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AN AUTOMATIC BEAMPLOTTING SYSTEM

P.J.Hill

Loughborough University of Technology, Loughborough, Leics.

SUMMARY

This paper describes the development of a relatively simple and economical computer-based automatic system for plotting the angular response of sonar transducers and arrays. The computer sends azimuth and elevation control signals to a stepper motor control unit which drives the transducer training gear. The received signal is sampled and then fed to the computer for display and storage.

INTRODUCTION

Manual methods of measuring and plotting the angular response of sonar transducers and arrays are time-consuming, tedious and often open to error. Since the training gear in use was based on stepper motors and hence was ideally suited for computer control, it was decided to build a low-cost automatic beamplotter system , the block diagram of which is shown in figure 1. As will be seen the heart of the system is the BBC microcomputer which controls the stepper motors driving the transducer training gear and at the same time accepts signals from the hydrophone via a peak sampling unit. The response is plotted on the monitor as the scan takes place and the results recorded for subsequent processing and display.

CIRCUIT DESCRIPTION AND OPERATION

The signal from the hydrophone is passed directly to a peak detector chip which is effectively a sample and hold unit with a very good droop characteristic. This latter quality is essential due to the relatively slow A/D conversion time of the BBC microcomputer (10ms).

As the transmitted pulse length can vary from some 50us to 100ms each second and the hydrophone can be a variable distance from the transmitter, there is only a short period in which it is valid to sample the received signal. This sampling period can be manually adjusted using two multi-turn potentiometers and an oscilloscope to suit the particular conditions prevailing at the time.

As shown in figure 2. the amplitude of the multipath signals (i.e. unwanted reflections such as from a lake bed or test tank wall), can in fact be greater than the valid part of the received signal described above. Hence the setting up of the sampling 'window' is critical to avoid misleading results.

Experimental results on the peak detector chip revealed it to have a very good dynamic range of at least 70dB and input and output impedances similar to an operational amplifier. To make full use of this dynamic range the maximum hydrophone output voltage must match the maximum input voltage of the peak detector. If necessary the input voltage could be amplified externally to give the maximum of 24V pp.

An output attenuator is used to match the peak detector output voltage to the 0 to 1.8V range of the BBC Micro's A/D converter. This converter is specified as 12 bits, but in practice is not reliable above about 10 bits giving a dynamic range of some 60dB.

SOFTWARE

The software is menu-driven and simple to operate. All major parameters are stored on disc to allow plots to be repeated easily without having to re-enter parameters such as scan width and step size each time a new beamplot is required.

Existing stored data can be reviewed and a hard copy made on an EPSON type printer, or alternatively the data can be fed to a graph plotter for a high-quality hard copy facility. This has the advantage that it is not limited to the 8 bits vertical resolution as the BBC display is.

Various printer options are available such as linear or log plots, automatic calculation of 3dB points and beamwidth etc. as can be seen from figures 3 to 6, which show some examples of beamplot screendumps taken from data obtained both on field trials and in Loughborough University's test tank.

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AN AUTOMATIC BEAMPLOTTING SYSTEM

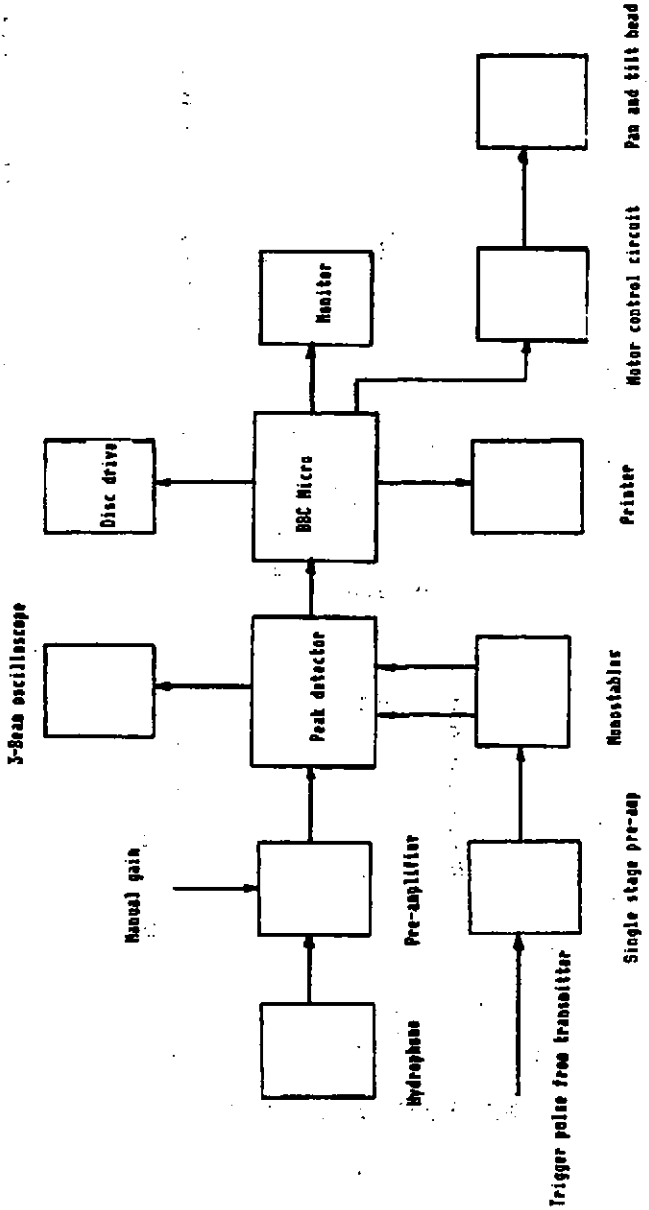

Fig.1 - Beamplotter block diagram

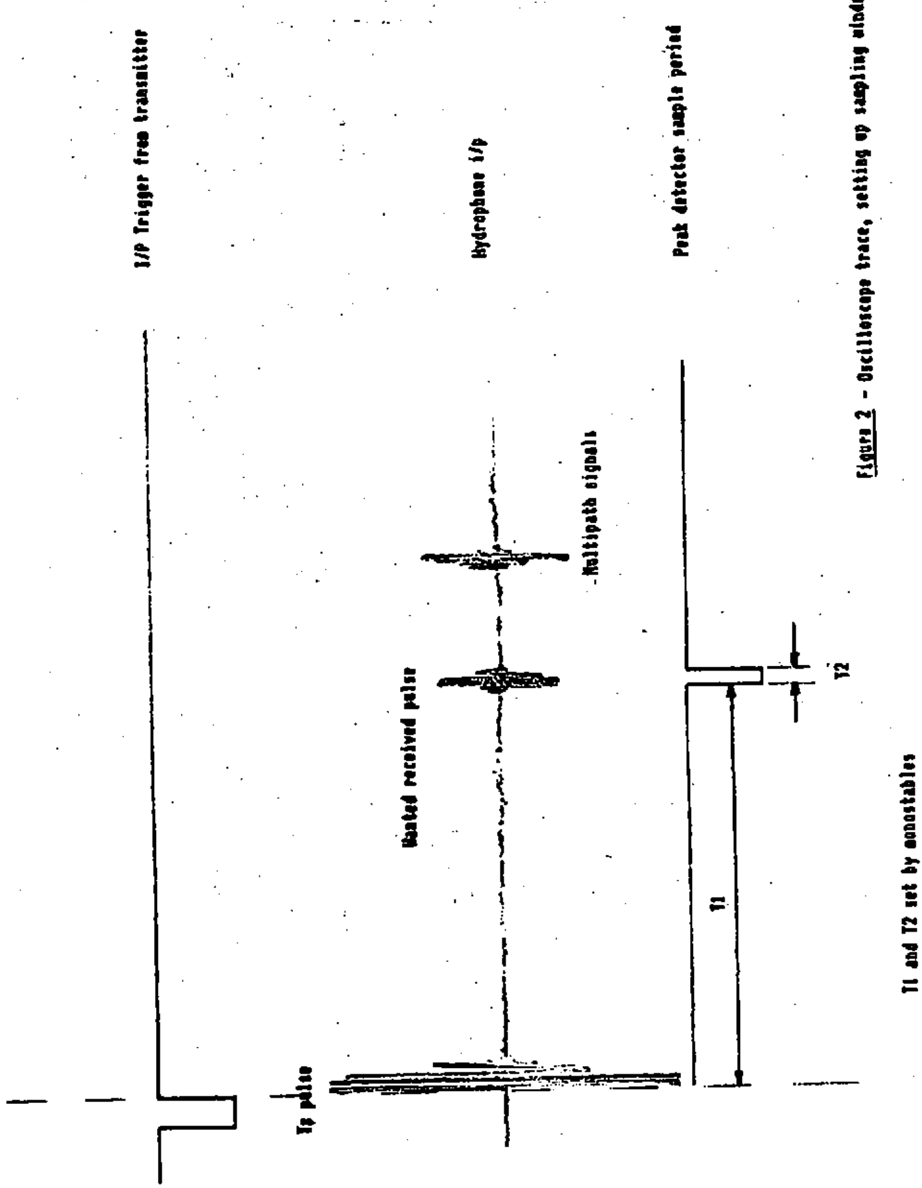

Figure 2 - Oscilloscope trace, setting up sampling window

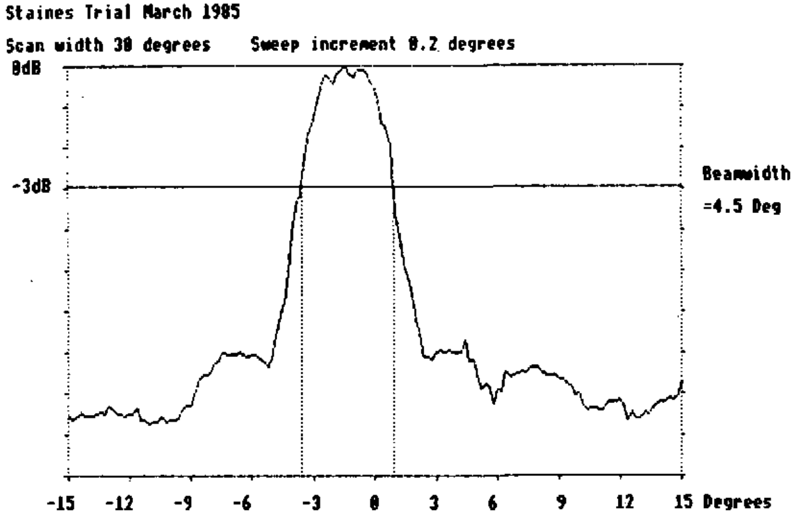

Figure 3 - Beamplot of Loughborough University's flexible transmitter at a Staines reservoir trial, March 1985.

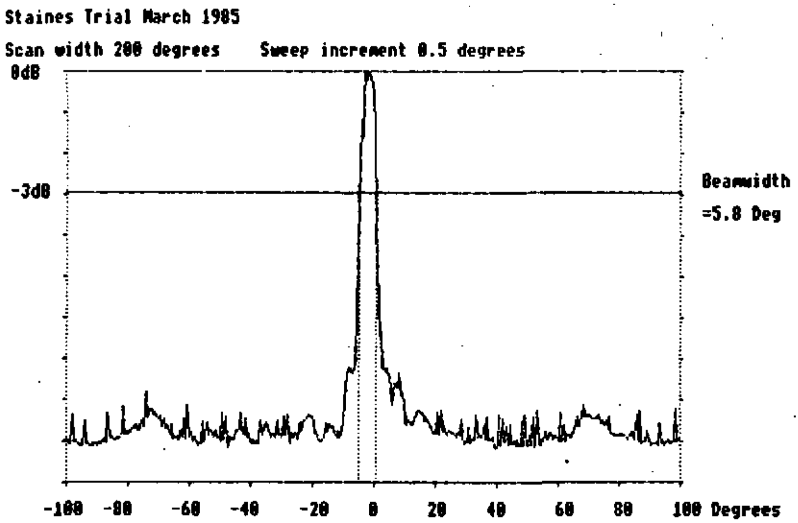

Figure 4 - As figure 3, but using a wider scan

Tank Room at LUT - Focussed beam at 1.5m

Scan width 40 degrees   Sweep increment 0.1 degrees

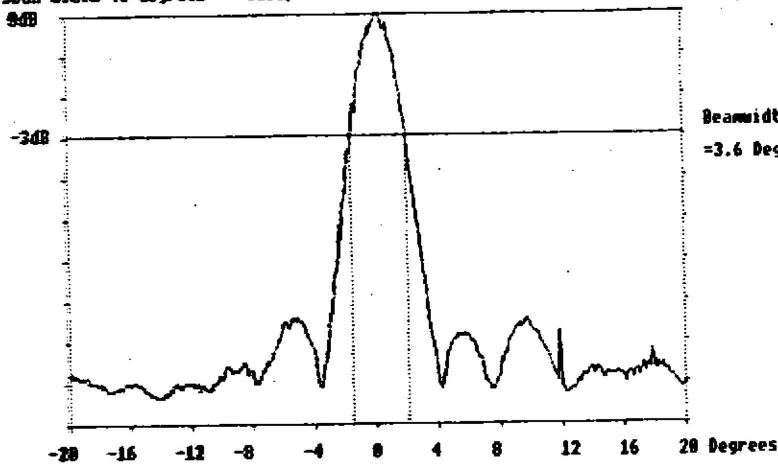

Figure 5 - Beamplot of focussed beam in LUT tank

Tank Room LUT - Seavision Beamplot

Scan width 60 degrees   Sweep increment 0.2 degrees

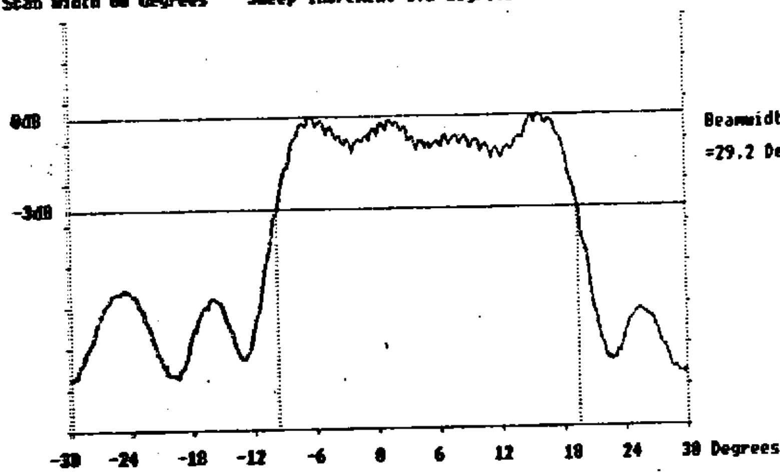

Figure 6 - Beamplot of Seavision in LUT tank