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Research on intelligent cruise regulatory mode of Huangpu River

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RESEARCH ON INTELLIGENT CRUSIE REGULATORY MODE OF HUANGPU RIVER

By

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DECLARATION

I certify that all the material in this research paper that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

(Signature): ....

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ABSTRACT

Title of Research Paper: **Research on Intelligent Cruise Regulatory Mode of Huangpu River**

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With the continuous development of the shipping industry, the traditional maritime regulatory mode needs innovations and reforms, moving from the traditional, passive, qualitative and decentralized management to the modern, active, quantitative and systematic management mode, and further adapting to the complex maritime security environment. Traditional maritime supervision did not make full use of rapidly advancing information technology, and the limitation on supervision means and efficiency hindered the development of maritime administration. The acceleration of Shanghai international shipping center construction and the port function transformation have pushed forward the reform of maritime dynamic supervision mode of Shanghai.

This paper is a study of visual intelligent maritime patrol in Huangpu river, which is guided by the concept of e-Navigation and higher efficiency and lower emissions, which aiming to establish a system with the integration of existing technologies and advanced equipments to improve maritime supervision of Shanghai Port, to provide an alternative supervision mode for the Shanghai MSA.

Through technology research and field investigation, considering the geographical position of Huangpu River, the practical navigation situation and the success and achievement of Changjiang MSA, the author finally formulates the overall construction frame and primary objective of the system.

The system includes data collection and transmission, data processing and automatic assessment. The design of the system not only concerns about monitor points, transmission means and surveillance equipments, but also considers the integration of subsystems. The functions design of the system will match the demands of maritime supervision. It will significantly improve the efficiency of maritime administration and save the energy and human resources.

KEY WORDS: Intelligent cruise, Electronic patrol, Maritime dynamic supervision, Regulatory measures

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LIST OF ABBREVIATIONS

AIS	Automatic Identification System
ARPA	Automatic Radar Plotting Aids
CCTV	Closed Circuit Television
CCU	Central Control Unit
ECDIS	Electronic Chart Display and Information System
EDI	Electronic Data Interchange
GIS	Geographic Information System
GMDSS	Global Maritime Distress Safety System
GPS	Global positioning system
HD	High Definition
IALA	International Association of Lighthouse Authorities
ICS	Intelligent Cruise System
IHO	International Hydrographic Organization
IMO	International Maritime Organization
IOT	Internet of Things
IVS	Intelligent Video Surveillance
IWS	Intelligent Waterway System
LAN	Local Area Network
LPG	Liquefied Petroleum Gas
LRIT	Long Range Identification and Tracking of ships
MEH	Regional Marine Electronic Highway
MIS	Management Information System
MOU	Memorandum of Understanding
MSA	Maritime Safety Administration
NGN	Next Generation Network

PSC	Port State Control
RIS	River Information Service
SAR	Search and Rescue
SD	Standard Definition
SIP	Strategy Implementation Plan
SOLAS	International Convention for the Safety of Life at Sea
VCA	Video Content Analysis
VHF	Very High Frequency
VTM	Vessel Traffic Management
VTMIS	Vessel Traffic Management Information System
VTMS	Vessel Traffic Management System
VTS	Vessel Traffic Services
WIS	Meteorological information system
WLS	Water level sharing system

CHAPTER 1

INTRODUCTION

1.1 Background

Huangpu River, a symbol of Shanghai, originates in Dianshan Lake and empties into the Yangtze River at Wusongkou (mouth of Wusong River). It is 114 kilometers (71miles) long and 400 meters (0.25 miles) wide. It is the last significant tributary of the Yangtze before it empties into the East China Sea. From Wusong lighthouse to Minhang power plant, a total length of 66.7 kilometers, is the most intensive traffic area. on both sides of the river, the distribution of about 500 piers including coal, building materials, petroleum, chemical, shipyard and other types of piers. Along the coastline, there are also 18 ferries and 7 bridges across the river. Some of the branch ports such as Wenzaobang and Zhagang are still in use. The complex and changeful channel, coupled with the heavy traffic density, easily leads to shipping accidents when ships navigate in this passage, which may seriously affect the safety of life and marine environment (Shen, 2004). Shanghai MSA is the competence authority of the marine safety which is responsible for ship's safety of navigation in Huangpu River. By comprehensively holding the ship's dynamic and static information, it regulates the navigation status of ship in the passage of Huangpu River.

Boat patrolling is one of the essential measures to supervise the dynamic navigation of the vessels. It has played an irreplaceable role in maintaining navigation order, guaranteeing the security and safety of navigation, preventing ship-sourced pollution and preparing for the emergencies (Ma, 2014). Nevertheless, the defects and the shortages are becoming increasingly apparent in recent years.

With the concept of e-Navigation gradually accepted by IMO and contracting parties, a strategic vision for e-navigation developed by IMO aiming to integrate existing and new navigational tools, in particular electronic tools, in an all-embracing system that will contribute to enhanced navigational safety (IMO, 2015). Moreover, China MSA, as the Competence Authority of State is also devoted to developing new ideas and new methods to explore the maritime supervision measuring, and electronic patrol as an emerging technology, has been applied in maritime supervision. The application of electronic patrol in Yangtze River already over three years, it received a remarkable result in maritime dynamic administration. Compared with traditional methods of marine patrol, the superiority of electronic patrol is higher efficiency and lower emissions. The quantities of illegal violations from ship decreased and the corrective rate increased, the pertinence of patrol boat strengthened and efficiency improved significantly. But Problems still exist, such as signals are not fully fused and the management needs further standardizing (Jiang, 2014).

In April 23, 2015, China MSA held a meeting to promote the innovation of maritime dynamic administration, promoting electronic patrol and strengthen the dynamic regulation of the vessels, in order to enhance the efficiency of the patrol and reduce accident. In this context, the construction of electronic patrol system of Huangpu River is imminent.

Compared with Yangtze River, it has decided advantages of implementation of electronic patrol in Huangpu River, such as the narrow channel of the river, the intensive coverage of CCTV and AIS base station, the higher positioning of video camera and radar. Therefore, the research on intelligent cruise system has practical significance.

1.2 Objectives of the research

Based on the analysis of the current status of the Huangpu River, this research proposed visual intelligent cruise as a complement to traditional maritime patrol means, to overcome the defects of traditional patrol mode and strengthen the active monitoring of Huangpu River, providing a safety and orderly water traffic flow, and improving the efficiency of maritime administration, search and rescue coordination and emergency response capability, to achieve the objectives of "visualization, automation, diversification, intelligent" patrol, and further improve regulatory efficiency and reduce cost of maritime cruise. Through intelligent analysis, it provides guide for duty officers, improve the accuracy of patrol boats assignment and judgment of violations. Through consistence monitoring, officers can master dynamic information as a whole to achieve refinement, standardization and normalization management.

1.3 Methodology

The development of relevant technology has been widely reviewed beforehand, including VTS, AIS, GIS, GPS, CCTV and etc., the appropriate IMO documents and regulations, international conventions, articles from contemporary journals, books and information from websites have been studied. The study of the implementation of electronic patrol in Changjiang MSA has brought a lot of inspiration to me. The successful experiences should be adopted and the deficiencies should be overcome during the process of design. The field investigation of Huangpu River proposed an overall framework of the system after due consideration of various factors affecting the project. Through the discussions with experienced law enforcement officers an professors, it achieves the ideas of function settings to dealing with primary tasks. Through the study of key technologies, it achieves function realization .

1.4 Structure of dissertation

This dissertation consists of seven chapters. Chapter one introduces the background of this research and the necessity of setting up a visual intelligent cruising system to change the maritime regulatory mode. Chapter two discusses the development of maritime regulation from the perspective of technical means and conceptual regulatory mode, emphasizes the value of a maritime dynamical regulation, compares the traditional and modern ways of regulation, and highlights the importance of advanced regulatory means. Chapter three provides the concept and overall planning of the system, introduces the concept of ICS and the configurations, including hardware and software system construction. Chapter four focuses on the structure and working principles of each subsystem. Chapter five structures the function and application of the system, presents internal and regulatory functions in details, relating to the effectiveness and efficiency of the system. Chapter six summarizes the advantages of the system and the utilization in maritime administration, provides a practical way of regulatory mode to the implantation of the system coupled with patrol boats. Finally, the last chapter discourses the overall summaries and conclusions, and predicts the further perspective of utilization.

CHAPTER 2

THE DEVELOPMENT OF MARITIME REGULATION

As an important means to guarantee the safety of maritime traffic, maritime affair cruise supervision is valued by each shipping nation in the world. Domestic and international maritime authorities and researchers have made a series of research results and practical experiences in maritime control techniques, regulatory philosophy and patterns.

2.1 Technical means of maritime regulation

In recent years, the technical means of maritime regulatory have experienced great changes, from navigation signals to the land-based radar, and finally to the modern technical supervision system.

2.1.1 The development of VTS and its application

The international VTS mainly experienced four periods (Li, 2012, pp.5-7).

2.1.1.1 The first period

At the end of nineteenth century, with the completion of Industrial Revolution in Europe and United State, the increase in international trade resulted in a commensurate increase in the volume of commercial traffic (Wan & Zinatul, 2011), seaborne trade as the cheapest way of carriage of goods was widely accepted by nations. In order to meet the rapid growth of trading, more and more ports and cannels opened for marine transportation. How to regulate the vessels and keep safety and efficiency become a practical issue to be solved urgently, so the concept of marine traffic management emerged. With the technology of wireless telegraph and telephone applied in vessel traffic management, the first generation of vessel traffic management (VTM) system has been set up (Lu, 2004).

2.1.1.2 The second period

After the Second World War, in 1948, the British installed the world's first port radar at Liverpool for pilotage, using radar and wireless telephone to guide the vessel sailing in poor visibility, later, it was introduced to many other countries in the world. In 1960s, Rotterdam, Hamburg, London built VTS one after another. With the radar technology gradually improving, the functions of VTS extended from navigational aids to traffic management, and traffic accidents decreased significantly under the control of VTS. It was called the second generation vessel traffic management system, the characteristic was the utilizing radar and wireless telephone (Liu & Liu, 2004, pp.1-2).

2.1.1.3 The third period

After 1970, with the rapid development of computer technology, America and Western European countries introduced computer technology into VTS. In this stage, the most notable feature is to deal with large number of complex ship traffic data by computer. In 1972, the world first automated vessel traffic management system has been set up in San Francisco. It has the function of radar data processing, which can identify and tracking ship automatically, it also can display related data of the ship, so it greatly improved the efficiency and level of traffic management (Koburger, 1986). In 1977, Tokyo Bay VTMS was established and officially put into use, it has the function of radar and traffic data processing, which formulate the basic pattern of advanced VTS automation monitoring system. Meanwhile, Canada, the Soviet Union and other countries also began to establish computerized vessel traffic management system later on. VTS has been applied to the international channel (such as the Strait of Dover), the majority of coastal areas, executive economic zone (such as North Sea oil fields). At the same time, the relevant maritime VTS regulations have also been developed, such as World Vessel Traffic Services Guide approved by IMO in 1985 and amended in 1997, which marks that VTS development has entered the stage of standardization (IMO,1997). The third generation VTS is a an integrated system with computer-centered multi-technologies.

2.1.1.4 The fourth period

In 1990s, With the widespread of the Global Maritime Distress Safety System (GMDSS), the development of marine satellite communication and radar technology, AIS systems, maritime traffic information network, vessel traffic management system now came into its fourth generation. During this period of time, vessel traffic management or service extent to the regional of water pollution monitoring and the coordination, and the distribution of internal and external information became the main task.

2.1.1.5 The developing trend of VTS

From the development trend of VTS, the next generation traffic management system should have the characteristics of information technology, digitization, networking and satellite communications, and these features have been realized through the application of AIS, CCTV, ECDIS, LRIT and other technical systems, as well as the Internet, LANs and high-speed data communications technology satellite (Zhu, 2012). The typical example is the VTMS in Bahia Blanca. The previous VTS system was replaced with the Transas Navi-Harbour system. The new Transas VTS installed makes use of the latest sensors like Radar, CCTV and AIS to provide comprehensive and reliable visibility of the marine traffic situation in and around the port (WVTSG, 2015). In addition, the online patrol also provides services in real time.

In 1990s, the concept of Vessel Traffic Management Information System (VTMIS) which incorporates the latest VTS and Management Information System (MIS) was proposed by European Union. The main function of this system is to integrate the information of individual VTS center and ship related parties, such as shipping companies, Pilotage Department and Port Services, in order to view a variety of information of the ship in real time, including static and dynamic information, and real-time understanding of harbor navigation environment and hydrological data to achieve information sharing between VTS centers, and ready to assist in decision-making (Li, 2012).

Intelligent-VTS is another mode of the future VTS which is based on the existing system to establish a vessel traffic service system composing digital traffic information technology, wireless and satellite communications technology, electronic chart technology, AIS technology and intelligent analysis and decision making technology. The research in this paper is a practical attempt to realize this idea.

2.1.1.6 The domestic status of VTS

China carried out radar navigation test early in 1958 in Dalian Port. Shore based radar navigation experiment has been put into effect, but the formal establishment and use of VTS began in 1970's. In 1978, the Ningbo Beilun began to build the first VTS in china. Since then, China has built 28 VTS centers, 96 radar stations and 51 AIS base stations in coastal line and inland water, which cover the majority of ports, channels and Yangtze River by 2009 (Li, 2012, P.9). VTS system plays an important role in improving maritime safety and efficiency, reducing traffic accidents and property losses, saving people's life and protecting marine environment.

2.1.2 The development of e-Navigation and its practice

On May 2006, the International Association of Lighthouse Authorities (IALA) proposed the concept of e-Navigation, which is the "harmonization of marine navigation systems and supporting shore services driven by user needs"(IALA, 2006). By electronic means, e-Navigation collects, presents, integrates and analyses information on board and ashore to enhance berth to berth navigational capability, and the corresponding measures relating to maritime safety, security and marine environmental protection (Patraiko, 2007). E-Navigation aims to integrate ARPA, GPS, LRIT, VTS, AIS and other existing systems to provide a comprehensive and reliable system to ensure maritime safety and shipping efficiency (Weintrit & Wawruch, 2007). The fifth e-Navigation Underway conference was held from 27 to 29 January, 2015. The theme for the conference was *The Implementation Phase*? 163 delegates, representing 26 countries and 112 organizations attended the conference. The final report (2015) reveals the recent development of e-Navigation.

In 2006, IMO developed e-Navigation strategy to take measures to actively promote the realization of e-Navigation, to bring about increased safety of navigation in commercial shipping through better organization of data on ships and on shore, and better data exchange and communication between ships and the ship and shore. Then Norway has subsequently developed a Strategy Implementation Plan (SIP) entrusted by IMO (IMO, 2015). IMO also carried out Regional Marine Electronic Highway (MEH) project in the Malacca Strait. The shore-based maritime information, environmental information and the corresponding maritime shipborne navigational equipment information were integrated and made available to the ship's operator and shore management personnel to ensure that ship and shore personnel could obtain sufficient information (Hao & Jiang, 2014). Currently, the concept of e-Navigation has been adopted by various countries in the world with the development of shipping water traffic supervision platform. The Intelligent Waterway System (IWS) and Waterway information Network in United State, for instance, the integration of AIS, automated data exchange systems, advanced navigation systems and transportation information network, contribute to the development of regulatory and water traffic information services (Spalding & Shea, 2002).

River Information Service (RIS) in Europe supported within the scope of a pan-European inland shipping standardization and collaborative, providing channel information, vessel traffic regulation, water emergency rescue and other functions (Gerhard & Lukas, 2012). Finland COAST WATCH system unified AIS, VTS, CCTV and other systems into a comprehensive platform, which was organized hierarchically, and the use of large-scale databases as support could realize the information sharing between Coast Guard, pilots, fisheries, military and other users (Peng & Zhang, 2012). Electronic Navigation Support System of Japan divided management information, navigational aids information, hydrological information into static and dynamic information, and tracked navigation of ship and send navigational warning, hydrological and meteorological data to ships timely, to transfer information between ship and shore (Bao, 2007).

2.1.3 The development of electronic patrol

With the development of e-Navigation and the increasingly severe situation for the administration of the water traffic, Changjiang MSA developed a system called Electronic Patrol System in 2011, and implemented it in the region of Yangtze River in 2012. Electronic Patrol system is based on the platform of geographic information system(GIS). It collects traffic information through supporting system such as VTS system, AIS, GPS, CCTV, meteorological information system and hydrological system and etc.. By comparing with the information of maritime database and the preset limitation value, it can monitor water traffic, tracking ships, coordinate cooperation for maritime search and rescue (Hao & Li, 2014).

The design principle of the system is Virtual Patrol, a fictional electronic patrol boat cruising on Chart, just like a real patrol boat on site cruising. When the fictional electronic patrol boat goes across the position, it collects the information from the supporting systems relying on the technologies of Internet of Things (IOT) and Networks of Maritime, then the data will be processed by computer and compared with the Expert system, it then evaluates the movement of the vessel and predicts further developing trend, and finally alarms the abnormal situation of the vessels as reference for the operators (Hao & Li, 2014).

For the purpose of enhancing the capability of supervision and promoting the safety of navigation, on the one hand, the system provides guidance for the vessel's navigation, alarms abnormal actions timely to eliminate potential accidents (Cheng, 2013); on the other hand, it reduces the frequency of routine patrol boats cruise and improves efficiency, completes the dispatch of dynamic enforcement power and reasonable use of regulatory resources (Yu & Xiong, 2012).

Electronic cruise as a generalization of the vessel traffic management, compared with the traditional VTS system has all functions of VTS but enlarges the coverage of the management. As a modern means of supervision, electronic cruise is aimed at strengthening the maritime scene supervision, organizing and maintaining the traffic order in order to ensure the water transportation safety (Chen, 2011). Electronic cruise provides information services, such as releasing hydrological and meteorological information; on the other hand, by the combination of monitoring platform and patrol boats cruising, it regulates traffic order, to realize violation corrections, coordination and navigation order maintenance.

After the implementation of electronic patrol, the data of violations found and remote corrections, the cruise of patrol boat and administrative penalties have experienced great changes. For example, Wuhu MSA found all kinds of illegal behaviors 10615 times between July and October in 2011 by electronic cruise, with 10203 times of remote corrections, which accounted for 96.1% of the total number. From January to June 2012, Wuhan MSA found 129 cases of violating navigation regulations through electronic patrol, accounted for 39% of the total number of violations. The consumption of the patrol boat decreased by 27% (Hao & Jiang, 2014).

From the data of electronic patrol, it showed that the number of violations has declined after the implementation of electronic patrol, the pertinence and the efficiency of patrol boat have been improved, the violation correction rate increased and the power of electronic patrol regulatory highlighted. Compared with the traditional patrol boat cruise, electronic cruise has a significant advantage in supervision automation and informatization.

2.2 The concept of maritime administration

The marine administration has continuously developed in recent years. The theory and practice of marine management have experienced significant changes under the background of informatization, from experience to scientific management and further to information management.

The traditional Experience Management mainly refers to the management relying on maritime management knowledge and practical experience to the implementation of the maritime administration, although it excessively depends on people's professional skills and moral, it accumulates operational knowledge to maritime scientific management. Scientific management is a theory of management that analyzes and synthesizes workflows, which was proposed by Frederick Winslow Taylor in the 1880s and 1890s (Ma, 2013).

Scientific management in the field of maritime management emphasized management procedures and strict norms, personnel training and skill requirements. International Convention for the Safety of Life at Sea (SOLAS), 1994 amendment to chapter Ⅺ contains one article of the license terms on behalf of the competent authorities to exercise functions of the State (IMO, 2004). Guidelines for the authorization of organizations acting on behalf of the Administration (IMO, 2013) provides that the exercise of the functions of accredited bodies on behalf of the competent authority shall comply with the minimum standards, and have adequate technical, management and research resources the ability to complete the delegated tasks. The competent authority shall establish a system to ensure that authorized representatives of the functioning of its institutions work effectively. Port State Control Procedures (IMO, 1999) provides guidance to countries on Port State Control (PSC), the regional Memorandum of Understanding (MOU) on Port State Control monitoring procedures take full account of the IMO recommendations. From the respect of the regulatory procedures, the scientific management has been widely applied in the field of international maritime management.

With the advent of the information era, and water traffic is becoming heavier and needs to deal with the large amount of information. The management with the information as its core has been taken by many Nations, water traffic monitoring platform which based on modern information technology and communication technology is widely used in the world (Barbosa & White, 2008).

2.3 Dynamic regulatory mode of marine administration

Marine dynamic regulatory mode (or water traffic supervision model) is a general name, covering operational mechanism, regulatory means and methods which taken by the marine competent authorities for the organizing and regulating of vessel's Movement. From a perspective of history, maritime dynamic regulatory mode can be divided into the traditional regulatory approach and modern regulatory approach.

2.3.1 Traditional regulatory approach

Patrol boats cruise is the main regulatory instruments and methods of traditional regulatory approach (Yang & Jin, 2009). Shanghai MSA, for example, cruise staff get traffic information mainly by visual observation, combined with VHF and other instruments to monitor traffic flow conditions. When a ship is found illegal or in disorder, law enforcement officers will call the ship with VHF or tweeter, and also can embark the vessel, when authorized by Marine Department if necessary to rectify or punish the violations of the regulations or rules. The cruise staff should carry out the jurisdiction area patrol according to the schedule of cursing plan, and standby on board round the clock. The patrol can be classified as routine and emergency. Marine Department carries out routine cruise or special and regulating activities according to schedule. All the staff are instructed by Marine Command Center for emergency response, and guided for search and rescue in case of emergency.

2.3.2 Modern regulatory mode

Compared to traditional mode, the most notable feature of the modern maritime control mode is the application of advanced technology systems and management methods into marine management. The modern regulatory systems such as VTS, AIS, CCTV and modern management methods such as risk management and grid management have been applied into the field of maritime regulatory. Currently, the marine grid management model has been widely used in China coastal areas and the Yangtze River for dynamic supervision. The maritime grid management refers to the comprehensive platform relying on the integration of marine management and digital technology. It divides the jurisdiction into small units in accordance with certain criteria, and through the strengthening of the inner event patrol, establishes a regulatory mode of discovery and disposal separation. As a regulatory approach, maritime grid management is borrowed from computer grid management ideas, the management object according to certain criteria divided into several units, the use of modern information technology, focusing on management of allocation of resources, and build resource sharing and collaborative work mode of operation (Tong, 2012). In addition to grid regulation mode, some scholars introduced risk theory and cybernetics into the marine dynamic regulation, and proposed different maritime dynamic regulatory theories, for example, Risk-Rule-Resource-Reaction, which is called the four R mode, is applied in the area of the Yangtze River Maritime Bureau, and the number of traffic accidents or casualties has decreased significantly (Chen, 2010).

From what has been discussed above, the development of maritime regulatory has the characteristics as follows:

First, regulatory technical means continuously progress. VTS as the representative of modern regulatory system is applied into the dynamic regulation of maritime affairs, especially under the background of e-Navigation. All kinds of new technologies continue to emerge, and the characteristics is the integration of all the existing systems and equipments.

Secondly, continuous innovation in regulatory philosophy. From the traditional experience of management to scientific management and information management, regulatory philosophy continues updating and tends to be more scientific.

Thirdly, the diversity development of regulatory modes. Modern maritime regulatory model changed traditional cruising mode which relied on site inspection. Replaced with the combination of remote monitoring and site cruise mode, it improve the efficiency of supervision. Meanwhile, with the diversification of management tools, the regulatory model is also diversified, for instance, the implementation of grid management to realize distinct management or applied Risk Control to strengthen the regulatory.

CHAPTER 3

THE DESIGN CONCEPT AND OVERALL PLANNING OF THE SYSTEM

In this chapter, the design concept of the system will be introduced, meanwhile, the frame of the system and the planning of establishing supporting hardware devices will be presented.

3.1 The design concept of the system

With the continuously development of shipping industry, the perception of the people and the function of the port experience huge changes. Navigation safety and environmental protection are increasingly becoming the focus of social concerns, and the widespread concerns for the public safety requires government authority to have great power to tackle the emergency. The traditional supervision mode has lost its power in reality, while current patrol mode and command system do not suit the development of the enforcement context. In order to get rid of the dilemma and overcome the deficiency of the traditional patrol, it necessary to establish a system with full coverage, all-weather operation, rapid reaction and emergency relief capability, and to better perform water safety supervision and rescue responsibilities, and to better serve the smooth, efficient, safe, green shipping industry and Shanghai shipping center construction. Therefore, the studies of new projects are not only necessary but also very tight. This subject concentrates on the study of design and development schema of Intelligent Cruise system according to the concept of low emission and high efficiency. It aims to save the cost of law enforcement by reducing the frequency of patrol boat cruise through intelligent cruise, increase the pertinence and accuracy of the patrol by the guide of intelligent system, grasp the overall dynamic situation of the ships in the area under the jurisdiction through the supervision of electronic devices, and finally meet the objective of the establishment of system, forwarding the standardization of marine management.

3.2 The concept of intelligent cruise

Intelligent cruise refers to the application of new generation of information technology such as Internet of Things (IOT) and Next Generation Network (NGN), to collect a real-time dynamic data through sensors, transmit the data through network, then process and analysis data by computers, and furthermore, apply the intelligent expert system and decision-making model to identify real-time status and the developing trend of the target, and issue finally early warnings of the abnormal activities and eliminate potential risks, thus improve the efficiency and effectiveness of supervision of maritime cruise.

Huangpu River Intelligence Cruise System (ICS) is based on platform of GIS, integrate CCTV, AIS, GPS, WIS, IVS, radar system, shipping management systems and seafarer management systems into one system, through simulation cruise receiving marine traffic information, then comparing with database and the boundary value, to achieve the goal of traffic service and supervision of ships, timely eliminate potential hazards. The most striking feature of the system is visual management which implies the visible shipping traffic and the traceable event of processing. The visible shipping traffic mainly relies on CCTV system supplemented by radar system in poor visibility and night. The traceable event of processing means all the operations of the duty officers can be recorded by system and available for checking.

3.3 The configuration of the system

The composition of the system includes hardware system and software system. Hardware includes CCTV station, radar station, meteorological station, VHF station, supervision center and so on. The software part refers to the establishment of the system and subsystem. It unifies all the hardware in good order and picks up useful information to serve the main system, and further strengthens the water traffic safety supervision, to achieve the objective of all-round monitoring ship's dynamic of the entire River.

3.3.1 The overall layout of the hardware construction

The principle of economy is using the minimum investment to get the maximum benefits. The hardware construction does not discard all the existing facilities, but upgrades or optimizes the old equipments and increase necessary new devices to fulfill the requirement of the system.

This project includes the construction of CCTV station, radar station, meteorological station, VHF communication station and the monitoring center. According to the various regulatory requirements and field investigation, different standards of devices are installed in appropriate positions for the right purpose. The specific layout is as follows.

3.3.1.1 CCTV monitoring station construction

CCTV is the core device of the system, which carries the most important tasks. All the reality pictures will be captured by them through the cameras installed.

Therefore, the position of the camera will seriously impact the effectiveness of the surveillance. The whole area will be divided into three grades (primary, secondary and normal) according to the principle of decentralized administration and the importance of the water area, and different standards of video camera will be selected for different positions. For example, the curve of the river which is also the key supervision point will be provided with High Definition (HD) video and night-vision camera. Primary monitor point refers to the important objectives (such as curves, shallow water area, ship turning basin and dangerous goods terminals) at the level of Shanghai MSA. Secondary monitor point means the key management area of the Branch of Shanghai MSA. Normal monitor point represents other positions that need surveillance. Furthermore, some of the particularly important areas will be selected for the installation of electronic police monitoring and video analysis devices. Table 3.1 shows the detailed information for the devices installation for different areas.

Table 3.1 The devices of CCTV system for the different grades of monitor points

Grade	Devices	Descriptions
Primary monitor point	Linage camera	One set of 2,000,000 pixel HD camera, less than 1KM =8-240mm zoom lens, 1KM-2KM = 10-360mm zoom lens.
	Fixed mosaic camera	Two sets of 1,300,000 pixel HD camera with the horizontal angle of 90 degrees and wide-angle fixed focal lens
	Infrared imaging night vision camera	One set of infrared imaging night vision camera
Secondary	Linage camera	One set of 2,000,000 pixel HD camera, less

monitor point		than 1KM =8-240mm zoom lens, 1KM-2KM = 10-360mm zoom lens.
	Fixed mosaic camera	Two sets of SD camera with the horizontal angle of 90 degrees and wide-angle fixed focal lens
Normal monitor point	Linage camera	One set of Standard-definition(SD) camera, 500M -1KM = 10-220mm zoom lens.
	Fixed mosaic camera	Two sets of SD camera with the horizontal angle of 90 degrees and wide-angle fixed focal lens

Source: Bidcenter, 2015. Video monitoring system equipment parameters

3.3.1.2 Radar station construction

The advantages of radar is active detection with less effects of visibility and weather. It is the most reliable shipping dynamic supervision device with high accuracy right now and the most effective complement of CCTV station in visual supervision. There are strict limits on the place of building radar station. The first is the sufficient height of radar, in order to increase coverage and eliminate the shadow of the radar. The second is the minimum effects of radioactive to the people onshore. The third is the enough cross covering region of two radars to continually track the targets. The last is no obstacles in front of radar. According to the current status of the river band and buildings, we choose five locations for the installation of radar. Due to the complexity of Huangpu river, large radar does not apply to this environment, while marine navigation radars which can meet the coverage distance and accuracy requirements, is undoubtedly the best choice. In this project, we intend to select FURUNO shipborne radar, 6.5ft slotted waveguide antenna, 25kW radar transceiver. The main performance index are shown in Table 3.2.

Table 3.2 FAR 2127 shipborne radar performance index

Antenna Type	X ray
Antenna Diameter	6.5ft（length 2.1m）
Antenna gain	28dB
Horizontal band width	1.23 °
Horizontal bandwidth	20 °
Depression angle	15 °
Rotation rate	24/42r/min
radar transmitter power	25kw
Transmitting frequency	9410 ±30Mhz
Other indexes	Display terminal interface with maintenance Can set up fan launch area 2 sets of radar analog signals (ACP/ARP) are provided, The radar simulation signal includes the following 4 pairs of signals: Analog radar video signal [L] VIDEO[H]/VIDEO Radar synchronizing pulse signal SYNC[H]/SYNC[L] North ACP[H]/ACP[L] code signal Directional increment code signal difference ARP[H]/ARP[L]

Source: FURNUO, 2015

3.3.1.3 Meteorological station construction

Meteorological station can get the information including atmospheric temperature, humidity, air pressure, wind direction, wind speed, rainfall and visibility through the automatic acquisition system. It will be transmitted through the network to the management center, through the uniform computer management that provides real-time data. In addition, the system also has access to hydrological information system.

The meteorological subsystem consists of various front sensors and central management computers. The composition of Automatic Meteorological Station is shown in Figure 3.1.

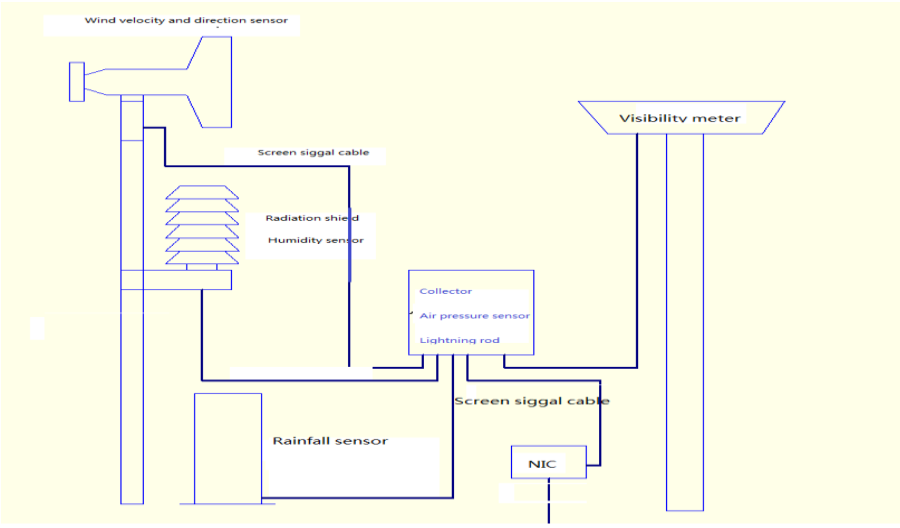

Figure 3.1 Composition diagram of automatic meteorological station

Source: Hu, 2004

Considering the importance of the station, we decide to establish 2 sets of meteorological monitoring system in the River, of which one is located in the Zhagang radar station, and the other set installed in the base of Coast Patrol Corps. Meanwhile, one set of meteorological monitoring system will be integrated into the system (located in the Marine Department of Wusong).

3.3.1.4 VHF station construction

According to the specific requirement of VHF station, one VHF communication base station should be set up in PSA Building, which is located in Lujiazui Pudong District. It is sufficient for the communications of the ship to ship and ship to shore, and the VHF control center should be established at the base station of Coast patrol Corps.

3.3.1.5 Supervision center construction

It is necessary to establish supervision center and database center in Shanghai maritime bureau and set up the control center in Coast Patrol Corps in order to realize the objectives of "visualization, automation, diversification, intelligentialize" patrol, and also establish a traffic display control system combined with the water traffic management system and 3D visualization system. The overall layout of hardware construction of the ICS is shown in Figure 3.2.

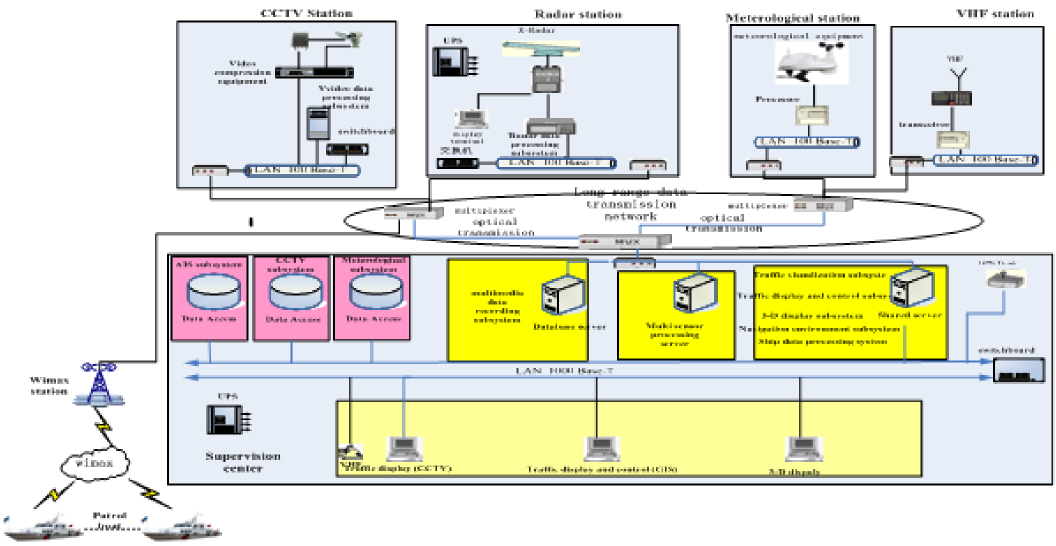

Figure 3.2 The overall layout of hardware construction of the ICS

Source: Author

3.3.2 The overall arrangement of the software construction

The Huangpu River ICS can be divided into 4 layers, namely, sensor layer, transmission layer, data processing and intelligent application layer. It includes radar subsystem, AIS subsystem, CCTV subsystem, VHF subsystem, meteorological communication subsystem, communication subsystem, radar data processing subsystem, CCTV video data processing subsystem, 2D GIS platform subsystem (including multi sensor processing subsystem, multimedia the data recording subsystem, data processing subsystem, environment subsystem, traffic navigation display and monitoring subsystem, traffic information visualization subsystem), and 3D traffic display subsystem. AIS subsystem access data from the existing China MSA shore-based AIS system, internal communication subsystem relies on the existing equipments, data processing and intelligent applications based on the platform of GIS. Figure 3.3 shows the configuration of the software system.

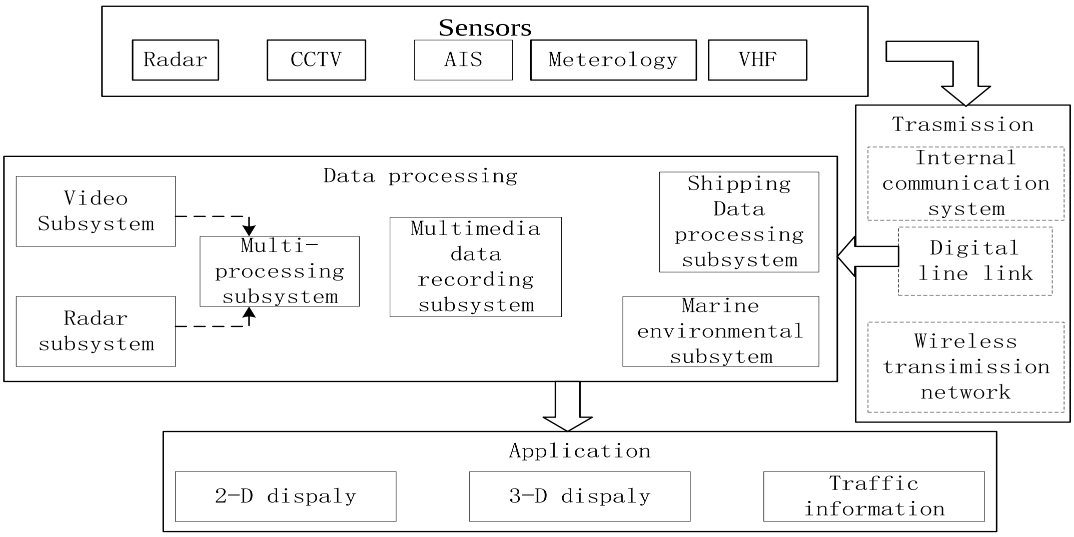

Figure 3.3 The configuration of the system (software)

Source: Author

3.3.2.1 The sensors

The sensors mainly used for various types of field information acquisition are required by maritime supervision, and the information will be transmitted to the information processing and display system. The sensors consist of AIS, Radar, GPS, CCTV, WIS and etc., by which information can be automatically collected, including ship's name, position, speed, direction and meteorological and hydrological information and so on.

3.3.2.2 Data transmissions

The function of Data transmissions is to transfer information to the data process system through internal communication, wireless and excusive network. It is the connecting part of the sensors and the processors. Unblocked and safe network is the basic guarantee of making full use of information acquired by sensors, and it should be supported by enough network bandwidth without delay. For example, data of Radar and CCTV are mainly videos, channel errors, which may cause packet loss, picture distortion, namely channel distortion, therefore, the excusive optical fiber is needed for these transmissions.

3.3.2.3 Data processing center

This section is responsible for handling all types of real-time static and dynamic traffic information, the static traffic information from the database and the dynamic traffic information from the radar, GPS, AIS and other equipment. All the collected information will be processed by processing centers. After information processing, it will be more useful for the intelligent applications. For example, through analysis of geographical data and vessel traffic data, it can provide accurate warning. Radar and AIS data generated by fusion can reduce information redundancy.

3.3.2.4 Intelligent application

This part is an intelligent interactive information systems, the use of information technology, simulation technology, computer technology and artificial intelligence technology to provide decision support for operators. It can make appropriate response automatically according to the changes in actual situations, improve decision support intelligence, thus reducing the workload of operator (Xi, 2013).

CHAPTER 4

THE SUBSYSTEM OF THE INTELLIGENT CRUISE SYSTEM

The composition of subsystem of ICS, which is differently designed in this program needs to integrate or redevelop on the various systems and the existing equipments. In this chapter, some of the key subsystems and technologies will be introduced to demonstrate the usage in this program..

4.1 GIS

Geographic Information Systems (GIS) consists of three parts, Geography, Information and System. Geography mainly refers to geospatial material objects, with geographic coordinates, the features can then be mapped and entered into Geographic Information Systems. Information refers to the basic spatial data and attribute data of objects, as well as knowledge that can assist decision-making and strategic planning of spatial analysis obtained on the basis of these data. System means the GIS as a whole, it has a certain structure and function, in close contact with each other. Information system generally refers to a series of organized programs designed to provide useful information to support decision-making (Wu, 2011). One important symbol different from other information systems of GIS is that it can capture, store, analyze and display spatial data. GIS extracts spatial information, get some implicit information through spatial analysis, and express vividly. It combines map display and spatial analysis organically, so as to effectively solve complex spatial problems and provide important decision support to relevant departments and spatial analysis (Yarus & Coburn, 2000). A complete GIS consist of five parts, a computer hardware and soft system, geospatial data, and GIS applications and GIS user model. Computer hardware and software systems provide work environment, the spatial data reflect the geographic content of GIS, and GIS applications are the core of the system. Application model provides a special theory and methods of solution, for the user to determine the way how the system works and the information expression (Qin, 2010). Figure 2.3 shows the structure of GIS.

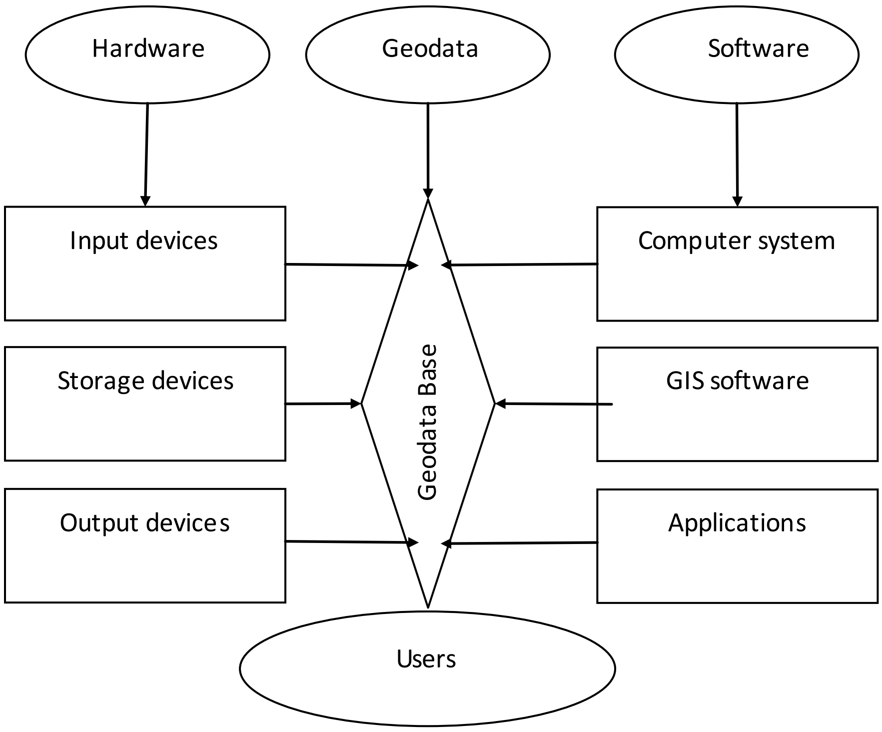

Figure 4.1 The structure of GIS.

Source: Qin, 2010

The upgrade and improvement of GIS systems mainly rely on the original Expo Security Command System which was developed by Shanghai MSA in Expo 2010. The re-design of GIS is in accord with the original platform of Electronic Chart

Display and Information System (ECDIS), which is a computer-based navigation information system that complies with IMO regulations and can be used as an alternative to paper nautical charts (IHO, 1993). As the land map has the Geographical names which are familiar to operators, integrating land map into ECDIS will facilitate the operator to identify the position of the vessel. Electronic chart data support the mode of S-57, ArcGIS and MapInfo. The re-designed GIS support displaying AIS, radar, CCTV, and other dynamic objects. Navigable environment-related elements include a main waterway, navigable intensive areas, passenger routes, obstacles, beacons, floating cranes, bridges, anchor area, turn around areas and etc., which will be labeled with different shapes and colors. It can be displayed in real time as needed. The operator can view static and dynamic navigation information interface with all relevant elements of the area. Electronic chart plotting function supports more than 190 kinds of navigation elements of S-57 international standard plotting including point, line, geometric figure and text.

GIS not only meets the display requirements of the intelligent cruise, but also provides other technical information resources of the integrated interface. It is the foundation of intelligent cruise. The application of GIS into intelligent cruise system will provide the following technical support.

4.1.1 Display of geographic information

Shoreline, waters, beaches and other geographic information will be displayed on the platform of GIS. It will provide intuitive visualization of geographic information for the system.

4.1.2 Plotting a specific area

It can plot navigational aids, waterways boundary, routing scheme, hinders and etc.

on the platform of GIS，and provide reference for ship's navigation. It also can designate key areas to achieve regulatory focus.

4.1.3 Comprehensive display platform

It provides a comprehensive display platform for other systems, such as VTS, AIS, GPS. Through the display of other system information, the dynamic behavior of the ship is reflected in real time on the platform.

4.2 CCTV

Closed Circuit Television (CCTV), also known as video surveillance, is the use of video camera to transmit signal to a specific place, on a limited set of monitors. CCTV systems may operate continuously or only as required to monitor a particular event. It can real-time display the event on the place of surveillance, it also can record data by utilizing the digital video recorder for years (Miroslaw & Jacek,2012).

CCTV consists of four segments: a camera segment including cameras, lenses, protective cover, bracket and electric head, and its function is to target the camera and converts them into electrical signals. Transmission segment including cables, modulation and demodulation equipment, line driver equipment, and its function is to send electrical signals emitted by the camera scene to the monitoring center. A control device is responsible for the control and image processing receiving from all devices. Display and recording segment converts the electrical signal into image and displays on the monitor equipment. The structure of CCTV system is shown in figure 4.2.

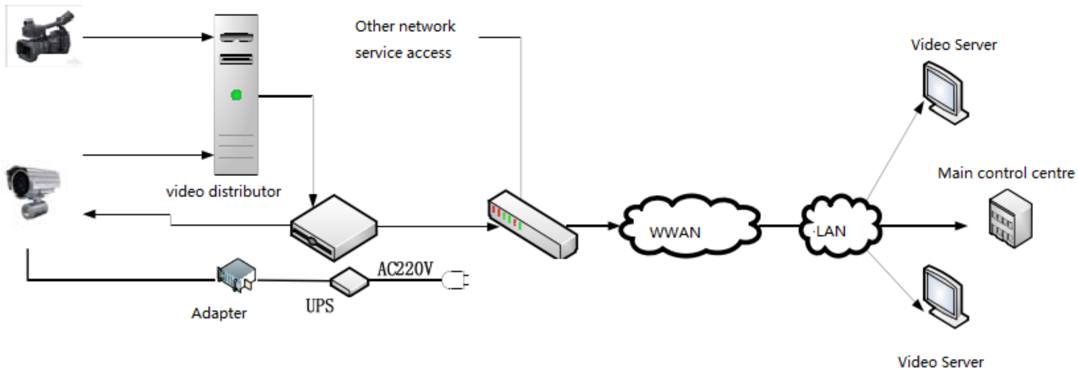

Figure 4.2 The structure of CCTV system

Source: Jiang, 2014

In this project, the technology of Video Content Analysis (VCA) will be used in some key areas. A system using VCA can recognize changes in the environment and even identify and compare objects in the database using size, speed, and sometimes color. The camera's actions can be programmed based on what it is "seeing".

To achieve the goal of target acquisition and identification by VCA, and acquire the track of vessel and speed. First is the use of video technology background separation, then extract the relatively stationary part as reference background to detect the image changes and it will become the target of tracking. Tracking is based on the target admission to find similar objective between video frames by feature information comparisons, form a continuous tracking of a target, and further extract motion information of the target, such as trajectory, direction, speed. CCTV system has the following functions.

1. CCTV system has the functions of information processing such as recording, playback, backup, automatically storage of video and image.
2. It can automatically recognize ship's shape, color, ship's name, port of registry and other characteristics, it also can get ship's scale from video image acquisition and

analysis.

3. Form the surveillance of CCTV, it can detect the ship's dynamic data such as speed and position.
4. It can count the number of ships in a specific line, so it can provide vessels' traffic flow information.

4.3 GPS

The Global Positioning System (GPS) provides users with positioning, navigation, and timing services. This system consists of three segments: the space segment, the control segment, and the user segment. The U.S. Air Force develops, maintains, and operates the space and control segments. The GPS web site gives further information on courses (http://www.gps.gov/systems/gps/). However, not all GPS serve for the military, Peter H. D (1994) said that there were many thousands of civil users of GPS world-wide.

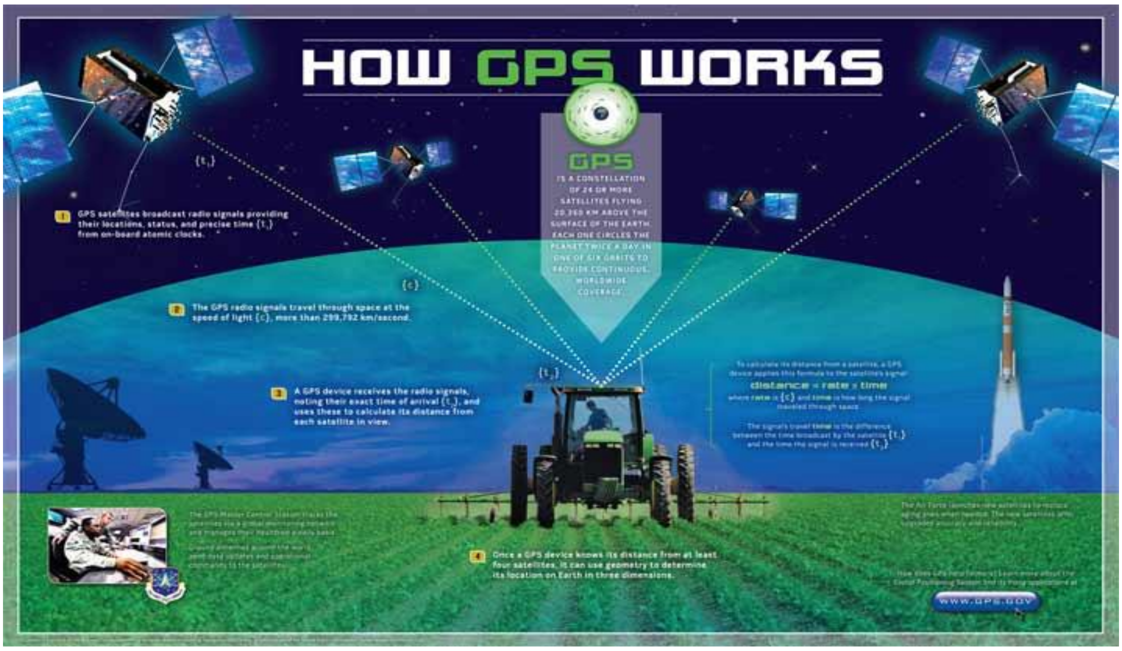

Figure 4.3 The working principle of GPS

Source: http://www.gps.gov

GPS provides the fastest and most accurate method for mariners to navigate, measure speed, and determine location. This enables increased levels of safety and efficiency for mariners worldwide. The GPS web site gives further information on courses (http://www.gps.gov/applications/marine/). The position information of ECDIS and AIS are both from GPS and/or DGPS.

GPS is playing an increasingly important role in the marine administration. GPS technology, coupled with geographic information system (GIS) software, is key to the construction of Intelligent Cruise System. GPS provides position signal for intelligent patrol, and increases the coverage of ships and other facilities. Currently, almost all the vessels have installed GPS terminals. From monitoring the dynamics information of the ship from the operation terminal-redesigned GIS, the officers can grasp the ship navigation status.

4.4 AIS

Automatic Identification System (AIS) is an automatic tracking system used on ships for identifying and locating vessels by electronically exchanging data with other nearby ships, AIS base stations, and satellites.

AIS consists of the ship-borne equipment and network of the land base, it is a new maritime safety aids and a new beacon facility. AIS transponder operates in VHF Channel 70, and can send information such as ship identification number, position, direction, ship’s length, width, type and draft, dangerous cargo and etc. to other ships and land-based stations. It means that within the transmission distance of signals, AIS can monitor the dissemination of information of any other vessels and shore-based facilities, meanwhile, the information will be updated automatically from the information changes. Shore-based AIS stations are mainly set up and governed by competence authorities. The shore-based station acquires the ships dynamic information within the coverage of AIS through high-speed computer network system, it also can broadcast various navigation aids and navigational warnings, exchange data with users and other government departments, enabling vessel information sharing, and provide basic data for a variety of professional applications (SHMSA,2012). Figure 4.4 and Figure 4.5 show the principle of ship-borne AIS and structure of shore-based AIS system, respectively.

AIS information supplements marine radar, which continues to be the primary method of collision avoidance for water transport.

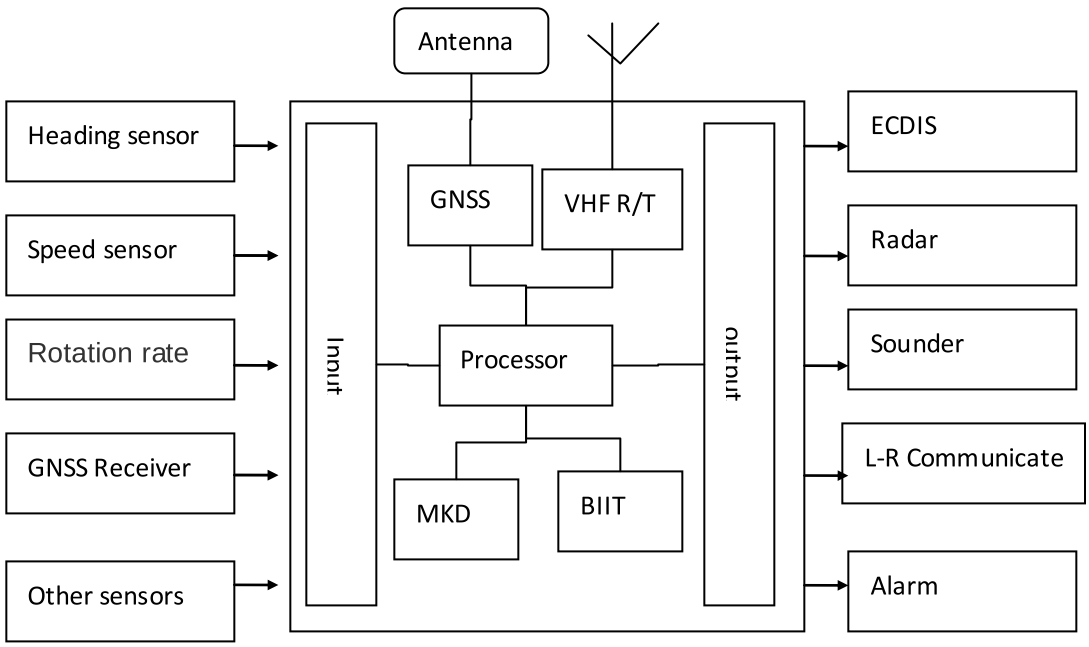

Figure 4.4 The principle of ship-borne AIS

Source: Mao, 2006

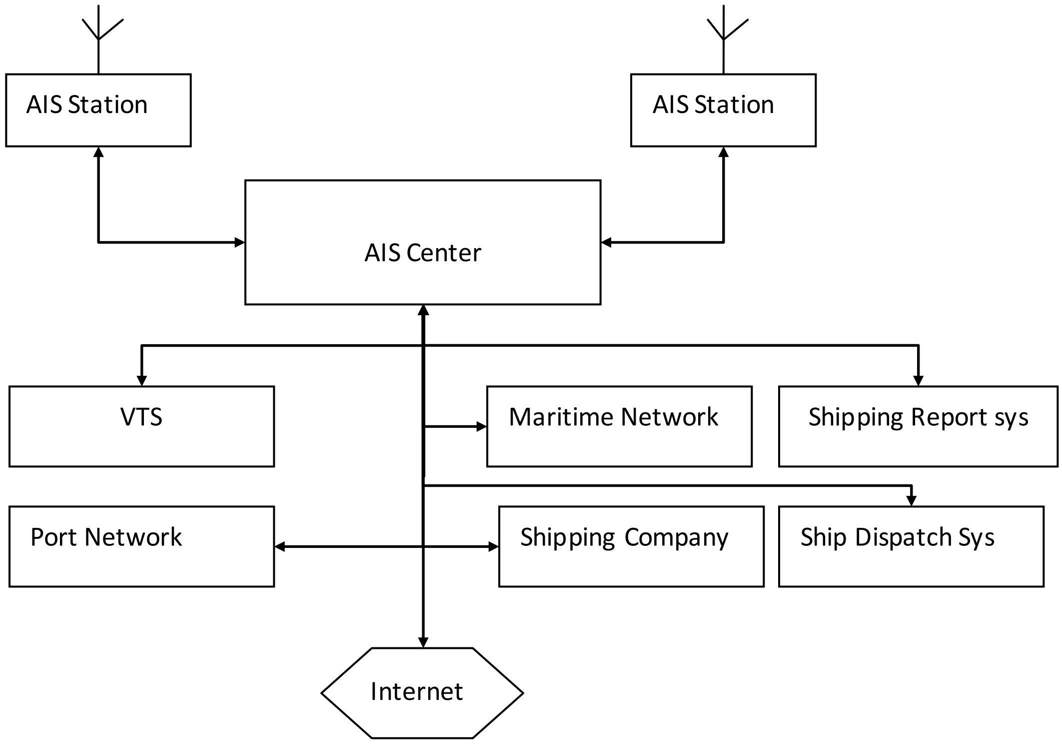

Figure 4.5 The structure of shore-based AIS system

Source: Mao, 2006

The application of AIS in intelligent cruise system is based on an accurate perception of the regulated entities. AIS can reflect the position of the ship on the electronic chart, and it also provides characters of the ship, such as ship's name, dimension, types and even the cargo information and destination. Duty officer can monitor and judge the navigation status of the ship through the real-time monitoring of ship AIS signals. When a violation is found, the name of the ship can be found directly. The accurate location of the ship provided by AIS will facilitate the operator to determine the actions of Search and Rescue (SAR) (Jiang, 2014).

4.5 Radar

Radar means radio detection and ranging. It is a system that uses radio waves to determine the spatial location of the objects which includes range, altitude, direction, or speed. Radar is mainly composed of antenna, transmitter, receiver (including signal processor) and display device. The radar antenna transmits pulses of radio waves or microwaves that bounce off any object in their path. A radar system has a transmitter that emits radio waves in predetermined directions, the echoes of the targets received by receiver and displayed on the screen of the Radar system (Ding & Geng, 2002，pp.1-6）. The radar system as an effective means of active detection is the supplement to AIS which will not be restricted by the visibility. The principle of the radar subsystem is shown in Figure 4.6.

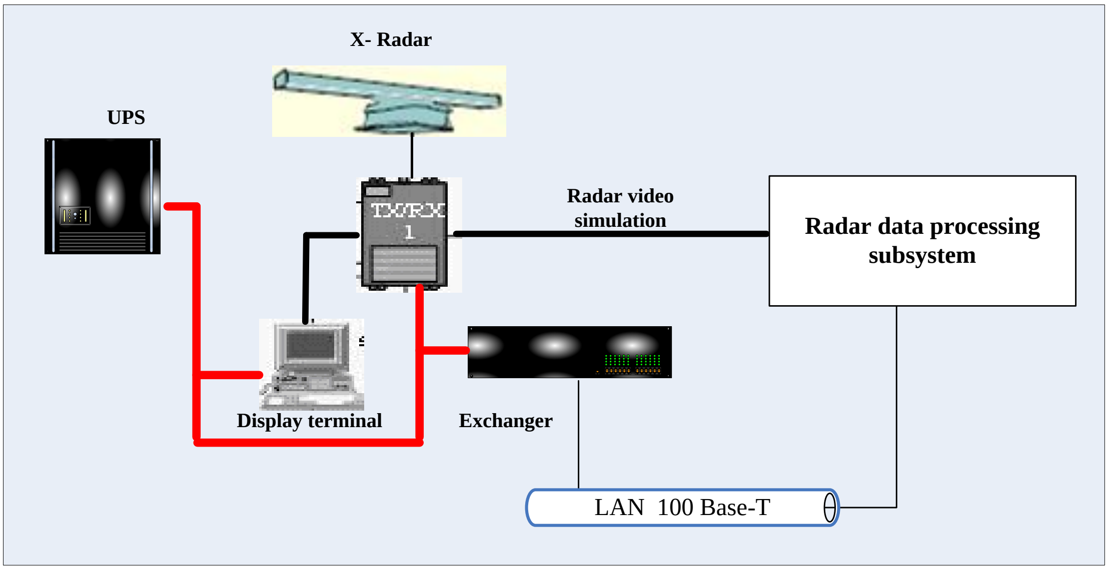

Figure 4.6 The principle of Radar data processing subsystem

Source: Ding & Geng, 2002

Radar data processing subsystem is responsible for the completion of digital processing, radar clutter suppression, target acquisition, target tracking and target identification. The system works according to the admission of plot to determine the target speed, direction of movement, so as to establish tracking, and display on the terminal of operational platform.

4.6 VHF

Very high frequency (VHF) uses the marine special channel to radio communicating between ship-ship, ship-shore and shore-shore (Qiu & Li, 2006). VHF communication system, a comprehensive platform for wired and wireless access control, switching and multiplexing through a dedicated digital multiplex equipment and transmission link, can achieve interoperability and system monitoring and management control center and VHF base station.

The VHF communication system consists of two parts, namely, the base station subsystem and control subsystem. The specified system working in the maritime VHF water band (156 ~ 174MHz).

The traditional VHF communication system consists of the radar station transceivers, multiplexer and central control unit (CCU). They are connected by a microwave link or other transmission link. The central control unit controls the VHF transceiver through operation desk. The basic structure is shown in Figure 4.7.

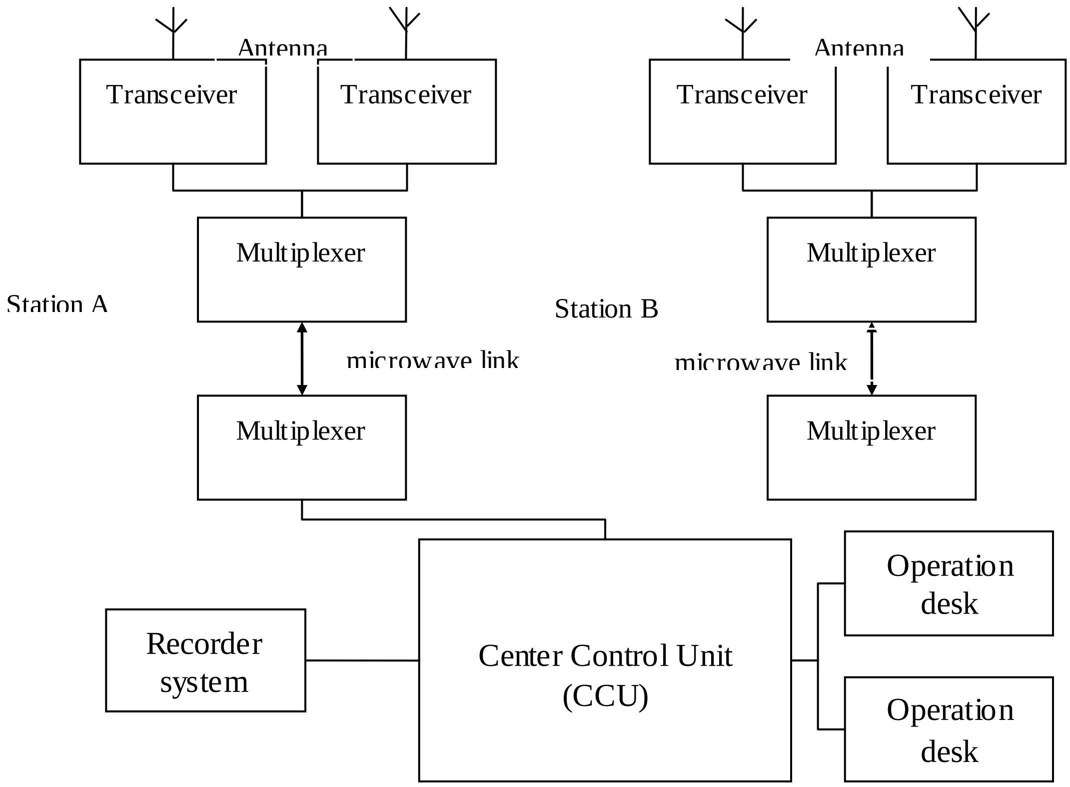

Figure 4.7 VHF communication system structure
Source: Hu, 2010

VHF as an important communication device between ship–ship, ship-shore and shore-shore, and its application in the ICS mainly is traffic organizing, to achieve the exchange of information during communications, such as correcting violation and guiding the en route vessel to safety area. In addition, the use of VHF broadcasts route information, navigation warning (notice), ship distress message and other navigation information.

4.7 Automatic ship illegal forensics system

Automatic ship illegal forensics system consists of ship violation warning service component, photo camera service component and a combination of administrative penalty component, as shown in Figure 4.8. Ship violation warning service component monitor the status of navigation through reception of real-time GPS, AIS signal, combined with the ship's information. When the violation actions of ships were found, it will send command to photo camera service component, then photo camera will take pictures or record video of ship's activities. It will provide evidence for MSA for the punishment. However, not all the judgments of the system are correct, so it still needs duty officer to confirm the behaviors and eliminate false alarm.

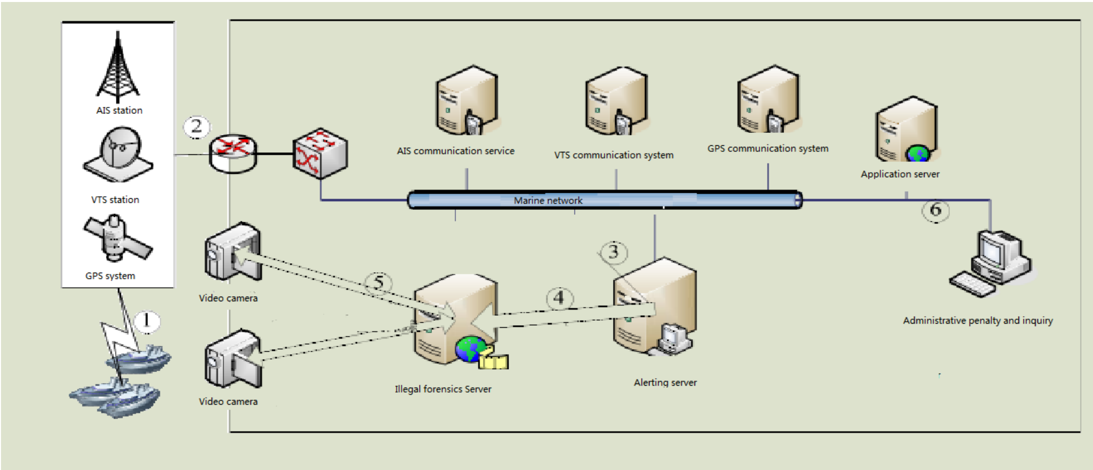

Figure 4.8 The structure and principle of the automatic ship illegal forensics system

Source: Jiang, 2014

The system will record every operation and disposal of the warnings and listed in a specific table. It saves a lot of time to take evidence of illegal actions. It also allows advanced officers to browse and query the records to eliminate the human errors and improve the quality of the enforcement. This system will simply improve the efficiency of the marine regulation.

CHAPTER 5

THE FUNCTIONS AND APPLICATIONS OF THE INTELLIGENT CRUISE SYSTEM

The main function of ICS can be classified into two segments, internal and regulatory functions.

5.1 Internal functions

5.1.1 Information collection

The information collected by system mainly includes vessel traffic information, environmental information and marine static management information. Vessel traffic information includes static information such as ship's name, scale and ship's type, as well as dynamic information like ship's position, speed and steering course. The acquisition of these information depends on devices such as CCTC, AIS, radar, GPS. Navigation environmental information includes geographical, hydrological, meteorological information and etc., which is accessible from WIS or WILS. Marine static management information is mainly from the marine data center such as ship's certificates, seafarers, inspections and visa information. These data is the foundation of the system; the accuracy of the data determines the accuracy of the system. All the information displayed on an unified platform facilitates the operations.

5.1.2 Intelligent assessment

Intelligent assessment means the comparison of the collected information with standard information. The standard information mainly includes two types, system settings and marine data resource. System settings is the definition of the limitation data, such as safety speed, safety distance between ships. Marine data resource provides the ship related information such as certificates, visa, inspection information. The function of intelligent assessment is the judgment of ship's status whether in danger or emergency. The modern technology used in intelligent assessment is shown as follows.

5.1.2.1 Simulate patrol

Simulate patrol is the process of acquisition and assessment of information on the coverage area, and all kinds of information is collected at the time of patrolling, meanwhile, data comparison will be processed, and the results will be shown on the terminal.

5.1.2.2 Line separating technology

Line separating technology is mainly based on Ship's Routing, by setting electronic channel center line to detect whether the vessel navigates in designated channel, if the en route vessel crosses the separating line, it will send alarm to duty officers automatically.

5.2.2.3 Boundary line technology

Boundary line technology is mainly applied in the scope of the specific regulatory region, to determine whether the region is safe, such as the bridge area, ferry line, construction area, mooring area, the alert zone, shallow water, water intakes.

5.2.2.4 Techniques of critical value

Techniques of critical value can be applied for early warning specific situation. If the detected value is over the pre-set safety value, it will provide early warning for operators. For instance, if the vessel's speed is over the pre-set value, the system will give warning automatically.

5.2.2.5 Techniques of filed value

Field value technology is used to detect the distance between ships, ships and specific area. If the distance between the ships and the specific area does not meet the requirements of safety sailing, it will provide warnings to avoid collision or close quarters situation.

5.1.3 Statistical analysis of categorical data

Statistical analysis refers to traffic statistics playback of single or multiple ships on a specified observation area or certain period of time on chart. It mainly includes voyage information, trajectory, speed, direction and others traffic related data, which are significance for traffic accident investigation, marine management and channel planning.

5.2 Regulatory Functions

5.2.1 Digital patrolling

A simulated patrol boat cruises along the river, just like a real boat patrolling. The GPS position of this boat will be shown on the platform (GIS/ECDIS) intuitively, meanwhile, the real-time supervisory pictures from adjacent CCTV camera will be displayed on the screen to show the visual image of the reality, and the camera will follow the position of simulated patrol boat automatically until the next camera takes over the task. For the purpose of displaying the passage more intuitionistic, it is necessary to establish a realistic situation of Huangpu River through 3D scene modeling and ship modeling technology.

The patrolling of the digital boat achieves continuous CCTV images simultaneously both on two-dimensional and three-dimensional platform, to form a multi-source, multi-screen linkage display. During the patrolling, comprehensive information of the river, including docks, channel, Navigational Aids as well as ship's dynamic information will be collected and displayed on screen. Water separation scheme, shallow water area and obstacles also can be shown if necessary. The abnormal status of ship will be caught and listed on screen according classification. After the completion of patrol, a patrol report will be presented by system. Figure 5.1 shows the synchronize displaying of the digital patrol.

Figure 5.1 The synchronize displaying interface of the Digital Patrol

Source: Shanghai MSA monitoring board, 2015

5.2.2 Ship's convoy

According to the regulations of Shanghai MSA, Vessels of 500 tons deadweight and above, carrying 23℃ flash point or with high toxicity and high polluted oil, dangerous goods in bulk and liquefied petroleum gas (LPG), inbound or outbound of Huangpu River, should be in accordance with the provisions of escort. Some special vessels such as warship and large cruise ship also need convoy. Traditionally, patrol boats will carry out the task in order to secure the safety of these vessels. However, after the construction of the system, it can accomplish this task to supervise the dynamics of the ships by electronic devices instead of patrol boats. The procedure will be like this, when a vessel get into the control area, the vessel's parameter and cargo information will be collected through information collection systems, and the intelligent assessment will judge if the vessel need escort. If the vessel meet the requirement of escort, the escort mission will be set up automatically and remind the operators to focus on it. After the conformation of the duty officer, the automatic escort will be processed according to certain procedure depending on the degree of risk, and video signal will be activated for tracking the vessel, the voice remind will be given if in urgent or abnormal situation during the process of escort.

5.2.3 Traffic flow supervision and warning

The ship flow means the vessel passing designated line in certain period of time. It is very important data for the maintain traffic order. According to the rank of vessel traffic density, the use of color like red, orange, yellow, blue, represents different density to display the real-time traffic condition on the electronic chart. If the traffic density is very high, the area will be colored red, and will remind the operators to give special attention or take precautions. If necessary, patrol boats will be dispatched to certain area to regulate the navigation order which will improve the patrolling veracity and pertinence.

5.2.4 Key vessel monitoring

The system has the functions of automatic identify, mark and track key vessels, such as dangerous cargo ship, large international cruise, ferry and yacht. The locked vessel will be displayed in pre-set color according to the level of risk. For example, the system will extract the cargo information from Electronic Data Interchange (EDI) system for operator's enquiry. The trace of these vessels will be kept in the storage devices for years.

5.2.5 Key water area supervision

Key water area refers to the area with high risks or needs protections. It consists of ferry lines, construction area, turn around area, water district, bends, shallow water, anchorages, bridge area and etc.. Through the technology of boundary line setting, various key water areas are established according to the regulatory requirements. The supervision of these areas will facilitate the operators to eliminate the accidents or potential incidents in time.

5.2.6 Traffic organization and maintenance

Intelligent cruise can realize remote traffic organization and maintenance. To organize and maintain the traffic order relies on the technology of line separation and filed value. Traffic organization means organizing ship's navigational status such as sailing, mooring, anchoring and loading/unloading. Through the system, we can supervise if the condition of the ship complies with the provisions of traffic separation scheme and special regulations, and also can supervise the mooring order and checking ship's certificates.

5.2.7 Illegal rectification

Through critical value setting, it can realize early warning of abnormal conditions of the vessel in navigating, berthing and operating. When the ship's behavior violates system settings, alarm will be produced automatically. The officers can recognize the vessel on GIS platform in time, including ship's name, position, speed and so on. So the officer can call the name of vessel by VHF in order to rectify the violations, if failed, he can take further actions such as dispatching adjacent patrol boat to correct the violations.

5.2.8 The illegal evidence collection and preservation of evidence.

Automatic acquisition of evidence will be processed by system and keep records for the illegal actions of vessels, the officers can acquire the evidence from the system to support the punishment of violations. This will significantly improve the efficiency of supervision and law enforcement level of standardization.

5.2.9 Serving for search and rescue for emergency

Search and rescue related resources and information are integrated in this system to facilitate the cooperation and coordination of all the parties involved, and the visual display, and provide effective data support for the commander. In addition, patrol and rescue integrated with the existing emergency response procedures can work according to the grade of accident to implement the contingency plan, provide the region's surveillance video and ship's data, and remote command and coordination become a reality.

CHAPTER 6

THE ADVANTAGES OF THE SYSTEM AND THE MODE OF REGULATION

With the characteristics of informatization and automatization, intelligent patrol is a modern maritime supervision mode, which is different from traditional patrol mode. It is a revolution of maritime regulatory mode in the field of concept, technology and site disposal mode (Wang, 2013). Intelligent cruise can achieve the objectives of patrolling, which can significant reduce the conventional patrol frequency and improve the pertinence of patrol; it also can realize the remote command and dispatch with full use of regulatory resources, and improve regulatory approach and control ability.

6.1 The advantages of the system

6.1.1 The improvement of coverage of patrol

Traditional cruise is the way of patrolling by people on boat, the coverage of patrol is around boat with eyesight range, and the regulatory measures mainly rely on the judgment of staff on boat, and they can not carry out effective supervision where unable to see. However, intelligent cruise can provide all round, systematic, continuous supervision through electronic devices and the integrated system. That is to say, the maritime administration agency can realize the supervision on the platform of intelligent cruise in order to achieve the objectives of 24 hours cruise, all-weather service, all-round monitoring and forensics. It can effectively improve the law enforcement of deterrence, safeguarding the security of navigation.

Although the routine patrol has strong power in practice, the restrictions of environment result in difficulty in sailing, inspection and evidence acquisition. Compared with the conventional cruise control, the concept of electronic cruise is more scientific and advanced.

6.1.2 The improvement of effective and pertinence

In conventional on-site regulation patrol boat cruise is the main regulatory measure. It cooperates with command center for the implementation of administration. The majority of the patrolling is routine work and with weak pertinence, it wastes a lot of time and energy. However, through the simulated cruising of navigational area, the navigational condition can be grasped by officers in time, intelligent supervision makes the remote accurate command become possible. The utilizing of the advanced technology of separation line, boundary line, boundary and field value helps make intelligent judgment become a more usable and accessible reality. The integration and optimization of CCTC, AIS, GPS, Radar and other systems make more harmonious and cooperative performance of the system and realize the objectives of all-round supervision of the control area. The receiving of information from the reliable devices can simply reduce human errors. The combination of traditional patrol and modern technology can effectively enhance the pertinence of patrolling, reduce the unavailing cruising to decrease the consumption of the fuel oil of patrol boat, and the cost of enforcement goes down correspondingly. According to the speed limitation of Huangpu River Navigation Management Regulations. The vessel speed should be under 8 knots, and the patrol boat should also comply with the requirements except emergency. The accomplishment of patrolling the 36.2 nautical miles will take 4.5 hours. However, the completion of digital cruise may only need

10 or 20 minutes according to the patrol speed setting. It significantly improves cruise efficiency and reduces labor intensity.

6.1.3 The enhancement of emergency disposal and pre-control

Intelligent cruise can locate the position of accident in the first place and comprehensively understand the situation, and provide emergency treatment against the further development, guide the search and rescue actions with the current resources in vicinity, dispatch patrol boat with law enforcement officers to command on site if necessary, thus, strive for valuable time and improve the efficiency of emergency disposal to reduce the loss and save people's life at sea. Moreover, intelligent cruise can find hidden or potential dangers of accidents in advance and provide warning to operators, which facilitates the operators to take countermeasures to stop or intervene in the dangerous activities beforehand, thus reduce the occurrence of accidents.

6.1.4 Guarantee the law enforcement

The automatic alarming of the abnormal behavior of shipping can assist the officers awareness of the situation and facilitate consistently good decision-making, which makes visualized remote control of shipping errors with VHF become possible. In some complex conditions, it needs the assistance of patrol boat to accomplish the tasks. The recording history of shipping continuously or automatically collects evidence of illegal actions, which guarantees the law enforcement or secure the implementation of regulations. It provides scientific basis for marine investigation and accident analysis. The navigational statistics can provide valuable reference or the management of shipping, channel planning, law enforcement resources arrangement and etc., in order to enhance maritime services, improve navigational safety and security and promote marine environmental protection and preservation, and regulate behaviors of vessels either in transit or calling port.

6.2 The role of intelligent cruise in regulation

The initiative of intelligent cruise will reduce shipping accidents and ship-sourced marine pollution. It will offer a lot of convenience to Shanghai MSA in monitoring the vessel passing by the River. Intelligent cruise should not be viewed a replacement for traditional regulatory measures. Instead, intelligent cruise should come with traditional regulatory measures and cooperate in administration. It is the supplement of the traditional regulatory mode. Traditional regulatory mode such as patrol boat and VTS are still important, and the combination with intelligent cruise may be the best approach for marine administration.

6.3 The regulatory mode

The regulation of intelligent cruise is the supervision with overall coverage of the jurisdiction, and the officers can hold all the traffic information through the platform, detect the violations of vessels and provide treatments in time. It spends shorter time on patrolling and the transition of information, with easier evidence collection and simple operation to facilitate the burden release of operators. However, the effectiveness of remote control is affected by the seafarers' quality and the communications tools, and remote correction can not guarantee the effective implementation, and salvage usually requires on-site disposal either.

Conventional cruise requires law enforcement officers to drive a patrol boats to patrol and implement supervision. The officers take actions based on the judgment of the traffic situation, deal with the violations on site to prevent accidents or give punishment， which has strong deterrence with good enforcement.

Therefore, for the choice of regulatory mode, it should be the combination of intelligent cruise and traditional patrol. The patrol boat commanded by the Command Center is to realize patrolling with targets and purposes. Along with consistent development of the intelligent cruise system and operation management, the advantages of intelligent cruise will gradually appear, and it will become the main means of maritime dynamic supervision.

6.4 Measure of safeguard

Intelligent cruise is a platform with the integration of modern means supervision and on-site supervision requirements, it requires the operator to have sufficient computer basic skills and skilled-site controls abilities. Due to the lack of professional personnel, it needs corresponding training of law enforcement personnel. In addition, the extent of stability and coordination of systems has a direct impact on the effectiveness of the cruise, which requires professional technical support team to carry out system maintenance, optimization, in order to solve operational problems and guarantee the running of system.

After the implementation of intelligent cruise, it needs to arrange special duty personnel monitoring platform. Intelligent cruise system includes multiple monitoring interfaces. With heavy responsibility and work load, it easily leads to fatigue for duty officers. Therefore, the arrangement of sufficient personnel on duty to share the works is vitally important, which can significantly reduce fatigue and human errors.

The degree of understanding and cooperation with intelligent cruise and scene will affect the effectiveness of the system, therefore, strengthening training and enhancing communication skills of officers on-spot will greatly improve the system efficiency.

CHAPTER 7

THE CONCLUSION AND PROSPECT

Intelligent cruise is a modern means of supervision of maritime safety administration. Using intelligent cruise system will realize the purpose of monitoring ship's dynamic information, maintenance navigational order, and ensure the safety of navigation. Intelligent cruise system is a technique system which adapts to the development of e-Navigation, and applied modern monitoring technologies, which brings challenges in regulatory mode of traditional measures. With the concept of informatization and modernization, it provides a new regulatory mode for marine administration, and the techniques and management will enhance the maritime supervision efficiency, and reduce labor cost and workload. Intelligent cruise follows the development of marine industry, it is an important part of the construction of the Maritime Intelligence, and application of intelligent cruise will play a positive role in the performance of shipping services, meanwhile, improve shipping efficiency, reduce the occurrence of accidents, ensure the safety of life at sea, and protects marine environment. Although it is a powerful measure to regulate shipping safety, it can not completely replace the traditional patrol. With the successful experiences in the Yangtze River, electronic cruise will become the development trend of the maritime supervision.

The research is based on the projects of Shanghai Huangpu River intelligent cruise system and a large number of on-site investigation and study works. Through the design of the system and function settings, investigation of patrol boat, VTS and command center officers, it analyzes the related subsystems, combined with current shipping conditions of Huangpu River. It finds the main tasks and difficulties, by the way of discussion with colleagues and staff of Software Company, and tries to find appropriate ways to deal with the problems in the process of design. Admittedly, this study has some limitations and restrictions, for example, the definition of function and applications need further improvement. Meanwhile, I hope that the results of the research can play an active role in intelligent cruise study and improve the management of maritime, which will bring great economic and social benefit for maritime administration.

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