EPDIS: the electronic pilot book display system

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Abstract

The Electronic Pilot Display and Information System (EPDIS) is a new technology that presents the traditional Pilot Book in electronic format by means of the current and latest information and visual representation developments. EPDIS is a project co-funded by the European Commission, DG IST and Fifth Framework Programme, incorporating six partners from four different EU countries (Germany, Estonia, Spain and Portugal) forming a consortium. The idea is to provide a system that integrates a 3D view of the coastline as seen from the ship’s bridge connected to an information system which is basically a compendium of the data contained in the traditional Pilot Book and other complementary texts like guides to port entry, radio signals and lights books. The 3D visualisation of landscapes and shorelines is built by means of digital elevation models (DEM) and a basic electronic charting system based on the Standard S-57. This 3D view is complemented with architectonical models of the relevant buildings and marks which are used for navigation in order to recognise difficult sailing areas. In this way a 3D viewer has been designed as a result of this research and development. The pilot book information is integrated into another database system. The Electronic Pilot Book, as it is called, is a system that organizes the textual information and images from paper pilot books in geo-referenced blocks, this structure of data could be accessed or queried from the electronic chart system when a zone or conspicuous point in the 3D viewer needs explanation. By means of an XML protocol many problems of connectivity and data transfer can be eliminated, mainly all those related to the data formats because of the different kinds of information blocks (text, images, mail addresses, telephone numbers, etc).

In this paper we will describe the most relevant aspects for the development of the EPDIS system and the results obtained from the work done on the trial areas of the Baltic Sea, the Portuguese Coast and the Spanish Mediterranean. Keywords: 3D Viewer, ECDIS, S57, OSG, Open Flight, DEM, culling.
1 Introduction

Since time immemorial seafarers used to “take marks” from the coasts along which they travelled in order to have a sure reference for future voyages. This was the dawn of what we now know as Pilot Handbooks. Subsequent publications of pilot books where the coasts and their peculiarities are described for navigators – mainly edited by the English, Portuguese and Spanish – have provided a suitable solution to the need for orientation. In general they are written with the intention of providing a simple and safe guide for the skipper and bridge personnel.

Most modern ships today have the facility to centrally control operations from the bridge with the extensive use of automation and computer technology. The future “intelligent vessels” will be even more “digitised”. The officers on watch duty on such vessels need to be provided with a large amount of information on screen in order to guarantee the smooth running of the ship. EPDIS, using an appropriate tool, facilitates the query and viewing of coastline data on screen. This tool consists of a position management system by means of GPS/DGPS and a 3D coast viewer using digital terrain models (DTM), three-dimensional models of physical objects placed in the coastline and digital charts information. The tool is thus capable of integrating the pilot book data into an extensive system that will make it possible to obtain information related with the ports, objects in the coastline, lights, port services and supplies and reduce the workload for the ship officer while improving safety of navigation.

2 System description

The EPDIS system is a multi-layer functions system and its components can be summarized in two main sub-systems: 3D Viewer and Electronic Pilot Book. The nature of the information for the two systems is different but they could be related for a common element, “the geographical situation”. In the 3D Viewer we find a 3D cartographic system where the data employed for its construction comes from Digital Elevation Models (DEM), S-57 based Electronic Charts (ECDIS), high-resolution photographs for texturing and three-dimensional models for the most relevant architectural objects and navigational aids within the coastline. The Electronic Pilot Book is an independent system that stores as much as possible, a big amount of information that comes from the paper based books edited for hydrographic entities, pilot books, guides to port entry, books of lights, radio-signal lists and all the information needed for the seafarers where they can find the main pilot services, vessel traffic services and port operations when they are approaching a specific harbour. These information is complemented with visual elements like photographs of conspicuous points, coast segments, lighthouses, weather diagrams, etc. For both systems the basic term OBJECT is useful for defining all those elements that integrate them. Both 3D viewer and Electronic Pilot Book as end user interfaces are supported on two separates databases.
In Figure 1 electronic pilot book and 3D viewer databases are independent and they supply data to the system as required. The electronic chart system ECDIS only supplies information required for the 3D viewer and its data base is not modified in any manner; at the same time, information from E-pilot book data base is linked through this system in order to access and show them when a query is made.

2.1 3D viewer database [1]

Database engine is the basis for the 3D viewer software components, it keeps track of all the static data (terrain, satellite imagery, 3D objects) and also manages dynamically updated data (ships, logs).

Database engine used for 3D viewer is able to quickly process queries with large results (3D scene data), on the other hand it is able to save small updates with very small overhead (ship position and other parameters). An important ability that is required from the 3D viewer database engine is the support of geo-referenced (spatial) data. Database engine must support both vector data (3D objects, TIN) and raster data (satellite imagery, textures) in addition to standard data types (strings, integers, etc.).

As far as a database is implemented with a special file structure (e.g. hierarchical trees) it should be kept in mind that this structure has also an impact on the usability of the database. Accessibility to one single data within a structure could be necessary in case of small changes e.g. of a 3D model. The existence of prefabricated models, terrains or even databases requires a data integration feature.
As far as not the whole database has to be updated every time, some parts may stay stable over years, there have to be mechanisms or the possibility to implement partial updates of data easily or with small effort and costs. One of the major goals in information technology is to enable interoperability between systems.

2.1.1 Database kernel [1]

OpenFlight Scene Description Database Specification (OpenFlight)

OpenFlight is a 3D scene description file format created and maintained by a software vendor (Multigen Paradigm, Inc). It is used for real time applications. The full implementation of OpenFlight offers a variable level of detail and variable degrees of freedom. Furthermore you can include sound, animation sequences and light features (scene lighting, light points). It is possible to use real-time culling to bound volumes and instancing both within a file and to external files. There is no need to implement all features. It is possible to create a subset of the specification and use such subsets as a database.

Most tools available are able to import or export the OpenFlight format since it is an quasi standard for simulation. The community around the OpenFlight format is mainly influenced by companies which demand constant development. Thus OpenFlight has been selected like the EPDIS data base kernel.

2.1.2 Objects modelling

Another important task in the 3D viewer definition is the object creation. Objects must represent as much as possible, realistic features of physical and relevant conspicuous points located in the coast or port approaching areas like light

Figure 2: Building created with Blender software.
houses, cranes, buildings, etc. Among the wide spectrum of software possibilities for modelling tasks, BLENDER [2] tool has been chosen. With this tool it is possible to create 3D objects in detail including textures and attributes. The objects created in .blend format must be converted to OpenFlight format in order to fit them in the master database.

In figure 2 a building located in the Tallin-Estonia harbour approaches is represented. The Estonian partners from EMA (Estonian Maritime Academy) have produced a large amount of objects and the harbour area is now represented in great detail.

2.1.3 Geomatics tool set [3]
In order to produce the whole master database for objects, digital elevation models and textures compilation the consortium has employed The Visual Coastline Generator that is a tool developed by German Company Rheinmetall Defence Electronics GmbH. This company develops simulators and through that field they started working at the creation of 3D environments. They found out very soon, that they need special software for the development of maritime environments. Also they wanted to speed up the generation of visual and Radar exercise areas. This was the start to develop their own software VCG, which automats the exercise area modelling. VCG uses the interesting approach to take ECDIS charts as the backbone for the terrain database. ECDIS includes all the relevant information for maritime applications. The ECDIS data are combined with Digital Terrain Elevation Data (DTED) from the US National Imagery and Mapping Agency (NIMA) to include more detailed elevation data. Further on objects are created to give buildings etc. a naturalistic view. The inclusion of ECDIS-data makes the VCG very interesting to be used as the geomatics tool in EPDIS. But it is rather an in-House application that is not freely available on the market.
2.1.4 Visualisation kernel for 3D data [4]
A basic scenegraph viewer for EPDIS 3D visualisation has been selected. The OpenSceneGraph software was selected on the basis of the great participation of the application engineers working in the field of 3D simulation or visualisation, OSG is a quasi standard for cheap implementations. As the culling (to cull a scene is to remove everything from the scene that will give no contribution to the final scene) and sorting functionalities are highly sophisticated due to enormous usage in the community, performance is improved regularly. Developers of 3D simulations and animations always work near the latest hardware and software releases. Furthermore development is done on a lot of operating systems and there is no need that the end user’s platform is the same as the platform developed on.

Figure 4: Scenario view in Hamburg.

3 Electronic pilot book
The Electronic Pilot Book development pretends to define a system that provides side information from paper based books employed for a safe navigation to the 3D viewer in EPDIS. This work has been carrying out in order to have an independent information system which could be accessed from external applications because of its nature and complex difference between 3D viewer and Pilots’ data. The development was carried out according to the following steps:

- Determination of necessary data sets of the information contained in the Pilot Hand Books and complementary books
- Information was classified into blocks within an object modelling context
• Study of the information structure as it is managed on paper based books.
• Assigning attributes and functions of a geographical information system (GIS) using geo-references to the defined objects
• Design of the table structures and the queries needed for access to the specific domains
• Analysis of needed features for a data base engine that is consistent with the range of the data kernel for the data contained in the Pilot Book
• Determination of the technical characteristics of a tool such as MySQL as the choice of the essential engine to the Data Base Kernel nucleus.

Processed information is stored on a SQL type data base system and makes easier the access by the information viewing system or 3D viewer queries
• There does exist a set of tables that stores all the information according to its classification criteria in order to unify the information in the E-pilot book system
• Updating process will proceed as in the object creation steps. An updating function will be implemented in the final interface

Figure 5: Electronic pilot book viewer.

The technical solution for this system was implemented under the philosophy of a web-service, encoding in JAVA and using the XML format and defining XLS templates so that data conversion to any type is feasible. This eliminates problems that come from the different data formats in pilot books, i.e. textual information, views, tables, etc. and those that come from operative systems and platforms.
XML has provided a strong basis for a framework that supports streamlined through flow of E-Pilot Book data management and has enabled the integration of all data management applications at the EPDIS system. The implementation of the framework significantly changed the way we traditionally viewed data and data management and continues to challenge traditional ideas. One such example is the inherited conception of metadata being data about data created in a file that is held separately from the data. By including metadata within a data sets’ XML file, applications like E-Pilot Book can provide traditional metadata search and retrieve functions with the added bonus of revealing the actual data as well if required.

4 Physical architecture

The final EPDIS concept is based on a two-workstation configuration, one for the ECDIS and E-Pilot book information with extended functions and interfaces and another one with high-end 3D graphics card where the 3D viewer is executed.

Figure 6: EPDIS system architecture.

5 Conclusion

At the beginning of the EPDIS project multiple interviews have been carried out to detect the interest of potential users in such system. During this sessions it
became obvious that traditional representation systems like paper-based charts, pilots books and ECDIS are widely employed. Today the world is re-defining the abstraction and representation techniques in a virtual world of 3D systems that can offer and promote services that will improve robustness and safety in maritime navigation. This is the challenge: to pass from a two dimensional conception to a three dimensional representation of real world.

References