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System for Bottom Typing with Geographical Context Mapping

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ABSTRACT

The paper presents a system of bottom classification with geographical context mapping. It combines two previously developed subsystems, viz.: EchoBase - a portable dynamic Geographical Information System and Visual Bottom Typer (VBT) System. A newly developed version of the system was supplemented with interprocess communications mechanisms which allow transfer of data from one system to the other. These two software packages can run concurrently in multitasking. The MS Windows operating environment provides a mapping possibility of a classified sea bed type with an on-line geographical visualization on the nautical map. Both systems were presented separately in previous Symposiums' proceedings [1],[2].

1. INTRODUCTION

In many mobile surveys those conducting acquisition of acoustic data have a real need to map the logged data in geographical context. For some of them particularly important are sea bed classification and sediment recognition especially on the water dams. If the on-board processing of bottom echo data is combined with collecting of navigation data from the Global Positioning System (GPS) then the data needed for a geographical presentation are ready. The only thing required is a portable dynamic GIS-like system which can be run on a notebook computers that is applied typically as a supplement tool measuring system.

To meet these requirements, a portable system of data evaluation and computerized mapping are proposed. The system is composed of two independent software systems which were modified to run together under MS Windows operating systems. The format of output files generated by one of the subsystems is accustomed to the format of import data for the other one. In that way both programs can be driven by either software programs and conveniently used by a typical user.

2. BLOCK DIAGRAM AND OPERATION OF THE SYSTEM

The EchoBase system was originally constructed as a geographic fishery research database system for storing and management

of data on pelagic fish resources from acoustic surveys and catch samples, combined with environmental data in a geographical context. The second version of this software package, called EchoBase II, was upgraded with some features described in [1], which allows one to treat this software as a functional Geographical Information System (GIS). Echobase is a dedicated GIS System, and gives the user the possibilty of using three internally defined relational databases (hydroacoustic, trawling and environmental) and a user-defined one for storing data acquired from echosounder, echo signal processor, environmental CTD profiler and GPS Receiver. The electronic digitized maps (based on C-MAP public format files and MapViewer ASCII files) provide active on screen nautical charts.

The second subsystem Visual Bottom Typer™ called VBT is another data analysis software package, which provides bottom and sub-bottom profiling, bottom composition classification and sediment analysis. It may also be used for monitoring and mapping of underwater vegetation. It processes and analyzes echo-signals from the BioSonics echosounders (DT™ 4000 Series) and Simrad EK-500 series. The data may be acquired in a geographical context by using information from GPS. Then survey data of bottom bathymetry, bottom composition, sediments, weeds etc. may be entered into GIS databases including EchoBase™. The Typer implements three methods of bottom recognition: [2]:

1. measurement of the energy ratio in the first and second echo reflected from the bottom,
2. comparison of cumulative averaged echo envelopes with patterns obtained from theoretical models,
3. energy ratio method obtained from the special division of the first echo.

Both EchoBase and Visual Bottom Typer operate in Windows™ environment as 16-bit applications. By using multitasking features of this operational system they can communicate using the internal protocol for sending data in between each other. Figure 1 shows a functional block diagram of the developed system. Both subsystems EchoBase and VBT can import and export data. The main objective of the system, viz,: mapping of the sea bed type classified by using VBT algorithms may be achieved in three ways described below.

The first way marked in the figure with a Windows Interprocess Communication is dedicated to software writers. It is worth mentioning that Windows environment allows 16-bit applications to communicate in different ways. From a very simple mechanism based on sending messages through a more complicated one using the Dynamic Data Exchange (DDE) control protocol, and finally to the modern and sophisticated Object Linking and Embedding (OLE) concept. The former idea is very simple for software implementation and was used in the proposed system, the two latter protocols are extensively used rather by huge applications as a standard way of interprocess communication.

The basic idea in programming communication of both subsystems is based on sending one message as a signal to start the transfer. Then as VBT playbacks the data from the survey, it generates reports successively in one of its document window and simultaneously sends a message to EchoBase. This message contains the position (latitude and longitude) from the GPS receiver with the classified bottom type. To implement this simple one-way messaging protocol EchoBase software was appended with a procedure which serves the messages with a fixed number WM_USER + 28. This procedure uses one parameter as a function number for starting a new track (function 1) and for appending one point to the track (function 2). The data are transferred as pointer to string data.

Below is a sample of an excerpt from EchoBase source code written in Borland C++ Object Window Library (OWL) style:

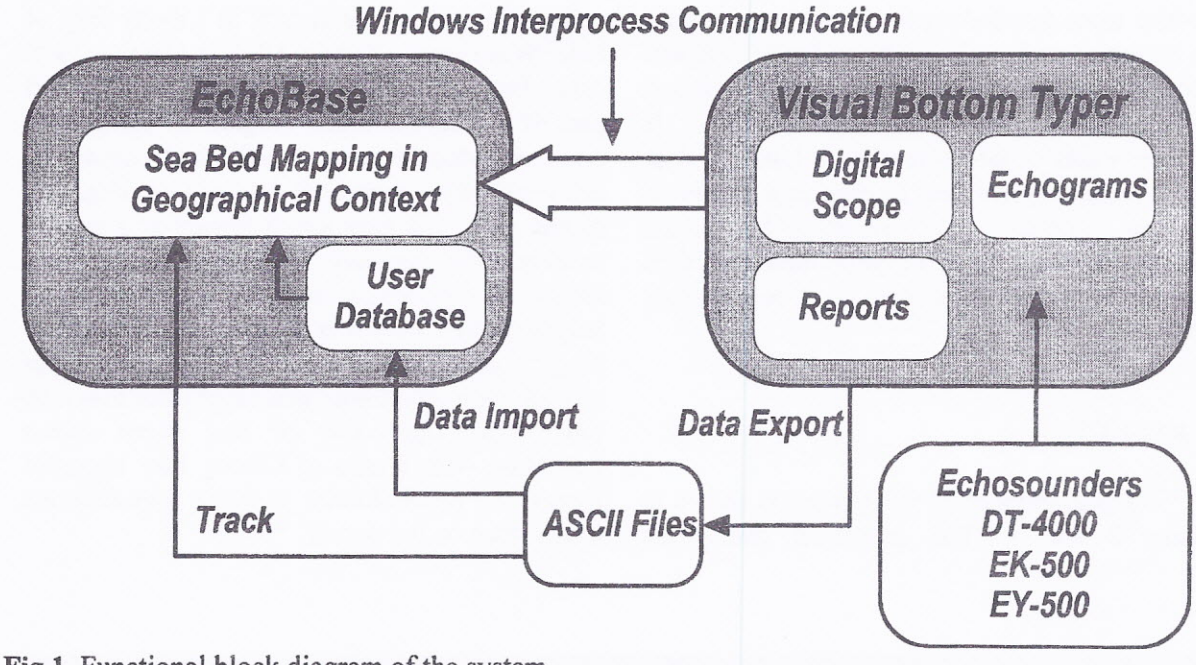

Fig 1. Functional block diagram of the system.

```
void TRegWin::WMCreateTrack(RTMessage Msg)
{ int mode= Msg.WParam;
  char *ptr = (char *) Msg.LParam;
  switch(mode)
  { case 1:     // Start
     if(itsTrack!=NULL)
     delete itsTrack;
     itsTrack = new TTrackPts(
                        itsMapPool.Map );
     break;
    case 2:     // Append
     HDC hDC=GetDC(HWindow);
     itsTrack->AddPoint(
                hDC,itsMapPool.Map,ptr);
  }
}
```

Any software program can use this interface to show some data in geographical context. Here is another excerpt of a code from VBT, which shows how to find running Echobase and send your message. This procedure written in Microsoft Visual C++ style uses the Windows function FindWindow to find the internal module name of EchoBase - "TMbfWin".

```
void CBtView::SendMessageToEchobase()
{ CBtDoc *pDoc=GetDocument();
  if(pDoc && pDoc->m_geog &&
     pDoc->m_Lat[m_ping-1]!=NOT_GEOG )
    { HWND hWnd=::FindWindow("TMbfWin",NULL);
      if(hWnd)
       { char buf[80];
         sprintf(buf,"%lg  %lg %u",
                 pDoc->m_Lat[m_ping-1],
                 pDoc->m_Lon[m_ping-1],
                 m_type);
         ::SendMessage(hWnd,WM_USER+28,2,
                       (LPARAM)(buf));
       }
    }
}
```

The following two types of communication between VBT and Echobase are particularly useful for users. These ideas are based on the fact that Echobase can import data from ASCII files. If the file represents data collected in a line oriented format with following fields:

```
latitude , longitude , data  ...
```

then Echobase can import this file treating it like track data. So finally it can show the track on its map if the currently opened one contains the area described by latitudes and longitudes of the data. This method guarantees the possibility of interpolating third column data in geographical context. However, Visual Bottom Typer can

produce more detailed reports including not only the bottom type but also bottom depth, first and second bottom echo energy and energy produced by sediments, which reside on the bottom. If the user wants to interpolate more kinds of data then it is more convenient to prepare a relational database template under ECHOBASE which describes all the fields of your data and then merge ASCII files produced as a report from VBT.

4. RESULTS

The performance of the systems is shown in figures 2 and 3. The presented data were collected on a mobile survey in Liberty Bay of Lake Washington, Seattle, USA in October 1995 using BioSonics DT4000 echosounder. The left part of the screen dump (Figure 2) shows two windows which belong to VBT and contain an echogram of the measured data and oscillograhm of one ping. The axes are displayed as a sample number. The sampling frequency 42kHz gives around 56 samples per meter of depth. The pulse length of the transmitted signal was 0.4 ms. The pings were transmitted at a rate of 5 pings per second. One report was generated after every 50 pings. The right side of this dump shows EchoBase with a map of Liberty Bay imported from C-AP public format. It shows four different tracks done on the survey.

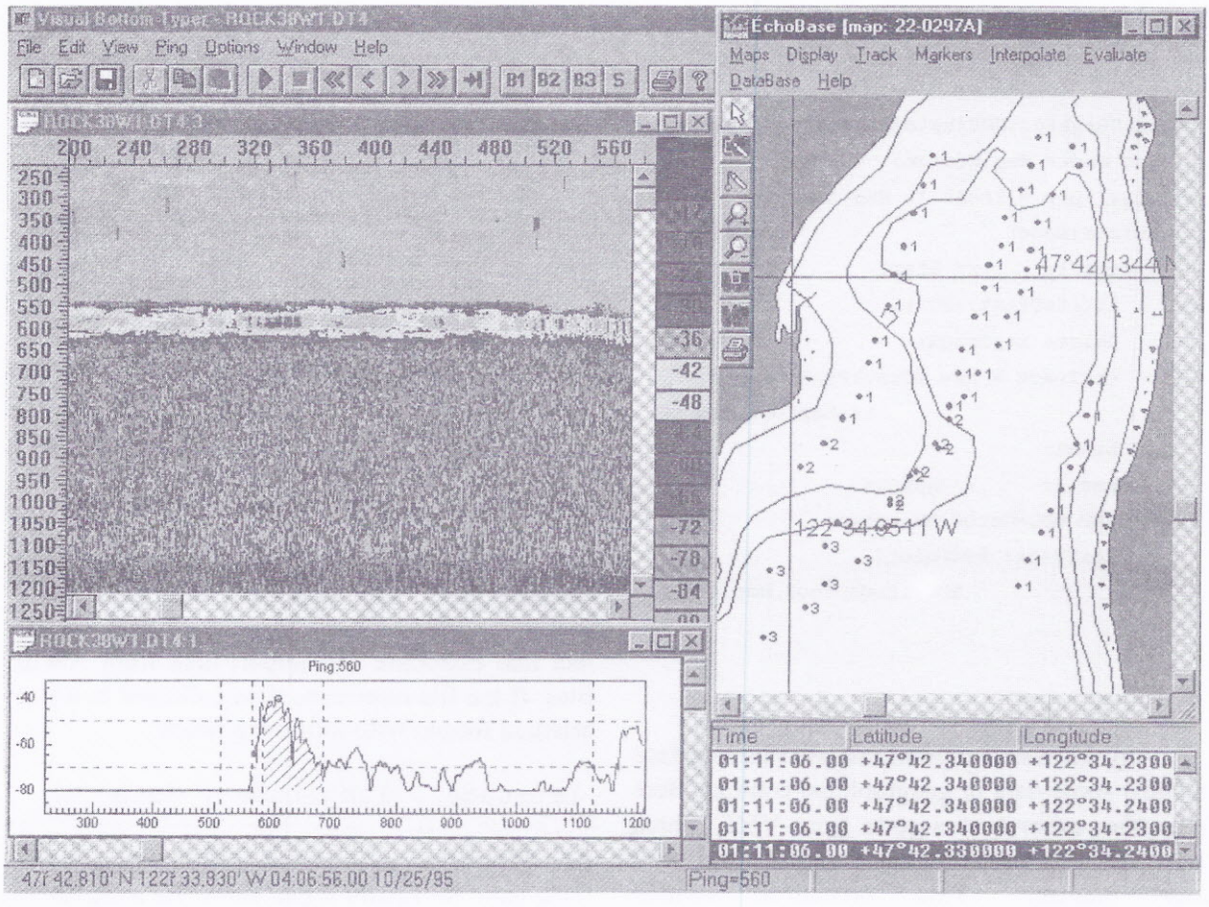

Fig 2. Screen dump of Windows 95 operating system running two programs concurrently.

Figure 3 shows EchoBase with an image of an interpolated bottom area from this survey. The area of interpolation is marked as a rectangle. The types of bottom are numbered as follows:

1 - hard sand
2 - soft sand
3 - soft mud

4. CONCLUSIONS

The developed system can be effectively used during mobile surveys as a powerful tool for on-line mapping and visualization of marine environment data. Additionally it can be used also as a postprocessing tool ready to prepare bathymetry maps from the surveys and maps with a classified see bed type. It is worth mentioning that using the correlation mechanism of images implemented in EchoBase both maps can be overlaid, compared etc.

From the point of view of computer users it is also important to underline that both systems can be installed from one floppy diskette each and executable codes do not extensively use computer memory and hard disk resources. Both programs which create the system can be executed independently on all Windows™ Systems.

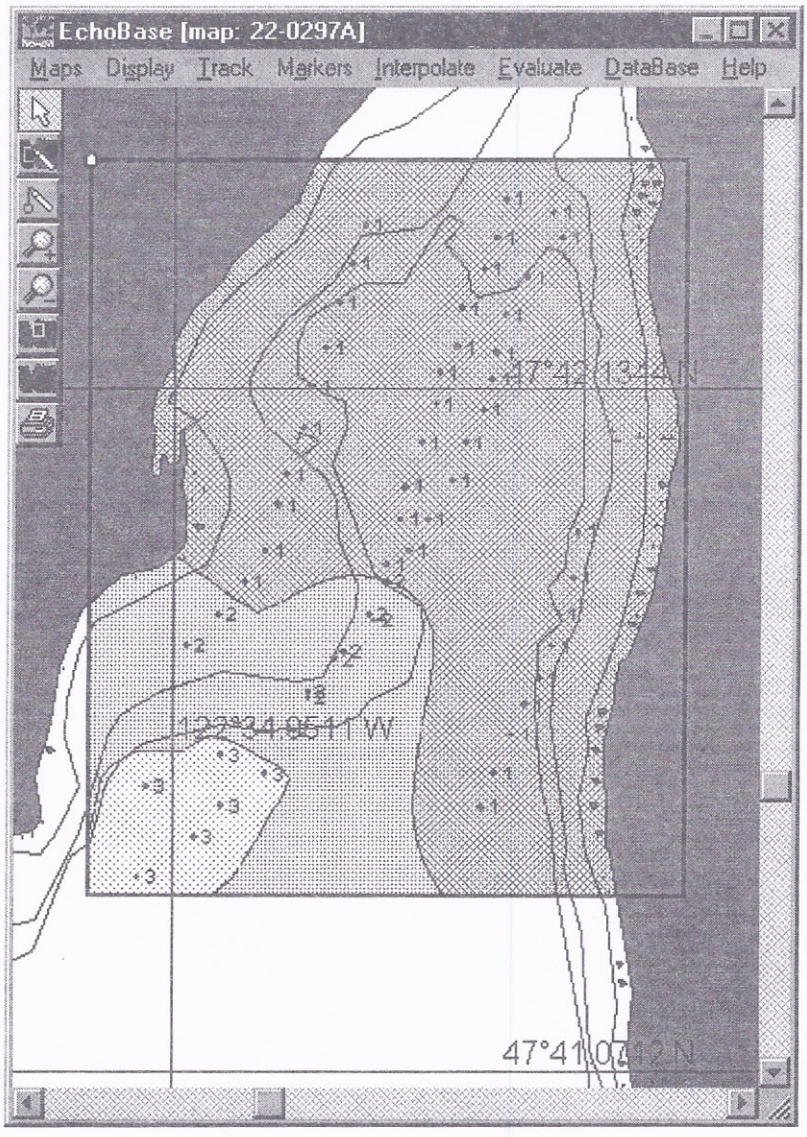

Fig 3. Interpolated map (image) of sea bottom type obtained from VBT using EchoBase

REFERENCES

[1] A. Stepnowski, M. Azzali, J. Burczyński, J. Lenkiewicz, A. Partyka, M. Moszyński, *A portable acoustic mapping/imaging system for assessing and monitoring of aquatic resources and environmental parameters*, Proceedings of 22 Conf. On Acoustical Imaging, Vol. 22, September 3-7, 1995

[2] A. Stepnowski, M. Moszyński, D. Bakiera, R. Komendarczyk, J. Burczyński, *Visual real-time Bottom Typer System (VBT) and neural networks experiment for sea bed classification,* Proceedings of 3rd European Conference On Underwater Acoustics, Heraclion, Crete, 1996