A FAST DISPLAY PROCESSOR FOR SONAR ECHOES

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ABSTRACT This paper presents a display processor for a CRT, which shows a horizontal projection of underwater targets. Sonar echoes are drawn as short lines across a 5^{o} beam, in random scan and with 50 Hz refresh. The high speed requirements is met by digital integration (TTL low power schottky). One of the main advantages of this display processor, relative to alternative principles, such as PPI or raster scan, is brightness. The screen can be viewed in full daylight. This is achieved because the beam spot is positioned only to points with light.

INTRODUCTION

As part of a display system for a fish finding sonar a fast, real time display processor is developed.

The principle and the advantages of this display processor is described here.

The display which is a CRT, shows a horisontal projection of underwater targets.

1 THE PICTURE ON THE CRT SCREEN

The display processor draws sonar echoes as short straight lines perpendicular on the beam direction. These echo vectors fill a 5^{o} beam width on the screen. See figure 1. There are 256 range cells in each beam. An echo vector can have one of four intensity levels, including black.

The picture is drawn in random scan. The beams are plotted one after another. Within each beam the plotting sequence is from the own ship position and out to maximum range.

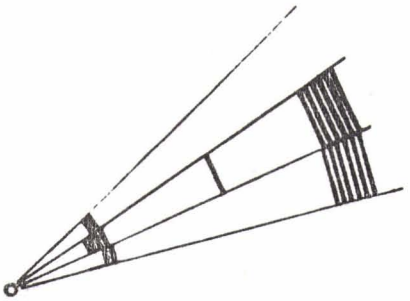

FIGURE 1.

2 THE DISPLAY PROCESSOR JOB IN THE SYSTEM

Figure 2 shows how the display processor is connected to the rest of the system. The display processor fetches the display data from the computer memory where they are placed by the computer program. The display processor has direct memory access with cycle stealing. The computer chosen for this project was ALPHA LSI from Computer Automation. The display is a Cathode Ray Tube with short persistence phosphor. Hewlett Packard 1311 was chosen. It has electrostatic deflection which gives high speed in moving of the spot.

It is the job of the display processor to generate X and Y deflection voltages for the echo vectors. The picture is refreshed with a rate of 50 Hz. This refresh is syncronized with the 50 Hz line frequency. Thereby hum in the deflection amplifiers will give only static errors and not a waving motion in the picture.

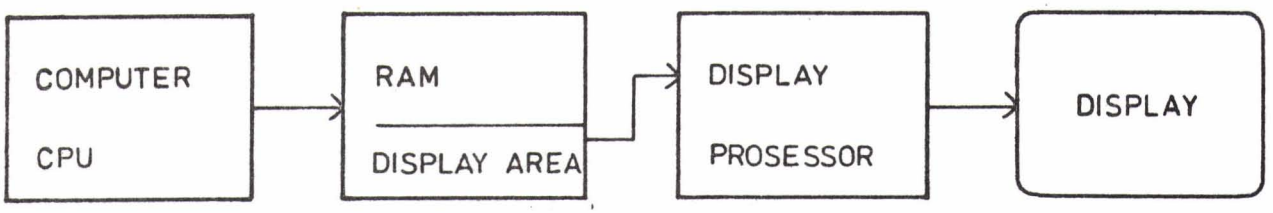

FIGURE 2.

3 FUNCTIONAL DESCRIPTION

The display processor has two identical addition units, one for X deflection and another for Y deflection. Only X deflection will be described here. Figure 3 and 4 illustrate how the echo vectors are drawn. The processor starts by loading the start position X_0 into the X register. With the addition loop in the right part of figure 4 increments ΔX are added. ΔX is

one range cell. The beam spot now moves out along the beam direction with the spot blanked. This continues until an echo vector with nonzero intensity is found. Then the left add loop takes action and generates the echo vector unblanked. A special circuit, not shown in figure 4, stops the incrementation when the echo vector has reach a length corresponding to the 5^{o} beam width.

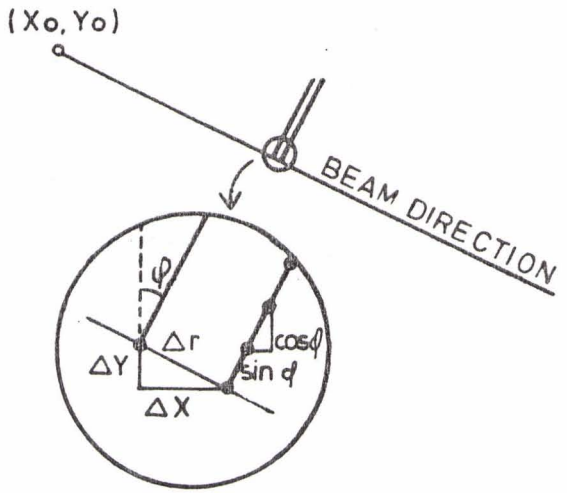

FIGURE 3

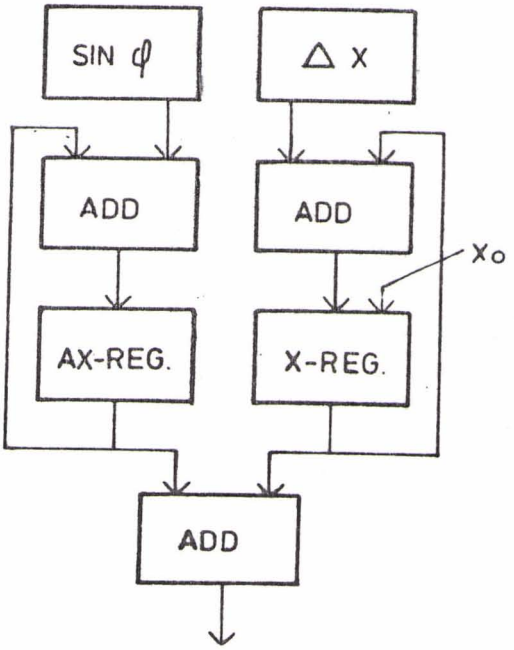

FIGURE 4

When the echo vector has reached this length the AX register is reset to zero, which brings the spot back at the beam direction line ready for a new ΔX increment.

The increment ΔX is set by the computer program without restrictions. This is utilized to control the display scale. A large ΔX gives a magnification of the picture, and can be used to study details.

The beam can be offset by changing X_o.

The increments between points in an echo vector are restricted in size in order to keep a constant point density and thereby a constant brightness. The angle ϕ of the echo vector is defined relative to the Y axis (north), therefore the X-increment comes out as sin ϕ.

The final point resolution on the screen is 1024 x 770. The resolution in the add loops is however much finer, this is in order to prevent accumulated position errors.

When all beams are drawn the display processor rest until the next refresh pulse arrives. The refresh period is 20 ms. If the display processor do not reach to draw all echo vectors in the 20 ms it will continue into next period. This means that no echoes are lost, but the refresh rate is halfed which cause flicker. This serves as a warning to the operator that he should lower the sonar gain or in other ways reduce the number of echoes. In normal use, with the own ship position in the center of the screen and sonar range out to the screen perifery, the display processor can cope with up to 25% nonzero in 27 beams (= 135° search sector).

Figure 5 shows a block diagram of the display processor.

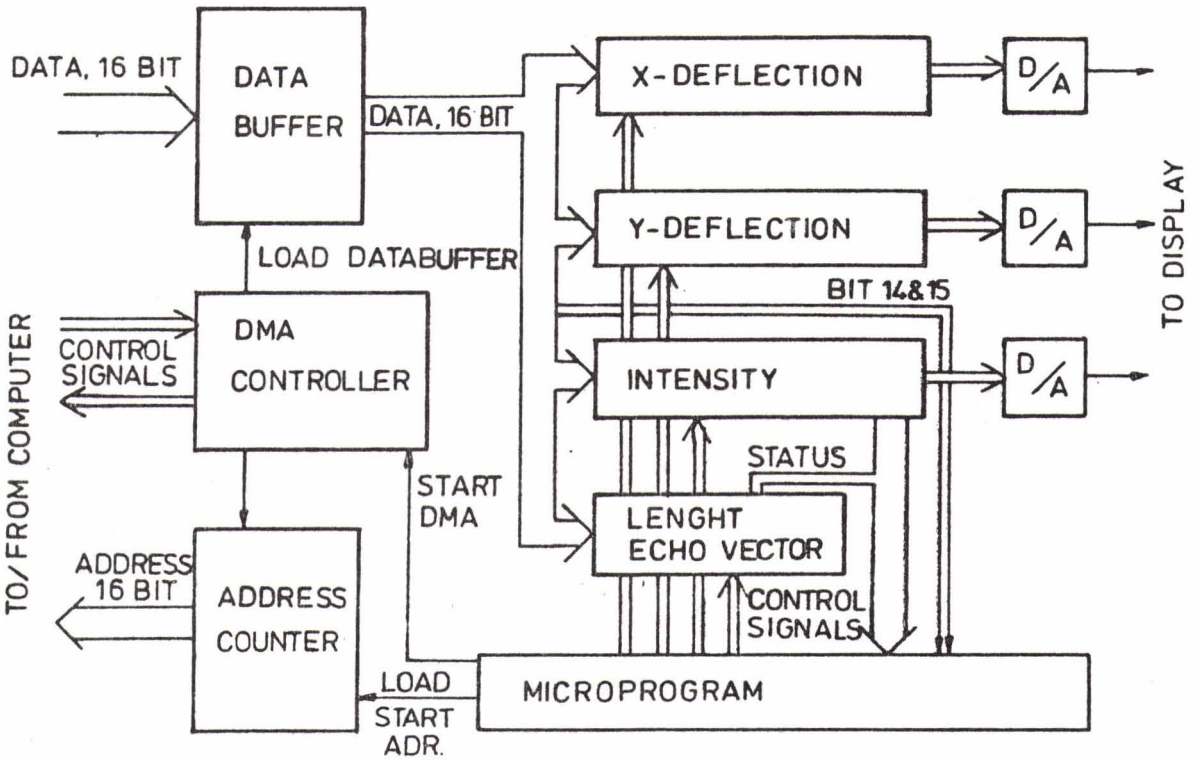

FIGURE 5

4 FORMAT OF DISPLAY DATA

The display data are placed in the memory one beam after another. The data for one beam consists of a data head and 256 intensities. The head has all information specific for this beam. See figure 6. Since the memory word lenght is 16 bit and the intensity is only 2 bit per range cell the intensities are packed, 8 in each word. The size of the display area in the computer memory is (6 words for the head + 32 words for intensities) x number of beams.

There is some redundancy in the data in the head. The reason for this is to free the display processor from timeconsuming trigonometric calculations. They are instead done by the computer program.

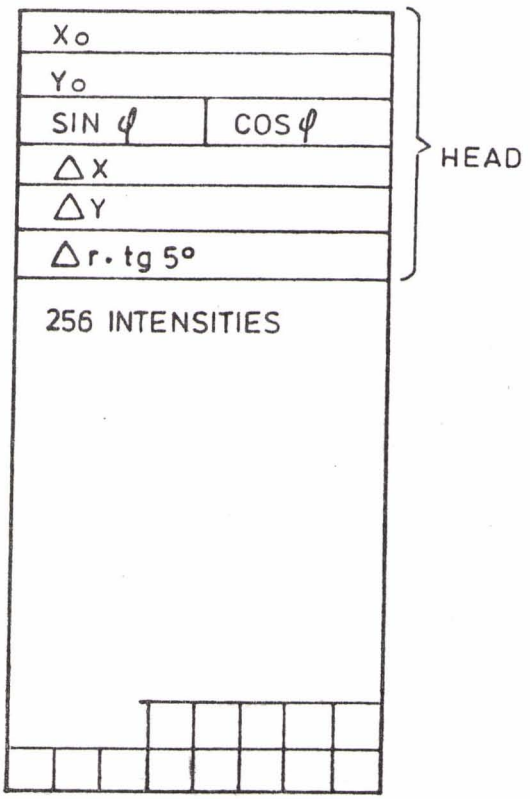

FIGURE 6

5 ADVANTAGES

The goals in the design of this diplay processor were:

1. A bright picture for daylight viewing
2. A picture where large targets, such as fish shools and bottom topography, are shown as bright areas.
3. A flickerfree presentation.
4. Minimum display area in the computer memory

1. A bright picture is achieved by the random scan. Only echo vectors with nonzero intensity are drawn. When the spot moves out along the beam it pass quickly all range cells with zero intensity. A raster scan would give less light output because the spot also devotes time on dark positions. A PPI could give still lesser light if the increasing writing speed in the spiral scan in compensated by lower intensity in the center.

2. In normal use the echo vectors are so close each other that they melt together and form a bright area when the target covers several range cells. The length of the echo vectors correspond to the real sonar resolution, good at short range and poorer at longer ranges.

3. The 50 Hz refresh rate gives flickerfree presentation.

4. The format of display data demands only a modest memory space. The alternative raster scan demands a much larger memory space because every pixel on the screen must have a corresponding memory cell. Such a pixel memory is necessary in a fast raster scan display processor. A random scan alternative with storage of the X-Y coordinates for each nonzero echo was considered. It demands only a small memory space when there are few nonzero echoes, this because all the zeroes do not need to be stored. When the number of nonzero echoes grows, the necessary memory grows.

6 SYMBOLS

In addition to the drawing of sonar echoes the display processor is also able to draw symbols as a vector generator. The computer specify starting point, angle and length. The display processor draw the vector utilizing the same incremental add loop as for echo vectors. Complex symbols can be built up of more separate lines.

7 SWEEP MARKER

It gives a very live impression if the computer program generates a flying sweep marker which moves out the beam just in front of arrived echoes. This echo marker is a single echo vector with maximum intensity. It erase old echoes and leaves the new arrived echoes.

8 PHYSICAL CONSTRUCTION

The circuits are built up of standard TTL low power Schottky and mounted on printed circuit boards which fit into the ALPHA chassis.

The principle of this display processor is patent protected.

Figure 7 is a photo of the display. The echoes in the center are from an artificial target. The echoes farther behind the ship are from the sea bottom.

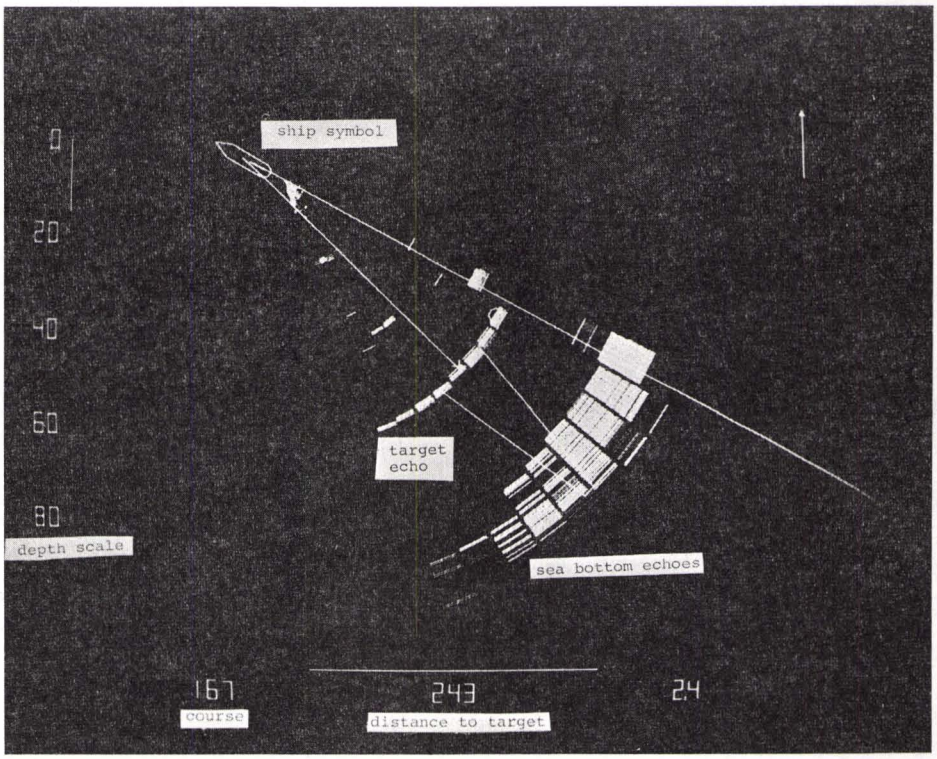

FIG. 7 PHOTOGRAPH OF A CRT SCREEN