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Greer et al.

[54] ELECTRONIC CHART ASSISTED NAVIGATION SYSTEM

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[51] **Int. Cl.**[7] **G01S 5/02**

[52] **U.S. Cl.** **342/357.13**; 701/213

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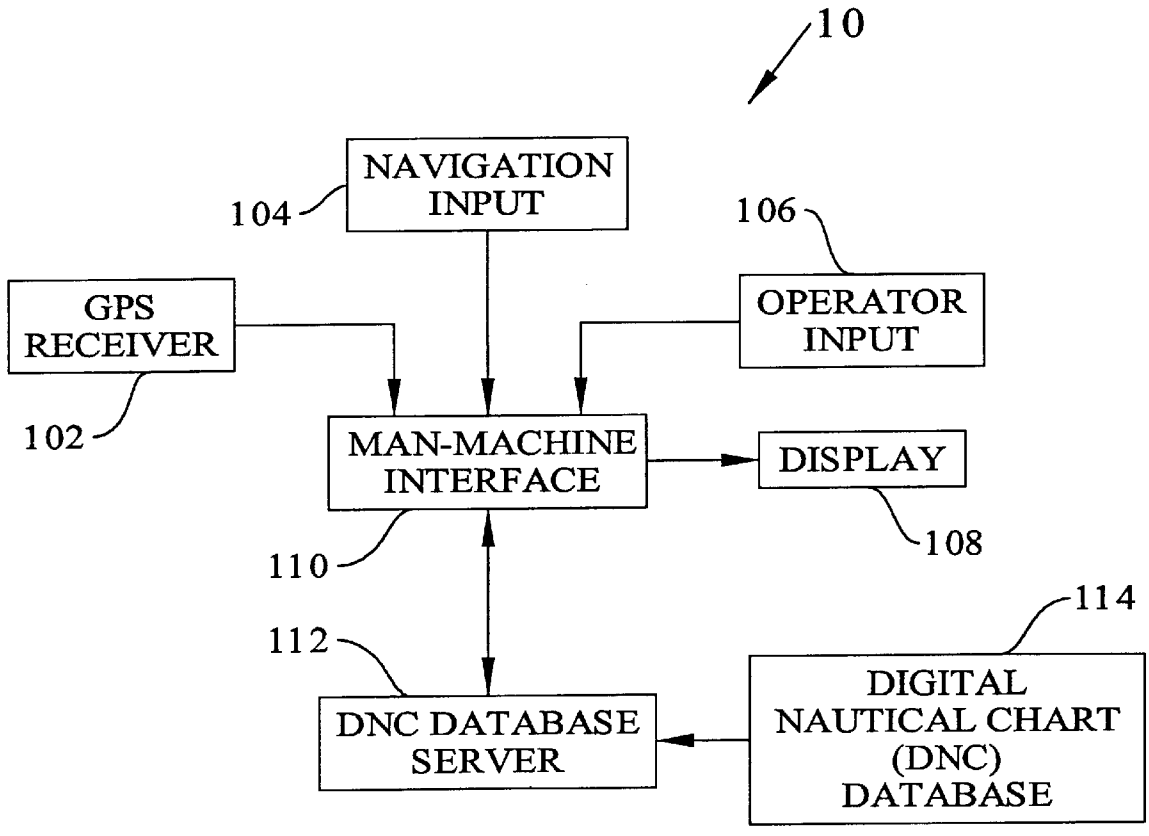
[57] ABSTRACT

The automated charting system of the present invention comprises a computer program for inputting current position from the Global Positioning System, accessing the Digital Nautical Chart database (DNC), selecting the best available nautical chart data for the current position, and displaying the current position on the selected nautical chart.

1 Claim, 4 Drawing Sheets

Microfiche Appendix Included
(1 Microfiche, 192 Pages)



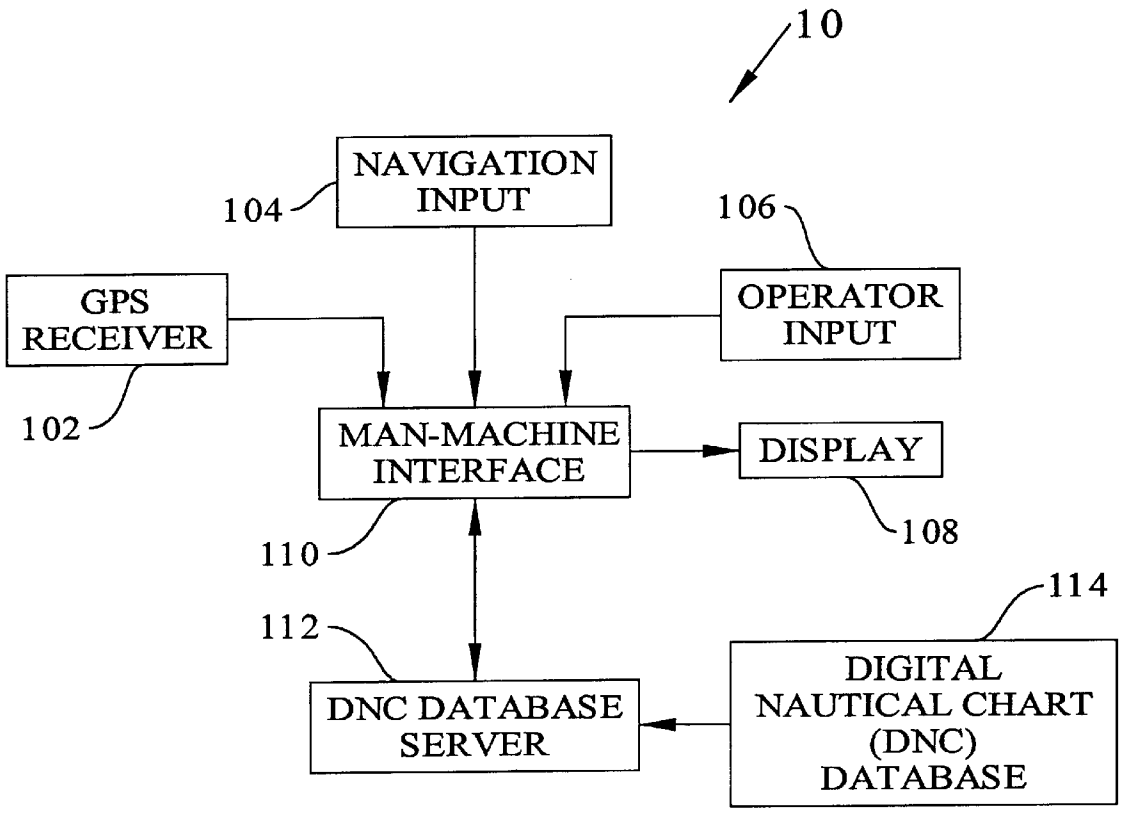

10
NAVIGATION INPUT
104
106
GPS RECEIVER
OPERATOR INPUT
102
MAN-MACHINE INTERFACE
DISPLAY
108
110
114
112
DNC DATABASE SERVER
DIGITAL NAUTICAL CHART (DNC) DATABASE

FIG. 1

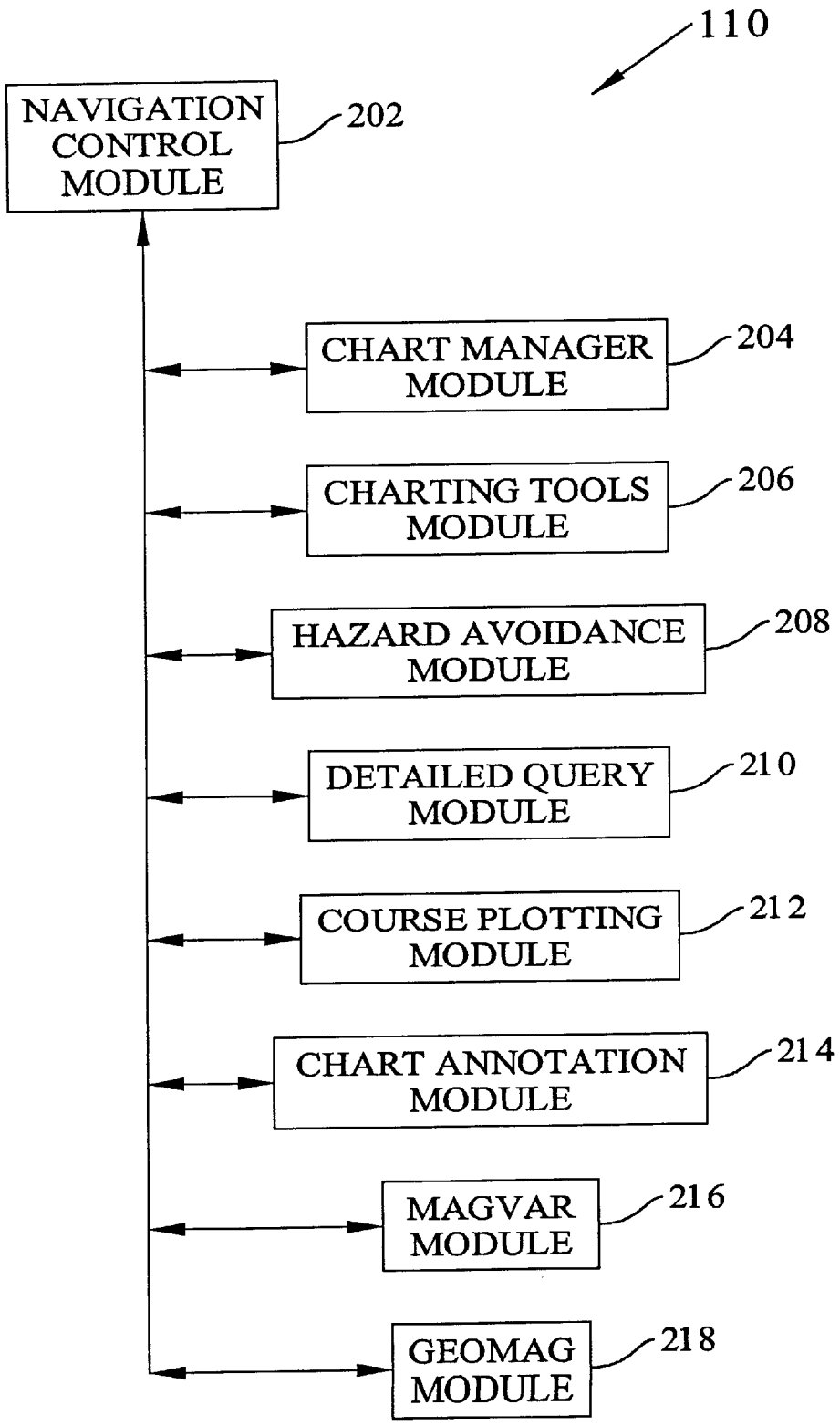

110
NAVIGATION CONTROL MODULE
202
CHART MANAGER MODULE
204
CHARTING TOOLS MODULE
206
HAZARD AVOIDANCE MODULE
208
DETAILED QUERY MODULE
210
COURSE PLOTTING MODULE
212
CHART ANNOTATION MODULE
214
MAGVAR MODULE
216
GEOMAG MODULE
218

FIG. 2

FIG. 3

FIG. 3A

FIG. 3A
FIG. 3B

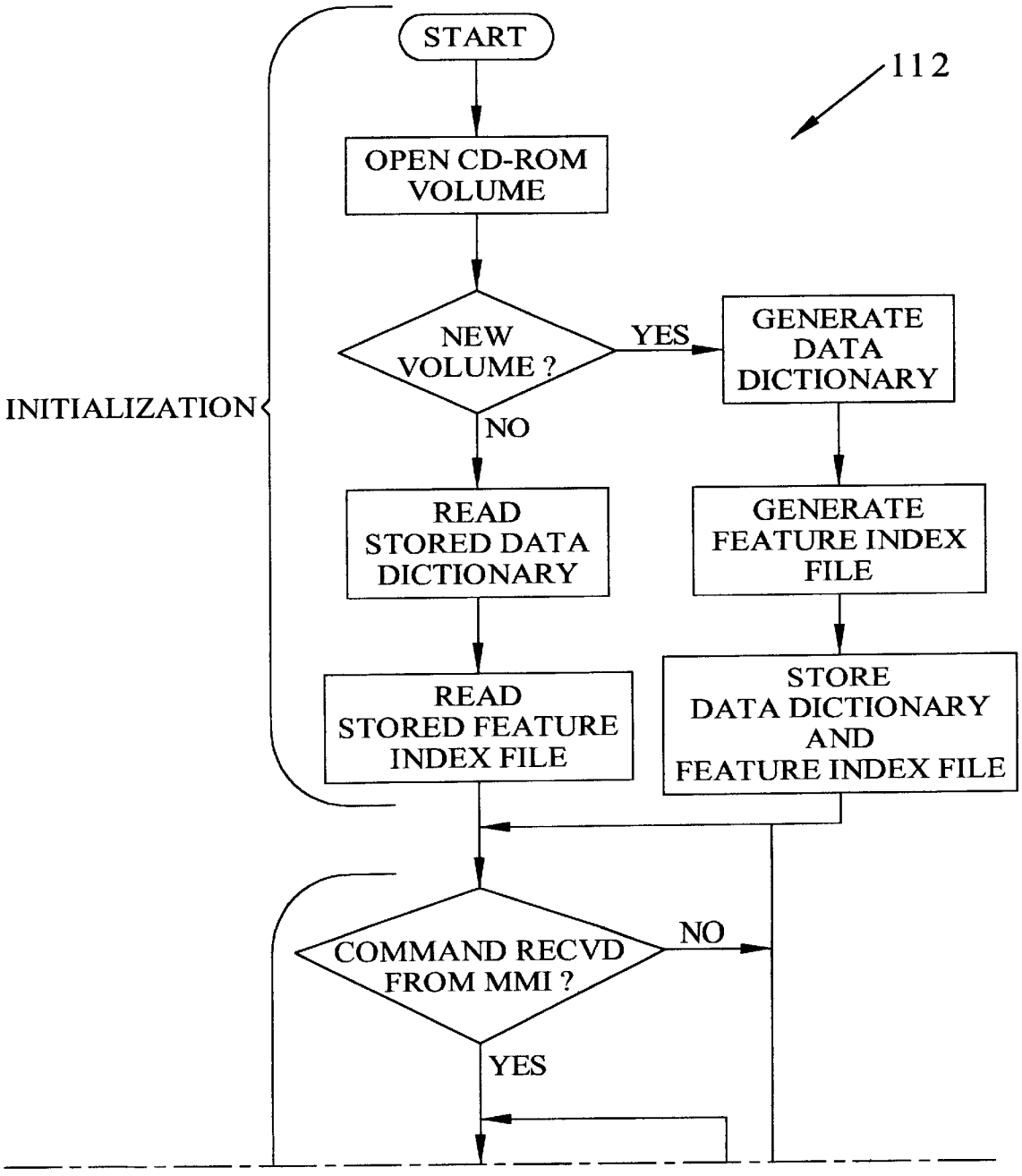
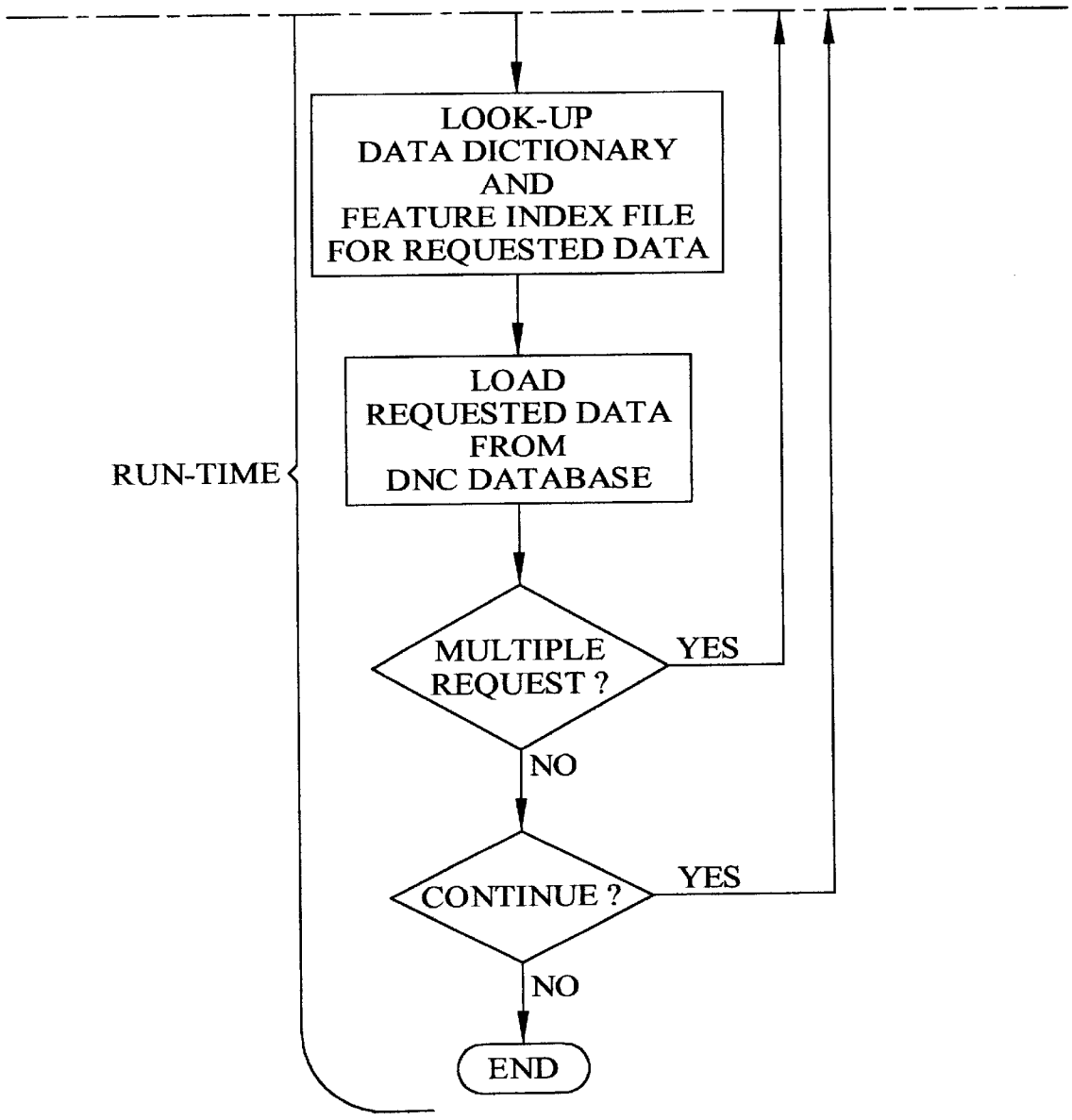


FIG. 3B


RUN-TIME
LOOK-UP DATA DICTIONARY AND FEATURE INDEX FILE FOR REQUESTED DATA
LOAD REQUESTED DATA FROM DNC DATABASE
MULTIPLE REQUEST ?
YES
NO
CONTINUE ?
YES
NO
END

ELECTRONIC CHART ASSISTED NAVIGATION SYSTEM

MICROFICHE APPENDIX

This application contains a Microfiche Appendix having 1 microfiche and 192 frames.

BACKGROUND OF THE INVENTION

The present invention relates to an automated navigational charting system for use with the Digital Nautical Chart database developed by the National Imagery and Mapping Agency. More specifically, but without limitation thereto, the present invention relates to a computer program for displaying nautical chart information corresponding to ownship position data from the Global Positioning System.

A traditional method for ship navigation is to plot information on a paper nautical chart on the bridge, and in the Navy's case, in the Combat Information Center. The information is collected from visual observation, reports by other members of the crew, readings from navigation systems onboard, e.g. GPS ownship position in latitude and longitude, range and bearings observed by watchstanders, dead reckoning data including speed and heading, and other information. The date recorded on the paper chart is often subject to interpretation by the navigator and is subject to human error in collecting or recording data. The traditional navigation method therefore suffers the disadvantages of being labor intensive, requiring extensive training, and being subject to human error.

Currently available electronic charts are typically raster scanned paper charts that have limited resolution, and generally require operator input of reference points and ownship position.

A need therefore exists for an automated navigation system that offers greater accuracy and reliability than current methods afford.

SUMMARY OF THE INVENTION

The automated charting system of the present invention is directed to overcoming the problems described above, and may provide further related advantages. No embodiment of the present invention described herein should be construed to preclude other embodiments or advantages that may exist or become obvious to those skilled in the art.

The automated charting system of the present invention comprises a computer program for inputting current position from the Global Positioning System, accessing the Digital Nautical Chart database (DNC), selecting the best available nautical chart data for the current position, and displaying the current position on the selected nautical chart.

An advantage of the automated charting system of the present invention is that no paper nautical charts are required.

Another advantage is that the Digital Nautical Chart database is updated regularly and may be downloaded and accessed electronically.

Yet another advantage is that the current position data is input automatically from the Global Positioning System and does not require inputs from a watchstander.

Still another advantage of the automated charting system is that course plotting instruments may be incorporated electronically and used by personnel requiring substantially less training than for the use of mechanical instruments.

Another advantage is that the automated charting system of the present invention conforms to the Electronic Chart

Display and Information System Performance Standards (ECDIS) developed by the International Maritime Organization and the International Hydrographic Organization for use with the Digital Nautical Chart database.

Yet another advantage is that the Digital Nautical Chart database has a Vector Product Format that has higher resolution than the raster scan format.

The features and advantages summarized above in addition to other aspects of the present invention will become more apparent from the description, presented in conjunction with the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of an automated navigation system of the present invention.

FIG. **2** is a detailed diagram of an exemplary man-machine interface.

FIGS. **3**, **3A** and **3B** are a flowchart of an exemplary DNC database server.

DESCRIPTION OF THE INVENTION

The following description is presented solely for the purpose of disclosing how the present invention may be made and used. The scope of the invention is defined by the claims.

FIG. **1** is a diagram of an automated navigation system **10** of the present invention comprising a Global Positioning System (GPS) receiver **102**, a navigation input **104**, an operator input **106**, a display **108**, a man-machine interface **110**, a Digital Nautical Chart Database (DNC) Server **112**, and a DNC Database **114**. Man-machine interface **110** receives inputs from GPS receiver **102**, navigation input **104**, and operator input **106** to determine the latitude and longitude coordinates to be charted and displayed. GPS receiver **102** may be, for example, a commercially available GPS receiver with an output for connection to a serial port of a computer. Navigation input **104** may be incorporated to relay navigation information from shipboard radar and other instrumentation used to determine ownship position. Operator input **106** may be, for example, a keyboard for inputting optional charting coordinates and for selecting overlays and drawing tools for making course plots. Display **108** may be, for example, a computer monitor. Man-machine interface **110** may be, for example, a desktop computer. DNC database server **112** may be, for example, a software driver and a CD-ROM drive for loading DNC database **114**. DNC database **114** is in production by the National Imagery and Mapping Agency and is described in the product specification MIL-D-89023.

In operation, DNC server **112** inputs chart coordinates from man-machine interface **110**. DNC server **112** retrieves the appropriate chart data from DNC database **114** and outputs the data in Electronic Chart Display and Information System (ECDIS) format to man-machine interface **110**. Man-machine interface **110** reformats the ECDIS data from Vector Product Format (VPF) and outputs the reformatted data to display **108**.

FIG. **2** is a detailed diagram of an exemplary man-machine interface (MMI) **110**. A navigational control module **202** inputs navigation data from navigation input **104** and distributes the information to the appropriate modules in MMI **110**. Chart manager module **204** predicts future position from the navigation data for retrieving charts with position changes. Charting tools module **206** provides charting aids such as range rings, bearing lines, and bearing

markers. Hazard avoidance module **208** predicts possible collisions with radar targets and potentially dangerous charted features and highlights them on the charts. Spatial Query module **210** accesses additional DNC database information that may be available for particular chart features. Course plotting module **212** may be used to plan routes for comparison with actual course and for navigation simulations. Chart annotation module **214** may be used to overlay charts with comments and figures to display additional information of a geographic area based on personal knowledge in accordance with International Maritime Organization (IMO) and ECDIS standards. MAGVAR module **216** may be used to display the local magnetic variation in accordance with IMO and ECDIS standards. GEOMAG module **218** may be used to calculate local magnetic force vectors from the Department of Defense World Magnetic Model. The model is updated every five years.

FIG. **3** is a flowchart of an exemplary DNC database server **112**. During initialization, the CD-ROM volume containing DNC database **114** is opened. A data dictionary and feature index are stored or retrieved to reduce the time required to access charts from DNC database **114**. During run-time, command messages are input from MMI **110** and the requested chart data are located from the data dictionary and feature index. The requested data is then loaded from DNC database **114** into shared memory, for example, for display by MMI **110**. The next command is then input from MMI **110** and the cycle repeats as long as operation continues.

Automated navigation system **10** may also include other optional functions for displaying alternate nautical chart data for a selected position including harbor, approach, and coastal; of plotting a course on a chart overlay; and for updating the Digital Nautical Chart database.

An exemplary computer program for practicing the present invention on a computer is presented in the attached Microfiche Appendix having 1 microfiche and 192 frames.

Other modifications, variations, and applications of the present invention may be made in accordance with the above teachings other than as specifically described to practice the invention within the scope of the following claim.

We claim:

1. An automated charting system comprising:

a Global Positioning System receiver;

a navigation input;

an operator input;

a display;

a man-machine interface coupled to the Global Positioning System receiver, the navigation input, the operator input, and the display;

a DNC database server coupled to the man-machine interface;

and a DNC database.

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