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APPLICATION OF ELECTRONIC CHARTS DISPLAY AND INFORMATION SYSTEM IN A RIVER NAVIGATION ON THE SHIPS OF THE RIVER FLOTILLA

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Abstract: *The problem of realistic and quality display of hydro navigation data that are necessary for realization of safe and secure sailing is a task that can be solved using modern information system, that is, electronic charts. One of such solutions is given exactly through the system of ECDIS. The mentioned system represents an efficient, information platform intended for successful planning, organizing and realization of navigation along river courses. It is about practical, efficient and useful system that provides necessary transparency, that is, river traffic visualization with all hydro navigation elements and the current situation on waterways. A working principle of ECDIS is based on data consolidation from electronic nautical charts, positioning device (GPS), thus contributing to more safe navigation and sailing in all hydro meteorological conditions.*
The paper will present Inland ECDIS system and its importance for the ships of River Flotilla of the Serbian Army, especially when it is about their sailings along the international river courses.

Key words: *navigation, sailing, electronic nautical charts*

1. INTRODUCTION

Electronic Charts Display and Information System (ECDIS) is a modern solution for secure ship management, safe and reliable navigation. (Hrle, 2007). The implementation of mentioned system in the ships of the River Flotilla, in addition to reliable navigation, enables a number of benefits such as: transparency of the whole tactical situation in real time and availability of larger number of hydro navigation information generated according to the circumstances prevailing at the certain moment of sailing.

2. ELETRONIC NAUTICAL CHART (ENC)

Geographic Information System (GIS) is a system of geographical coding of orientation data, in which all important objects are determined by the correct geographical coordinates (latitude and longitude). The existence of the GIS enabled creation of a digital chart (DC) on which platform are made electronic charts, and the so-called electronic nautical charts for the purpose of ship navigation.

ENC can be used in combination with almost every navigation instrument: GPS receiver, radar, gyrocompass, depth gauge… The real position is known at any moment with the use of electronic chart. Analog data can be written in digital form in two ways: raster and vector.

Raster chart represents an equivalent of a classic paper navigation chart by its content and volume of information. As a matter of fact it represents scanned version of a paper navigation chart which must be georeferenced due to its utility value in ECDIS, i. e. the coordinate for every raster pixel must be determined.

There is no possibility of layered display as with the vector charts and once you create a raster chart it cannot be updated.

Vector charts represent the base, the core for the information system of ECDIS with its database in which it is possible to place all necessary and useful data for safe sailing. They are aligned with the standards of IHO (International Hydrographic Organization) and IMO (International Maritime Organization). The creation of these charts consists in vectorization of the raster (the scanned variants of up-to-date paper navigation charts). Coastal lines, waterway borders, dams, ship locks, depth and, in general, all the data important for sailing on internal waters are vectorized.

Vector charts are “intelligent”, because thanks to the vector data it can predict situations in dangerous areas, mark a target object and warn the user of an imminent danger on time.

3. ELECTRONIC CHARTS DISPLAY AND INFORMATION SYSTEM

“Automatization and digital technique, except for the possibility of creation of electronic charts, also enabled combined use of electronic navigational charts with other navigation devices and instruments. There are multiple systems for the use of navigation charts, however the most used ones are Raster Charts Display System (RCDS) and ECDIS.

Raster Charts Display System is a system that is less common than the ECDIS. It is a base on raster chart and it is intended for medium and larger ships. The data are based on the content of the database and they are only visually available, a selective selection of the data is not possible and it is not possible to turn off the redundant information. Only advantage is similarity with paper charts and a way of working that is more familiar to users (Soskic, 2016).

Electronic Chart Display and Information System represents computer system which serves for display and work on electronic nautical charts, travel monitoring and navigation planning. This system is able to present raster and vector charts.

ECDIS shows real situation on the navigation area. In other words, this system shows the position of its own ship as well as the position of other ships. The system receives navigational data about its own ship from GPS, while positions of other ships recieves from the Automatic Radar Plotting Aid (ARPA). The system shows similar to the radar, movement of the ship in relation to other ships (Soskic, 2016).

Display of electronic charts is just one of many aspects of ECDIS, because the ECDIS is also an information system. As an information system, the ECDIS enables the user to seek for

additional information about target object on the chart. For example, the lighthouse on the chart is marked with a proper symbol, system is able to provide every possible information about this object (height, work mode, is it served by man or automated, photograph etc.)

The core of ECDIS consists of: hardware, software and database.

Hardware of ECDIS (computer, monitor, computer case, keyboard and mouse) must be projected and produced so that it works in specific ship conditions, without reducing quality and reliability. All hardware components are placed in the wheelhouse, so they are protected from all weather conditions. The central component of the ECDIS hardware is a high-performance computer which is connected with other ship devices, through which it receives key information such as: gyrocompass course, turning speed from direction indicators, ship speed from the speedometer and ship position from GPS, which provides a constant stream of highly accurate position data via the National Marine Electronics Association (NMEA) interface, etc.

Software of the ECDIS system is projected, developed, implemented and tested in accordance with software requirements of valid international standards. It consists of user interface and the so-called ECDIS carnelian which enables reading the data and its display. The software, in addition to the chart image with information, also displays command keys, as well as keys for working on the nautical chart.

The ECDIS system uses the following databases (Raskovic, 2001):

- SECDB (System Electronic Chart Database) is a database to which the user does not have a direct access, i. e. it can only read data, however it is not able to change it.

- SENC (System Electronic Navigational Chart) is a database that is equivalent to the database of electronic chart, but it is designed so that the user is able to change it. More precisely, this base needs to be updated.

The main database of the ECDIS system is a vector chart which contains multiple data that are important for safe navigation.

Database of the charts is organized so that it covers the whole earth surface, without overlapping. All nautical cartographic objects are stored in it, as well as the objects created during system operation, such as: pivot points, notes, position of own ship and other ships position (Raskovic, 2001).

The chart is generated based on the read data from the database and then it is displayed on the screen. The user can open the data about depth around some shoal using the cursor, which enables us to provide the function for anti-stranding and collision avoidance. The computer continuously and automatically checks given parameters and establishes if the ship is on the course.

Electronic Chart Display and Information System has three basic work modes:

1. Navigation monitoring mode

2. Navigation mode and

3. Navigation planning mode (Soskic, 2016).

Navigation monitoring mode is mandatory and works continuously in order to ensure adequate safety of the navigation and it enables the following:

- Continuous display and tracking of own ship

- Automatic recording of the movement of own ship and other ship

- Recording of the movement of targets given from the ARPA

- Keeping an electronic ship journal

- Graphic presentation of the overview of the accuracy of the ship's position and plotted objects on the chart

- Collecting the data of the ship's position in relation to the paths of the ship

- Getting the calculated vector of the current position of the ship

- Shows the current scale of electronic chart and

- Display of the data given from the auxiliary navigation sensors.

In case the ship gets near to some of the isolated hazards such as: the soil of a certain depth, underwater obstacle, oil platform, rock, well, shipwreck etc., the ECDIS automatically gives adequate warnings.

Navigation mode is the basic work mode of ECDIS. It shows the position of its own ship on the screen and simultaneously works with the navigation tracking part. This mode provides and displays the following data to the user:

- The position (symbol of the ship and motion vector) and the path of its own ship

- An electronic chart with layers of automatic and manual corrections and special user information

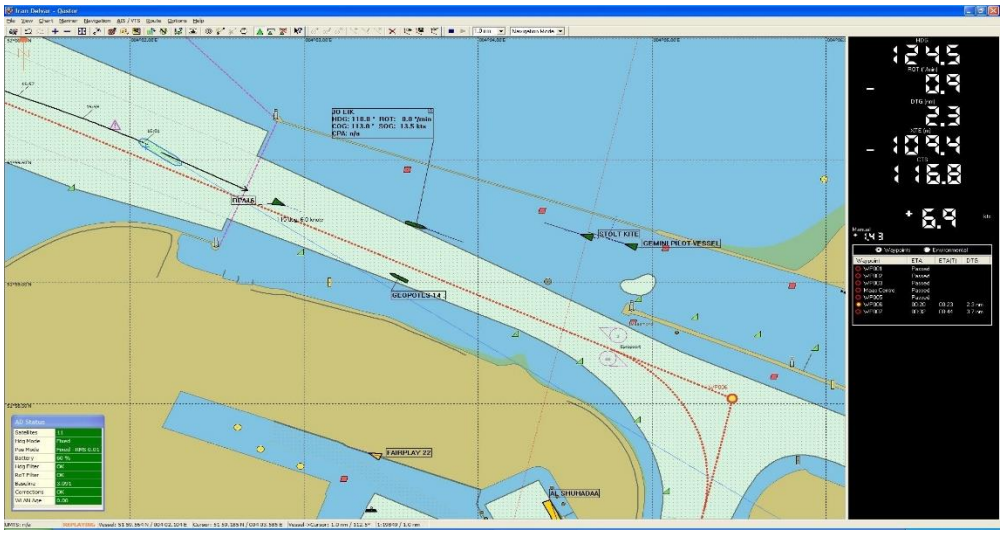
- Secondary radar information in graphic form which are activated if necessary

- Targets obtained from GPS

- Results of the ship's trial maneuver in graphic form

- Navigation planning on the chart and

- Displaying the sector of lights visible from the ship's position, taking into account the visibility range.



Picture 1. Navigation mode
Source: (http://gisforumdanube.org/ecdis/)

Navigation planning mode ensures two basic ways to create and modify the ship's route and those are: graphic and tabular. In accordance with the IMO requirements, the possibility of checking the planned route must be applied due to eventual passes through the safe contours and dangerous areas. During such dangerous passes adequate warnings are activated. In

addition to this, the calculation of arrival to the turning point is also activated, considering the speed of the ship or the required speed, depending on the entered arrival time at a certain point.

4. APPLICATION OF THE ECDIS ON THE SHIPS OF RIVER FLOTILLA

Ships of the River Flotilla take trainings, exercises and other engagements on internal waters of the Republic of Serbia, and most of the sailings include international waterways and therefore, like all the other vessels, are subject to the Law of Navigation and Ports on Inland Waters.

Due to work on the development of safety and security of navigation, the defense system of our country saw the need for implementation of the Inland ECDIS system on the ships of River Flotilla, which facilitated the work on preparation of the ships for sailing and ensured safe and reliable ship navigation, as well as the timely informing of the crew about the conditions on internal waters.

Inland ECDIS is a system built in the ships of the River Flotilla in accordance with all valid international rules and standards that are important for navigation on international waters. The mentioned system, in addition to the image on the computer screen, shows the navigational environment in real time, and unifies various information necessary for safe navigation. Furthermore, the system is fully automated, continuously follows the position of the vessel in relation to the land, as well as the objects and obstacles on a waterway. Inland ECDIS reduces job volume of the crew in navigation preparation of a ship for sailing compared to the traditional preparations and informing methods. It contains all important cartographic and additional information that can be useful (data function) for navigation.

Inland ECDIS is used in one of the four configurations (Soskic, 2016):

- Independent equipment of Inland ECDIS without the radar
- Independent equipment of Inland ECDIS with the radar
- Inland ECDIS equipment with the radar and a common monitor and
- Independent radar equipment with integrated equipment of Inland ECDIS.

In the first configuration, only work in information mode is possible, while in the other three it is also possible in the navigation mode, with the fact that only the end result is different (output to one or more monitors, integrated radar image or not). In the second configuration, the radar function is included, with the fact that the radar image is on the separate monitor. In the third configuration, the radar function is also included, and the radar image can be displayed via the chart or independently, without it, and all that takes place on the common monitor. (There is a switch for the video output from the radar and ECDIS.)

Inland ECDIS found its application on the ships of the River Flotilla in the domain of the navigation information system (NIS) which represents a subsystem of a command information system (KIS). Furthermore, the navigation information system consists of navigation devices that are interconnected and software integrated into a single system.

The basic parts of the NIS are:

1. River navigation radar,
2. Automatic identification system,
3. **Information system for display of electronic charts (Inland ECDIS),**
4. Global Positioning System (GPS),
5. Devices for optical navigation-cameras and laser distance meters,
6. Navigation sensors:

- Depth gauge-echosounder,
- Compass,
- Speedometer,
- Wind speed and direction sensor
- Yaw rate sensor.

What especially characterizes Inland ECDIS is a possibility of storing large number of data which is directly connected with the navigation safety, because with more information it is easier to guide the ship through the navigation dangerous areas. Furthermore, the advantage of this system is that it also enables display of unlimited number of information for different objects in continuity. The application of this system on internal waters is huge, because it gives the data about target objects-their radio frequency, size, volume, capacity, audio images etc. (the example of the ship lock, where by clicking on the lock all the necessary data from the base are listed) (Soskic, 2016).

5. TENDENCIES OF FURTHER ECDIS DEVELOPMENT AS A PART OF THE NIS SYSTEM ON SHIPS OF THE RIVER FLOTILLA

There is an idea about the development of NIS navigation information system that is complicated and requires bigger resources, but it is a multidecade solution. To be specific, we have to think about the development of a completely independent system for navigation on internal waters that would at least partially rely on the products that would originate in the River Flotilla itself. If there is no possibility in the domain of information engineering to make separate software for navigation on internal waters, that would be compliant with prescribed standards, then the possibility of creation of ENC could be considered.

Considering that there is a Multibeam echosounder in the River Flotilla, and that there is a hydrographic staff within Republic of Serbia that would do hydrographic recordings using the Multibeam echosounder, we could say, with a certain dose of enthusiasm, that in the future, with adequate resources, we could become an important manufacturer of ENC by valid standards.

The River Flotilla in the navigation domain can claim its own prosperity in the future. We can even think about the creation of ENC by valid standards, that in the second step of creation would be filled with the data useful for the River Flotilla and the Army of Serbia and to which database only entities from the defense system would have access.

6. CONCLUSION

ECDIS information system facilitated modern navigation where it went one step further in terms of availability of valid and important information for the navigation itself, respecting traditional values and maritime specifics. The use of ECDIS does not exclude the use of commercial marine charts, but it provides a new dimension for safe and reliable ship guiding (Bistorovic and Komorcec, 2015).

The system is very rational, efficient, reliable and applicable. In terms of navigation, the system offers more options than navigating on classic paper charts, and an update of data is very simple and practical. A system like this contains all conditions for guiding navigation on a safe, efficient and secure way. Storing the data is much easier with the possibility of a constant expansion of vector bases in which useful information for navigation are placed. Easy planning and control of a chosen route, constant display of own ship and surrounding ships, availability of all important data for safe ship navigating (speed, course, distance from

neighboring ships or objects) are just a part of recommendation for application of this practical information navigation system.

These characteristics make ECDIS almost mandatory on the bridge of every ship. What is necessary and very important is constant updating data on ENC, because the electronic charts are the basis of this system. The system follows prescribed international standards and provides safe navigation even in dangerous navigation areas using updated and concise electronic charts. Considering that it is about one information system, it is to be expected that in the future the ECDIS, based on new software solutions, will be even more improved and will make planning and performing navigational activities even easier.

REFERENCES

Bistrovic, M., Komorcec, D., (2015). Impact of E- Navigation on ECDIS Development as a Decision Support System, University of Rijeka, Faculty of Maritime Studies, Rijeka.

Hrle, Z., Radonjic, A., Pjevcevic, D., (2007). Primena sistema elektronske navigacije u vodnom saobracaju, University of Belgrade, Faculty of transport, Belgrade.

Raskovic, M., (2001). Terestricka i elektronska navigacja, University of Montenegro, Faculty of Maritime Studies, Kotor.

Soskic, S., (2016). Kartografsko modelovanje i vizuelizacija hidronavigacijskih podataka na plovidbenim kartama, University of Defence, Military Academy, doctoral dissertation, Belgrade.