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WAN Xiaoxia GAN Chaohua

1 Introduction

Electronic charts are new navigation aid that can provide significant benefits to maritime navigation, safety, and commerce. More than a simple computer graphics display, electronic chart systems combine both geographic and textual data into a readily useful operational tool. The electronic charts are a real-time navigation system that integrates a variety of information displayed and interpreted by the mariner. The most advanced form of electronic chart systems represents a new approach to maritime navigation^[1].

2 ECDIS and ENC

There are two basic types of electronic charts. The most advanced form of electronic charts is the Electronic Chart Display and Information System (ECDIS). All other types of electronic charts can be regarded, in general, as Electronic Chart Systems (ECS).

2.1 ECDIS and international performance standards

To be considered as an ECDIS, an electronic chart must comply with the Performance Standards for ECDIS established by the International Maritime Organization (IMO). Under development for over 10 years, the IMO Performance Standards for ECDIS specify the components, features, functions of a system in which the primary function is to contribute to safe navigation^[1]. They were formally adopted by IMO on 23 November 1995 and issued as IMO Resolution A. 817(19). Back-up arrangements for ECDIS were adopted by IMO in November 1996 and became Appendix 6 to the Performance Standards.

In conjunction with the IMO Performance Standards for ECDIS,

KEY WORDS ECDIS; ECS; display; key features; performance standards

ABSTRACT This paper introduces the most advanced form of electronic chart display and information systems (ECDIS) which complies with the Performance Standards for ECDIS established by the International Maritime Organization (IMO) and the International Hydrographic Organization (IHO). It also describes the key features and the important functions of ECDIS. Then the future development of ECDIS in marine is discussed.

the International Hydrographic Organization (IHO) developed technical standards for the digital data format and display. IHO Special Publication 52 (IHO S-52) is the IHO specification for chart content and display of ECDIS^[3]. It includes appendices describing the means/process for updating, colour and symbol specifications. The 4th edition of IHO S-52 was issued in December 1996. IHO Special Publication 57 (IHO S-57) is the IHO transfer standard for digital hydrographic data^[4]. The current edition (Edition 3.0) was released in November 1996. Both IHO S-57 and S-52 are specified in the IMO Performance Standards for ECDIS.

The International Electromechanical Commission (IEC) developed its own ECDIS Performance Standard that describes the operational methods of testing and required test results for an IMO-compliant ECDIS^[5]. In September 1997, Draft of IEC 61174 was completed, and a final draft of the international standard was issued on 30 March 1998. Following a formal voting process, IEC 61174 was officially published by IEC as an international standard in August 1998. IEC 61174 is the basis for type-approval/certification process for an IMO-compliant ECDIS.

2.2 ECS

An Electronic Chart System (ECS) can be considered as any other type of electronic charts that does not comply with the IMO Performance Standard for ECDIS. This general category can be further sub-divided into electronic charts that use either raster or vector data.

In a vector-based system, electronic chart data is

comprised of a series of lines (vectors) in which different layers of information may be stored or displayed. This form of so-called intelligent spatial data is obtained by digitizing information from existing paper charts or by storing a list of instructions that define various position referenced features or objects. With a vector ECS, the user has considerable flexibility and discretion regarding the amount of information that is displayed for the task at hand.

2.3 ECDIS components and data flow

ECDIS components consists of:

- Computer processor
- digital database (i. e. electronic chart data)
- navigation sensor inputs (e. g. GPS, Loran)
- color display

Additional shipboard sensor inputs may include ship's gyrocompass, depth sounder, a marine radar/ARPA and shipboard automated identifications systems (AIS). Since ECDIS can function as the "Mariner's Window to the World", other navigation-related information could be displayed as well. This could include navigation-related information such as tides/water level, current flow, ice coverage, visibility, and the location of other vessels beyond visual or radar range. In this regard, IMO has recently adopted draft recommendation on Performance Standards for Universal Shipborne AIS that would operate in a ship-to-ship (transponder) and ship-to-shore/shore-to-ship (broadcast) mode of operation^[6].

Fig. 1 shows the primary functional components of ECDIS.

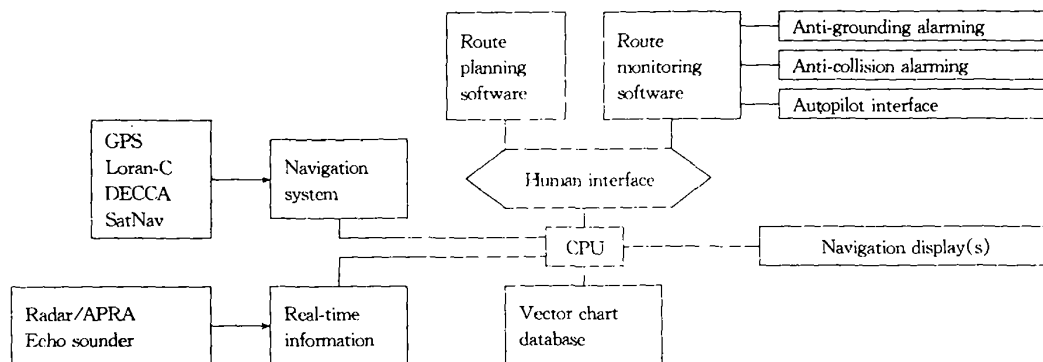


Fig. 1 ECDIS components and data flow

3 Key features for ECDIS

The IMO Performance Standards for ECDIS provide specific guidance regarding the various components, features, and functions which make up an ECDIS. As described in the various sections of the IMO Performance Standards for ECDIS, there are important features, functions, and capabilities provided by ECDIS. From 1998 to now, we have been developing the electronic chart display and information system which based on international standards. The following are the key features.

3.1 Updating

ECDIS must be capable of accepting official up-

dates to the system data, provided in conformity with IHO standards. We have developed an ECDIS which can keep a record of updates including time of application, and allow the mariner to review their contents and ascertain that they have been included in the system data.

3.2 Colours and symbols

The colours and symbols used in an ECDIS display must conform to the specifications contained in IHO Special Publication 52. This includes a specified size and appearance of symbols, figures, and letters. A particularly useful feature is the Mariner's ability to select different color display schemes for daylight, nighttime, or twilight conditions.

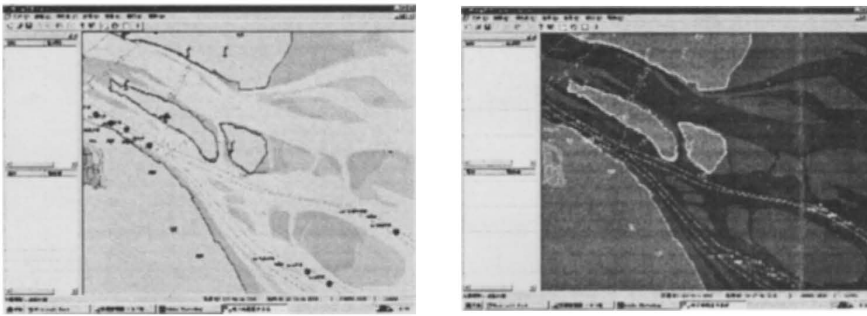


Fig.2 ECDIS display in bright daylight and during dark time

3.3 Standard display and display base

This is the level of information that should be shown when a chart is first displayed. Depending upon the needs of the mariner, a amount of information may be modified by the mariner for route plan-

ning or route monitoring. However, an ECDIS must return to the standard display at any time by a selection operation. Thus, it is the mariner who decides what level of information is required during a particular situation or task at hand.

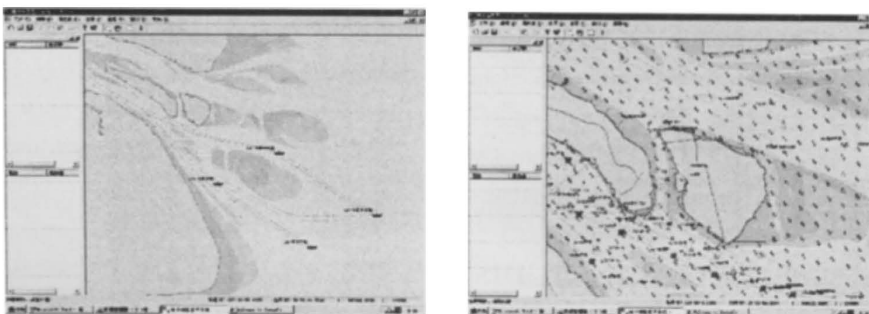


Fig.3 Chart data in the overview display and the same data in detail

Display base is the layer of information which cannot be removed from the display, and includes information which is required in all geographic areas and during all circumstances. It is not intended to be sufficient for safe navigation.

Depending on the needs of the mariner, information may be displayed at different scales (i. e. zoom-in or zoom-out). This system will show us

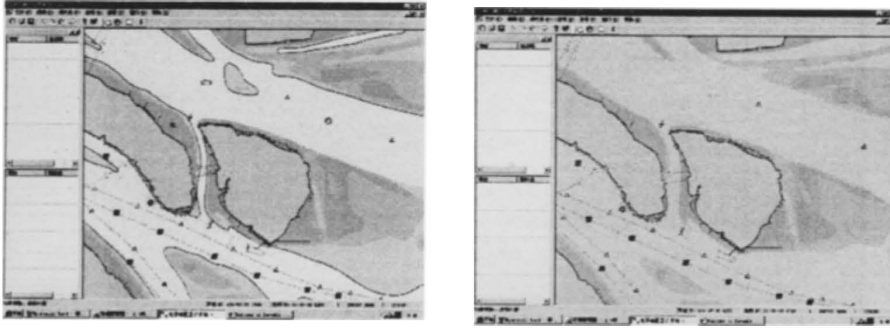


Fig. 4 Safety depth/contour in 5 meters and 30 meters

3.5 Display orientation /mode

With ECDIS, the mariner can select either a “north-up” or a “course-up” orientation. The ECDIS display can also be configured to operate in a true motion or relative motion mode of operation. In true motion, own ship’s symbol moves across chart display. With a relative motion display, the own ship’s symbol remains stationary in the center while the chart information appears to move.

3.6 Other information

Radar signal or other navigational information may be added to the display. However, it should not degrade the display and not obscure other electronic chart information. Different information is not simply superimposed together. Transferred radar information may contain both the radar image and ARPA (automated radar piloting aid) information. Those information can be crucial for collision avoidance.

4 Important functions for ECDIS

ECDIS is different from other GIS. It has not only its own displaying features, but also some special

different details .

3.4 Safety depth /contour

With ECDIS the mariner can select a safety depth or safety contour. For a safety depth, all soundings less than or equal to the safety depth are emphasized. For a safety contour, ECDIS highlights this contour over other depth contours.

important functions.

4.1 Route planning

With ECDIS the mariner should be able to perform route planning in a simple and reliable manner. It should be possible to add or delete waypoints, or to change the position or order of waypoints in a selected route. It should also be possible to plan both primary and alternate routes.

4.2 Route monitoring

During route monitoring, ECDIS must show own ship’s position whenever the display covers that area. Key information provided during route monitoring includes a continuous indication of vessel position, course, and speed. Additional information that ECDIS can provide includes such information as distance right/left of intended track, time-to-run, distance-to-turn, position and past track history.

4.3 Voyage recording

After the voyage, ECDIS must be able to reconstruct the navigation and verify the official database used. Recorded at one minute intervals the information includes:

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