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MODIFICATION OF ECDIS INTERFACE FOR THE PURPOSES OF GEOINFORMATIC SYSTEM FOR PORT SECURITY

ABSTRACT

The paper presents a functional concept of an interface for one of the users in Geoinformatic System for Port Security. The system goal is to support port security by providing a selected groups of information and displaying them on precise charts. The complex system assumes simultaneous employing of various users including port management and port authorities. One of the planned users is patrol boat crew, which role is to be a mobile tool for waterways monitoring and should perform as on-scene sensor. The interface concept presented in the paper is based on ECDIS, as it was assumed, that the user on patrol boat is usually familiar with thus system. The goal of the research was to create interface project with the principles of UCD (User Centered Design) based on CHI (Computer-Human Interaction) approach. In the article the short functional analysis of standard ECDIS interface is presented. It is followed by comparison between its common users and the future users of GEO system with the emphasis on their requirements, expectations and demands. As a result a group of dedicated, user-orientated functions were agreed. A modification of ECDIS user interface is proposed in order to implement mentioned features.

Keywords:
ECDIS, port security, waterways monitoring.

INTRODUCTION

GIS solution for operational actions related to the marine port security is a system based on very precise land and underwater geospatial data for implementation in the Szczecin — Świnoujście port area. The system (further referred to as GEO) is being developed in Maritime University of Szczecin as an R&D project.

Already in its early stages a problem of a dedicated interface for system's users occurred. Due to a certain range of systems participant a need to determine a versify interface for each group was defined. One of the system's users is the navigator on board of patrol ships monitoring the coast and the port from the sea side. Thus one of the tasks is to create a project of dedicated interface for such users.

Due to its purpose and wide application, it was natural way to take into consideration ECDIS (Electronic Charts Display Information System) interface as a base, which is widely known to the navigators. Such an interface can be then adjusted for the needs of GIS security system. There are several main functions of ECDIS which can be useful also in GEO. Other things need to be adjusted or changed. Main changes assumed introducing of additional functions comparing to ECDIS interface for managing new layers of charts created in the system. Simultaneously additional features like options or operations toned to be allowed with new functions. The interface shall remain however ECDIS-like to allow easy and intuitive access to additional functions even for new users.

The paper consists of several chapters in which a process of creating an interface is presented. First, GIS for port security system's concept is described with special attention to patrol boat user. Then, ECDIS functions are analyzed and described with the use-case diagrams. Finally, proposals of modifications are stated and presented with use-case diagrams.

GEO system's functionality was tested among users in Szczecin — Świnoujście sea port which allowed applying technical solutions that take into account already existing equipment and capabilities of target users.

GEOINFORMATIC SYSTEM FOR PORT SECURITY (GEO)

The main purpose of GEO project was to create a geoinformatic system that would support operational actions related to monitoring and securing marine port together with its staff and facilities. As a system based on static and dynamic precise geospatial information it exceeds traditional CCTV-based monitoring system. It consists of 4 main modules. The basis of the GEO system is a 2D/3D map module that contains precise spatial data of the port and its surrounding area. It includes not only topographic and bathymetric data, but infrastructure, communication, security and mains information as well. It allows to visualize current or archive situation

together with dynamic information on ships, dangerous goods, mobile on-land and boat security patrols. It also contains informatics tools for performing certain spatial analysis. The second and third modules are MEMS module and data transmission module. Together they allow collecting and transmitting MEMS sensors data being equipped by security team members. It allows monitoring the localization and chosen life-functions parameters of the security team members. They also allow voice and visual communication between all users of the system. The whole system is complemented by user interface module separate for each group of users. The generalized schema of system features is presented in Fig. 1. It describes which users are in charge of creating or managing certain information and which users only display provided information in the system.

Systems users are varied both in terms of access to particular modules and access to specific functions in each of them. The system is designed to be able to manage access to the contents of the data, functions and modules for each user. Participants can moreover be divided into active and passive, that is, those who use the system and manage its resources (Operator of Port Monitoring Center, Port Captain, Vessel Traffic Control Operator) and those who only provide data to the system (Security Team Member, Mobile Patrols, Patrol Boats, Ships).

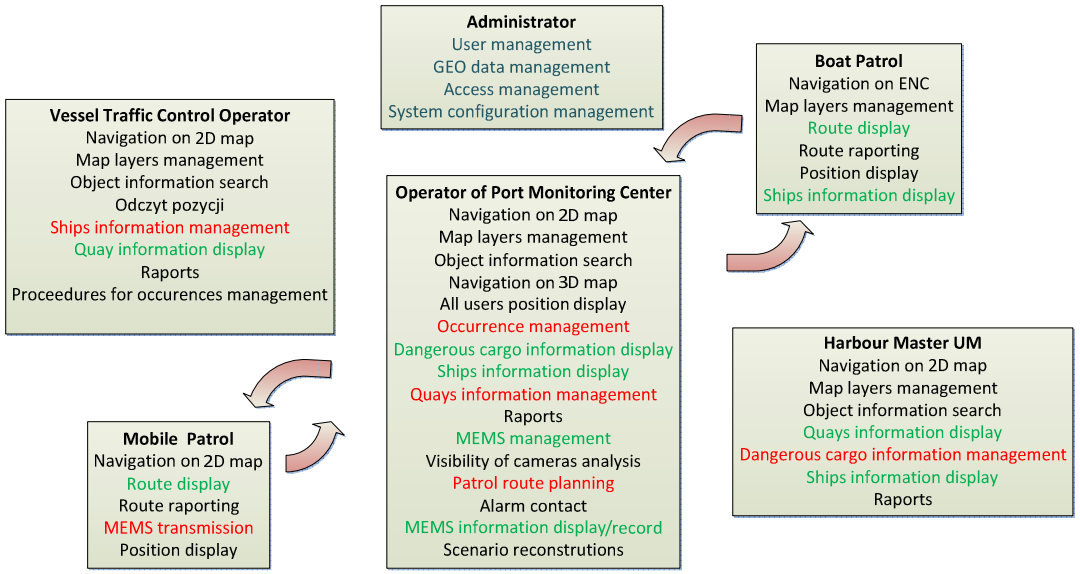

Fig. 1. Generalized schema of GEO systems features; functions that provide information — in red, functions displaying provided information — in green [own study]

PATROL BOAT IN GEO SYSTEM

Main threads for port security may arrive from different directions. One of the most important areas is the sea with water fairways leading to the harbor. There are several threats coming from the sea-side which should be considered as security accidents according to ISPS Code [3]. In this aspect, monitoring of waterways seems to be an important issue to be included in GIS for Port Security. This task is in the concept of the system divided between Maritime Office (VTS) and patrol boat. Patrol boat should be a mobile tool for waterways monitoring and should perform a role of on-scene sensor. It is worth of noticing in this place, that such patrolling with a boat is performed neither by Maritime Office nor by Port Authorities due to inaccuracies in law regulations. However there is a need for such a user to seal up the system.

During the research project a concept of such a user has been prepared. It is assumed that a major task for waterway patrol should be supporting the operational actions for harbor security from sea-side, by proper monitoring and reporting. Three modes of operation can be proposed: scheduled patrolling of an area, emergency patrol and intervention patrol. All of these actions can be performed by one or many units, depending on model considered. In different areas and for different tasks various boats can be pointed as a suitable solution. The functions and layout of the interface are though quite the same, despite of the model. The most important (common for each mode) are:

— chart displaying and management;
— presenting of other important information overlaid on the chart;
— route planning and monitoring;
— communication with other users in system (including reporting);
— logging;
— measurements.

While analyzing the functional requirements stated above, it has been noticed, that most of them are quite similar to ECDIS concept. On the other hand patrol boat crew is usually familiar with ECDIS devices therefore it is a good idea to propose GUI for this user as a modification of ECDIS.

ECDIS

Electronic Chart Display and Information System (ECDIS) is a navigation information system capable of displaying selected information from a system electronic navigational chart (SENC) together with positional information from navigation sensors, and eventually additional navigation-related information to assist the navigator in route planning and route monitoring [4]. As SENC is defined as a database containing electronic navigational chart (ENC), ECDIS can be considered as GIS technology applied into navigational field. Thus ECDIS can be also defined as information system for collecting, storing, processing and visualizing geodata, which aims at improving of navigation safety [7].

ECDIS and other ENC systems are currently more and more popular on board of the ships and soon it will be mandatory for most of commercial vessels. It shall be noticed that according to SOLAS convention ECDIS with adequate back-up arrangements may be accepted as complying with the up-to-date charts required by regulations, replacing traditionally used paper charts.

IMO performance standards

First requirements of IMO regarding ECDIS appeared in 1995 in Resolution A.817(19). Since that time however a significant technological progress has been made and a lot of experiences with ECDIS have been gained. Having this in mind IMO proposed a major revision of performance standards for ECDIS, which was adopted by Maritime Safety Committee in 2006 in Resolution MSC.232(82) (IMO, 2006). New performance standards are recommended for ECDIS equipment installed on or after 1 January 2009.

The primary function of the ECDIS is to contribute to safe navigation and for this reason detailed operational and functional requirements are proposed. From the paper point of view, the most important is module B of the standard and therefore it will be presented more thoroughly in the next part. The other modules present ECDIS as a platform for providing ENC to the navigator together with additional data from other sensors influencing safety of navigation. ECDIS should be therefore connected to the ship's position fixing system, to the gyro compass and to the speed and distance measuring device. Additionally data from radar and AIS may be integrated.

ECDIS means also a system of provision and updating of chart information. For the ENC itself, a link to IHO documents is made (S-52, S-57), and the standards focus on automatic chart updating possibilities and on quality and usability of data. It is stated that ECDIS should facilitate simple and reliable updating of the electronic navigational chart. ECDIS also should have at least the same reliability and availability of presentation as the paper chart published by government authorized hydrographic offices.

ECDIS functional requirements

In general, ECDIS main functionality is to provide information both on ships status and surrounding area. It must allow displaying SENC data in one of three modes depending on required level of details (*Display Base*, *Standard Display* and *All Other Information*). Ships information can be supported by both AIS and RADAR information and can be presented according to maps scale and orientation (north-up or other) preserving specified accuracy and symbolization, especially if overlaid with a radar image.

The other functions are related to planning and monitoring the vessels voyage. Adding/removing or editing waypoints are main functions allowing to perform a route. User can plan multiple alternative routes and display them while monitoring. System uses alerting feature in case of poor planning (safety contour crossing, proximity to any hazardous object or area) or deviation from the route. While in navigation mode, system can present position, course and speed of the ship. Display of safety contour is obligatory while referencing soundings (depth information) to given by user so called 'safety depth' is optional. Also true distance and azimuth between any two geographical positions or a position from a known position and distance/azimuth can be calculated at any time while operating. Furthermore additional geodetic calculations can be performed. The vessels route is always recorded without any possibility to change automatically generated logs.

Also ECDIS allows its user to automatically or manually carry out on-board tests of major function and preliminary diagnose where the malfunction occurred (alarm). Main ECDIS functionality is illustrated in the UML diagram below (Fig. 2).

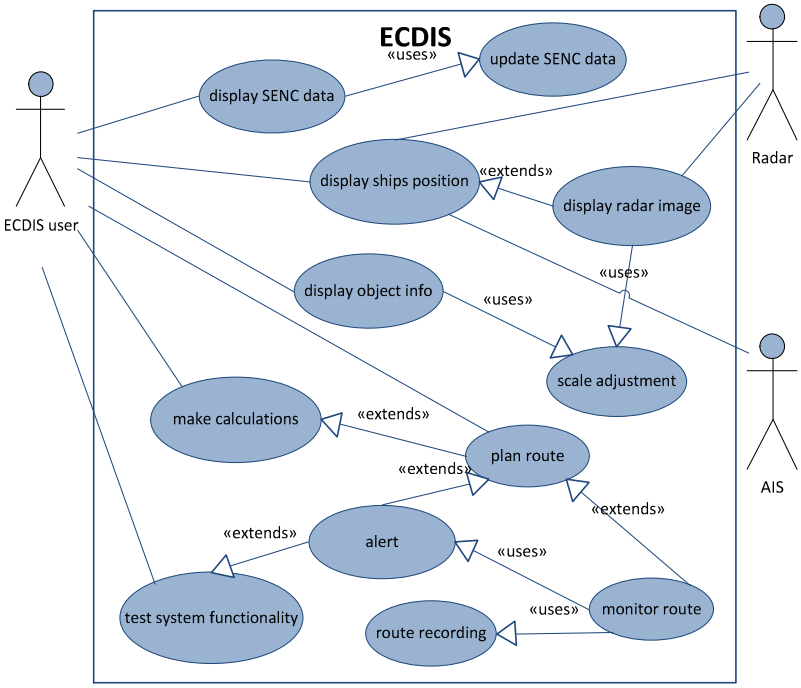

Fig. 2. UML use-case diagram of ECDIS system [own study]

ECDIS INTERFACE MODIFICATION PROPOSAL

ECDIS is designed for supporting safe navigation of the vessel. The aim of waterway patrol in GEO is not only safe navigation, but also monitoring waters and performing patrol tasks. Therefore typical ECDIS interface has to be modified to adjust it for different requirements and also for the other GEO users. Some of traditionally used functions have to be enhanced and the other reduced. New functions, dedicated for patrol tasks have been proposed. A concept of ECDIS modification is presented in this part. The description is divided into function groups as per (IMO, 2006). There are however some things, which remain unchanged, e.g. Colors and Symbols, which has to be displayed as per IHO S-52 recommendation (IHO, 2010), as well as requirements regarding display mode and generation of neighboring area. Also tests, malfunction alarms and indications may be adopted form ECDIS performance standard requirements.

The interface of system for specified user means not only software GUI, but also hardware arrangement. It is assumed, that the application will be installed on a dedicated computer. The particular station for a user depends on a kind of boat used in particular case. For a small boat a desktop system or even a laptop should be sufficient, but for larger ships a standalone station, like for e.g. radar or ECDIS, on the bridge shall be consider. In both cases a practice shows that using trackball instead of traditional computer mouse is more convenient. This should facilitate using the system. The overall layout of GUI is presented in the Figure 3.

Fig. 3. Layout of Graphical User Interface [own study]

Provision and updating of chart information

Chart management, displaying and handling are the basic functions for operating with system. ECDIS requirements, describes especially the concept of updating and encourages for using official ENCs. The chart used in GEO is an ENC enhanced with additional layers of information. The chart specification was prepared by research team in the project described in such way that a new standard was created as a result of integration of ENC, DIGEST and additional own-proposed layers. The interface thus has to be capable of proper displaying new GEO_ENC standard.

In the interface new functions for layer management has to be also proposed. First of all additional set of layers must be implemented apart of IMO *Display Base* and IMO *Standard Display*. There should also be a possibility of defining own set of layers (displays) by the user. There is also o place in proposed standard for user defined layer and a possibility of editing it should be ensured. It is assumed that there might be a need for user to draw on a chart any special area for any task (for example for monitoring or special attention).

Display of other information

Other information in (IMO, 2006) means mostly radar and AIS information, but also other navigational information. This functionality is proposed to be slightly reduced. There is no need to present all radar information, as the system is not designed for safety of navigation. Tracks of radar and AIS targets shall be displayed if available and target data shall be available. Additional information means mainly weather information. No navigational or safety alarms are required in this concept.

Voyage management

Voyage management includes route planning, monitoring and voyage recording. All requirements regarding route planning for ECDIS are in force. Additionally there should be a possibility of receiving/ sending planned route from/to other users of the system. There should be a possibility of indicating if planned route is for routine patrol or for an intervention. Additional, advanced tools for planning (e.g. parallel to the berth) may be included. In future tools for automatic route planning based on destination point shall be provided.

Route monitoring is basically used for safe navigation of vessel and as it is not focused on security it may be reduced to presenting ETA for different vessel's speed. Voyage management should also propose tools for logging of data (voyage recording) received from different sensors, these include own ship data, other ships data, planned route and a log of communication with other users.

Calculations and accuracy

GIS_PS adopts accuracy requirements for ECDIS. Linear calculations may be reduced to non-spherical calculations as the area of the system would be usually limited. Additionally calculations for polygons should be provided.

Additional functions

The most important additional function for this user, comparing to ECDIS is the possibility of generating reports and sending them to other users. A report should contain screen shot of a chart with selected layers overlaid with graphical and text descriptions created by user. Report generating wizard should be included and the report itself should be saved locally and send electronically to other users. Direct electronic communication is also an additional possibility, not provided in ECDIS, which allows mainly receiving and sending of communication but also special chart layers, reports and other comments. Figure 4 presents use-case diagram for an interface including all of the modifications stated above.

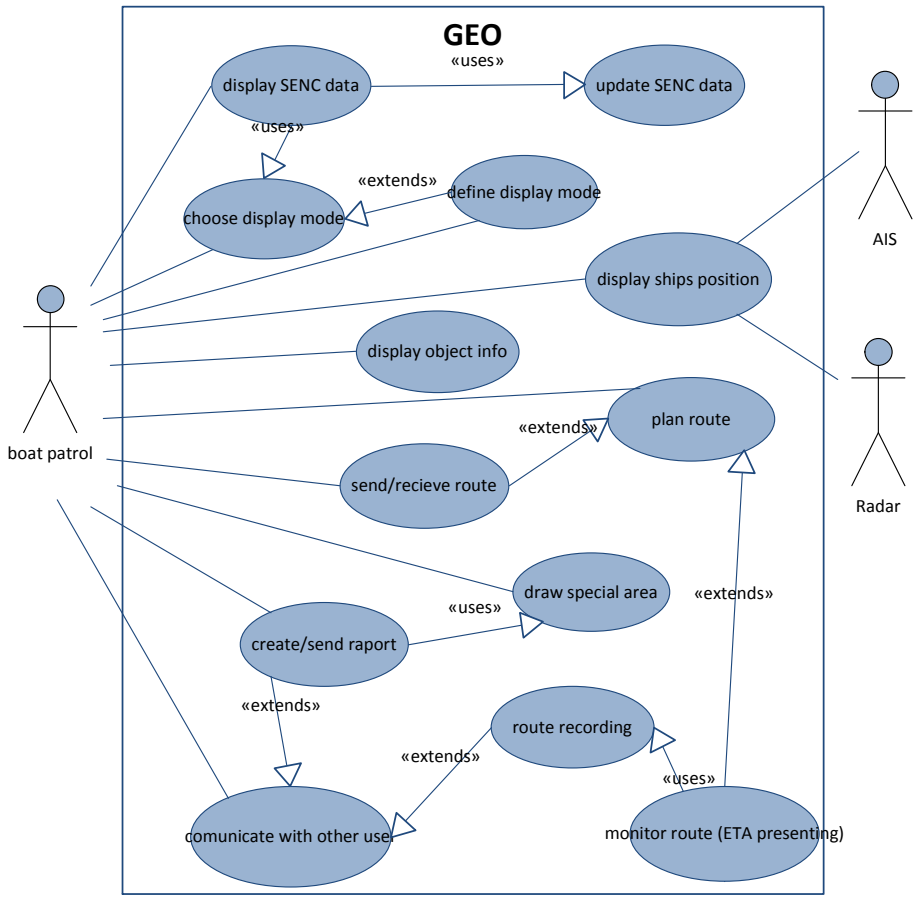

Fig. 4. UML use-case diagram of GEO system functionality for boat patrol [own study]

SUMMARY

The paper presented a description of an interface for patrol boat in GIS for port security. Use-case diagram methodology with the UML description was used. This approach has an advantage of being independent from any software and allows universal definition of functionality which facilities implementation of system.

The interface is based on ECDIS functionality, however most it functions has been modified. Some of the issues have been reduced, some developed and also new functions have been proposed.

System designed with the presented interface description will allow in future performing all of the tasks set for patrol boat, which are mostly patrolling, monitoring but also intervening. The interface will be implemented in software application and after this, it will be tested among potential users in the area of pilotage implementation if Szczecin — Świnoujście sea port.

It can be also regretted that commercial ECDIS systems are not open-sourced. It would be much easier to implement any modification to it, including the interface presented in the paper.

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STRESZCZENIE

Artykuł przedstawia koncepcję funkcjonalną interfejsu dla jednego z użytkowników geoinformatycznego systemu bezpieczeństwa w porcie. Celem systemu jest wspomaganie bezpieczeństwa w porcie przez dostarczenie wybranych grup informacji i pokazywanie ich na tle dokładnych map. Cały system zakłada równoczesne wykorzystanie różnych użytkowników, włącznie z kierownictwem portu i kapitanatem. Jednym z przewidywanych użytkowników jest załoga łodzi patrolowej, która ma pełnić funkcję ruchomego patrolu na drogach wodnych. Koncepcja interfejsu przedstawiona w artykule jest oparta na ECDIS, tak więc założono, że użytkownik na łodzi patrolowej jest obeznany z takim systemem. Celem badań było stworzenie projektu interfejsu na zasadach skupienia się na użytkowniku z uwzględnieniem zasad interakcji człowieka z komputerem. W artykule przedstawiono krótką analizę funkcjonalną standardowego systemu ECDIS, która została uzupełniona porównaniem obecnych i przyszłych użytkowników takich systemów, z naciskiem na ich wymagania, oczekiwania oraz popyt na tego rodzaju usługę. Jako rezultat zaproponowano zespół dedykowanych, zorientowanych na użytkownika funkcji systemu. Zaproponowano modyfikację interfejsu użytkownika ECDIS z myślą o implementacji wspomnianych własności systemu.