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Design of an ECDIS Checking the Status of Vessels and Marine Devices

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Abstract

Large vessels are currently operating by using an ECDIS, a system enabling automatic navigation and checking marine conditions. In the past, the ECDIS was used for vessels but in these days, it has been used as a method for collecting and verifying marine information, etc. from land by using a computer, instead of taking a boat out. The ECDIS on sale is generally used by companies which operate marine workers. However, this system has caused inconvenience to marine workers, in terms of tasks, services, or operations. Marine workers move out to the sea after checking the status of the system at the office. Due to the weather such as waves and winds, marine devices are not often found on the relevant coordinates. In such a case, the workers onerously need to come back to the land and track the marine devices again. In order to solve such a problem, this thesis purposes to develop a system which can check the locations of marine devices and verify a marine chart even on the sea by using a mobile. The proposed system can integrate and support a variety of protocols of relevant devices in the system itself and check data via mobile through the data transmission and streaming functions.

Keywords*: S-57, s-63, ECDIS, Marine Navigation*

1. Introduction

For a vessel, there is an electronic chart display and information system (ECDIS) which can make a voyage by using radar, NAVTEX, automatic identification system (AIS), and depth sounder [1]. In the past, the ECDIS was used for vessels but in these days, it has been used as a method for collecting and verifying the marine information, *etc.* from land by using a computer, instead of taking a boat out. The ECDIS on sale is generally used by companies which operate marine workers. The ECDIS displays marine devices through an electronic marine chart based on the international standard S-57. However, a chart in S-57 format, which has no security settings, falls under data with security vulnerabilities. In December 2002, the International Hydrographic Organization (IHO) offered an electronic chart whose database is encrypted, in order to prevent data from being attacked due to the security vulnerabilities. This electronic chart has been designated as the international standard named S-63 [2].

This thesis provides users with a viewer function based on the electronic chart of S-63 by decrypting and analyzing the chart on its own. Moreover, this thesis not only provides the viewer function simply to show the chart but also enables data transmission by connecting the respective devices such as lighthouses, light beacons and buoys which have been installed on the sea through the network. However, data transmission causes a few of problems. One of the proposed problems is that at the time of data transmission, the protocols provided by the respective devices lack unity. The reason for such a lack of unity is that the existing devices had not been removed but still used as they were when updated devices were installed on the sea. Accordingly, the devices installed on the sea currently support a total of three protocols such as AIS, TRS, and WCDMA. Moreover, as

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for two protocols, one system does not provide all functions but uses an independent program to transmit data through three protocols. Therefore, the marine companies using the ECDIS cannot help but find their inconvenience in using the system.

This thesis purposes to develop an integrated system enabling data transmission by way of integrating protocols and algorithms which may decrypt an encrypted chart based on its own method. Furthermore, it also plans to develop a streaming service to display the chart on a terminal device.

2. Related Research

The existing ECDIS involves three technologies: a technology to convert S63 charts into S-57, a technology to integrate three types of protocols, and a technology to support streaming service.

Figure 1 shows the structure of schema to convert S-63 into S-57 [3]. ECDIS can be manufactured only with an official approval from IHO. This is because S-63 is an encrypted chart with strengthened security, and the kernel to convert S-63 into S-57 can be produced only with M_ID, M_Key issued by IHO. Such production of kernel may be deemed as the most significant part in the development, and the core technology. Also, the production of kernel is one of the reasons why there are only five manufacturers for ECDIS, including e-Marine Logix Co., Ltd. and Samsung Heavy Industries Co., Ltd., registered in Korea.

In order to integrate the protocols supported by the devices installed on the sea, a technology to analyze and integrate the message values delivered by such protocols should be developed. However, even if data processing is based on such integration, this is not the end of development. The number of light buoys installed on the sea amounts to approximately 3,300. Since there are so many devices, there is a need for developing a technology to process data transmitted by a great number of devices immediately and in real time. The devices transmit data not by wire but by wireless, and this leads to differences in transmission speed and time, depending on the distance between devices. Moreover, the transmission manners is wireless and thus, there is possibility of data loss. Taking into account those matters, the system has been developed in this thesis [4].

Lastly, this thesis provides a streaming server for responsible workers to see the analyzed electronic charts not only on the computer screen but also on a mobile, even outside the office. To provide streaming service, there is a need for developing a server to save data received from the electronic charts, lighthouses, light beacons, light buoys, *etc.* The total number of electronic charts in Korea is 690 and the devices afloat on the sea are approximately 3,300. In order to transmit data in real time without ceasing, the goal should be to reduce the transmission speed to the maximum, based on the data size. Although there are lots of data to be processed, there will be no need for using big data. However, it is necessary to research compression of data to the maximum and enhancement of faster transmission speed [5].

The existing system receives data from the devices currently installed on the sea and displays the data on ECDIS. Responsible workers have to not only confirm data in the office but also visit the sea in person to check the marine environment, *etc.* and collect materials. For such duties, responsible workers have come to need a system to check the devices installed on the sea and charts with ease. For this reason, some have opined that streaming service should be also provided in order to check some functions of ECDIS via mobile. However, due to the large volume of S-63 charts and the capacity thereof, it is considerably difficult to transmit data onto the mobile device without the electronic charts being broken [6]. To solve such problem, charts are converted into JPG files, respectively and the capacities thereof are reduced, before transmitting those charts onto the mobile device. Moreover, in order to emphasize the importance of security, charts are not simply converted into JPG files but security is strengthened by having the JPG files encrypted through the RSA algorithm. The RSA algorithm is strong but takes more time to decrypt, compared to other decryption algorithms. Such a downside may be solved by adding the modular multiplying algorithm

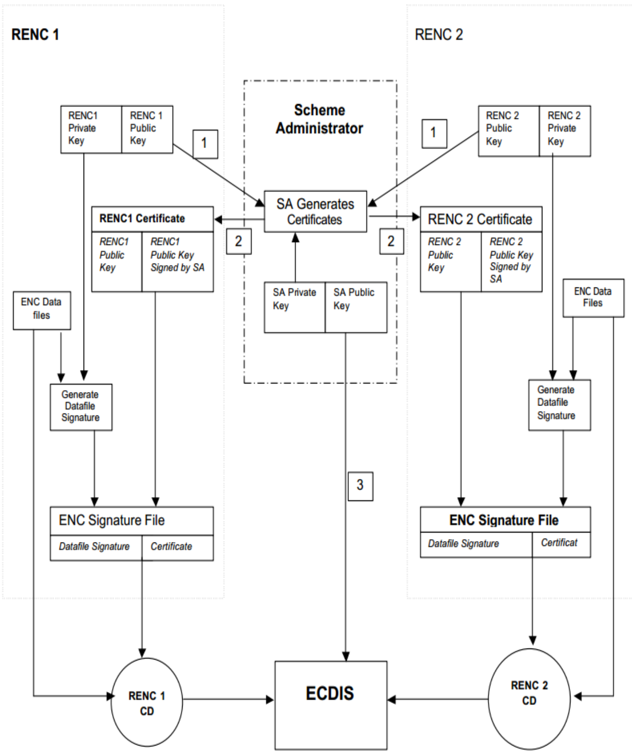

Figure 1. Schema Structure for Converting Electronic Charts from ECDIS

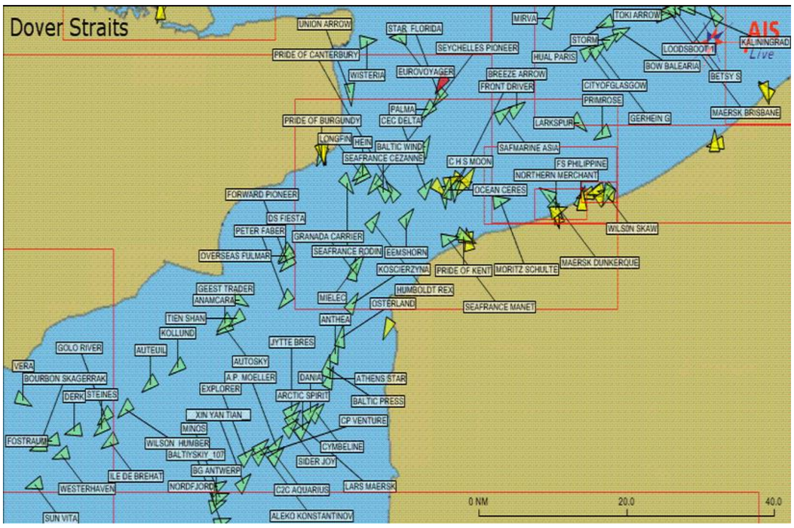

Figure 2. Display Data in the Viewer Using AIS Equipment

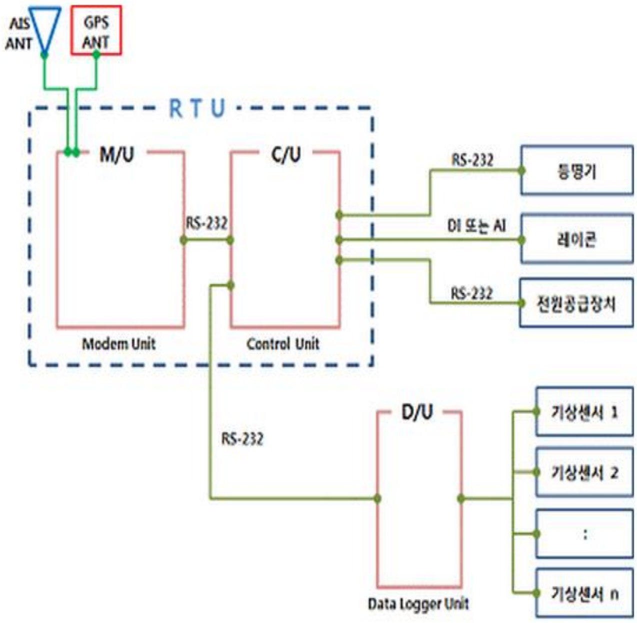

Figure 3. The System Comes from the Device Receiving the Communication Hierarchy

3. System Structure and Design

3.1. System Structure

Implementation of the ECDIS proposed by this thesis requires devices such as lighthouse lanterns to transmit and receive data, a computer, a server, and electronic chart files. In the ECDIS installed in a desktop, electronic charts in S-63 format are decrypted through kernel. When the processing of decryption is complete, the system viewer shows electronic charts and other files which are converted into S-57 format are saved separately. Moreover, by trying to connect with the respective devices including lighthouses, buoys, light buoys, *etc.* installed on the sea, data may be transmitted and received from/to those devices. The data received from the devices are displayed on the charts or saved onto the system. Lastly, by way of transmitting the electronic charts in S-57 format and data values which have been separately saved to the server again, responsible workers may be provided streaming service to check them out of the office as well.

Figure 4. System Structure

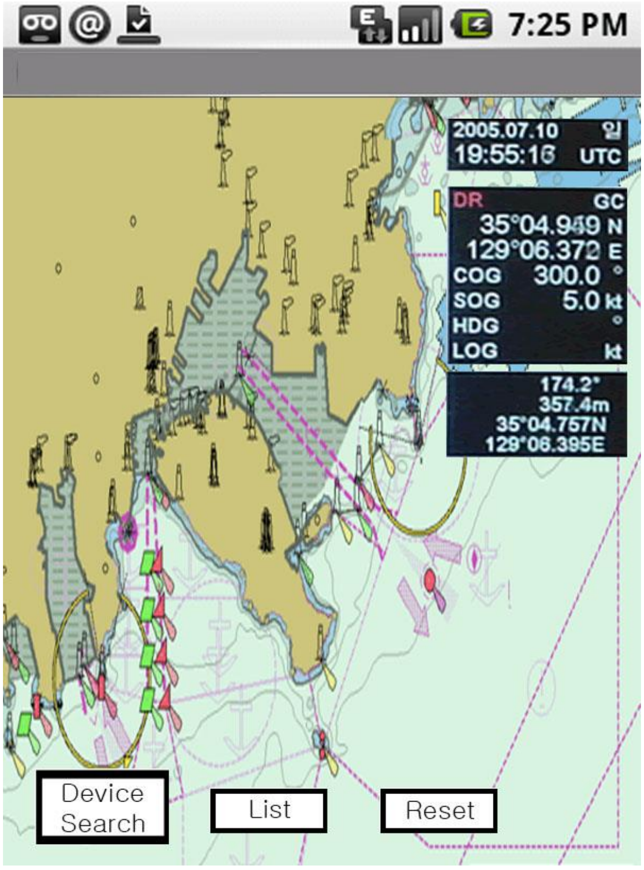

Figure 5. Mobile Screen

3.2. System Design

It may be deemed that the operation of this system starts from successful decryption of electronic charts in S-63 format. After then, they are converted into the S-57 electronic charts, and such converted electronic charts are displayed on the system viewer and saved separately. Until then, the system simply functions as a viewer to display electronic charts. Once charter analysis is complete, the system tries to connect with approximately 3,300 devices installed on the sea. When succeeding in the connection, the system may receive data from the devices. However, the data are not values which users can see with ease.

The devices transmit one-line commands to the system as shown in Figure 5. The system conducts parsing by use of those commands and classifies 27 data including latitude, longitude, battery voltage, *etc.*, so that users may see the charts with ease. Next, the system consolidates displays and saves such classified data, and transmits the data values and electronic charts onto the server in real time.

Lastly, when succeeding in accessing the server through the application installed in a mobile, the charters and data values may be received from the server. A mobile user may hereby check the status of the system in real time even outside.


```
!AIVDO,1,1,,A,8>IEM@POBjODQkcOPh<NOh7wwtO?tOOwwwwwwwwwwwwwwwwwwwwwwww201whO,2*18
 (using flag) UsingFlagPrior1Que : 0x0 by msg.8 tx done
 (MU->CU,2) $MUQRY,S*3D
 (CU->MU) $CUOK*12
 (CU->MU) $CUSTS,3,0,0,13.9,21.3,13.9,0.03,0.00,0.00,1.50*68
 (cu state) Lantern=3:Off
 (cu state) RACON=0:Not Install
 (cu state) Data-logger=0:Not Install
 (cu state) Main Power Voltage=13.9[V]
 (cu state) Solar Voltage=21.3[V]
 (cu state) Battery Voltage=13.9[V]
 (cu state) MU Current=0.03[A]
 (cu state) Lantern Current=0.00[A]
 (cu state) Data Logger Current=0.00[A]
 (cu state) Charger Current=1.50[A]
 (MU->CU) $MUOK*1C
 (tx msg contents) Messsage ID=6
 (tx msg contents) Source ID=994401602
 (tx msg contents) Sequence No=0
 (tx msg contents) Destination ID=004403105
 (tx msg contents) IAI=DAC:440, FI:51
 (tx msg contents) Destination ID=994401602
 (tx msg contents) Function=1(Response)
 (tx msg contents) Date & time=2014/01/04 02:03:09
 (tx msg contents) Latitude=35N02.407'
 (tx msg contents) Longitude=128E36.614'
 (tx msg contents) Lantern state=0(off)
 (tx msg contents) RACON state=0(Not install)
 (tx msg contents) Battery state=0(Normal)
 (tx msg contents) Charger state=0(Normal)
 (tx msg contents) Solar state=1(Abnormal)
 (tx msg contents) Data-logger state=0(Not install)
 (tx msg contents) Spare state=0(Not install)
 (tx msg contents) Main Power Voltage=13.9V
 (tx msg contents) Solar Voltage=21.3V
 (tx msg contents) Battery Voltage=13.9V
 (tx msg contents) Spare Voltage=00.0V
 (tx msg contents) AIS Current=00.03A
 (tx msg contents) Lantern Current=00.00A
 (tx msg contents) Data-logger Current=00.00A
 (tx msg contents) Charge Current(+)=01.50A
 (tx msg contents) Charge Current(-)=00.00A
 (msg txd) 1114, Msg.6, SeqNo=0 at Ch.A
!AIVDO,1,1,,A,6>IEM@P13;r4KS?e5GD97oc8:eIP58Lrop<22;Jb;000H0000Bh002,4*56
 (msg que) Prior4Que[0].state=1, cnt_tx=1 by msg.6 tx done
02:43:30  p2 s2o SPI:m0,d8 sr00 ir00 rn00 st1 ca1 by0 ch1 mb00 rd00 I2C:w2,r2 gm
 (msg que) Prior4Que[0].state=2, cnt_tx=1 by rx time-out
 (tx msg contents) Messsage ID=6
 (tx msg contents) Source ID=994401602
 (tx msg contents) Sequence No=0
 (tx msg contents) Destination ID=004403105
 (tx msg contents) IAI=DAC:440, FI:51
 (tx msg contents) Destination ID=994401602
 (tx msg contents) Function=1(Response)
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Figure 6. Maritime Device is Sent to the System Log Values

4. Conclusion

The system proposed by this thesis is an integrated ECDIS to consolidate various protocols into one and to process it in real time. In order to reinforce the differentiation from the existing systems circulated in the market and the mobility for users, the system supports streaming service. The design goals for this system are to make it possible to have a number of core functions and UI which is simple and intuitively easy to see, and to transmit the charts and data immediately without any loss, by means of streaming service. However, system overload may occur because all the functions are performed by only one system. In order to solve this problem, we will research and implement a method for processing data with flexibility by developing a parallel processing algorithm.

Acknowledgments

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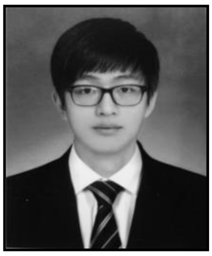
References

[1] Wikipedia, "ECIDS", http://en.wikipedia.org/wiki/Electronic_Chart_Display_and_Information_System.
[2] G. H. Kim and J. W. Jang, "Design of Integrated Viewer System for S-63 Electronic Chart by Using Mobile", ICFICE 2015, vol. 7, no. 1, **(2015)**, pp. 494-497.
[3] IHO, "Data Authentication and Integrity Checking within the S-63 Scheme", http://www.iho.int/iho_pubs/standard/S-63/S-63_Guidance_Notes.pdf
[4] S. M. Oh, Y. B. Im, H. S. Park, J. C. Lee and S. H. Kim, "Protocol for Delivering Data in Real Time based on Multi Routes in the Wireless Sensor Network", 2011 Autumn Digest of Technical Papers by Korea Information Science Society, vol. 38, no. 2, **(2011)**, pp. 218-221.
[5] Ministry of Maritime Affairs and Fisheries, "Facility Status of Aids to Navigation", http://www.mof.go.kr/content/view.do?menuKey=394&contentKey=47
[6] J. Y. Kim, D. H. Kim, G. S. Ok and I. S. Jo, "Trend of Streaming Technology for Electronic Chart and Status of Development", 2014 Autumn Conference of Korean Society of Marine Environment and Safety, **(2014)**, pp. 177-181.

Authors



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