Real-Time Dynamic Data Fusion Technology Based on Traffic Information Control Model

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Abstract

The safety monitoring capacity of our shipping enterprises on inland craft Have weak place because of geographically separation of ship and shore, and it is lack of effective monitoring to the state of shipping and goods carrying. The advanced computer information technology, communication technology and network technology should be used to combine the safety monitoring management of ship and shore organically. The interactive data at any time and collaborative management of ship and shore can ensure the safety and efficiency of inland water transport. This paper analyzed the multi-level sensor data fusion technology based on the summary of existing data fusion technology, and the data fusion model of navigation environment was put forward. This paper put forward the data fusion model of multiple data sources and its main algorithm based on multi-data fusion of traffic information control model and information collection of research field of Yangtze River shipping.

Keywords: Navigation Environment; Integration of Ship and Shore; Multi-data Fusion.

1 Introduction

Shipping industry has vivid particularity compared with other industries. Shipping enterprise is composed of company in charge of the management (shore) and fleet in charge of production operation (ship). The inland water transport enterprises and ships are considered as two objects which can not associate with each other because of geographic separation of the shore and ship. The control of shipping enterprise to ship, such as navigation safety, management of maintenance and marine surveyor, are all individual behavior in enterprise terminal or ship terminal. The information about the events of ship exchanged to shore mainly by telegram, telex, fax and mail. Its highlights problems such as the information hysteresis and subjectivity, history recording nonuniformity, history recording continuous storage, thus it is lack of effectively monitoring to the navigation environments of ship, state of shipping and goods carrying. Information Island between ship and weak monitoring bring lots of hidden dangers and adverse effects to the safety of ship navigation. This paper regarded the ship-shore cooperation as the object of study, and discussed the establishment of the data fusion model based on the navigation environment of Yangtze River, and studied the fusion of multi-data sources.

2 The Data Fusion of the Navigation Environment of Inland River

A. NAVIGATION ENVIRONMENT OF INLAND RIVER

Navigation environment is the space and condition of ship motion, including the natural conditions (wind, stream, visibility, etc.), channel conditions (width and depth of channel, head room, radius of curvature, etc), traffic condition (traffic flow, traffic administrative rules, navigational aids, etc) of ship navigation. Yangtze River waterway is the most representative navigation environment of the inland waterway. As the third largest river in the world, the Yangtze River has surpassed the Mississippi River in United States and the Rhine in Europe to become the navigable river with the busiest and the largest volume among the worldwide inland rivers. Presently, the main study of the Yangtze River transportation includes the collection, transmission, sharing and employ of the information about Yangtze River waterway transportation, and ship maneuvering simulation, ship communications simulation, water traffic macro simulation, navigation environment risk comprehensive simulation, etc is researched by computer simulation technology. It provides a technical support for enhancing the availability factor of the information, increasing the navigation capacity of Inland River and reducing the occurrence of disaster accident [1, 2]. Among them, studying of the navigation environment risk assessment has a great significance to the technological development of the Yangtze River transportation.

B. THE CONDITION OF DATA FUSION NOWADAYS

Nowadays, there have no unified block form for the construction of information fusion system, and the process of information fusion system can divide into four

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grades from the perspective of the function of information fusion, that is, detection (decision) level fusion, status (tracking) level fusion, properties (target identification) level fusion, assessment of situation and threat [3]. As shown in Figure.1, among them, the assessment of situation and threat is mainly used in military field and can realize the reciprocal chiasma; therefore they are put into the same grade.

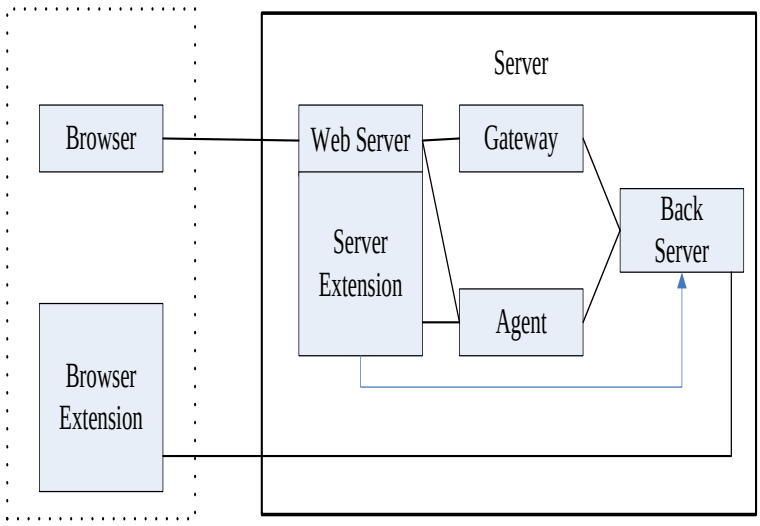

FIGURE 1 Block diagram of the level of multisensor information fusion function

Detection Level Fusion

The function of detection level fusion can be summarized as judging the presence of target. It is closely related with the arrangement of the sensor, and has three topological structures: parallel topology, serial topology and tree topology.

Status Level Fusion

The function of status level funsion can be summarized as estimating the state of objective (distance, kinematic velocity, etc) or tracking after the objective. It can be divided into centralized and decentralized (distributed) and hierarchical structure, and the hierarchical structure can also divided into have feedback structure and no feedback structure. What is more, these four basic structures can constitute a number of different hybrid structures.

Information collected by sensors which disperse in different places can be transmitted to fusion center directly and disposed by the centralized structure, while the low-level sensors are lack of necessary connection. It is characterized by simple construction and high precision, and is similar to single station processing in fusion algorithm; information fusion work only when it receives information from the certain sensor. Therefore, it has a heavy communication burden, slow convergence speed and poor system survivability. In the hierarchical structure, the information is disposed layer by layer from lower nodes to higher nodes; the higher nodes receive the fusion results from the lower nodes, and the information of higher layers also participate in the fusion processing in lower nodes when it has a feedback. Decentralized structure (including hierarchical structure) is no need of management by a controller, and it is also no need to maintain a major integrated data store; every sensor node can makes its own decision to the system by its processing unit and communication device, and it has a quick convergence speed and light communication burden; the invalidation of a certain sensor will not influence the proper functioning of the whole system. Therefore, it is characterized by higher reliability and fault tolerance; however the fusion accuracy of it is not as good as the centralization.

Properties Level Fusion

The aim of properties level fusion is to determine the identity of the target, and it can be divided into three parts by the data abstraction: data layer (pixel) fusion, characteristic layer fusion and decision level fusion [4].

Data layer fusion is the lowest hierarchical fusion and directly fuses the data from the same kind sensor (that is, the original data must be suited), and original data is synthesized and analyzed by it before pretreated by other sensors. The process is completed by extracting an eigenvector from the original data and making the attributive judgment of the secondary characteristics. The data layer fusion can provide the most exact result and need prodigious communication bandwidth. It is shown in Figure 2.

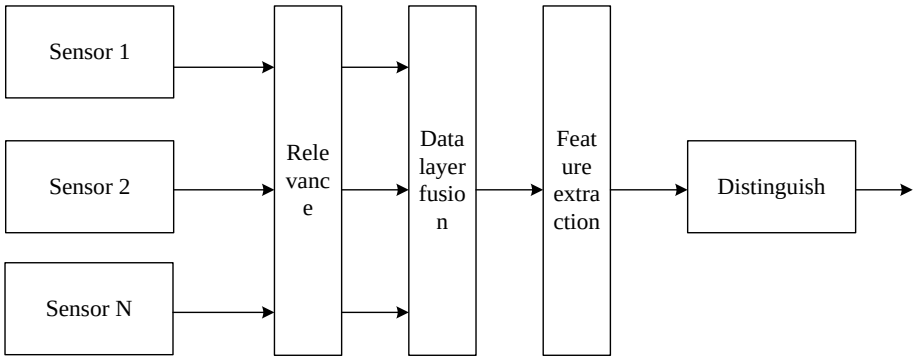

FIGURE 2 Data layer fusion

Characteristic layer fusion is belong to the middle tones and every sensor first conducts the feature extraction to their own original data, then the feature information is comprehensively analyzed and disposed by it. That is, it extracts lots of eigenvectors from the observation data and connects them into a single vector, then identify. It is shown in Figure 3.

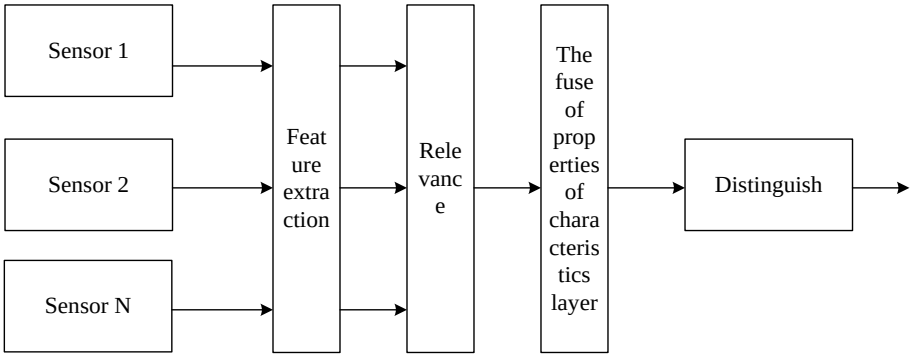

FIGURE 3 Characteristic layer fusion

Decision level fusion is a kind of high layer fusion and every sensor makes the decision based on its own monophyletic data. These decisions are fused into the final decision, and it mainly solves the problems like multiple target recognition, situation assessment, threat assessment, etc. Its instantaneity is the best. It is shown in Figure 4.

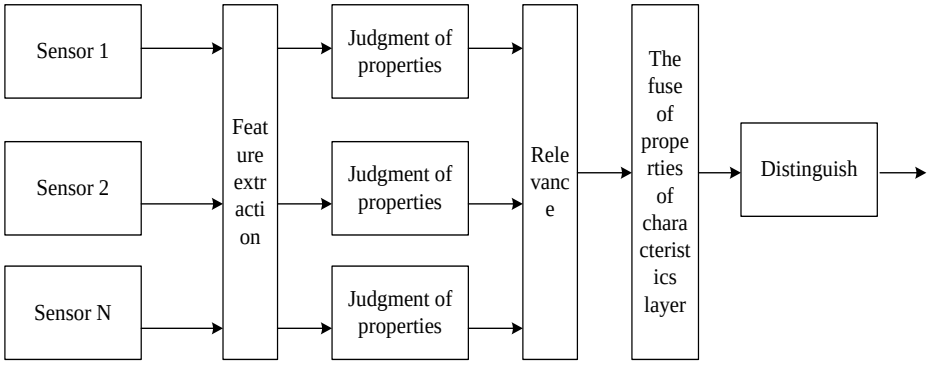

FIGURE 4 Decision level fusion

Information fusion of every layer has its own characteristic; it should be chosen in specific application based on the objective and condition of the fusion.

C. DATA FUSION MODEL BASED ON NAVIGATION ENVIRONMENT

The Yangtze river shipping informatization have a significant improvement with perennial construction and development; a series of breakthrough have achieved, including construction of port and waterway, promotion of transportation equipment, construction of information platform, development of intelligent shipping, etc.

"Digital Yangtze River" characterized by digitization, informatization and intelligentize has become the important engine for Yangtze river shipping modernization; the informatization is becoming the key factor to enhance the quality and boost the transformation of the Yangtze river shipping development, and promote the modernization construction of the Yangtze river.

The real-time sharing and interaction of the information of ship and shore can be realized by the objective of ship shore integration, and then the real-time monitoring of various kinds of vessels (fleet) can be realized; and the capacity of scheduling and management, decision making of the management layer can be improved; at the same time, it can greatly improve the safety of the marine shipping and protect the safety of navigation environment of inland port, what's more, it can improve the transport ability of inland port; the ability of inland port e-commerce platform can be greatly improved by integration and interaction of logistics information between port and ship [5]. Therefore, ship shore integration is the advanced stage of development of ship automatics, and it is also the development direction of transportation technology of ship and logistics and e-commerce technology

Through the analysis of the above situation, a multiple source data fusion model of the inland river navigation environment was be designed including three layers(data, information and decisions) and two processes (abstraction, classification) based on characteristics of the inland river navigation environment and the actual demand. The data fusion model of inland river navigation environment is shown in Figure 5.

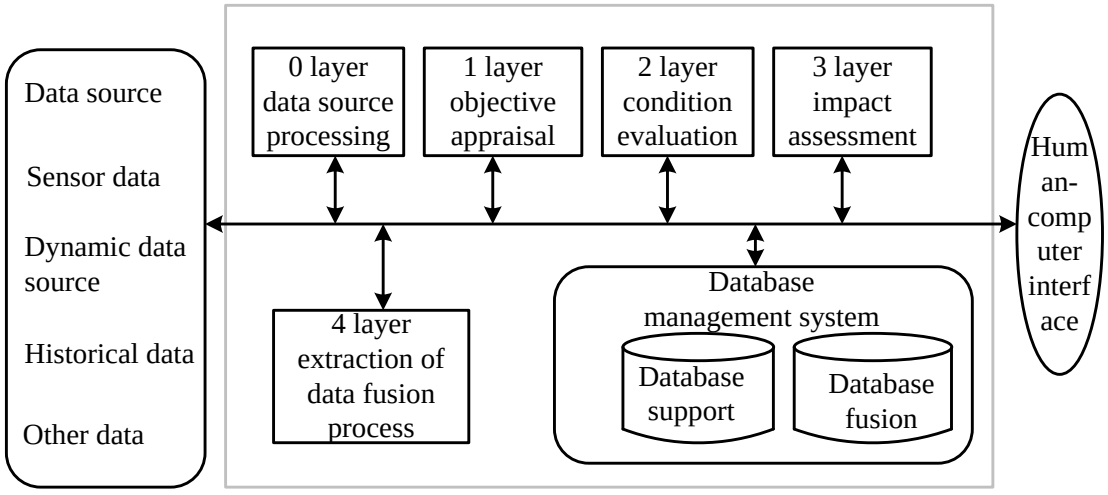

FIGURE5 Data fusion model of inland river navigation environment

The data input on the above model is from different data source, including all kinds of sensor, such as induction coil, cameras, infrared and microwave detector, etc, or dynamic data source from internet, such as the related parameters of navigation condition of inland river ships navigation environment, etc. Certainly, the historical data is also another important data source. In addition, that also includes meteorological data, channel information (geometry, topology, etc), crew information, etc. The main process of data fusion is described by the data fusion model of inland river navigation environment of the ship, that is, extraction of data preprocessing, target evaluation, status evaluation, impact evaluation, the data fusion process. The external interface on the right hand of the model provides an interface for the result issuance of the human-computer interaction and fusion. The information fused can be issued by the TV, broadcast, web service and communication subsystem of the ship. Meanwhile, the interface of human-computer interaction can also provide an interface to the administrators to query data fusion model, monitor and evaluate system performance.

3 Data Fusion Model of Multiple Source Information

In practice, multi-sensor information fusion is actually a kind of functional simulation of human brain to synthetically dispose the complicated problem. The multi-sensor information fusion can be multi-layered and multimode, therefore, it is completely necessary to have a topological structure to research the fusion. The topological structures of multi-sensor information fusion are mainly centralized and decentralized [6]. Centralized fusion is judged to have a high level confidence with comprehensive information and no missing information. The requirement of the distributed fusion to transmission network is not strict because its data size is little, and the processing time for the fusion centre is short; so it has a quick computation speed and response speed, and a good reliability and continuity. The requirement of the centralized fusion to transmission network is high

because its data size is big, and the reliability of it is low; its processing time is long, and it affects the responsiveness of system. The tracking precision of distributed fusion is not as high as the centralized fusion.

The network form of information monitoring communication network topologythe of the ship in the channel is not always the same because of the peculiar geographical landscape of Yangtze River basin and circuitous stretches narrow surface in water surface, therefore, it is suitable to use the distributed fusion method to fuse the information which is collected back by multi-sensor. The sketch map of preliminary design of distributed data fusion which is obtained from VTS, sonar and GIS is shown in Figure 6.

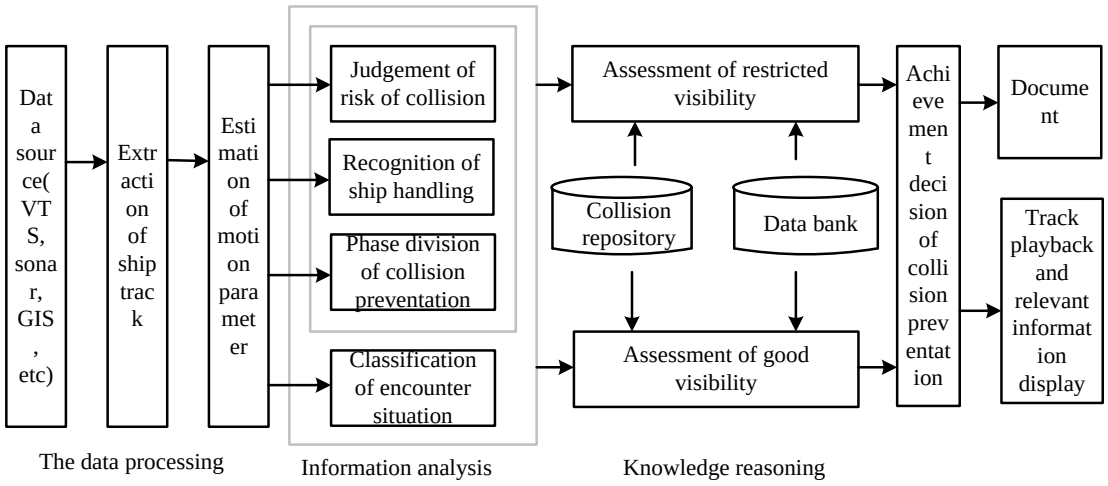

FIGURE 6 Multi-source information fusion model

4 Conclusion

Information fusion has a great significance to the application of safety pilotage and collision avoidance of ship and it is also the key technology in realizing the ship shore integration. With the development of the science technology, more and more sensors are used in modern ship, and the information can be displayed solely by radar, AIS, GIS and omnirange, etc; a huge workload will produce when the crew and supervisor of hore-based manage these sensors at the same time. The advantages of each sensor can be brought into full play and the disadvantages of them can be restrained by data fusion technology of multi-sensor; thus, the information about ship navigation and navigation environment state can be received timely, and safety of ships navigation and navigation efficiency can be enhanced.

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