Study of Ship Navigation Auxiliary Display System

Weijie Hu [a], Hongxiang Ren [b]

School of Dalian Maritime University, Dalian 116026, China.

[a]934952794@qq.com, [b]1404561437@qq.com

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Abstract: Modern ships are equipped with more and more equipment. In order to solve the problems of complicated structure, independent equipment, complicated operation and difficult information sharing of ship navigation system, the ship navigation auxiliary display system is designed. The system mainly includes ship navigation information reading module, ship navigation information display module and ship identification module. The ship navigation information reading module adopts the bus technology and single chip microcomputer to collect the data of each sensor on the ship. According to AR technology, navigation information display module can display the navigation data information and the actual navigation video interactively. Ship identification is responsible for the identification of ships in the navigation video. The experimental results of the ship operation simulator show that the system can provide simple data of the ship's navigation state, facilitate the crew to observe the information around the ship, and reduce the impact of the redundancy of the ship's instrument data on the ship's drivers.

1. Introduction

Recently, maritime transportation has increased significantly. Meanwhile, ships are developing towards a larger and more intelligent trend. South Korean maritime data show that over the past five years, 80% of maritime accidents are caused by errors in the operation process. In order to prevent or reduce this situation, it is necessary to develop ship navigation equipment with advanced IT technology. At the same time, each ship is equipped with a large number of instruments and sensors to provide the crew with ship navigation data and achieve safer driving. However, not all instruments and equipment provide useful information to the crew. Such complex equipment may bring more burden to the crew, cause information redundancy, and interfere with the safe operation of the crew [1]. Therefore, it is very necessary to develop the navigation auxiliary display system to provide the ship's state data to the ship's drivers, so as to achieve more safe operation.

At present, most ship navigation systems judge the navigation information of ships on the sea based on electronic chart, AIS, radar and other equipment. Due to the large amount of instrument data, there is data redundancy. The application of Augmented Reality Assisted driving system in various industries of aviation, automobile and ship is increasing rapidly [2]. HUD (head up display) system has been used in fighters and commercial airliners to reduce the instrument data that pilots need to observe when driving and enhance pilots' driving ability [3]; the head up display system based on augmented reality technology can intuitively display various auxiliary driving information of vehicles to drivers to avoid driver distraction and reduce traffic accidents[4].

In this paper, nw.js and webgl technology are used to develop the navigation assistant display system, which can effectively display the key data in the navigation of the ship [5], which can reduce the burden of the complicated equipment in the navigation of the ship and interfere with the normal operation. Using the Darknet network model of deep learning framework and the yolov3 algorithm to develop the ship identification module [6], combining with the AIS data to identify the ship information on the system, and to show the crew the status of sea navigation in the form of visualization.

2. Overall design of the system

2.1 System function analysis

The system functions include ship information collection, ship identification and ship information fusion display. The ship information collection adopts the form of master-slave single-chip microcomputer, which collects the distributed data. Combined with serial port communication and bus communication technology, the sensor data on the ship is centrally transmitted to the master single-chip microcomputer [7]. The ship recognition module reads the video stream of the ship navigation from the camera, and recognizes each frame of the image through the yolov3 recognition algorithm of the deep learning framework. Ship information fusion display uses nw.js and webgl technology to analyze, process and display, providing a good visual display interface.

2.2 Functional design.

The system uses the bus technology to collect the sensor data through the single-chip microcomputer, and extracts the ship environment information such as channel and water depth in the electronic chart system. By means of COM component reading camera, the ship navigation image is processed and analyzed to identify the position of the ship on the sea. Finally, the recognized image and the extracted navigation information are transmitted to the computer for rendering.

Using the modular design idea, the ship navigation auxiliary system is divided into three modules according to the function (Fig. 1): ship navigation information reading module, ship navigation information display module and ship identification module.

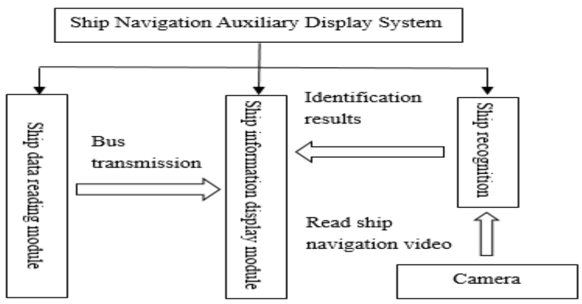

Fig. 1 Composition of ship navigation auxiliary display system

3. Key technologies of the system

3.1 Data information collection

The ship navigation information reading module is responsible for the collection of ship navigation data information. For ship data extraction, through the use of master-slave single-chip interactive form, slave computer for distributed data collection, using CAN bus communication technology, the sensor data on the ship is centrally transmitted to the master single-chip computer, the structure design is shown in Fig. 2.

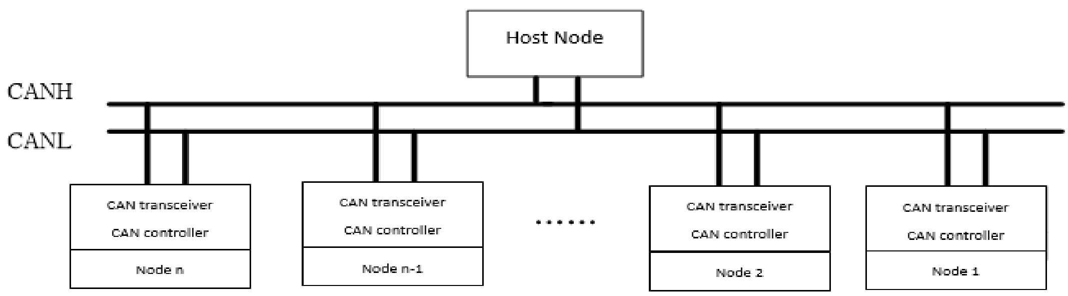

Fig. 2 System hardware design structure

3.2 Ship recognition

The ship identification module of the system is based on the Darknet network model, which is realized by combining the yolov3 algorithm. Because the system is tested on the navigation simulator, the input training pictures are all three-dimensional virtual simulation ship model pictures. Based on the collected training data of virtual simulation ship pictures, the deep network model is constructed, and the convolution operation is carried out based on the formed ship feature matrix. The ship features are extracted and the virtual simulation ship feature model is obtained by deep learning training. Then the feature interaction layer of the network is divided into three scales. In each scale, the local feature interaction is realized by convolution kernel, and the local feature interaction between feature images is realized by convolution kernel (3 * 3 and 1 * 1). On this basis, classification and position regression are realized, and then the center position coordinates of virtual simulation ship in the image are identified. Based on the above experiments, the image effect of the virtual simulation ship is shown in Figure 3:

Fig. 3 Virtual simulation ship identification

3.3 Screen coordinate conversion

Through ship identification and AIS data fusion processing, the system can display the corresponding ship data information after clicking the target ship. Using ray casting algorithm, as shown in Figure 4 (a), the screen coordinates pointed by the mouse are converted into projection window coordinates, and a ray is introduced to the point through the projection center, and the ray is converted to the world coordinate space through the inverse transformation of viewfinder transformation. Judge the intersection of the ray and all space objects in the world coordinate space. If there is no intersection, the target ship object is not selected. Otherwise, record the index of all intersecting objects, and then sort these objects according to the distance from the projection center. The nearest is the target ship. When clicking the target ship, the corresponding ship information can be displayed to realize the interaction with the target ship.

4. System experiment results

In this experiment, the ship handling simulator is used for testing. The simulator integrates camera and ship navigation data information module. By integrating the data information of ship navigation, the upper part of the software interface displays the rudder angle, main engine speed, navigation speed, steering speed, heading and position information of the ship in the combination of instrument and digital. The bottom of the software interface displays the water depth, channel, main engine gear, dangerous water area and other information when the ship is sailing. Through the ship identification module, the surrounding ships in the navigation environment can be identified and processed, and the data information of radar and AIS can be displayed on the corresponding positions, as shown in Fig. 4

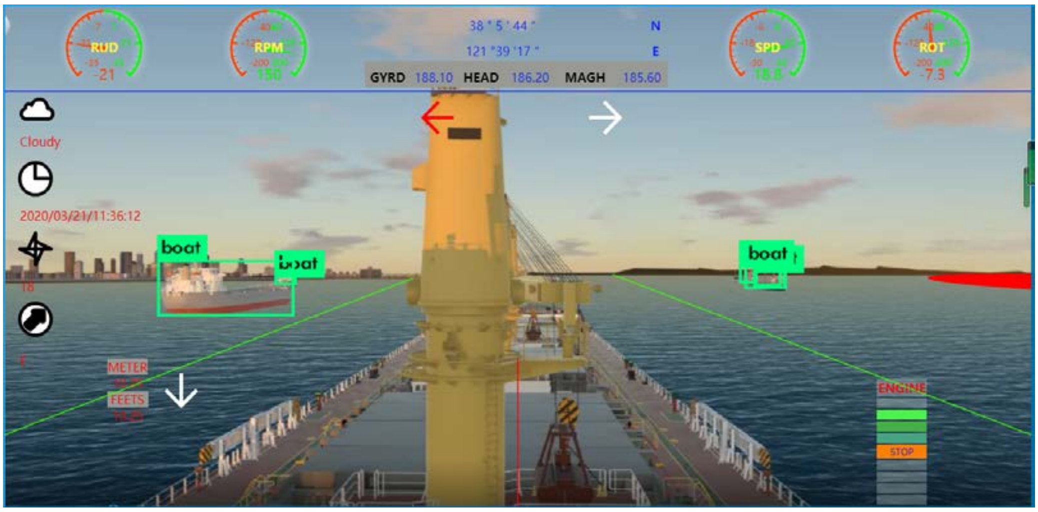

Fig. 4 Display of ship navigation auxiliary system

5. Summary

Although all kinds of advanced equipment can be used to improve the safety of the crew's operation of the ship navigation, it is still necessary to conduct in-depth research on the effective way of navigation information display, rather than providing a large number of ship navigation information without any choice. For this reason, this paper designs a navigation assistant display system based on augmented reality technology. The system integrates the ship equipment information on the ship navigation video image, adds the marine ship identification function, reduces the adverse impact on the ship's drivers due to the redundancy of the ship instrument data, and then assists the crew to drive the ship. The system has carried out the application experiment of the ship handling simulator, which provides the ship driver with more concise and clear observation of the state of the ship and the surrounding navigation environment information, and has a good auxiliary effect for the ship navigation. The follow-up research can be carried out in the following two aspects: using better rendering effect, improving the visual display of ship navigation data, highlighting the rendering of dangerous areas; improving the recognition rate of ships on the sea, on the basis of recognition, the ships are classified and identified.

6. Acknowledgments

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