Assumptions to the Selective System of Navigational-maneuvering Information Presentation

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ABSTRACT: In the era of emerging technologies in the transport decided to create three-dimensional visualization system which virtualizes real navigation situation of the ship in a restricted area. The system in its destiny is a part of a large branch of the eNavigation and is intended as a tool to assist decision navigator on the ship's bridge, particularly in the berthing maneuvers. The article presents the technical assumptions for the system. Presents its destination, innovative solutions including the ability to multi-territorial virtualization and preview the actual position of the individual.

1 INTRODUCTION

For several years in the maritime field, we distinguish the "eNavigation" term. The IMO's eNavigation initiative has as its goal the seamless integration of information: "eNavigation is the harmonized collection, integration, exchange, presentation and analysis of maritime information onboard and ashore by electronic means to enhance berth to berth navigation and related services, for safety and security at sea and protection of the marine environment" (IMO, 2004).

The decision support systems (Navigation Aids) also enroll into this area, which covers broad scope of information to assist the navigator in the safe passage of the ship. These include:

– classified hydrometeorological information,
– anti-collision and alarm systems,
– cargo handling operations systems,
– systems to monitor ship traffic parameters,
– for the route monitoring systems,
– systems for presentation of vessel's location in space
– other.

We also note the tendency to integrate multiple systems, with the properly selected, multi-level form of presentation of navigational information - Human Machine Interface (HMI), forming the Integrated Bridge Systems (IBS). They are characterized by, among others:

– simplified watchkeeping,
– standardize HMI,
– enhanced conning display,
– multifunction workstations provide any function at any place,
– consistent data available at each workplace,
– health monitoring of system status and performance,
– data quality and sensor selection management,
– intelligent alert management,
– simple to install and upgrade due to open architecture,
– standardized hardware improves logistics of spares,
– standardized software eases configuration and service,
– increased efficiency,
– improved safety,
– cost savings,
– integration of further ship system data and operation (Raytheon Anschütz GmbH. 2009).

2 INTEGRATED BRIDGE SYSTEMS REVIEW

Later presented, System of Navigational-maneuvering Information Presentation is mainly a part of areas of presentation the vessel's location in space and monitoring the parameters of motion systems, forming the so-called Enhanced Conning Display (ECD). Hence, a further part of this paper will only get down to these types of systems.

Referring to the review of existing IBS, presenting the ship's location in space and its motion parameters, it can be noted that the most of them are used by the navigator in the passage in open waters. Examples:

− ECDIS 2D/3D - system mainly designed for presentation of vessel's location in space based primarily on Global Positioning Systems - GPS/DGPS, very cumbersome in mooring maneuvers, vector coastline often do not coincide with the actual shape of the berths, simplified the waterline of the vessel (Fig. 1);
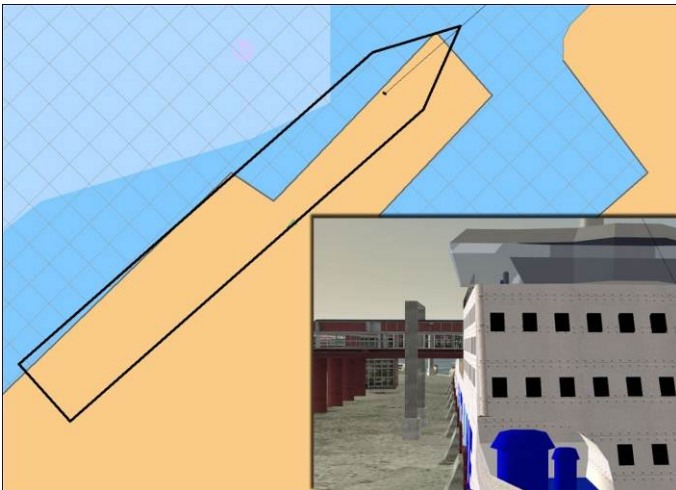

Figure 1. ECDIS – costal line deformation (Own work).

− Radar / ARPA systems – presentation of vessel's location and anti-collision system mainly used in the open sea voyage, not very accurate and inefficient inside the ports (Fig. 2);
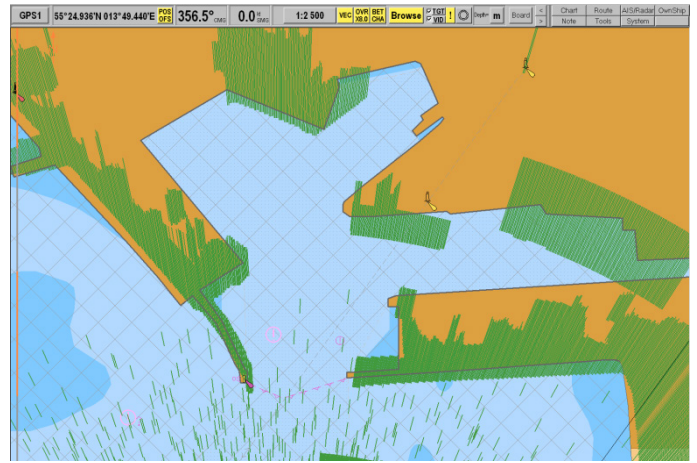

Figure 2. Radar/ARPA echoes distortion (Own work).

− Planning Station / DP systems - expensive positioning systems and presenting of unit's location, which are applied only to the specialist vessels and ferries. Applying them to common units of the merchant fleet is a highly costly and inefficient (Fig. 3).

− Dedicated positioning and presenting of ship's location systems - systems created against order, dedicated for a specific restricted areas or port infrastructure (LNG, Ferries, Narrow Channels). Systems based on highly accurate positioning systems such as Real Time Kinematic (RTK), ladars, ultrasound, which allows navigator to maneuver the ship safely. They are mostly two-dimensional presentation of information systems, with a very simplified model of the ship (Fig. 4).
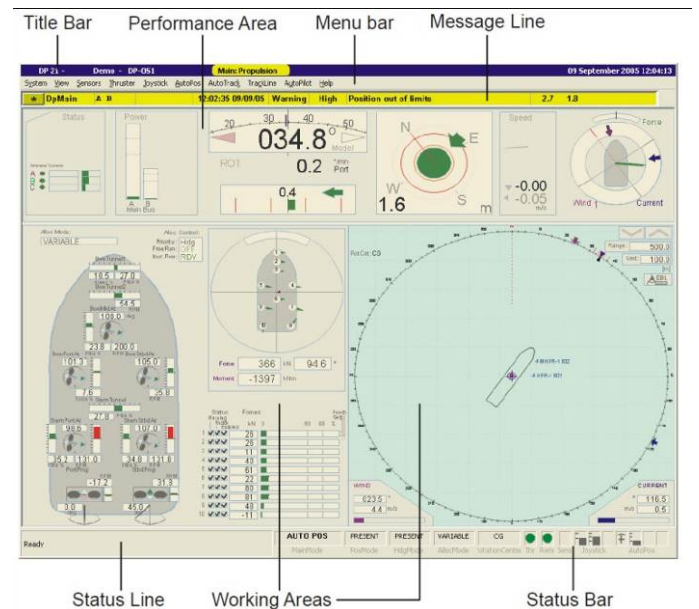

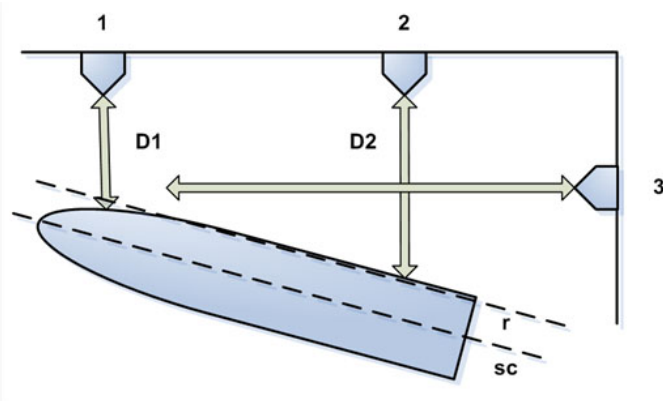Figure 3. Dynamic Positioning Interface (Kongsberg AS. 2005).

Figure 4. Dedicated LNG positioning system (Gucma, S. & Gucma, M., 2010).

Invariably, for centuries the simplest and most efficient way to assess the vessel's location in space in the restricted areas, in ports is a visual observation.

3 SYSTEM ASSUMPTIONS

No system being supplied with modern navigation bridge is able to completely replace the human factor. Thus, it is necessary to provide the navigator with navigation and maneuvering information as much as possible, and then submit them in an ergonomic form (HMI).

As mentioned utility of systems which presents the position of the vessel against berths in the last phase of passage and during berthing maneuvers is very limited because of its systematic and unsystematic errors.

The only reliable source of information for decision-making is a visual observation. However, it has two basic limitations:

1 is strongly dependent on the currently prevailing hydro-meteorological conditions, particular on the degree of visibility,
2 the navigator has the ability to simultaneously observe only one side of the ship.

For long ship with superstructure in the stern, the navigator on the bridge is not able to assess the distance between the bow section and the obstacle at the height of the waterline. Conversely, the superstructure in the bow - no information about the location of the stern. To perform a safe approach and berthing maneuvers it is necessary to provide information about the navigator position outside of the bridge. Generally it is a crew member equipped with radio communication device or installed on the side of the quay/vessel CCTV camera. Both methods are very limited in heavy fog.

Given the above, decided to create a selective system of navigational-maneuvering information presentation based on mathematical (graphical)

models of dedicated vessels and areas. The system allows multi-level assessment of the vessel's location relative to obstacles, regardless of weather conditions.

Main task of system is to faithful reproduction of actual navigational situation with use of mathematical (graphical) models of the vessel and area. Created models were implemented into the virtual environment, where based on standardized data from the positioning systems they are located in the space in three degrees of freedom (in the future the destination is six degrees of freedom).

3.1 *Mathematics (graphical) ship's model*

Mathematics (graphic) ship model is built in three-dimensional environment based on the technical documentation provided by the unit owner. Virtual hull in both its parts above and below the waterline is a faithful reproduction of a real vessel as to the scale, location and shape (Fig. 5).
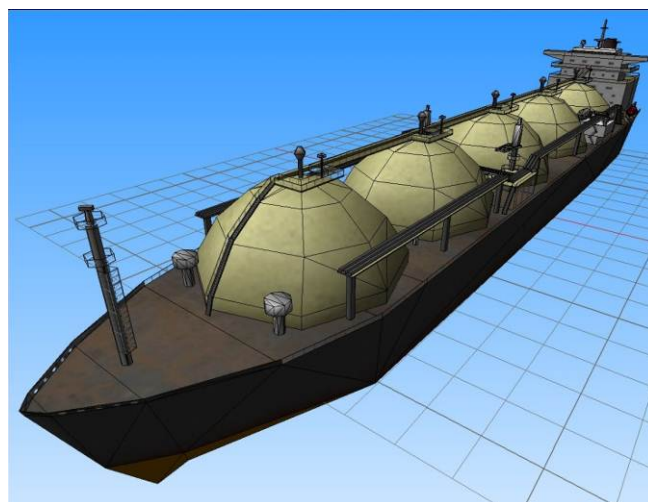

Figure 5. Graphical ship's model (Own work).

The degree of detail of the model depends on the complexity of the original hull's shape. There is possibility to make a virtualization of elements constantly attached to the hull well as moving parts.

3.2 *Mathematics (graphical) area's model*

Mathematics (graphical) model of areas is also built in three-dimensional environment based on the technical, spatial plans, digital maps (Fig. 6) In the absence of sufficiently accurate plans, it is possible to digitize the virtual model of the basin on the basis of geodetic measurements of such wharves with the use of RTK for instance.
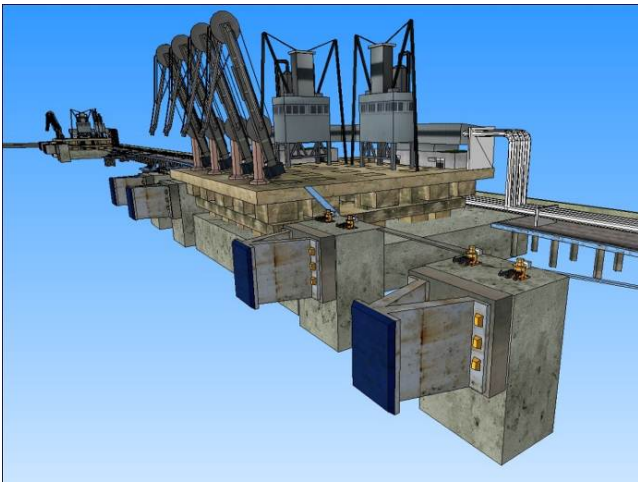
Figure 6. Graphical area's model (Own work).

In addition to the model of the area coastline it is also necessary to make a virtualization of:

- buoys and navigation marks
- hydrotechnical architecture,
- water surface (simplified model).

Thus prepared, the model is positioned in the WGS84 datum of the behavior of the real values of coordinates Lat / Lon or UTM.

4 SYSTEM STRUCTURE

The system consists of two blocks:

1 collecting and recording of input data into system memory
2 reading and data processing

Ad.1. Block of collecting and recording of input data is an independent algorithm that allows to implement to the system variables from independent sources, without requiring changes to the code of second block. This means there is possibility to connect, e.g. various positioning systems, continuous hydro-meteorological data, etc. (Fig. 7).
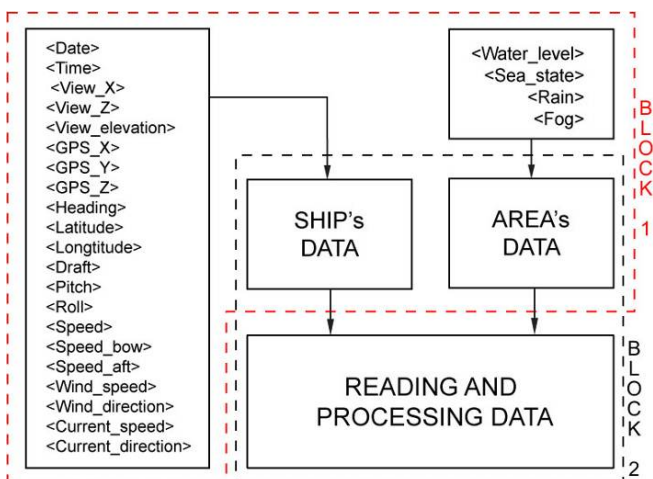
Manual defining of the fixed input is also available.

Figure 7. Collecting and recording block (Own work).

Ad.2. Block of reading and data processing is responsible for the division and assignment of the relevant variables to the mathematical (graphical) models of the vessel and area (Fig. 8).
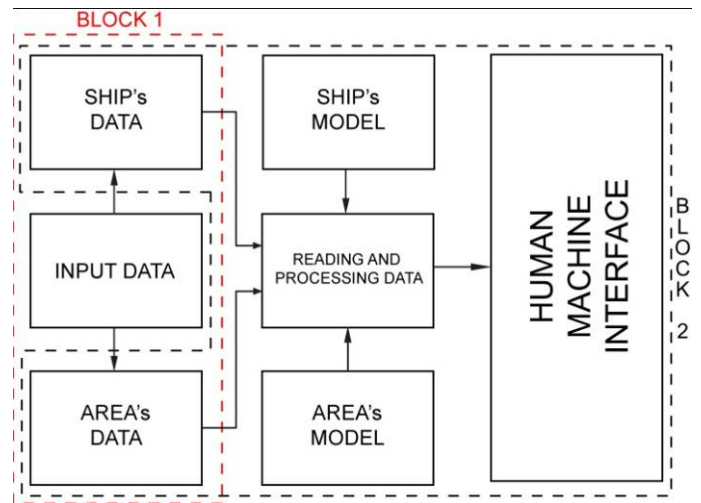

Figure 8. Reading and data processing block (Own work).

In the first version of the software there are available:

1 Data for the model of the ship:
- the date and time,
- local coordinates of the point of view and the viewing angle from the bridge,
- local coordinates of the positioning system's antenna location (it is possible to define more points of reference for the ship's hull),
- heading,
- global position of the antenna (vessel's position),
- draught,
- the value of trim / pitch (automatic only available with an additional gyro),
- the value of roll (automatic only available with an additional gyro),
- the longitudinal and transverse speed,
- the strength and direction of current / wind.
2 Data for the model of the basin:
- current water level,
- sea State (simplified model),
- intensity of rainfall (automatic only with additional sensors),
- fog level (automatic only with additional sensors).

Models with the actual data associated, create a virtual interface that reflects the actual navigation-maneuvering situation.

5 SYSTEM INTERFACE

The concept of an interface for the involves the implementation of the following features (Fig. 9):

1 The main screen - a view from the bridge at the centerline of the ship;
2 The navigation bar - the presentation of weather and maneuvering information, with the option of transfer to any location on the screen;
3 System Tray;
4 New camera button - a function that allows simultaneous viewing up to five places in the vicinity of the ship,
5 Preview of added cameras – by clicking on the thumbnails for the camera larger screen is obtained.
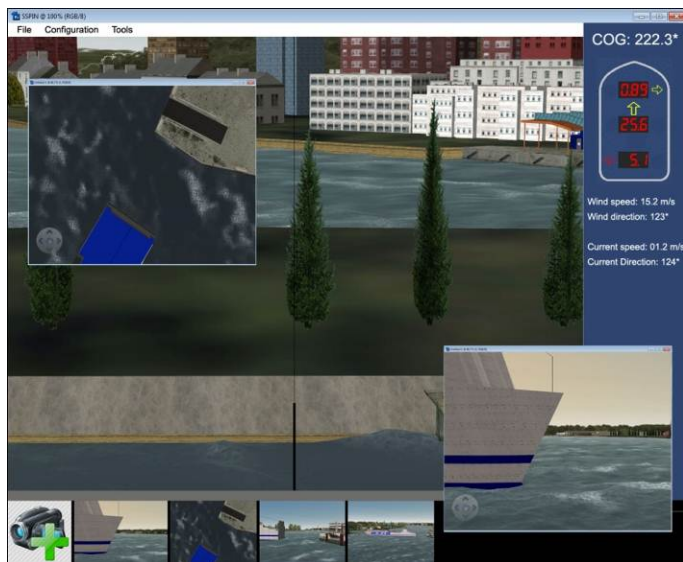

Figure 9. Proposal of system interface (Own work).

One of the system's novelty is function, that allows to place the navigator at any point in space around the vessel (including outside the vessel) to 5 virtual cameras simultaneously. With this option it is achieved a full picture of the current navigational situation regardless of weather conditions (Fig. 10)

Each newly-added camera has a thumbnail preview at the bottom of the screen. At any time you can zoom in on a miniature picture, placing it on the screen as the larger windows (Windows® style). In this mode, there is possibility to make moving, rotating, zooming each camera individually. Site selection is made on the two-dimensional map.
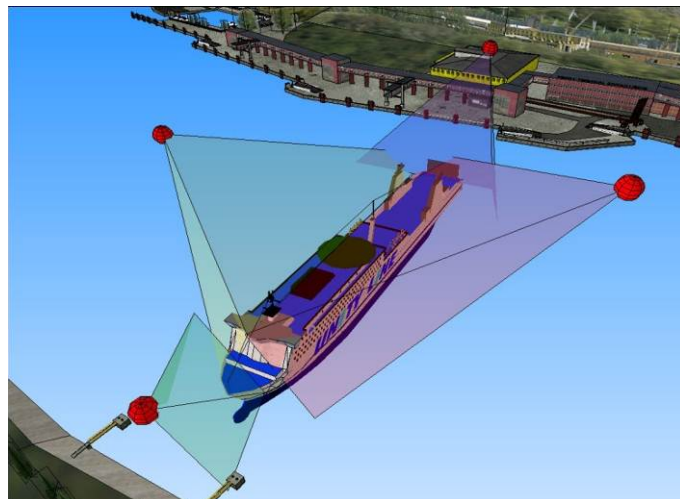

Figure 10. Additional cameras location – turning maneuver (Own work).

The interface system is designed to faithfully reflect the actual navigation and maneuvering as much possible in the virtual environment and, through its innovative features to enhance the safety of the ship maneuvers in a restricted area.

Verification of the graphic interface will undergo a expert tests, in order to improve ergonomics of reading and interpretation of shown information.,

6 CONCLUSION

The proposed decision support system will be developed to improve the safety and to optimize the maneuvering in restricted areas. It was assumed that non-autonomous methods will be used to its verification with a fullmission bridge simulator, as well as selected aspects will be examined in reality (with m/s Navigator XXI).

In the future, the following tests, inter alia, are expected to perform in configuration with and without the proposed system:

− safety maneuver in different weather conditions - safety lines,
− energy hull contact with the fender,
− optimize the number of given orders by a navigator,
− others.

Presented system has a development structure. This means there is possibility to implement the modern features such as: anti-collision system, planning and monitoring of virtual routes, automatic measurement of the CPA to the berth, the prediction power of contact with the fender, etc.

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