THE ICARUS PORTAL: AN AID TO IMPROVE SAFETY OF NAVIGATION

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\textbf{ABSTRACT}

Leisure ships and non SOLAS (International Convention for Safety of Life At Sea) ships as fishing vessels or small tugs, are not subjected to International Maritime Organization (IMO) standards related to the equipment, but by the classification societies through additional requirements related to the control centre physical distribution.

The ICARUS concept tries to provide to the end users, a practical tool supplying information from the books collection on board like Pilot books and others as well as meteorological information and weather forecasting, all integrated in an internet portal, accessible from portable devices like the latest generation mobile phones or palms. GPS or positioning systems will make possible to update information and selected screens will display data required by means of a complete menu. Today communication and internet based technologies with the support of GIS technologies have created a very friendly environment. XML and JAVA technologies have been used for the data interchange and software development in the end user’s application.

\textbf{Keywords:} Safety data, non SOLAS crafts, GIS, XML, JAVA, portable receivers.

\textbf{INTRODUCTION}

Among the most important data required by seafarers is that related to the weather; meteorological observation from ships has been a major pillar supporting...
this modern science. In the sea side, the automation on board merchant ships suffered during some decades, a kind of blocking that has changed only some years ago towards a progressive assimilation of the technical advances offered in the market. Thus affording the ship’s technical, functional and operational integration.

Within the control centres on board, referred as not only the ship’s navigation bridge but also the functions carried out in it by their users and the technology used, from the mid nineties, it has been possible to percept (verify) the number of integrated bridges is growing, even though they are fitting integrated navigation systems. However non SOLAS ships as fishing vessels or sailing crafts are not subjected to IMO standards related to the equipment and other information systems requirements. But sometimes those standards could be a guide to be followed while the manufacturing cost is maintained in low levels.

THE QUESTION IN ITSELF

The basic requirement when a ship is going to proceed to any port is not always safety but cost and time minimization, when calculating the track. Talking about costs, we can consider fuel consumption, time or even risks. In land navigation, the vehicle is restricted to the existing ways or roads and very little modifications are possible. But in the sea navigation the different chances widen due to the freedom to select any track for going from one port to another except when the weather conditions deteriorate as existing tropical revolving storms or any other heavy weather conditions. (Martínez de Osés, 2003)

The optimal track calculation and side information from pilot books and guides (sailing directions) are important parameters to be considered in the present paper.

The optimal track calculation

On a spherical surface the shorter way is the great circle track. For this purpose the sailor uses the spherical trigonometric and the great circle formulae, obtaining the first course through:  
\[ R = \frac{\tan \left( l_B \cos l_A - \sin l_A \cos \Delta L \right)}{\sin \Delta L} \]
and the distance:  
\[ D = \sin l_A \sin l_B + \cos l_A \cos l_B \cos \Delta L \]
(being \( l \) the latitude and \( L \) the longitude).

Obviously the time will be obtained dividing the distance by the mean speed. However the resulting arc used to be converted into a polygonal track, using a series of waypoints, as the ship is going to follow a series of short but different tracks, describing an arc.

From those mathematical solutions we can calculate an optimum track for minimising the fuel consumption. And the only limitation (apart from islands and dangers to navigation) is to sail on higher latitudes, where weather deteriorates fast. But is it possible to approximate the most efficient track considering the avoidance
of the worst weather?. We know that this is not always true because the longer is the voyage the more incidences of external forces can be received, as wind, waves and currents. At that time we are going to need to refresh the calculations redrawing the track.

The question is: “can a computer do those calculations?”. We are convinced that the everyday improvement suffered by the software and computers, points to the affirmative answer. The question is to know how to programme the software and how to provide it with the proper data (Nilsson, 2001).

THE GRAPHICS

The graphics is a mathematical resource used for computing purposes.

We can define it as a set of elements called vortex together with another group of those vortex pairs, called sides. Both can be represented by means of points connected by straight lines. One can see an everyday example in a metropolitan map.

If we can go from the blue–green link to the blue–red one, what is the best route?. In a first step we are going to need the times, those can be represented by means of a matrix.

Up side way \(1 + 2 + 1 + 2 = 6\) minutes.

Down side way \(2 + 3 + 2 = 7\) minutes.

So the best option is the up side one.

THE NAVIGATION

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Applying the previous concepts to navigation where no physical connections are, we must create them, using for example, the following options:

a) Fixed net with variable weights

The vortex is geographically fixed and each side has a variable weight depending on
the weather conditions in the area. So the optimum path will deviate from those areas.

The prohibited areas (land, reefs, etc.) will have no sides or the sides will have an infinitum weight.

b) Variable net

In this case the sides are going to have a constant weight and the vortex will change their geographic position. One example is the isochrones method, proposed originally in 1957 by R. W. James.

From the beginning the navigator will open several different courses at intervals of 5, 10 or 15 degrees. Further the track will be drawn depending on the effective speed developed on a constant time basis. The speed will depend on weather conditions. (Hagiwara, 1989)

The process will be repeated as far as reaching the destination, completing what is called a tree.

The only problem is the big volume of data to be managed in order to do efficient optimisations. In that situation the classical algorithms (Floyd, Dijkstra, etc.) are not so effective due to the way of working, looking for all the vortex, even those too many away from the destination point. (Bauk, 2003) Then it is needed to apply heuristics technical for reducing the searching room, using for example artificial intelligence as the A star algorithm. (Sanjuán Mourelo and Martínez de Osés, 2005)

**GENERAL DESIGN OF THE APPLICATION**

One of the main components on the service is “The Electronic Pilot Book”, hereafter called the E-Pilot Book, which consists of an integrated information system; this system includes the required information by the end users and has its origin in different text and graphic sources. Pilot book has bee designed by Cetemar, SL in several applications as in EPDIS project 5th Framework Programme. IST directorate co-funded project (EU Commission). This system will store and handle the static data contained in the ICARUS portal, currently available in the paper-based pilot books.
Because this information is distinct in nature, it first needs to be interpreted and then integrated into a system for its handling, access and querying processes. Therefore, data has been grouped into subsets depending on their sources. For this task the database concepts and dynamic information are of fundamental importance.

The information contained in navigational databases, includes geographical coordinates; hydrographical, geographical and charting information; shipping legislation and ruling; references to aids to navigation; waypoints and meteorological data. The navigational databases have a set of specific characteristics that set them apart from the others that provides for more efficient use. At the same time they do have some common features with other databases making possible to relate them with others databases.

Some details are:

1. They must be periodically up-datable in accordance with the control and legal cycles for international shipping information.

2. The user of ICARUS will have access to official and updated information. For this purpose the database should have a valid period, showing an alert if it has not been possible to update it or when the valid date expires.

3. Integrity and data quality must guarantee precise navigation.

4. The end user will not be able to access or modify the contents of the databases.
COASTAL NAVIGATION AID SYSTEM. SERVICE DESCRIPTION

The ICARUS concept provides a service of maritime navigation aid within a context of portable consoles and limited possibility devices and/or laptops, served by internet; the service is operated in boats of small dimensions (coastal traders) and preferably leisure ships.

The idea is to provide a system framed within the marine navigation aids and which tries to make an expert treatment of the information available and accessible from established criteria, based on safety; after the analysis of operative and security needs from the navigators point of view. This idea proposes a conceptual system for its future implementation under an client-server architecture and supported on portable and ergonomic type devices like agendas or pocket PCs, mobile telephones or laptops. These terminals would have internet connection by means of mobile GPRS communications, either another available wireless connection in the surroundings of navigation, harbour approaches or when the boat is in the port.

The service integrated in a web portal will provide a solution to some problems when the navigators are near to the coastline or when they want to plan a safe and fast route until his port of destination, making possible the access to the official information mainly available for professional mariners and ruled for the IMO boats.

In this way all the limitations of paper guides, known like “map courses”, in terms of ergonomics and updating, are avoided. Apart of the innovating of this business idea, the main target is to improve the safety in the leisure navigation, exploiting to the maximum the present information and communication technologies reaches.

ICARUS SYSTEM DESCRIPTION

Part of the information supplied by the service comes from some of the IMO ruled paper books like Pilot and Sailing directions, light and radio-signal and guides to port entry books. This point must be strongly considered because of the copyright rules as official publications are edited and published for the Hydrographical Organizations at local and international level; for example the Instituto Hidrográfico de la

Fig. 7. Port searching example in the electronic pilot book.
Marina de Cádiz, in Spain, or the UKHO “United Kingdom Hydrographic Office” Admiralty charts and publications. This part of the service is managed by a large database system; its implementation has taken into account the International Hydrographical Organization (IHO) rules for the implementation of maritime and hydrographical information, using the guides in their standard 57 (S57).

Legal and copyright procedures have been discussed with the hydrographical offices involved, in our case: IHO, UKHO and the Instituto Hidrográfico de la Marina de Cádiz have been contacted, thus, official and updated information is supplied. Data is organized implementing a database which considers object oriented programming, the main goal using this concept is the possibility in adding a special attribute to the records on database (Objects): “the geo-reference”. Using geo-references, queries and updating processes are easier handling. Interaction with GPS signal is actually possible when geo-references are used.

**E-PILOT BOOK FUNCTIONS**

The E-Pilot Book has been designed to provide an easy way for the user to query and search for the information. The WEB environment supported by HTML design is ideal for this purpose (See http://www.cetemar.com). The user starts out at the index page to initiate the search from a collection of pilot books data listed for a given area. The user can either implement the search option or browse the route marks for the area of interest. This last option provides access to the Pilot Text Page or the Objects, such as land marks, lights, aids to navigation, and so on. The main point for the ICARUS and E-pilot book are the easy linkage of information by means of geo-references which makes possible to view information by means of the position clicking on a specific place on the charts available on the portal. It is important to notice that the end user application does not depend on the operative system platform, memory or hard disk capacity of his device. XML, web services, SQL database management and JAVA technologies improve the ICARUS capabilities. The ICARUS portal includes other possibilities for accessing information related with sea, wave and wind behaviour on real time. A future development will include the optimal route calculation, where meteorological and sea parameters would be considered.
CONCLUSIONS

At this project development stage, it is very soon to point out some solid conclusions. However we can confirm that main problems foreseen in the near future are not coming from the optimum route calculation engine, but from the availability of high quality weather information. It is needed that proper geo-referenced data are ready to be translated into graphic, clear and intelligible safety information for the leisure sailor.

Legislation is almost behind of the industry needs. It means that weather information devices required on board can not cover the data needed for a global weather vision. There are a lot of services to optimise tracks. The only problem is the cost and sometimes the data availability once the ship has passed the weather episodes.

Regarding the algorithms we think that Dijkstra one needs a big calculation capacity, so they are needed heuristic methods that could discard the worst cases, then concentrating the computing resources in the possible paths.

An integrated information system for leisure ships must be friendly user and accessible; the end user not necessary has to think in the internal algorithms involved neither the platforms he must carry for displaying information. The advantage and added value on ICARUS service is the possibility of having access to official information and advanced calculations needed from a field of user not always being professional mariners. Current information technologies make possible to take this step forward in the leisure ships industry.

REFERENCES


International Maritime Organization.


El Portal Icarus: Un Sistema de Ayuda a la Navegación

El presente artículo pretende dar a conocer un sistema de ayuda a la navegación para embarcaciones no SOLAS, que esté disponible a través de un portal donde la aplicación va a permitir descargar cartografía de calidad, información para la navegación y en un futuro la optimización de la derrota en función de la información meteorológica.

Las embarcaciones menores en general y las de recreo en concreto no están sujetas a la legislación SOLAS, aunque cabe aclarar que el cumplimiento del capítulo V del mismo está recomendado en todos los casos, aunque las sociedades de clasificación pueden establecer requisitos adicionales. Con ello pretendemos decir que el nivel de seguridad exigible legalmente en este tipo de buques no es el mismo que en los buques SOLAS.

El concepto propuesto en ÍCARO es el de proporcionar a los usuarios una herramienta, que en línea con el tipo de información exigible a todo buque en cuanto a publicaciones náuticas y derroteros, práctica y que proporcione información de las publicaciones que debe de llevar todo buque a bordo así como la posible previsión meteorológica y la recomendación de la derrota mediante un algoritmo de cálculo. Todo ello disponible desde un servidor que bajo demanda transmitiría dicha información a un receptor portátil como un teléfono móvil de última generación o una PDA.

Gracias a la integración de un sistema de posicionamiento GPS, las tecnologías basadas en internet con el soporte de técnicas GIS, permiten crear un entorno de intercambio de información que permite hacer funcionar aplicaciones como la presentada.

Una de las bases de esta aplicación, es el E-pilot book o derrotero electrónico, la cual en diseño HTML, corre en el portal ICARO. El usuario simplemente debe de conectarse al servidor y posteriormente usar la opción de búsqueda o simplemente indagar en las marcas o señales de navegación existentes en el área. La principal utilidad del sistema permite llamar la información sobre un punto, de forma fácil con lo que se descargan no sólo características e los puntos que consultamos, sino también la carta de la zona y el texto que correspondería en el lugar proveniente del derrotero.

Otra baza del sistema, es el hecho de que la aplicación no descansa sobre el sistema operativo del usuario. Adicionalmente pueden descargarse la información sobre oleaje, viento y en un futuro la derrota recomendada en función de esta información.

Como conclusión aparte del desarrollo en sí mismo de la aplicación, es la obtención de información de calidad tanto cartográfica como meteorológica. En el
primer caso la empresa que desarrolla la aplicación tiene acuerdos tanto con el Servicio Hidrográfico de la Marina y el Almirantazgo Inglés.

La utilidad meteorológica inicialmente apuesta por un auténtico servicio de asesoramiento y no sólo de reporte a, optando por un método de desarrollo heurístico que evitaría tener que calcular todos los nodos como es el caso del algoritmo de Dijkstra.

En cuanto a la ergonomía y facilidad de uso, esta se ve ayudada por el hecho de que un marino con titulación deportiva y poca experiencia profesional, no deberá de preocuparse por cálculos e interpretaciones de la información, que el receptor la proporcionará ya tratada.