Arduino Controlled Ultrasound Beam Profile Measurement System

Dakota Booth [1]; Benjamin Hage [2]; Max Twedt [2]; Greg Bashford [2], PhD
[1] Biomedical Engineering, Mercer University; [2] Biological Systems Engineering, University of Nebraska-Lincoln

Extended Abstract

The goal of this project was to design, build, and test an Arduino controlled ultrasound beam profile measurement system for the eventual purpose of assessing the safety of ultrasound transducers built in the Biological Imaging and Biosignals Analysis (BIBA) Lab at the University of Nebraska-Lincoln. The device was built using parts from a Prusa i3 3D-printer kit, 3D printed parts (designed in ANSYS DesignModeler), and machine milled aluminum parts. The ultrasound beam profile measurement system was used to assess the effectiveness of three types of soundproofing materials. There are future plans to improve the design, including adding an additional motor and using more cleanly designed parts.

While ultrasound is regarded as one of the safest imaging modalities, rigorous testing is necessary to ensure that safety concerns, including tissue heating and cavitation are mitigated. This testing includes hydrophone mapping of the acoustic pressure field, which provides information on the mechanical energy input of the system.

The purpose of this project is to construct a translation stage for an ultrasonic hydrophone using Arduino and 3D printer parts (from a Prusa i3). Hydrophones are most frequently used to measure exposure levels to the power created by the pressure field created by medical ultrasound devices (Harris). Specifically, this project aims to design, build, and test an x-y plane driven by stepper motors and Arduino/Marlin/Repetier software. Deliverables include a working prototype, a poster at the Nebraska Summer Research Symposium, a manuscript delivered to the lab, a submission to the 2017 Proceedings of the Engineering Honors Program, and a podium presentation at the Engineering Expo.

The final device was capable of moving the transducer around in a grid (created using a MATLAB script to generate G-code). The device will require an additional motor on the x-axis, new 3D printed parts, and microstepper actuators to increase the spatial resolution. In future iterations of the project, one program should be used to drive the device and to collect data from the pulser-receivers. LabVIEW would be an appropriate software package to use for this purpose.