Research on VDR data analysis for realization of data-based autonomous remote control

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ABSTRACT

The implementation of smooth remote control between land and sea is a key goal of autonomous operation. In addition, it is also a prerequisite for remote ship control for land controllers to grasp the ship's operation status. We need to select the data required by the land controller among the multiple data transmitted and received through the wireless network environment, and find out how to deliver the selected data to the land controller. To this end, important information on ship navigation was selectively collected using the VDR log of the Korea Maritime University, and as a result of program production and analysis according to the purpose, there were three types of data that could be collected (text, video, image), and 35 types. Among them, it was analyzed that there were 10 essential data for identifying the ship operation status of land controllers, and it was found that data necessary for remote control can be extracted from VDR data. It is expected that this can contribute to the implementation of smooth remote control in the development of autonomous ship technology.

1. Introduction

The navigator who controls the ship on the sea receives and checks a lot of information from the bridge. Information received on the bridge includes information on the ship itself, such as Speed and Heading, as well as information on the marine environment surrounding the ship, such as barometric pressure, wind direction, wind speed, and water depth, or external force. When controlling a ship at sea, it does not take much time to identify and respond to the variables encountered by the ship. This is because it is relatively easy to give the next order by synthesizing the information. However, when the controller is on land, it is not easy to immediately determine the importance of information among the various numerical values transmitted through the monitoring device and to take the lead in giving control orders. Therefore, before the start of land control, the information deemed important was selected in advance to determine whether smooth transmission to the land controller was possible.

For this, two things had to be identified first. First, it is the flexibility of the act of selecting only the information we want among the multiple pieces of information received by VDR. Regulations have not yet been established on information that autonomous vessels, i.e., vessels remotely controlled from land controllers, must receive. SOLAS mandated the installation of VDRs for international passenger ships and cargo ships over 3000 tons built since July 1, 2002, and the [1]IMO regulations stipulate information that must be recorded to a minimum under compulsory installation. Therefore, it is necessary to first check the currently legally stipulated DATA items and receive information that is deemed useful for ship control in consideration of the specificity of land remote control.

Second, if it is possible to select the data, it is a matter of how the selected VDR data can be delivered to the land controller once more. Basically, the VDR on board the ship receives various information and automatically records it. We must deliver this information to the land controller once more through the processing stage of screening. It was intended to find out the optimal way to connect land and ships to which circuit to select information and how to deliver it, and whether the data value at that time will be deformed. In this regard, Chapter 2 explained the basic concept of VDR as defined by IMO and its role as navigation equipment. It also identified the items in the VDR Data listed in the regulations and identified what information was required to be recorded.

Chapter 3 describes specific experimental methods. Based on the ship-land control platform currently being implemented, the overall process was explained in which section the data will be selected and how the data will be delivered. It also describes the justification for extracting the screening data to be sent to the land controller and includes procedures for converting the data format to facilitate interpretation by the controller.
Finally, Chapter 4 describes the comprehensive conclusion of this experiment, future goals, and possibilities

2.`Method

According to the definition of [1]IMO regulations, VDR stands for Voyage Data Recorder, which means a complete system containing all items. All items at this time mean the final recording medium, playback equipment, power supply and dedicated spare power required to interface with the source, processing and encoding of the input signal.

Picture. 1. T/S HANNARA VDR

The Picture.1 shows the VDR installed on the compass deck of the T/S HANNARA at the Korea Maritime University. It is installed on the top deck so that it can be supported at a certain water pressure in the event of a ship sinking, and is in a conspicuous color form.

No.	Data to be recorded
1	Data and time
2	Ship's position
3	Speed
4	Heading
5	Bridge audio
6	Communications audio
7	Radar
8	ECDIS
9	Echo sounder
10	Main alarms
11	Rudder order and response
12	Engine and thruster order and response
13	Hull openings status
14	Watertight and fire door status
15	Accelerations and hull stresses (if fitted)
16	Wind speed and direction (if fitted)
17	AIS
18	Rolling motion
19	Configuration data
20	Electronic logbook (if fitted)

Fig. 1. Minimum VDR information

Fig. 1 shows the items to be stored in the VDR data recommended by the IMO performance standard, [2]RESOLUTION MSC.333(90) (adopted on 22 May 2012). Twenty items are specified, including if fitted, equipped with measurable equipment. The fact that there is a recommended minimum item among various information means that the information necessary to determine the authenticity of marine accidents and to determine based on ship in case of an emergency is limited and selected. Therefore, given the specificity of land remote control at the moment when there are no legal provisions for autonomous vessels, the type of information required may vary sufficiently. It also suggests that it will be very important to select ship information to immediately make appropriate judgments in consideration of the environment on land and sea.

3. Experiments

In addition to a total of eight types of information selected and collected through experiments: Lat, Long, Speed, Heading, Radar, rpm, wind SPD., and wind DIR., CCTV and ROT added in consideration of the specificity of remote control. In the case of ROT, since the ship controller is not on board, the ship's whiplash speed cannot be actually felt and controlled. Therefore, the actual ship's ROT can be checked as a numerical value and referred to. CCTV was installed in the land control center to collect image information outside the center. In order to deliver the selected data on land, a procedure connected to an actual vessel VDR line was devised.

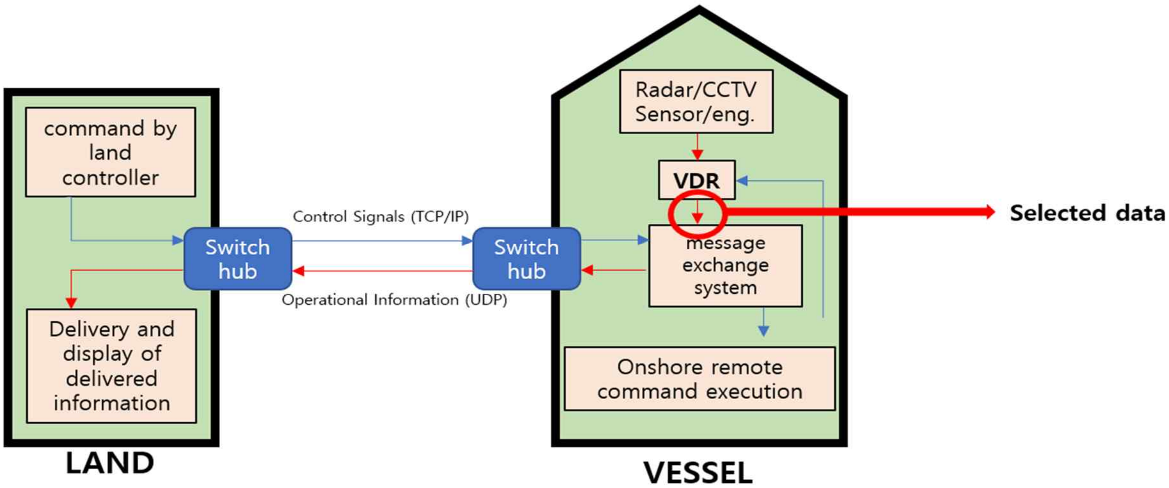


Fig. 2.VDR Information transfer process

The procedure is as follows. First of all, ship operation information such as radar, CCTV, and Rudder is stored in the VDR in the ship. The selected data for land remote are then delivered to the pre-built message exchange system, and the VDR data and information from the network monitoring system are received and mutually delivered to the switch hub connected to the ship and land. The navigation information of the vessel delivered to the land switch hub is transmitted to operation monitoring, network monitoring via the land message exchange system and displayed on the land display device. The land controller controls the ship based on the ship navigation information received on the display device, and the ship control command on land is transmitted back from the message exchange system to the ship message exchange system through the switch hub. The rudder/telegraph/thruster is used to match the value of the command transmitted, and the signal is stored in the VDR again.

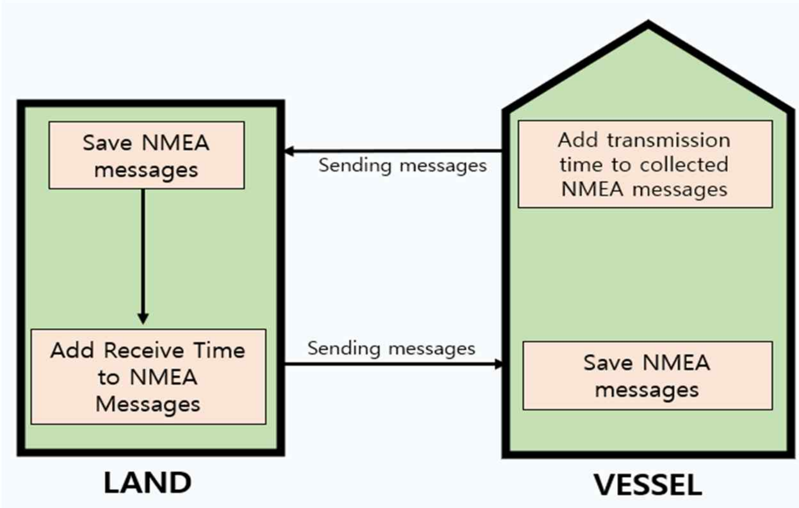
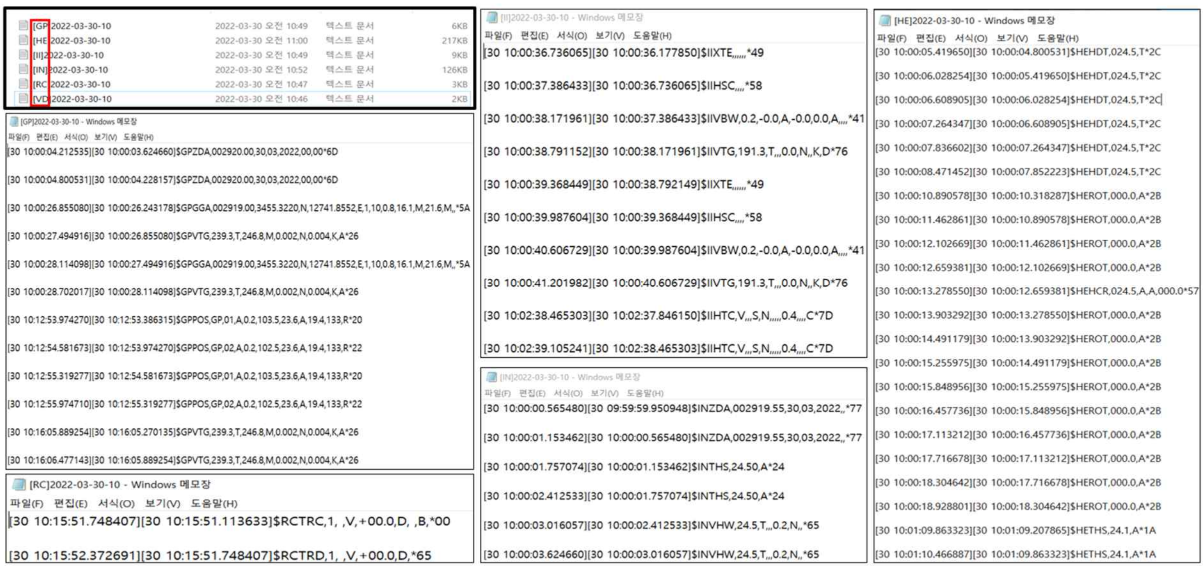


Fig. 3. NMEA Delivery Procedures

The communication means of the experiment conducted at this time is LTE commercial network, and the communication method is TCP socket communication. The important point is that the format of the message transmitted and received in the VDR is the NMEA protocol. When the vessel's VDR information arrives on a land computer, the information in the TEXT shall be interpreted as per the protocol's manual to obtain the information.



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[HE]2022-03-30-10   2022-03-30 오전 11:00   텍스트 문서   217KB
[II]2022-03-30-10   2022-03-30 오전 10:49   텍스트 문서   9KB
[IN]2022-03-30-10   2022-03-30 오전 10:52   텍스트 문서   126KB
[RC]2022-03-30-10   2022-03-30 오전 10:47   텍스트 문서   3KB
[VD]2022-03-30-10   2022-03-30 오전 10:46   텍스트 문서   2KB

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[30 10:01:10.466887][30 10:01:09.863323]$HETHS,24.1,A*1A
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Fig. 4. Original VDR data

Fig.4. is a VDR information TEXT transmitted on land through a line. Each TEXT content is recorded in a form that is difficult to grasp at a glance. The land controller interpreted these data one by one for remote control of the ship and determined that it was very difficult to accept information, and the text was parsed in the intermediate stage to be delivered on land.

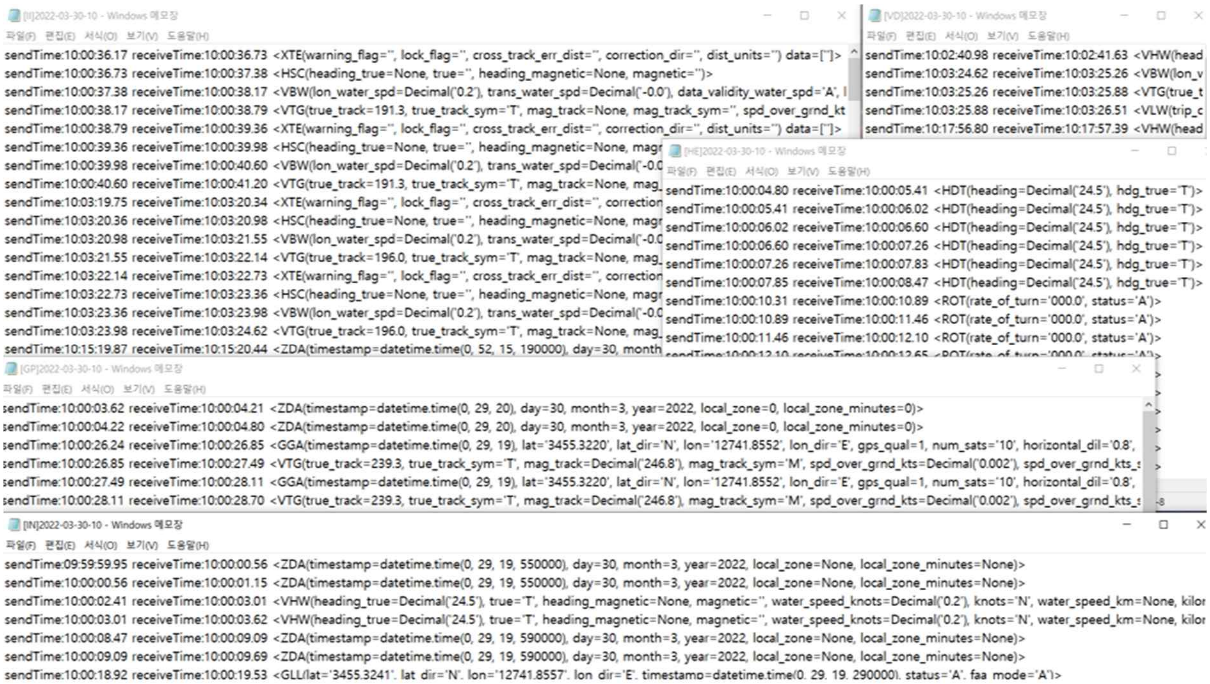

Fig. 5. PARSING VDR DATA

The fig.5. is TEXT that PARSING the data to fit the NMEA code manual and delivers it on land. It was worked to make it much easier for land controllers to recognize and judge information immediately. The PARSING data value is automatically stored in the message exchange system installed in the ship mission.

4. Conclusion and further study

4.1 Conclusion

We added CCTV and ROT considering the limitations of land control, including eight types of ship navigation information that are usually recognized as important data among the requirements recommended for existing maritime ships, and this is considered a suitable judgment. Since the audio information in the VDR item is already stored in the existing VDR, it is determined that there is no need to double-forward to the land controller. The procedure itself, which selects only the necessary information and receives data, is considered to be of great help in the construction and operation of remote control equipment as there is no special abnormality at present. These selected information includes sending it to the Switch hub using a message exchange system installed on the ship, and parsing it to facilitate data verification in the middle. It will be of great help in establishing a land remote control system through continuous improvement and development of the screening and delivery process.

4.2 Further study

We plan to study to improve the form of PARSING so that it is easy to grasp all information at a glance. In addition, due to capacity problems, CCTV images are captured and received as image files, and in order to preserve and receive the images themselves, it is necessary to establish a platform that plays a role of delivery in the middle. In the future, if it is determined that a video image form is necessary, research and experiments related to this will be conducted. In addition, in the case of ECDIS among the collection data, the ship's navigation information is collected in the form of letters, and it is planned to be collected as image in the form of RADAR/CCTV and used as ship control information. Accordingly, it is necessary to check whether there is a possibility of limited capacity in additional data reception or confusion with other existing information and communication disturbance problems when receiving new information.

Acknowledgement

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https://www.imo.org/en/MediaCentre/PressBriefings/Pages/08-MSC-99-MASS-scoping.aspx. (accessed on 31 May 2018).

[2] RESOLUTION A.861(20) adopted on 27 November 1997 PERFORMANCE STANDARDS FOR SHIPBORNE VOYAGE DATA RECORDERS (VDRs)