COMPUTER NETWORK FOR FISHERY RESEARCH VESSELS

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INTRODUCTION

A comprehensive system for data processing on board research vessels is described. The system is designed by a group of experienced scientists and technicians at the Institute of Marine Research in cooperation with Simrad Subsea A/S and Christian Michelsens Institute.

The central element in the system is a graphical workstation with a relational database which collects data from a number of sources on the vessel. An important source is the new scientific sounder, Simrad EK500, which delivers partially integrated echo data. Data from the echo-sounder are stored with high resolution, which makes it possible to recreate the echogram on the graphical display, where the final integration can be performed. Important settings such as layer limits, echo threshold and bottom-discriminator level, which before had to be done prior to the measurements, can now be done afterwards according to the displayed echogram.

The units in the system communicate in a Local Area Network (Ethernet). Thus, if the data logger for temperature and salinity, for example, is on-line, then T-S profiles can be displayed together with the echo registrations as a support in interpreting the acoustic data. In the same way, it will be possible to display auxiliary data from other sources, e.g., trawl-station data, meteorological data and navigation data. The echo-sounder with split-beam transducer can also produce target strength distributions. These can also be presented together with the echogram on the graphical display, again to help in the interpretation of echo data. Data collected and refined during the survey can be plotted automatically to produce maps of fish density distribution and hydrography.

The system is based on internationally approved software modules. These include UNIX operating system, C-language, X-windows, SQL relational database, Ethernet with TCP/IP protocol and GKS graphical standard.

HISTORY

Since the late 1960's, the Institute of Marine Research has developed software for digital computers used on board its research vessels. The first system was based on the NORD-1 digital computer [1]. This was primarily designed for logging oceanographic and meteorological data, but it also had a 10-bit A/D-converter with a sampling frequency of 50 kHz. With this equipment, the very first experiments with digital echo integration were made.

In 1974 a special computer system for echo-integration and CTD-logging was designed [2]. This was the first second-generation echo-integrator, which was also based on the NORD-1 computer.

A new system based on the NORD-10 computer was initiated in 1977 [3] and was under continual development until 1987. At present, NORD-10-based echo-integrator systems are used on board five research vessels. The main task is to integrate, in real time, the squared voltage-signal from the calibrated output of scientific sounders. The raw data output consists mainly of area backscattering coefficient s_A values (m^2/nautical mile^2), integrated over 5-nautical-mile intervals in 50-m channels. Included in the program is also a semi-automatic interpreting facility: s_A values are interactively divided into pre-defined species or groups of species, and interpreted data are stored on floppy discs prepared for final computerized treatment.

Threshold voltages in each channel and bottom-discriminator level are given before the measurements. Corrections for deviations in the time-varied-gain function in the echo-sounder are also preset.

As a secondary task the NORD-10 system also accomplish the logging and storing of CTD (salinity, temperature and depth) data.

OVERVIEW OF THE NEW SYSTEM

The total system for processing and presentation of fishery research vessel data is described in a system design report [4]. The computer network for fishery research vessels (Fig. 1) covers many tasks and integrates data from a number of sources. This description, however, deals mainly with the part that takes care of the acoustic data.

A standard graphical workstation (SUN 4/110) is the heart of the system. The software is specially prepared for logging raw data from the new echo-sounder, Simrad EK500 [5]. This echo-sounder, in addition to be a self-contained echo-integrator and target strength measurement device, delivers integrated values for every meter, or less, depth interval in each sounding.

The raw data are stored on the workstation's hard-disc memory and represent a set of pixel-values that are used to recreate the echograms on the CRT of the workstation. When the echo data are presented with such high resolution, it is possible to define the layer limits after the measurements are accomplished, for example, in accordance with what the operator observes on the screen. In the same way, the echo-threshold can be moved up and down, and the detected bottom line can be corrected interactively. The system aspires to utilize the latest advances in computer technology, and in particular the computer-user interface is given high priority.

ECHO INTEGRATION

Raw data from the echo-sounder are sent via the Local Area Network (Ethernet) and stored on the hard disc in the graphical workstation. The dataflow consists of series of telegrams with S_v (volume backscattering strength) values for every sounding. As the echo-sounder is calibrated against standard targets, [6] it always delivers absolute S_v values. The telegrams have a heading with position data, log counter and bottom depth, followed by 500 S_V values. The resolution is selectable between 1 m and 10 cm and is set in accordance to the bottom depth. In addition, there are 150 values (each 10 cm) representing the 15-m-expanded bottom layer, 10 m above and 5 m below the bottom.

The resolution in the horizontal plane can be either "ping-based" or "log-based". With the "ping-based" presentation, the number of soundings and therefore the length of the echogram is dependent on the vessel speed. In the "log-based" presentation there will always be 200 sets of values in each nautical mile. The graphical workstation can display 1000 values horizontally, which means that in the "log-based" mode, registrations for 5 nautical miles can be displayed. When a sufficient number of soundings are logged, the echogram can be recalled on the display at any time (Fig. 2).

Originally the echogram is divided into 50-m channels. According to the distribution the operator observes, he can now make new limits in order to assign parts of the biomass to their respective species. With a mouse-operated cursor, the operator is free to draw new layer limits at will, both with straight and curved lines.

The integrator values are converted from S_V to s_A, and the numerical value is displayed for all layers. When the biomass is distributed to the different species, the interpreting window is of vital importance. This window, shown in Fig. 3, also contains a heading with different parameters such as log number, time, and depth as well as room for entering a correction factor for air-bubble absorption.

A pre-selected group of represented species is listed, and to the right the interdependent absolute and relative s_A values are given. The operator can now, by pushing and pulling horizontal scroll-bars, adjust the distribution between the different species as he interprets the echogram. This is repeated for each layer, and when the "ready"-button is pressed, the echogram for the next 5 miles appears automatically.

The integrator values for each species are stored in the relational database. In order to be able to correct later for depth-dependent target strength, the integrals are stored separately in 50-m channels. If parts of the registrations are classified as schools, the data for these can be stored separately for later use in describing the distribution of schools in an area.

BOTTOM DISCRIMINATION

In acoustic surveys it is often the registration close to the sea bottom that causes the greatest problems. Even the new EK500 cannot avoid the physical laws, so a blind zone will always exist. However, it is important to be able to separate fish echoes from bottom echoes, and during bad conditions the bottom echoes are imprecise and need to be corrected. On the CRT-display the expanded bottom channel is shown with a resolution of 10 cm per sample or, in other words, a pixel-resolution of 10 cm. The channel consists of 150 pixels vertically which covers 15 m, 10 m above and 5 m below the detected bottom. The detected bottom is presented as a straight horizontal line. If the operator finds it necessary, he can adjust the bottom line by drawing a new bottom line, and thereby separate fish echoes which have been included in the bottom echo or by avoiding bottom signals that accidentally contribute to the integrator values.

It is emphasized that there always will be a zone close to the bottom that cannot be observed acoustically. But, in accordance with the density that can be measured in the channel immediately above the bottom, one can do a statistical analysis and calculate the probable density in the blind zone.

NETWORK

In order to be able to interpret the acoustic data with a certain degree of confidence, one needs physical samples of the objects that are registered and integrated. This is mainly carried out by means of a bottom or pelagic trawl. The size distribution of the different species gives the key to the relation between echo-abundance and the number of individuals [7]. These fish-sample data are punched into a personal computer connected to the network and stored in the common relational database. During the interpreting process, the data from relevant trawl stations can be fetched and displayed in a suitable window on the CRT, Fig. 4.

From the EK500, which is a split-beam echo-sounder, measured target strength distributions will be provided as long as conditions allow. These distributions are divided into ten independent selected layers and can also be stored in the database for later recall in a window with supporting data during interpretation.

In the same way it is possible to open windows to have additional data from any relevant instrument that is connected to the local network. Temperature- and salinity-profiles are examples of such data, and therefore the CTD-logging unit is on-line. From a survey-grid window, the nearest CTD-stations can be picked out and displayed on the CTD-window.

SYSTEM IN GENERAL

A guiding principle of the system development has been user friendliness in the computer-man interface. The operator will have a great deal of freedom to divide the integrated values in accordance with the auxiliary data available on the network. Whenever new knowledge about the observed data appears, one can return to the raw data and reconsider the interpretations. The distance intervals are selectable between 1 and 5 nautical miles. Scrolling is allowed with steps of 1 nautical mile, and it is possible to fetch any 5 mile interval that is logged. When the interpretation of an interval is finished, the operator simply presses the soft key "finish". The refined data are then stored in the database, and a new interval appears automatically.

Often the character and distribution of the registration is homogeneous over long distances. Therefore the settings and percentage divisions of species are inherited from the previous interval. In this way one can just press "finish" instead of making the same adjustments over and over again.

CONCLUSION

The scientific tool that is described here is by no means complete. It has an enormous potential for further development. This report has focused mainly on the functions for collecting primary data necessary for calculating fish stock sizes. By the end of a survey, electronically generated maps for the fish stock distributions should be available. Similarly the total biomass of the different species should also be available. These results, however, are only parts of the total stock assessment.

In order to carry out the final calculations, the survey data have to be transported to the Institute for combination with fisheries statistics and data from other vessels and cooperating nations.

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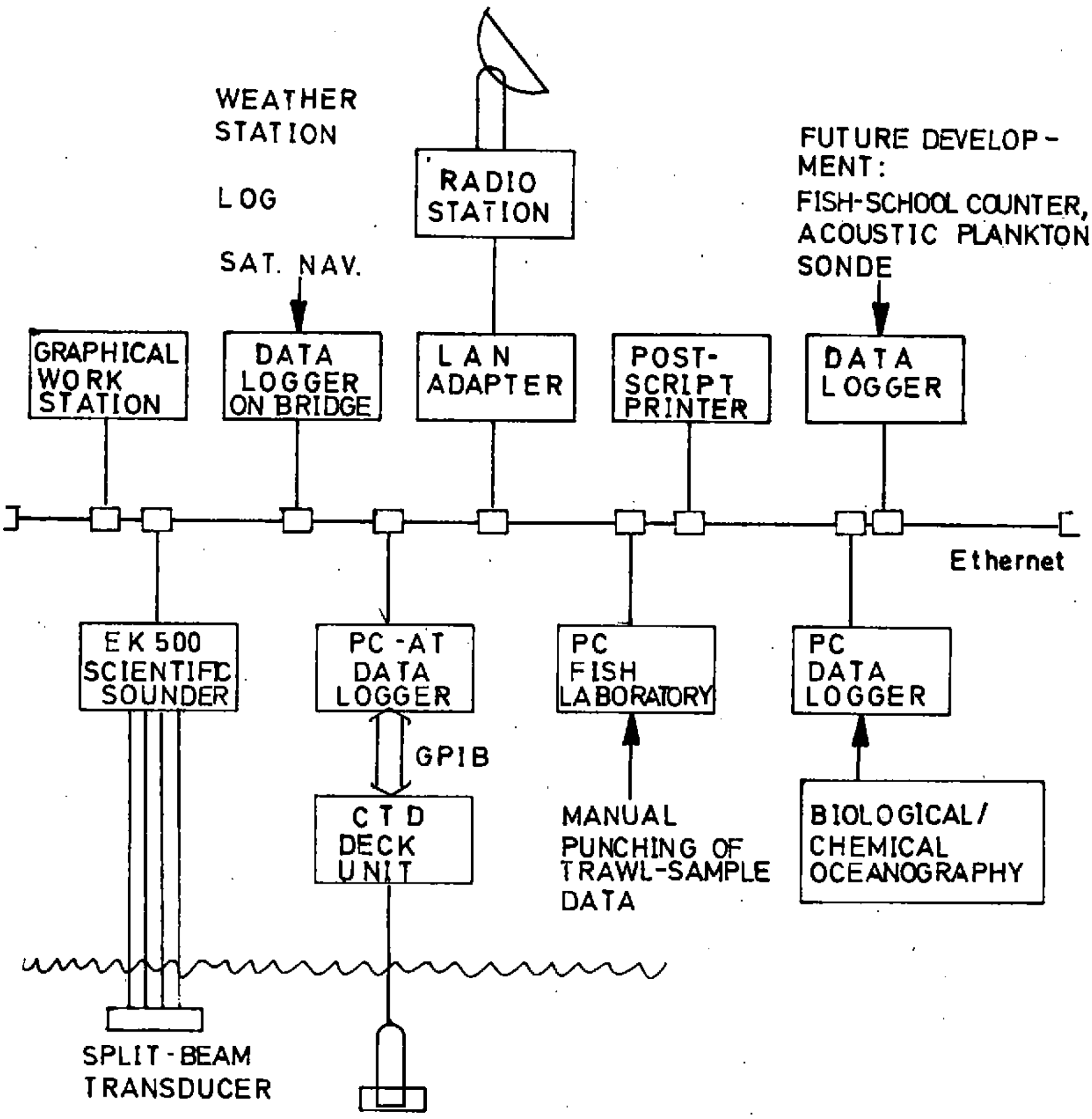

Figure 1: Computer network for fishery research vessels

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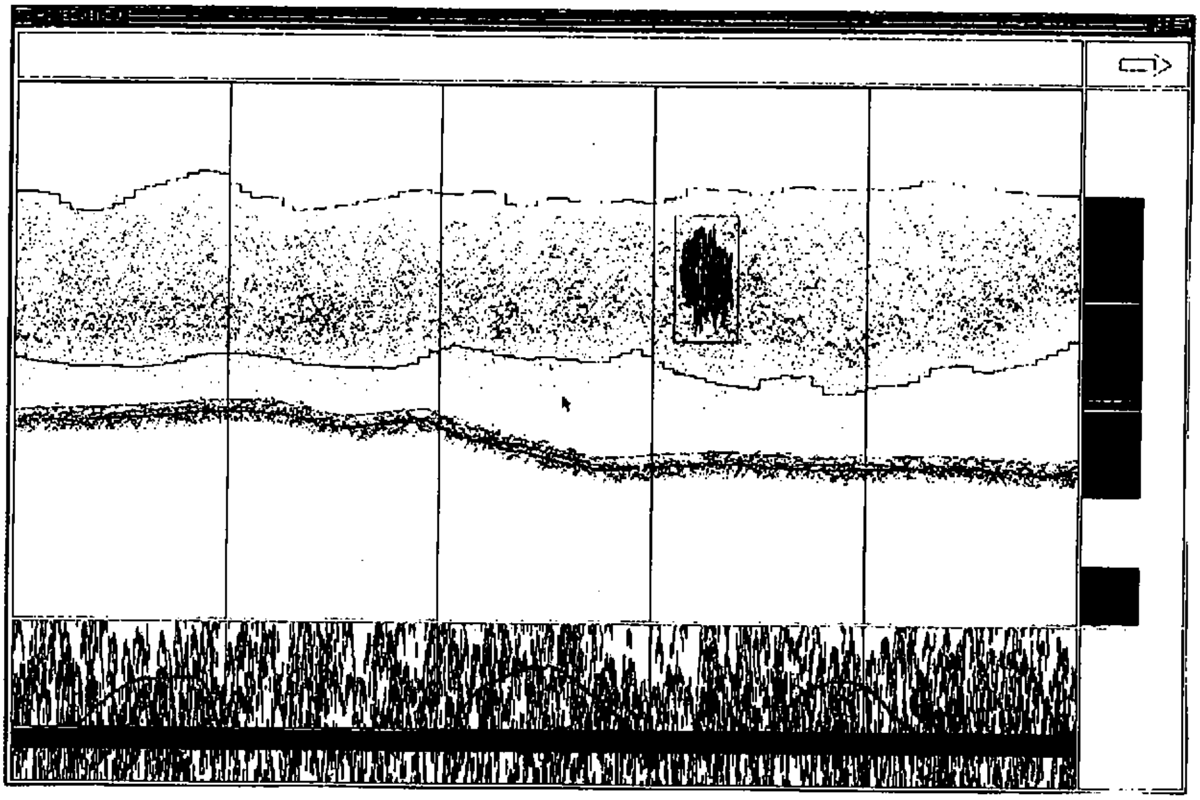

Figure 2: Main window

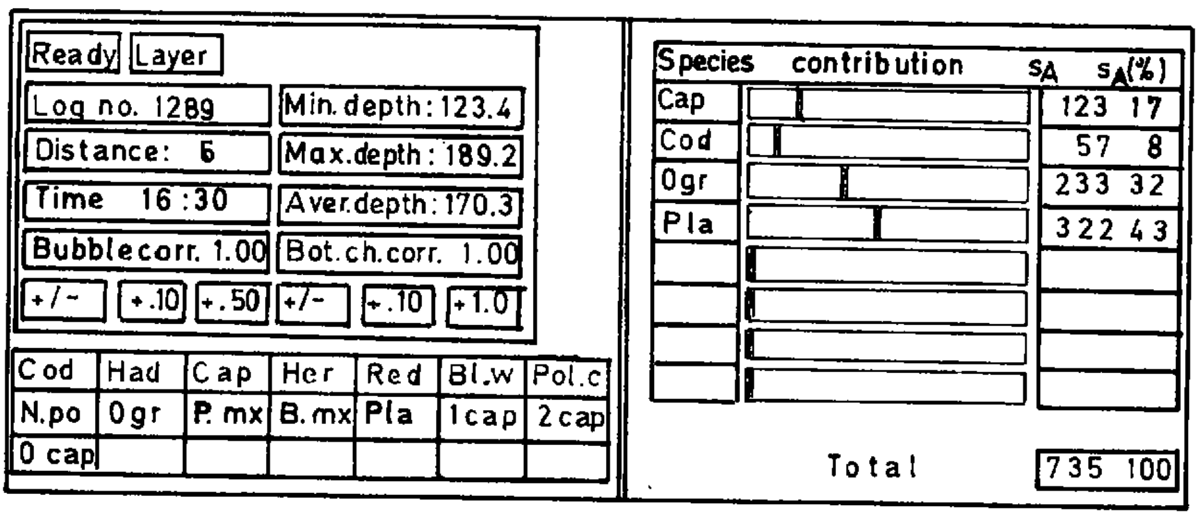

Figure 3: The interpreting window

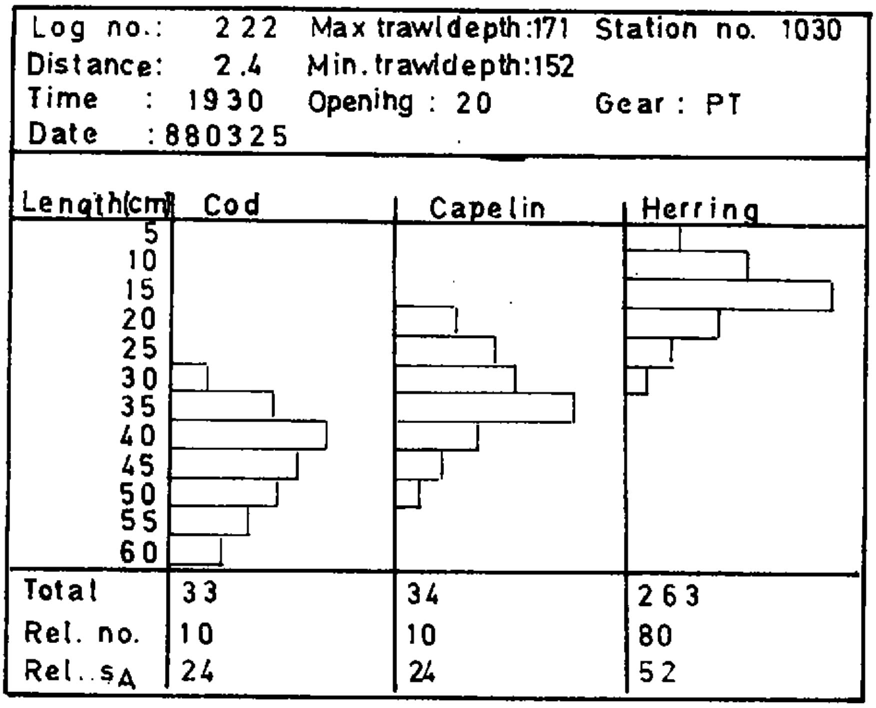

Figure 4: Trawl-station window