VISUALISATION FORMS IN MCM SIDE SCAN SONAR

LECH KILIAN, ALEKSANDRA RAGANOWICZ, TOMASZ SIDORKO

Gdansk University of Technology, Faculty of Electronics, Telecommunications
and Informatics, Department of Marine Electronics Systems
Narutowicza 11/12, 80-233 Gdansk, Poland
ragola@eti.pg.gda.pl

The article discusses forms of visualisation on the monitors of an MCM side scan sonar with towbody modernised by the DMES. The introduction gives an overview of the structure of the sonar, how it collects signals and the nature of the signals. This forms the basis for how the signals are visualised. Next a description is given of other factors which determine the form of visualisation on the sonar's monitors. They are the operator's tasks and the display of the settings, the readings of additional sonar sensors, how the system cooperates with other onboard systems, operator training and ergonomics. Examples of visualisation are included.

INTRODUCTION

Recently the DMES has carried out a major modernisation of three military side scan sonars. Almost all blocks of systems were modernised, except the quadrant davit and cable winch.

The principal goal of the modernisation was to introduce a modern technology and ensure that it will support the functional structure of the acoustic arrays, the towbody's electronic systems and the related deck unit's systems.

The second goal of the modernisation is to improve the system's tactical and technical parameters, its operability and reliability.

Apart from the new technology, the addition of dynamic control of the horizontal wide of the receiving beam on both sides of the towbody will add to the sonar's modernity. With the new feature the constant angular resolution will be replaced with constant linear resolution. As a result, the speed of the sounding will increase without losing echoes from the towbody's near targets.

The scope of the modernisation meant that all electronic systems in the towbody had to be replaced, except several PCBs inside the rescue transponders, and all analog sets in the deck unit.

The most important change was the introduction of an additional, second monitor and replacing the old DOS system with WINDOWS, a system operators are familiar with.

1. STRUCTURE OF THE SONAR

The military sonar in question has a more complex structure than commercial sonars. First of all its electronic and mechanical technologies increase its reliability significantly. Data (digital data only) are transferred between the towbody and the deck unit in a single-core, thin (diameter about 8mm) coaxial cable. The thin cable has a minimal effect on the stability of towbody movement. The towbody is equipped with systems that ensure that it can be located in water with high accuracy (echosounder, hydrostatic pressure meter, length of cable meter and special software to correct the towbody's position in relation to the array of the onboard GPS receiver). The data is also helpful with converting and linearising the scale of distances to the targets on the bottom. Because the sonar works together with the sound velocity meter, it can forecast and estimate any distortions of the scale caused by deflections of acoustic rays. Understanding the distortions and the ability to minimise them is very important especially in shallow seas such as the Baltic.

The dynamic stabilisation of linear resolution and the systems mentioned above add to the structure of the side scan sonar and help with an optimal (in the given system parameters) detection performance and classification. They support the positioning of underwater targets and identification of the bottom profile in three hundred meter strips on both sides of a ship going at a speed of 6 knots.

With so much effort going into the design and construction of this complex structure, it was important to provide the sonar operator with a user friendly visualisation of both echo signals, with new functions for target detection and location and reporting the results of the sounding.

2. THE STRUCTURE OF THE HARDWARE AND SOFTWARE IN THE DECK UNIT

The deck unit is operated by one operator. To help him better understand the process of scanning a specific area, the operator has two monitors operated by two computers.

The heavy duty design of the monitors and computers, just like of the other electronic sets in the sonar, is to withstand mechanical and climatic stress onboard the ship.

Because the previous version of the sonar only had one monitor and a dedicated keyboard, in the new version the main (lower) computer and its keyboard are left almost unchanged. The upper auxiliary monitor uses the standard keyboard.

Fig. 1 shows a photograph of the deck unit – the operator's console with two monitors and a double keyboard in the control desk and a card cage with cable interface, computer cards and power supplies.

Fig. 2 shows the structure and the tasks performed by the software in the deck unit's computers. The computers and the modem which transfers data bidirectionally to and from the towbody communicate in a network. The GPS receiver and sound velocity profiler communicate using a serial interface RS 232.

Computers CMP1 and CMP2 have software which is responsible for synchronising the operation of the sonar, controlling the measurements, the settings, navigation and display of echo signals and the tactical situation.

The software on each computer consists of two visualisation programmes (SHL200.exe) and a navigation programme (GPS.exe). While they are identical on both computers, the programmes perform slightly different functions, depending on where they were installed.

Despite that, visualisation of information on both monitors (with some exceptions) is the same. As a result, the operator can decide on how the information will be displayed, for example sounding results will be shown on the main monitor and the navigation situation, analysis of acoustic wave propagation or targets on the auxiliary monitor.

Fig.1. Deck unit – operator console

Computer CMP1 manages the operation of the entire sonar. It synchronises measurements, sends new settings changed by the operator to the towbody, processes measurement data and transmits them to the auxiliary computer CMP2. It receives navigation data from the GPS and sends them to computer CMP2.

Computer CMP2 in fact repeats the visualisation of a sounding and the tactical situation (the area searched is illustrated on a grid of geographical coordinates) and manages and archives data read from the sound velocity profiler.

As you can see in Fig. 2, if we add a switch or a router network access can be multiplied and, as an example, the images can be sent to computers that are not part of the sonar's console.

3. BASIC VISUALISATION

A simple visualisation of a sounding (Fig. 3, Fig. 4) is shown as "waterfall" on the main and auxiliary computers and a cartographic image of the area scanned (tactical situation) .

At the top of the main monitor there is a toolbar and a visualisation bar. The buttons grouped in the centre of the toolbar deal with equipment settings: range, length of the sounding pulse, horizontal wide of receiving beam, gain, TVG and anti-reverberation filter. The buttons on the left-hand side control the visualisation, display echo signals from both or
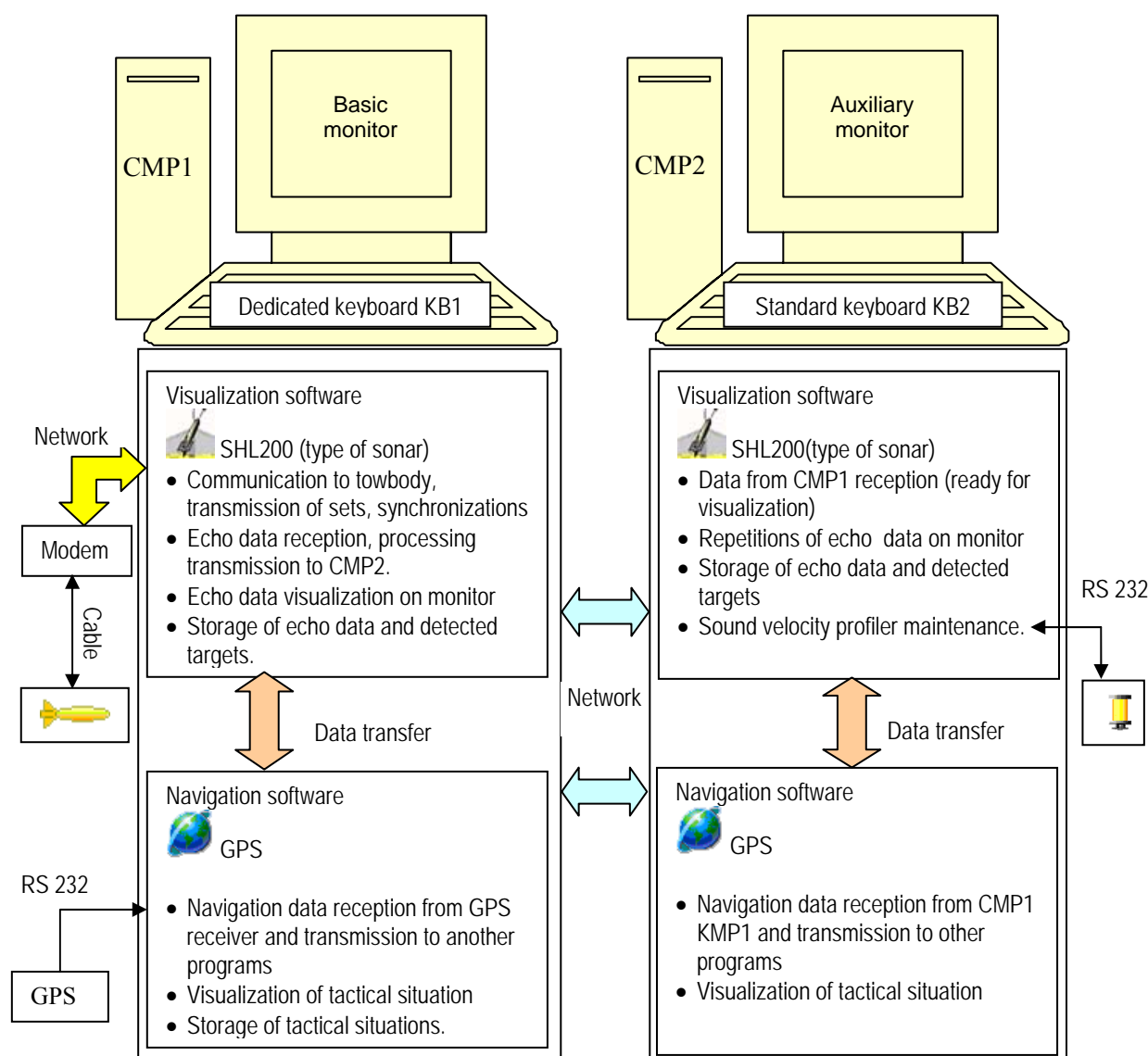
Fig.2. Structure of software in the deck unit's computers

one of the towbody's sides, increase signal understanding by selecting colours and linearisation of the visualisation. The buttons on the right-hand side are used to put in the length of the cable, release the readout and return to the main menu. There are also buttons for data and image archiving. The left-hand side of the toolbar includes a pictogram of the towbody's position in water. The pictogram's upper text field gives draught information and the lower one informs about height above the bottom. Navigation data such as the position, course and speed of the ship are given to the right.

The echo signal is visualised with "flowing" lines going towards the bottom of the screen which show echo signal transmissions from one or both towbody sides ("waterfall"). The levels of the signals are marked with different colours or intensity. The time / distance scale "flows" towards the middle of the screen showing the time elapsed (from the start of the sounding) and distance (where navigation data are provided) covered from the start of the sounding. All these data are closely related to the image of the bottom.

Fig. 3 also shows:
- range scale - identifies the distance between the target and the towbody measured along the bottom,
- status bar - a message bar; it shows the side distances coordinated with the movement of the mouse cursor,
- scroll bar - for scrolling the history of visualisation.

Fig.4 shows the zoom window with the area already marked in the basic visualisation. It can be used to set three types of markers (numbered from 0 to 300): bottom mine, pelagic mine - when the operator has classified the target or a question mark marker when no classification is possible. You can also, the conditions permitting, identify the size of the target and the distances between targets.

4. VISUALISATION ON THE AUXILIARY MONITOR

Fig. 5 shows the typical screenshot of the auxiliary monitor. You can see a small pictogram of a ship with an orange belt behind the stern moving on the screen and the geographical grid produced from GPS data which are continuously fed to the system. The belt behind the ship is the size of the selected sonar range (2x150m or 2x300m). As it moves it leaves a pale blue trace behind it. Markers are provided as well, those set in the main visualisation. As a result the sonar's operator knows exactly what area of the sea has been scanned. Because this display is very helpful for the ship's officer in charge of the movement of the ship, it should be exported to another computer to ensure easy access.

The toolbar at the top of the screen is used to operate the geographical grid and list of markers with their geographical positions.
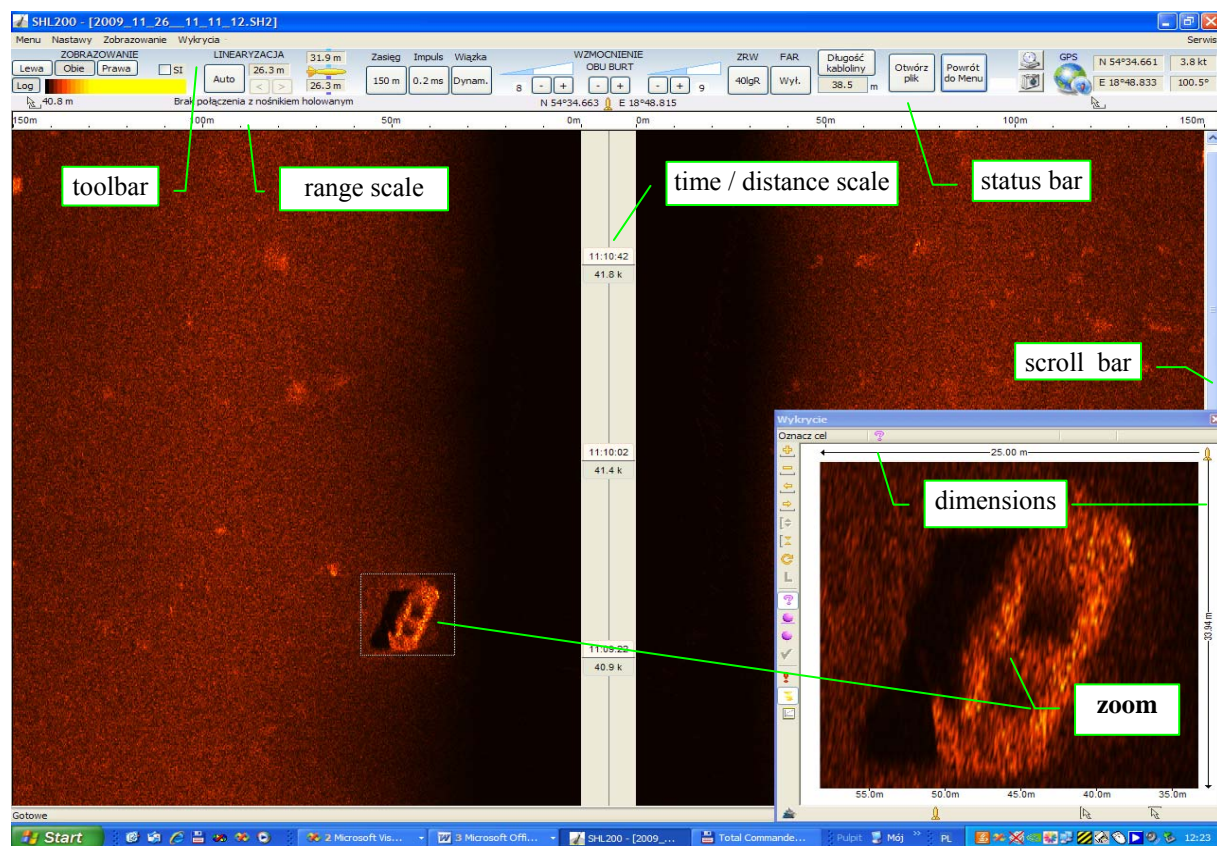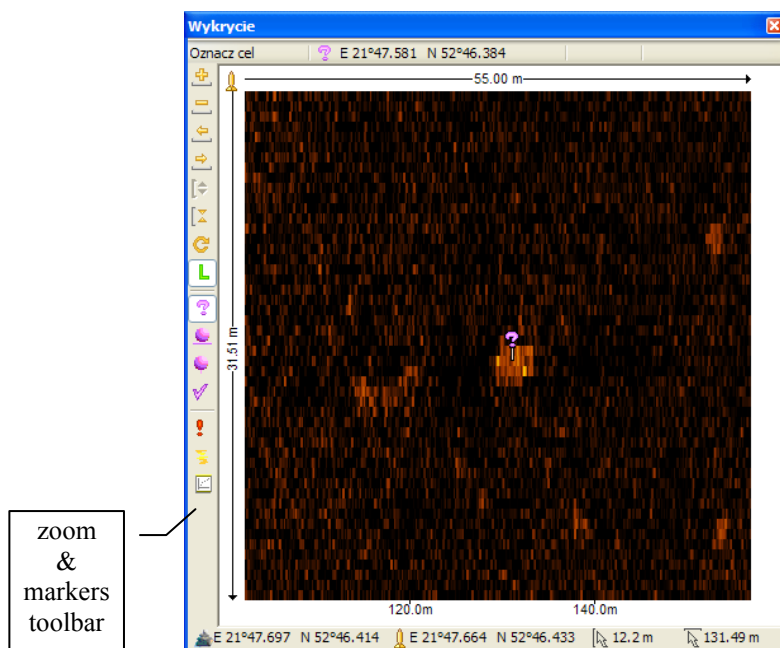

Fig.3. Main display. Wreck image

zoom & markers toolbar

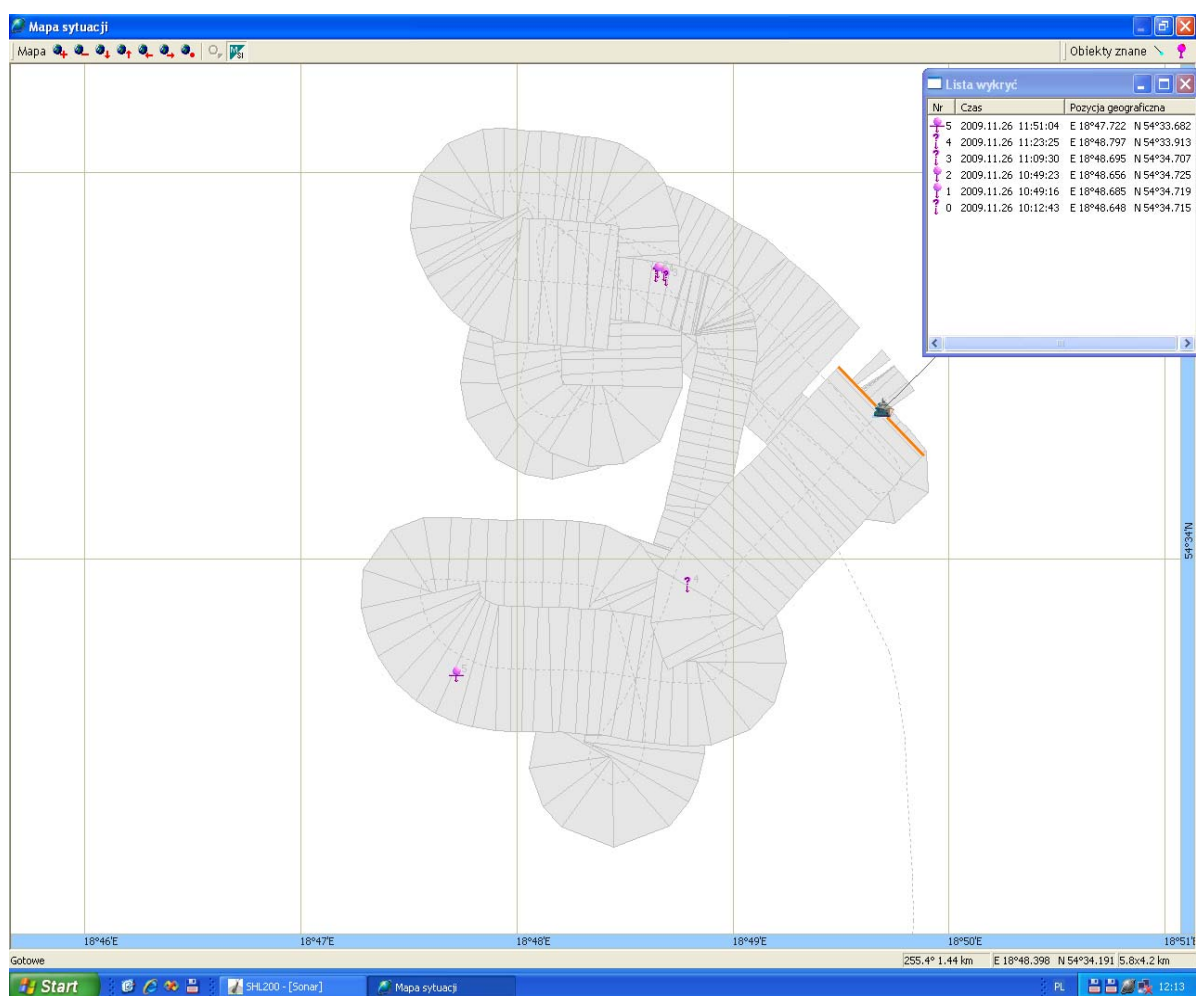Fig.4. Zoom window. Bottom mine image

Fig.5. Auxiliary display

5. OTHER FORMS OF VISUALISATION

The visualisations presented above are part of the main sounding. However, there are also several other groups of visualisation.

The first group are temporary windows which appear as the sonar's operating systems are opened or closed.

When the system is open, an important toolbar window (Fig. 5) appears for choosing the mode of operation:
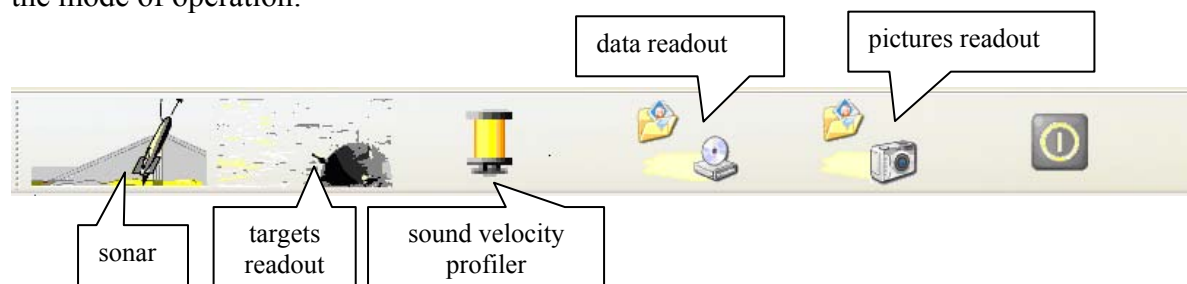

Fig.5. Toolbar "mode of operation"

The sound velocity profiler offers a number of visualisations. However, the end effect in the side scan sonar is different from the visualisations produced in sectoral sonars because here the priority is wrong readouts of target positions as a result of sound propagation ray diffractions. If a mistake is made, the operator is warned with pictograms on the range scale in the main display (Fig. 6)

Real propagation

Ideal – rectilinear propagation

Fig.6. Range scale with wrong target location readouts

When watching the image of a marked target, we can read the real distance to the towbody and the corrected geographical position as shown in Fig. 7.
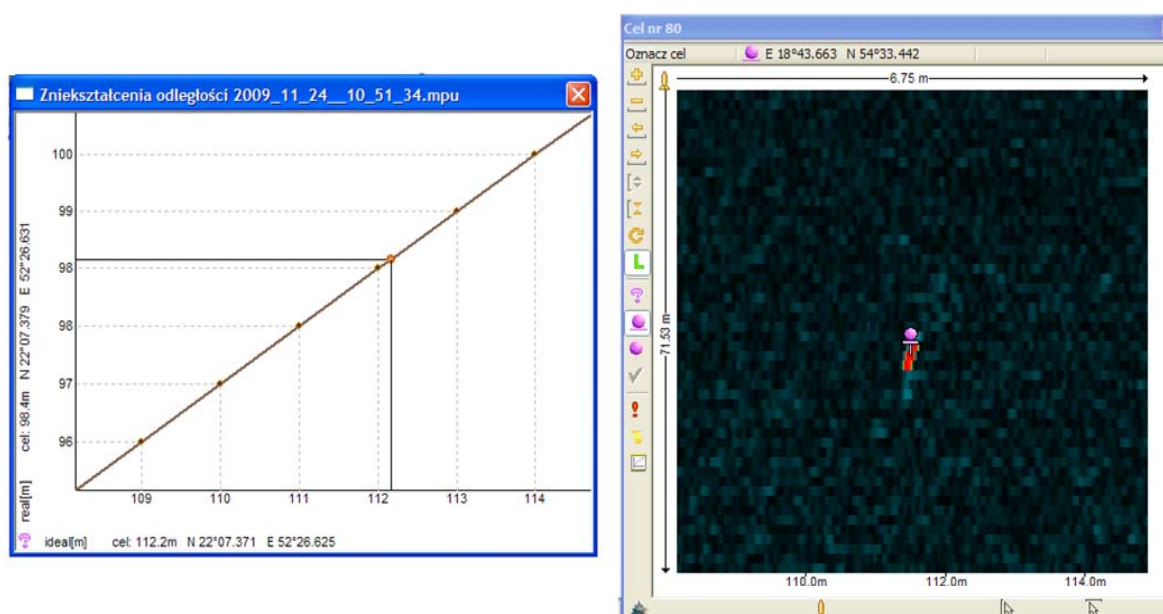

Fig.7. Real distance from the target to the towbody and corrected geographical position of the target

The effects of sounding can be recorded in three ways:

- the marker and its surrounding (zoom window) with an edit option (new scale, checking distortions, target dimensions),

- images from the sounding produced within 4 minutes (for a 300m range) or 8 minutes (150m),

- continuous recording with files split every 30 minutes for better safety of the recording.

4. CONCLUSIONS

A user friendly and attractive visualisation is key to the functionality and perceived quality of the equipment. What made the visualisations so special is that they have replaced (although not on all ships yet) visualisations which were modern some 10 years ago, described in e.g. [1] and using what is today an archaic system, the DOS.

Apart from the ability to improve target detection, zoom, set the dimensions, record and read data in different ways, the users are very happy with the "geographical" auxiliary visualisation and are in favour of allowing the navigating bridge to use the images.

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