AIS Implementation and Experiment with the Korean Satellite

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Abstract: In this paper, authors introduce about Wide Range Vessel Traffic Service (VTS) system using Automatic Identification System (AIS). In order to develop the prototype of Wide Range VTS system, Korean satellite is used for data communication system for AIS. In this system, ship position obtained by using GPS is reported automatically to VTS center through Korean satellite. By using this system, VTS center can cover more wide area than the case using radar only. And the uncertainty of information is decrease. The results of test show the good possibility of VTS using satellite and AIS.

Keywords: Vessel Traffic Service, Automatic Identification System, GPS, Satellite Communication, Ship Tracking System

1. Introduction

Recently, the impacts of serious major oil spill on the natural environment and society are immeasurable. And, the very arge pollution area by marine casualty shows that the coastal area as well as harbor area has to be administered by Vessel Traffic Service (VTS). Specially, in the case of dangerous cargo carriers, many VTS center want to track them from ocean ine beyond the coverage of radar.

In many countries, the researches about the new VTS to overcome the limit of radar are being carried out. Several nethods are being considered to exchange the navigational information on ship-to-ship and ship-to-shore through the vireless data communication. Furthermore, International Maritime Organization (IMO) carried out the standardization of Automatic Identification System (AIS) using VHF.

But, the majority of systems using VHF or UHF have some problems of the coverage of radio wave or the shadow area. They are not significant in the case of the information exchange between ships for the prevention of marine casualties. However, it is difficult that the systems are used for the long range ship tracking such as the monitoring of the violation of erritorial waters, the watching of the area to be avoided and so on.

Authors have realized the necessity of development of wide range VTS to monitor and control ships located beyond the coverage of VHF AIS. Further, authors have undertaken an extensive research program to investigate the possibility of mplementation of long range VTS using AIS transponder and satellite in the Waters of the Republic of Korea. The esearch was started in 1997 and included data transmission using satellite communication, the integration of AIS ransponder and the application of AIS information in VTS center. It is found that the ship monitoring system using Korean satellite (Mugungwha satellite) communication was proved to be an alternative solution for the long range AIS communication.

In this paper, the details of the test and the system introduced.

2. Ship Tracking Experiment using Satellite AIS

The research project included several tests for tracking ships in Korean coastal waters using satellite AIS on the basis of the consideration that satellite communication is effective in covering wide areas beyond the communication limit of VHF.

2.1 Structure of System

The total system is composed of the transponder installed on the ship, the Network Management Center (NMC) and the communication center. Of course, the Korean satellite is included.

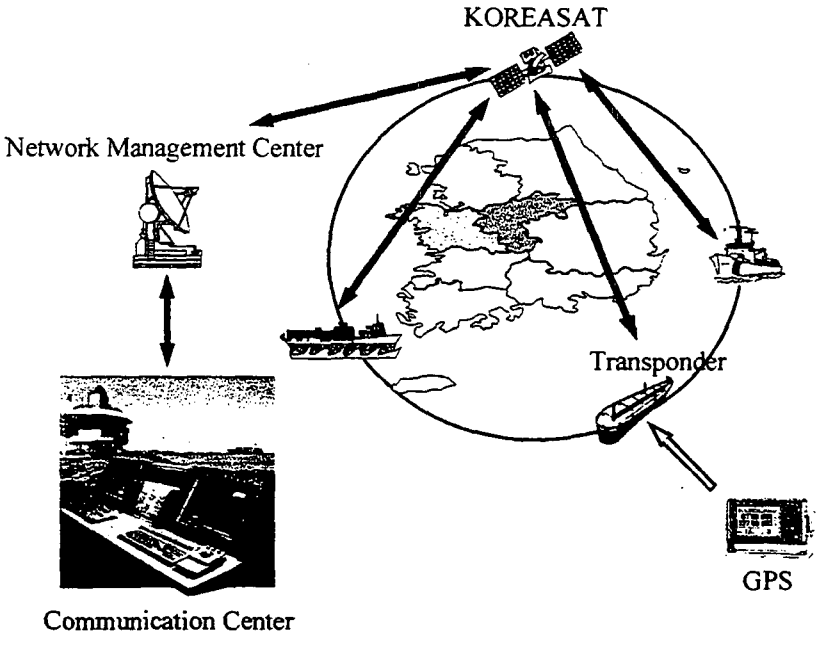

Fig. 1 System Configuration for Wide Ship Tracking System

2.1.1 Transponder

On the ship, the satellite antenna, GPS antenna and the transponder are installed. In addition, to edit the sending message and to display the received message, the display terminal is installed. The transponder obtains the ship's position from GPS and report the data to communication center by using satellite communication.

2.1.2 Network Management Center (NMC)

The NMC is maintained by the satellite communication service company. In our system, a VAX machine is used as main computer. The data communication with the communication center is achieved by using dial-up modem. The NMC polls all transponder at regular intervals and saves the data from each ship.

If the communication center demands some information, the NMC sends it from the saved data. On the contrary, the NMC delivers the message from the communication center to a special transponder.

2.1.3 Communication Center

The communication center receives the navigational data of ships equipped the transponder through the NMC and displays them on the control screen.

The developed program has the basic functions of the real time display of received data and the replay of time history of a special ship. To display the position of ship, the program utilizes the electronic navigational charts (ENC) of S-57 format. Strictly speaking, the program can read and write only the Shapefile format of ESRI. So, authors converted all ENC of Korea from S-57 format to Shapefile format.

First of all, in order to verify the possibility of the system, the program displays only the shoreline, the depth information and the place name in the many information of ENC.

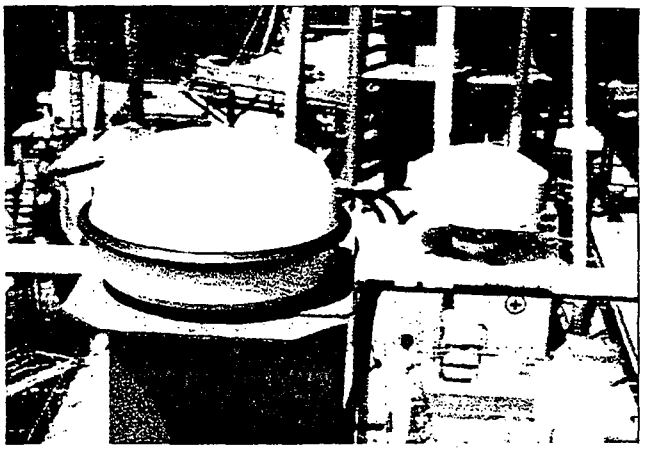

Fig. 2 Transponder Antenna and GPS Antenna

Fig. 3 Transponder Terminal

.2 Sea Experiments

Authors carried out several experiments for tracking hips in Korean coastal waters. They are as follows.

.2.1 First Sea Experiment (7 Sept. 1997 ~ 9 Sept. 1997)

In order to verify the possibility of the ship tracking system using a satellite (Korean satellite "Mugunghwa"), M/V IANBADA was used as a sea experiment equipped with satellite transponder and all tracking of sea experiment was arried out over a period of three days. In the system, the NMC polled every 90 seconds, and the communication center eceived data by the access to NMC concurrently. Basically, the system managed the position of the ship. Of course, as ccasion demanded, communication using text telegram was possible. From the results of this experiment, it was verified iat the tracking of ships by using satellite was feasible in coastal areas.

.2.2 Second Sea Experiment (Apr. 1998 ~ Sept. 1998)

The tracking experiment of ships that covered all the Korean domestic coastal areas was carried out. The transponders vere installed on three ships. The navigation area of selected ships covered all the domestic coastal areas of Korea. So, the ossibility to track many ships covering all the domestic coastal areas was investigated by tracking the three ships imultaneously. From the results of the tracking experiment during six months, it was verified that it is possible to track nany ships covering all the domestic coastal areas over a long time.

.2.3 Third Sea Experiment (Feb. 1999 ~ Sept. 1999)

The development of hardware and configuration had been emphasized in the first and second experiments but the levelopment of software was emphasized in the third experiment. The method to use the ENC database in the software

was developed. The developed program uses the Shapefile format for the GIS data. So, all the ENC data of S-57 format were converted to the Shapefile format.

2.3 Results and Discussion

The following figures show the results of the third sea experiment. The transponder were installed a Pusan-Cheju car ferry and a coastal oil tanker.

Fig. 4 shows the round-trip track of car ferry. The ship's position was recorded for two days. In the figure, it is found that the positions of ferry were tracked with the high accuracy and the proper time interval. Fig. 5 shows the enlarged view near Pusan harbor. In the figure, it is shown clearly that the ferry puts in at and leaves Pusan.

Fig. 6 is the track chart of a coastal oil tanker. After experiencing several oil pollution accidents by oil tankers in coastal waters, the Korean government has introduced a Traffic Prohibition Zone between 30 - 40 miles from nearest land, in which oil tanker, chemical tankers and gas carriers are not permitted to navigate. In the figure, the inside of long straight lines is the zone. Fig. 7 shows the enlarged view of the moment that the tanker entered the Traffic Prohibition Zone to put in at Ulsan harbor.

Fig. 8 and Fig. 9 are the track charts of the car ferry and the oil taker for one week. In the figures, it is shown that two ships followed the fixed routes without any fluctuations. Specially, in the case of the tanker, it is shown that the ship followed the route as straightened as possible near the Traffic Prohibition Zone.

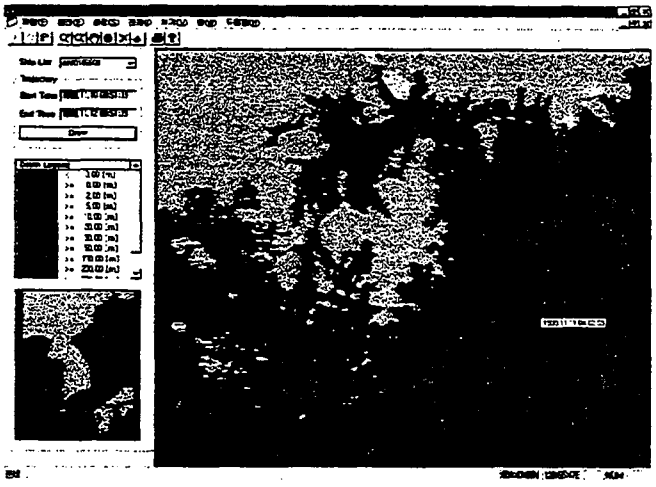

Fig. 4 Track Chart of Pusan-Cheju Car Ferry

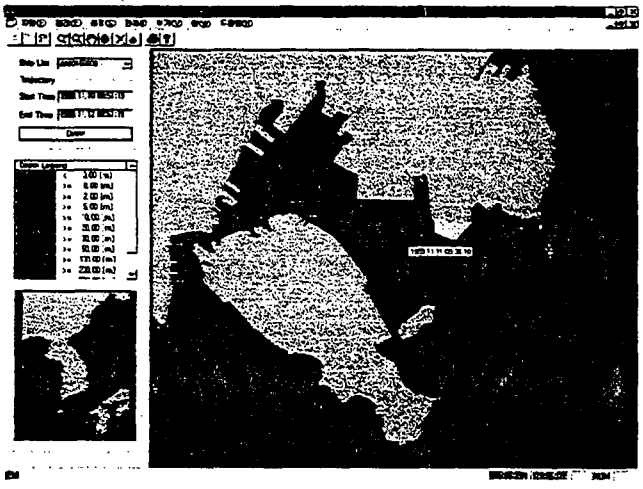

Fig. 5 Track Chart of Car Ferry near Pusan Harbor

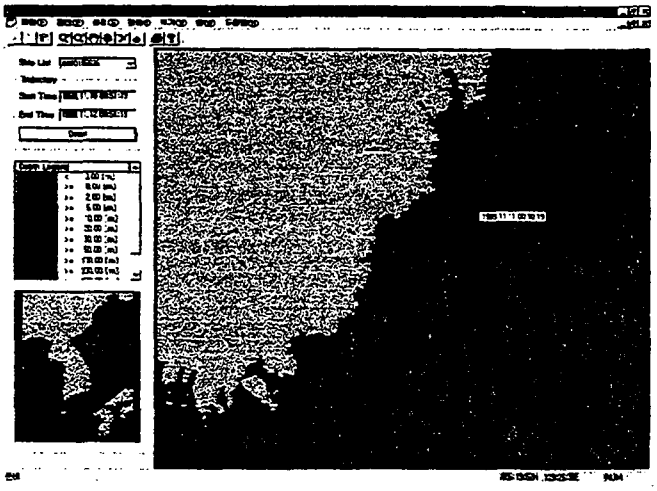

Fig. 6 Track Chart of Oil Tanker and the Limits of areas to be Avoided

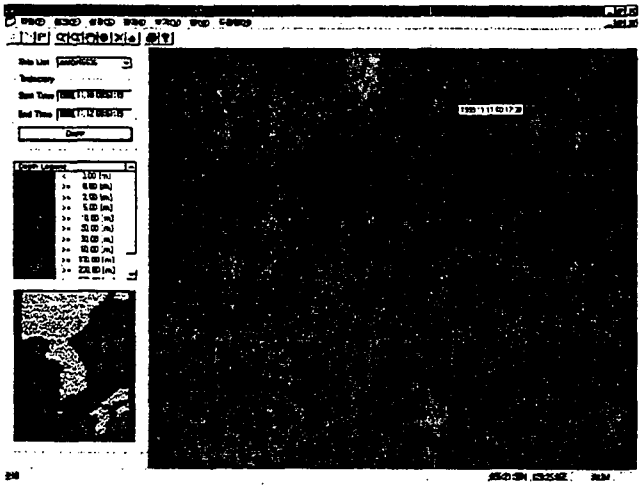

Fig. 7 Track of Oil Tanker Passing the Areas to be Avoided

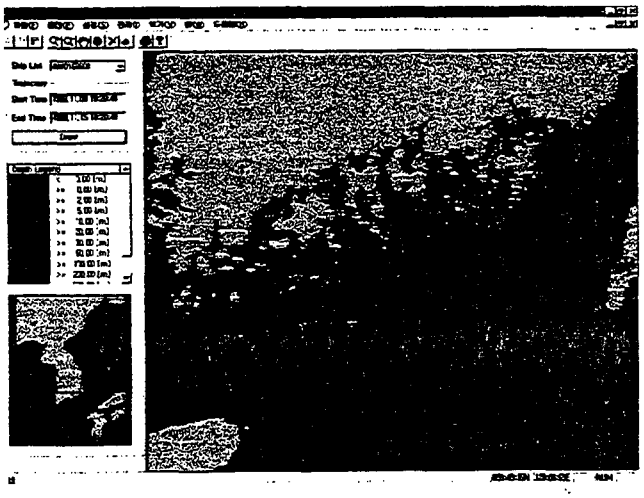

Fig. 8 Track Chart of Car Ferry for One Week

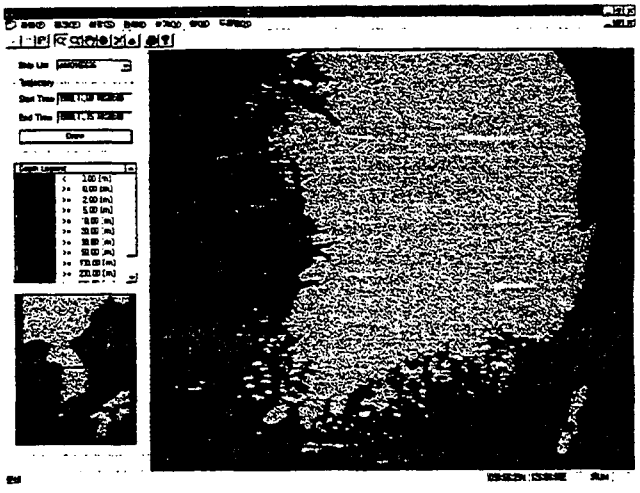

Fig. 9 Track Cart of Oil Tanker for One Week

3. Conclusion

The key results of the tests are as follows.

- With the satellite AIS, the communication center was able to get real time information from a ship navigating in coastal waters.
- The possibility of tracking and traffic surveillance of ships equipped satellite AIS was demonstrated.
- The test results prove that large marine pollution accidents can be prevented from monitoring of oil tanker's violation of Traffic Prohibition Waters.

As the possibility and availability of using satellite AIS in wide area VTS are proven, the system should be further leveloped even though the VHF AIS was adopted as international standard at IMO. In order to provide for the case that /HF AIS will be utilized in domestic area, the software interface for the international standard AIS as well as Korean atellite must be developed. When considering international and domestic environments, the possibility of using both VHF nd satellite is high. Therefore, it has to be planned that one program for VTS and tracking can manage the information rom two types of AIS.

Furthermore, authors found that the ship monitoring system using satellite communication can be an alternative solution or the long-range AIS communication. The project will be expanded as a comprehensive control and surveillance system y combining the outcome of the research gained so far with the development in other areas such as expert system of avigation.

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