? Many psychologists advise to spend more time with your 'self'. Think about something positive. Do not think about work, about current affairs, but make plans, think about yourself and your future, about how to achieve your own happiness, and what should be done to get it.

The question becomes even more complicated by the problem of trust in social networks, which might leave you scratching your head wondering how much, if any, of an individual's virtual identity is really – real?

We asked the participants to keep a daily diary and jot down who they spoke to, what they said and whether they were telling the truth or lying, even during the most casual interactions.

The results turned out discouraging: people dropped an average of two-three lies every day. An ugly truth revealed: everyone fibs left and right.

We asked the students to consider two factors in assessing online honesty: (1) the communication venue, and (2) the topics people lie about. When it comes to the venue, research suggests that we are *most* honest on social networking sites and *least* honest on dating sites. When it comes to *what* we lie about, we are most honest about our personality, and *least* honest about our physical appearance. ('Despite the fact that the Internet makes it easy to fabricate major lies, most of the online lies are minor').

"Most people believe that given the opportunity, everything else equal, people will lie more online than they would face-to-face", said Jeff Hancock, an associate professor of communications at Cornell University who specializes in information technology and deception.

"Deception online and face to face is motivated by the same human needs", said Catalina Toma an assistant professor of communication at the University of Wisconsin-Madison who has studied online deception. "Technology simply interferes in some ways that might decrease or facilitate the opportunity to lie."

Technology is not the gateway to rampant deception; instead, Toma and Hancock both suspect that our distrust of communication technology is more likely rooted in our fear of it.

7 Virtual reality and virtual identity development based on the Theory of Graphs

With the advent of the Internet and computer-mediated environment occupying so much time in our lives, the understanding of how and where individuals explore and construct their identities is beginning to surface, with the focus turning from the real world to virtual worlds and from real identity to virtual identity.

However, individual's personal identity is not inherent or static, on the contrary, it is a story that a person keeps writing throughout his life. But our life and our behaviour is strongly influenced and shaped by social, technological and cultural changes arising from a rapidly advancing ICTs that are shaping a new emerging culture – the culture of real virtuality facilitating the development of virtual identities.

The developed model of identity construction in the computer-mediated global environment based on the Theory of Graphs [4] reflects an Identity System *(IS)* of an individul that develops and self-organizes within a bigger organized global information-communication system never available before (see Figure 2). An individual, as a social being, enhances, constructs, and develops his complex identities through interaction and communication as an information-based developing system [5-7].
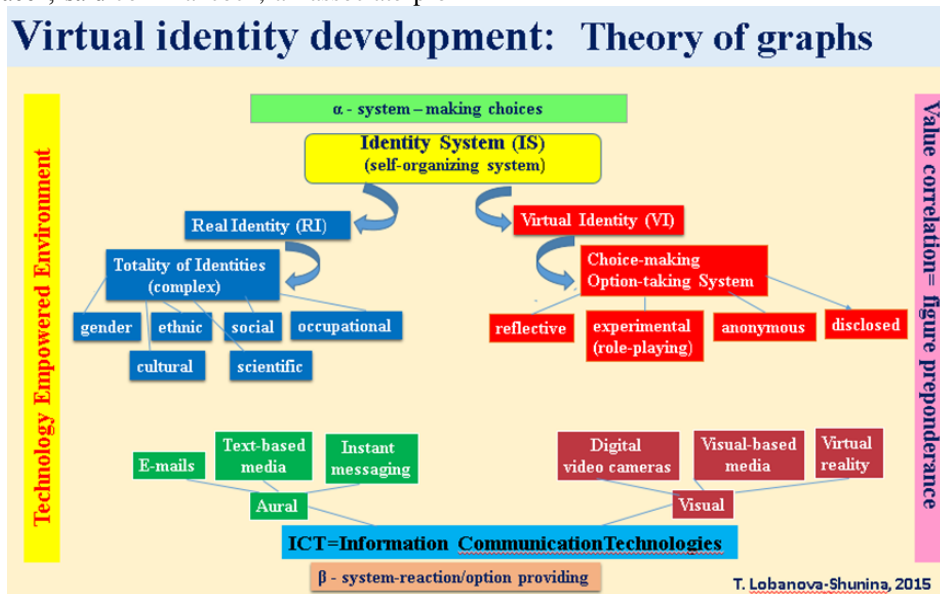

FIGURE 2 Virtual identity development

The model is presented in the form of the so-called graphs, each of which consists of vertices connected by ribs. Each vertex carries a certain meaning. Each rib indicates a certain relationship between a pair of connected vertices. Some ribs are considered in two directions.

Weuse a special type of graph which is called a 'tree', where α-vertex is the IS which makes choices, while β-vertex is the ICT-reaction system providing options. Identity System functioning is based on the investigation of the proposed options – the so-called 'tree of viewing options'.

The root vertices of such a tree present a current state/configuration, while IS - is option-taking and choice-making [5-7]. Usually there is quite a big choice of variants. As a result of their choice-making, Virtual Identity expands very fast.

8 Sociometric matrices for calculating the Virtual Identity Quality Index (VIQI)

If education professionals are to prepare for the new challenges presented by emerging media, we need to have a basic understanding of what a typical media diet looks like for today's students. We were interested in how our students use the Internet. Specifically, we wanted to know the things youth spent most of their time doing when they were online and, particularly, how the amount of time students spend on the Internet correlates with their interests. They were asked to evaluate the purposes for which they use the Internet – for studies and work, entertainment, communication, searching information and reading news, visiting blogs, etc (see Table 9).

TABLE 9 Students virtual activities

Most common Internet activities	N=92
1 Doing schoolwork +	31%
2 Social networking websites -	38%
3 Playing games -	24%
4 Listening to music -	28%
5 Instant messaging -	19%
6 Surfing the web -	17%
7 Emailing +	15%
8 Something else -	18%

Assuming that the virtual identity quality depends on the time spent in the electronic virtual space and the type of specific activities, we consider, from the educational point of view, the useful time spent on the Internet activities (i.e. that serving educational purposes) as positive (+) and the rest of the time spent on surfing the Internet - as negative (-)(see, e.g. Figure 10).The applied sociometric methods allow us to analyse partial contributions of a computer user activities and to introduce a *Virtual Identity Quality Index (VIQI).*

The method helps to identify either positive or negative virtual identity quality index (VIQI) of every person – i.e. how efficiently a person consumes his time from the point of view of educational perspective and self-development.
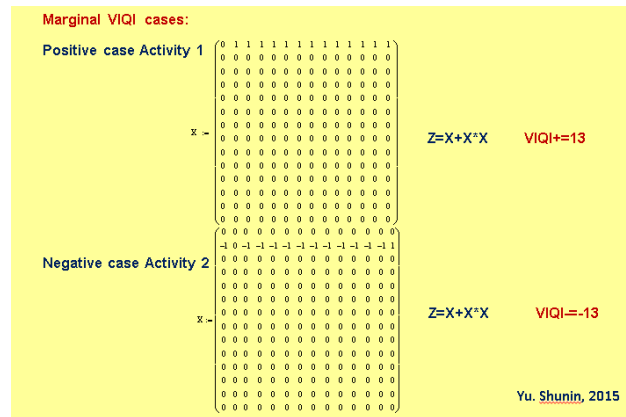

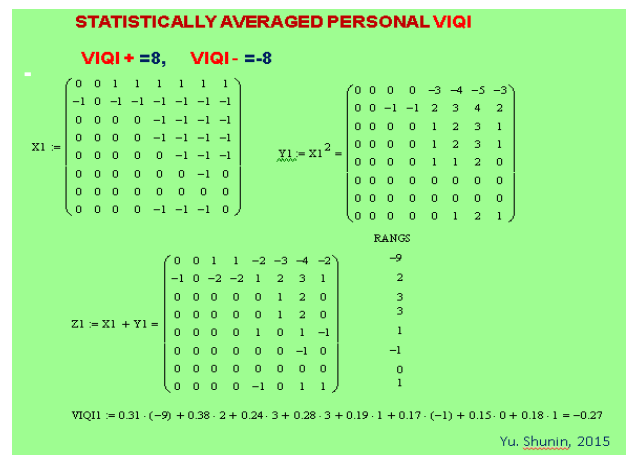FIGURE 10 Evaluation of marginal virtual activities: pure 'plus' and pure 'minus'

FIGURE 11 Evaluations of realistic VIQI

Based on these data, we can provide recommendations on how to most efficiently use contact computer time and how to help students to arrange their activities (both online and offline) with the maximum positive result for self-development.

9 Implications for education

Media plays a monumental role in the lives of young people today. The online world and interactive communication tools, such as text messaging, are transforming the experiences and relationships in education. The possibilities of VR and education are endless and bring many advantages to students of all ages. Technology has made the process of accessing multiple perspectives and highlighting different points of view cheaper and easier than ever before. Teachers can use the advances of ICTs and new emerging technologies to help students learn how to seek out multiple perspectives, how to synthesize various viewpoints, and how to make informed choices. Globalized society needs an educated citizenry. This requires a revision of many existing curricula and the development of objectives and content themes, and teaching, learning and assessment processes that emphasize moral values, ethical motivation and ability to work with others to help build a sustainable future. Viewing education for sustainability as a contribution to a technologically literate society is central to the reformulation of education and calls for a 'new generation' of theory and practice in education and a rethinking of many familiar approaches (Alexandersson (2012).

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Wiszniewski and Coyne state 'Education can be seen as the change process by which identity is realized, how one finds one's place [8]. Education implicates the transformation of identity. Education, among other things, is a process of building up a sense of identity, generalized as a process of edification.' Students interacting in an online community must reveal something about themselves and have others respond to this contribution. In this manner, their identity is gradually formulated in dialogue with others and thereby students will gain a richer and deeper sense of who they are. There will be a process of edification that will help students come to understand their strengths and weaknesses.

Online identity in classrooms forces people to re-evaluate their concepts of classroom environments. With the invention of online classes, classrooms have changed and no longer have the traditional face-to-face communications. These communications have been replaced by computer screen. Students are no longer defined by visual characteristics unless they make them known. There are pros and cons to each side. In a traditional classroom, students are able to visually connect with a teacher who was standing in the same room. During the class, if questions arise, clarification can be provided immediately. Students can create face-to-face connections with other students, and these connections can easily be extended beyond the classroom. For timid or socially awkward students, this ability to form and extend relationships through personal contact may hold little appeal. For these students, the appeal may reside in online courses, where computer communications allow them a greater degree of separation and anonymity.

Online learning situations also cause a shift in perception of the professor. Whereas anonymity may help some students achieve a greater level of comfort, professors must maintain an active identity with which students may interact. The students should feel that their professor is ready to help whenever they may need it.

Online identity can offer potential social benefits to those with physical and sensory disabilities. The flexibility of online media provides control over their disclosure of impairment, an opportunity not typically available in real world social interactions.

10 Conclusions

We are interacting in a new environment where with the facilitation of information and computer technologies,

individuals may go beyond their physical community and interface, and form virtual identities by means of interactions with diverse cultural beliefs and behaviours on a global scale.

The virtual interactive spaces mediated through the synchronous and asynchronous communication tools transform traditional notions of identity and a new cultural 'hybrid' identity emerges – the offspring of real and virtual identities.

Advances in technology have created a global communication network providing humans a new and diverse habitat – computer-mediated and online virtual world. The Internet provides virtual worlds that, in turn, provide individuals an outlet for their virtual identity.

No one can deny that the rapid developments in ICT catalysing and accelerating the dissemination of information, values, beliefs, and the spread of global culture have far-reaching effects on the development of identities and communities.

Some of them may be positive whereas others may be negative. The reduction of time and energy for the information, and the increased communication between cultures of different geographical areas and ethnic backgrounds may be deemed positive and therefore desirable.

However, the disruptive and disintegrative effects of global culture on the changing patterns of socio-cultural identities and institutions, such as youth, families, languages, educational settings and religions, may be considered negative and undesirable.

With students consuming the greatest number of hours watching television and playing video games, students between the ages of 18-22 spend an equivalent of six hours each day or 40 hours a week using media. Such amount of time devoted to media exacerbates a growing concern that media sources like television and video games have the potential to distort worldviews. This is an important concern for educators because most of the time the Internet, video film, and computer video graphics are incorporated into the curriculum. When such media are associated with youth culture, they construct representations of the world and serve as socializing agents, providing young people with beliefs about the behaviours of the world.

Schools and universities need to promote a balance way of technology diffusion that youths can properly fit to their own way of life, traditions, customs and cultural heritage at the same time they can adapt themselves to the challenges and realities of the twenty-first century in order to find their own place in the real world of globalization.

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Authors	
	Tamara Lobanova-Shunina **Current position, grades:** Associate Professor at Riga Technical University, Aeronautics Institute, PhD, Dr.edu **University studies:** University of Latvia, She obtained her PhD (2009) on innovative education at South-Ukrainian National University **Scientific interests:** current research activities concern nanotechnologies, nanomanagement, nanoeducation, nanorisks, and nanothinking in the EU FP7 Project CACOMEL (2010 to 2014), special interests are connected with the systemic approach to nanosystems applications. **Publications:** 53 regular papers **Experience:** She was a member of the NATO ARW Local Organizing Committee 'Nanodevices and Nanomaterials for Ecological Security', Riga, Latvia, 2011. She has been working as a visiting researcher at INFN-Laboratori Nazionali di Frascati, Frascati-Roma, Italy (2010 to 2015). She was the Head of International Business Communications Department, Director of the study programme 'International Business Communications' at Information Systems Management University (till 2013). She is the Editorial Board member of the journal 'Innovative Information Technologies'. She is the author of over 53 scientific papers in international scientific journals.
	Yuri N Shunin **Current position, grades:** Professor and Vice-Rector on academic issues at Information Systems Management University and a leading researcher at the Institute of Solid State Physics, University of Latvia. **University studies:** PhD (physics and maths, solid state physics, 1982) at the Physics Institute of Latvian Academy of Sciences and Dr. Sc. Habil. (physics and maths, solid state physics, 1992) at Saint-Petersburg Physical Technical Institute (Russia). **Scientific interests:** His current research activities concern nanophysics, nanoelectronics, nanodevices, nanomaterials, nanotechnologies, nanorisks, nanoeducation, and nanothinking **Publications:** over 470, 1 book with Springer **Experience:** director of NATO ARW "Nanodevices and Nanomaterials for Ecological Security," Riga, Latvia, 2011, a visiting researcher at Gesellschaft für Schwerionenforschung mbH, Darmstadt, Germany (1995), INFN — Laboratori Nazionali di Frascati, Frascati-Roma, Italy (2010 to 2015), participation in EU FP7 Projects CATHERINE (2008 to 2011) and CACOMEL (2010 to 2014), education practitioner in Higher Education from 1975 till nowadays

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Computer-mediated environment as a new technological real virtuality triggering virtual identity development

T Lobanova-Shunina, Y Shunin

*Computer Modelling & New Technologies 2015 **19**(5D) 7-16*

In contemporary higher education, it has become a commonplace to emphasize that our globalized world is undergoing an identity crisis. The signs of this crisis particularly in social and cultural spheres are abundantly increasing as we go through the global, postmodern and information era in which the concept of identity turns out to be more complex than ever before.

This paper explores significant trends in contemporary higher citizenship education including a specific focus on the role of ITs and communication technologies, as well as new emerging technologies on the development of new emerging identities, particularly, virtual identity.

The purpose of this paper is to bring together various elements that represent the complex conceptuality of virtual identity within technological society. It engages into a research of what awareness young people are now getting of new information and communication technologies and how global media may possess the potential to transform their identity and in what way educational institutions should understand and respond to this evolving virtual reality.

In this paper, we address these issues both from a quantitative and qualitative standpoint. The key issues under research include the Systemic approach to identity formation as a synergy of information and communication technology (ICT) and virtual reality in citizenship education at Riga Technical University, Faculty of Mechanical engineering, Transport and Aeronautics (Riga, Latvia). The Sociometry method and Optimization theory are the factors that integrate all the elements.

The research results have demonstrated that the Tree-model of identity development offers a methodology for identity construction by evaluating virtual reality as the potential for the development of a creative personality. Implementation of the obtained research results can contribute to the working out of a scientifically grounded concept providing recommendations for the efficient strategy of identity formation in a computer-mediated global environment.

Keywords: identity crisis virtual reality virtual identity synergy of information and communication technology (ICT) and virtual reality new emerging identities global media