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ITJ

ISSN 1812-5638

INFORMATION TECHNOLOGY JOURNAL

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Information Technology Journal 12 (16): 3645-3649, 2013
ISSN 1812-5638 / DOI: 10.3923/itj.2013.3645.3649

Design and Realization on Simulation Software of Echo Sounder

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Abstract: Echo sounder is currently one of the main navigational instruments. Using the simulation software of Echo sounder to train seamen, the training cost is lowered and the efficiency is improved. The key technology to realize the echo sounder simulation software is studied in this paper including its function and interface. The seabed echo and the speckle noise generation are introduced in the function part. Bitmap button and knob algorithm are described in the interface part. On that basis, the SKIPPER GDS101 Echo Sounder is simulated. Practice shows that the function of the Echo Sounder can be fully realized by the simulation software with good results.

Key words: Echo sounder, simulation, echo, noise, knob

INTRODUCTION

Currently, the navigational instruments are used in the seaman training generally. The training colleges and institutions have to buy some instruments, which increases the cost of training. During the using, accidental damages may be brought into the navigational instruments. Those problems can be solved by using the simulation software of navigational instruments. The efficiency of training can also be improved. In a word, it is necessary to develop the simulation software of navigational instruments.

The Echo Sounder is one of the main navigational instruments. The related acoustic and electronic technologies are used to detect the seabed and the sea obstructions and then results are displayed on the screen in the form of the echo images (Skipper, 2011; Fu, 2012). The Echo Sounder plays an important role in both monitoring the water depth of ships' location at real time and ensuring navigation safe of ships. The Echo Sounder of SKIPPER in Norway has been widely used at present. This paper uses computer graphics technology to simulate the SKIPPER GDS 101 Echo Sounder (Fig. 1) and then focuses on simulating the seabed echo, speckle noise and bitmap buttons. It also presents a design of an algorithm to simulate the knob of Echo Sounder using mouse-move to pull the knob.

FUNCTIONAL SIMULATION

When detecting the seabed and obstructions, the Echo Sounder displays a series of related echo images on the screen. So, the simulation should include the generation of seabed echo and clutter echo of obstacles. The simulation results should be basically same with the Echo Sounder image.

Simulation of seabed echo image

Generation of the seabed echo image: The seabed echo image of this software consists of a series of consecutive lines with different length (Hearn and Baker, 2008). These lines are draw using Bresenham algorithm and a continuous image is formed (Ding, 2006). The generation of seabed echo mainly involves the following two functions:

Fig. 1: Skipper GDS101 echo sounder

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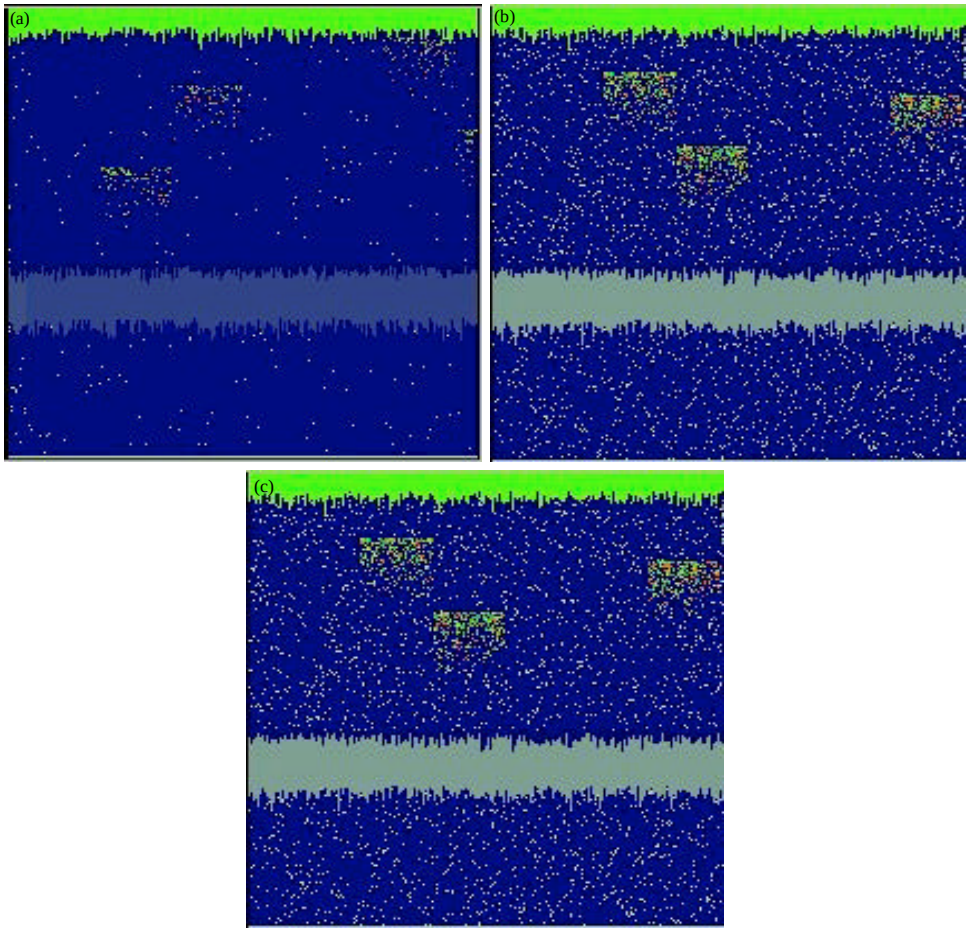

Fig. 2(a-c): Simulation result of the echo image, (a) Unsharp display of the echo, (b) Excessive display of the echo and (c) Clear display of the echo

- DrawSeaBed(CDC* pDC, int x1, int x2, int y1,int y2)
- SetColor(CDC* pDC, int a, int b)

In the DrawSeaBed function, (x1, y1) is the coordinate of front pixel point in horizontal direction and (x2, y2) is the next. The SetColor function is mainly to set the echo color and control the strength of the echo concavity.

Adjustment of the seabed echo image: The clarity of seabed echo image can be changed by adjusting GAIN. That is to say, the echo has a gradient effect (from invisible to dimly visible and then clear, at last to excessive intensity). To achieve this effect, the echo and background color are mixed in order to adjust the image (Cong *et al*., 2011). The clarity (transparency) of the echo image is changed by adjusting the Alpha. The specific formula is as follows:

$$SC = RC \times \frac{Alpha}{255} + BC \times \frac{255 - Alpha}{255} \quad (1)$$

where, SC is the color needed to be displayed. RC is the resource color. BC is the background color. Alpha is a number from 0 to 255. 0 is transparent and 255 is opaque.

The clarity adjustment of the echo image can be achieved according to the above method. As is shown in Fig. 2a, the gain is too low, the display of the simulation result is unsharp and we cannot obtain a stable water depth. Figure 2b shows that the gain is too high, the simulation result is too bright, the seabed echo and clutter mix with each other and we can hardly identify the shape of seabed echo accurately. Figure 2c shows the simulation result of the echo image with a suitable gain. The seabed echo displays clearly.

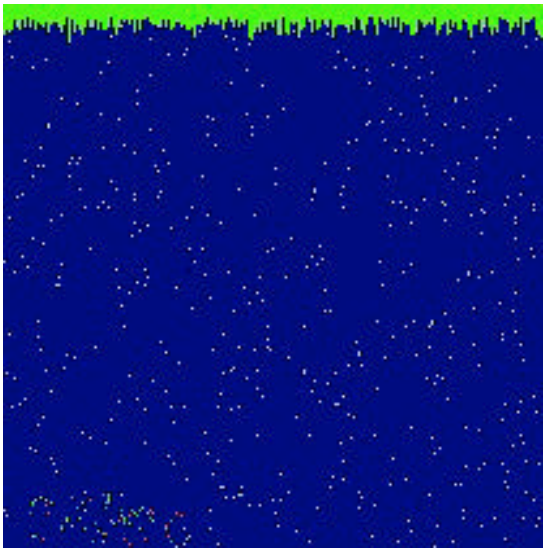

Fig. 3: Simulation result of speckle noise

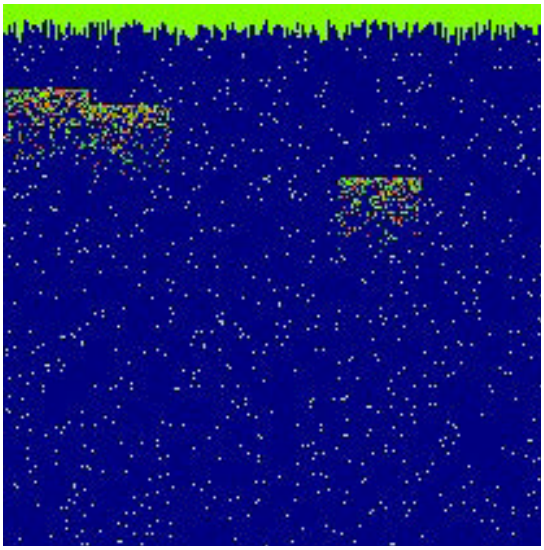

Fig. 4: Simulation result of clutter

Generation of speckle noise and clutter: When the Echo Sounder sends sound wave to seafloor, the impurities in seawater will interfere the sound wave leading to some speckle noise and clutter on the screen, which are uncorrelated with seabed echo. Therefore, when we develop the Echo Sounder software, the simulation of speckle noise and clutter cannot be ignored.

The random function generates pixels randomly in the display area, leading to the generation of speckle noise. The display area of Echo Sounder constantly moves to the left. In an interval, we can select pixels randomly to draw the image from the right row of display area. With controlling the number of pixels, the density of all the speckle noise can be adjusted. The result of the speckle noise simulation is shown in Fig. 3.

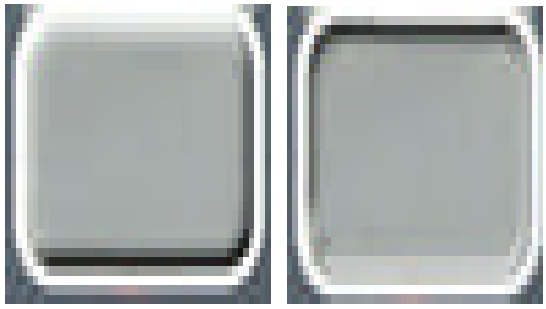

Fig. 5: Release and press the button

The method of generating clutter is similar to the method of generating speckle noise. A group of speckle noise is gathered within a certain range and then a random position is generated by the random function. Set different color in order to make the simulation image look more like the clutter of Echo Sounder. The clutter simulation result is shown in Fig. 4.

DESIGN AND REALIZATION OF INTERFACE

In order to keep simulation software consistent with Echo Sounder in the interface, we use the pictures of the Echo Sounder. After a series of beautification process, the bitmap is pasted in memory firstly and then in dialog client area. The focus design is buttons and knobs.

Buttons: In order to simulate the concavity of pressed buttons and the convexity of released buttons, each button is switched by two bitmaps (Fig. 5).

The method is as follows: Firstly, we define an object with Cbitmap class and the two bitmaps are stored in it. Secondly, the two bitmaps are associated with the button control. When buttons are released or pressed, the two bitmaps switch alternately. Thus the concavity of button is realized which is consistent with Echo Sounder.

Knob: In order to make the simulation closer to Echo Sounder, this study has designed a feasible method that the knob is pulled by the mouse-move. The angle of mouse-move rotation around the knob determines the direction and the angle of the knob. Then, select the corresponding bitmaps to display.

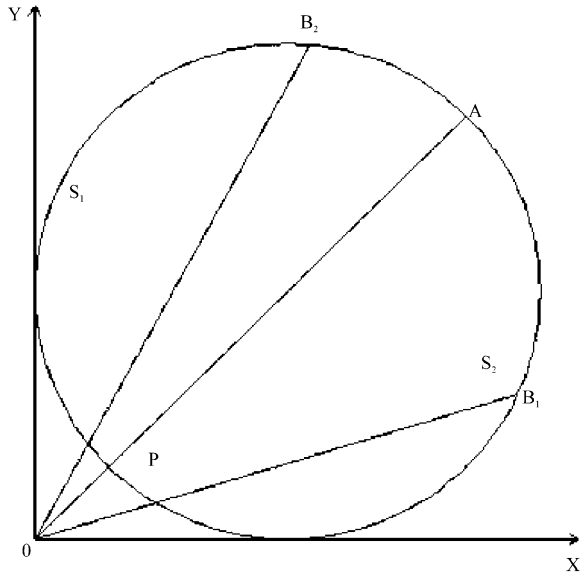

Fig. 6: Calculation of the rotation angle

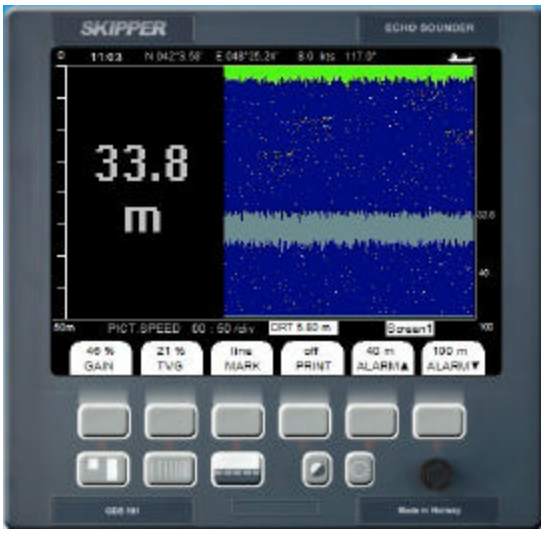

Fig. 7: Simulation of echo sounder

When we select the coordinate system to calculate angle of rotation, we put knob in a rectangular area, to establish a coordinate system that the origin point (O point) is in left bottom of the rectangular area, in order to avoid repeated judgment of the mouse's quadrant. The knob is located on the first quadrant of the coordinate system (Fig. 6).

When the left mouse button was pressed, connect the starting point A and the origin point O and intersect at the point P with the edge of knob. The knob is divided into two regions byAO. The area of AB_1P is S_1. The area of AB_2P is S_2. $<AOY = \theta_0$.

The judgment of the knob rotational direction:

- When the mouse is in area of S_1 (As Fig. 6 the position of B_1), set $<B_1OY = \theta_0$. If $\theta_1-\theta_0>0$, the mouse moves clockwise and the bitmap of clockwise rotation was pasted in the area of knob. If $\theta_1-\theta_0>0$, the mouse moves a counterclockwise and the bitmap of counterclockwise rotation was pasted in the area of knob
- When the mouse is in area of S_2 (As Fig. 6 the position of B_2), set $<B_2OY = \theta_0$, $\theta_1-\theta_0<0$ the mouse moves clockwise and the bitmap of clockwise rotation was pasted in the area of knob. If $\theta_1-\theta_0>0$, the mouse moves counterclockwise and the bitmap of counterclockwise rotation was pasted in the area of knob

CONCLUSION

In this study, the simulation software can realize the main function of Echo Sounder, such as depth settings, GAIN settings, TVG settings, setting frequency, alarm settings of shallow and deep water and so on. Both the simulation of display area and the fidelity of operation (Fig. 7) are closed to Echo Sounder. It has a good simulation effect. Therefore, the simulation software can be used in the training taking place of Echo Sounder. Furthermore the research of this simulation software offers a reference to the simulation of other navigational instruments.

ACKNOWLEDGMENTS

This study was supported by National Basic Research Program of China (973 Program, No. 2009CB320805), Natural Science Foundation of Liaoning Province of China (201202018), the Fundamental Research Funds for the Central Universities (No. 2012QN001, 2011QN148).

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