Low-Cost Directivity Measurement System Motivated By Development of Variable Beam Width Transducer

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Introduction

After being commissioned to build a variable beam width transducer, Constantine Technologies (CTL) uncovered a need to build a cost-effective transducer directivity measurement system for ultrasonic-range transducers. For $235 in materials, an automated directivity measurement system and accompanying software were produced.

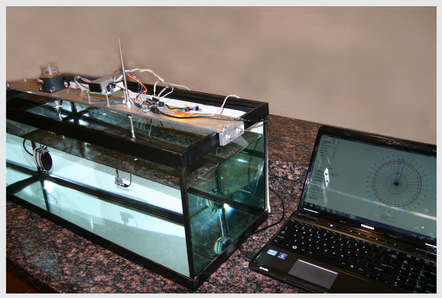

Figure 1: Photograph of directivity measurement system

Background

The variable beam width transducer design specifications called for a beam ranging from 10°-40° in the far field with minimal side lobes and an operating frequency of 50-200 kHz.

Methods and Materials

Hardware and Electronics

CTL acquired a medium sized fish tank ($20), stepper motor and driver circuitry ($100). An aluminum support structure was constructed to hold the stepper motor and device under test (DUT) ($40). Using a 2.5mm, 2 MHz, PZT element and generic electronic components a receiver including pre-amp was constructed. A peak detector and DC post-amp were added after the receiver for signal detection.

Fish Tank	$20
Stepper Motor and Driver	$100
Aluminum Support	$40
Arduino Uno	$25
Electronic Components Including Ceramic	$50
Total	$235

Figure 2: Table of materials and costs

Firmware

Using an Arduino Uno microcontroller ($25), firmware was developed to send trigger pulses to an HP 33120 function generator for the DUT and control signals for the motor. Knowing the receiver-DUT distance, the Arduino also served as a firmware gate for receiver pulse detection.

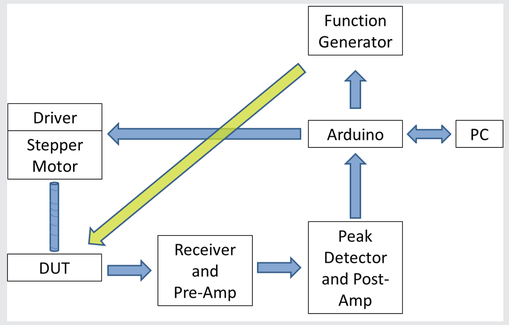

Figure 3: Block diagram of directivity measurement

Software

Utilizing the Arduino's serial communication capability, a user-interface (UI) was developed with Visual Basic in Visual Studio. The interface controls all system functionality as well as providing a real-time display to the user. Storage and post-processing of received data are also included.

Results

Directivity patterns can be produced in 5-10 minutes depending on the number of reading averages. Resolution is .18° when full-stepping the motor. With minor adaptability the test fixture will be fairly portable. The motor mount and receiver can be removed from the tank and placed on floats in a larger body of water if necessary.

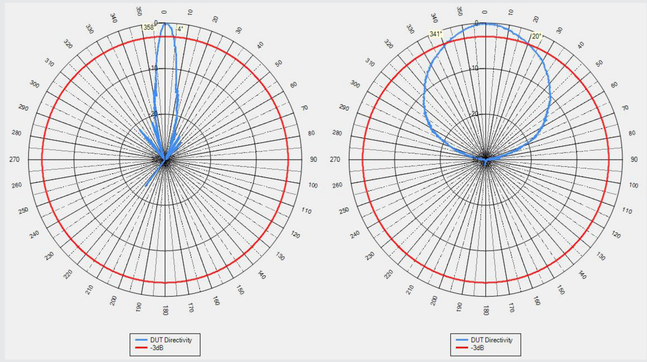

Figure 4: Directivity patterns for variable beam width transducer

It was initially assumed that an absorbing medium would be required on the insides of the tank, but the firmware gating has been sufficient.

Limitations include: high cap of bandwidth for electronics and low cap of bandwidth due to long wavelengths in a small tank.