Digital Reference Hydrophone

Digital Reference Hydrophone for Acoustic System Test
ELECOMP Capstone Design Project 2018-2019

Sponsoring Company:

Raytheon
1847 West Main Road
Portsmouth, RI 02871
http://www.raytheon.com

Company Overview:

Raytheon Company, with 2017 sales of $25 billion and 64,000 employees, is a technology and innovation leader specializing in defense, civil government and cybersecurity solutions. With a history of innovation spanning 96 years, Raytheon provides state-of-the-art electronics, mission systems integration, C5ITM products and services, sensing, effects, and mission support for customers in more than 80 countries. Raytheon is headquartered in Waltham, Mass.

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Project Motivation:

Hydrophones are underwater receivers akin to audio microphones. Reference hydrophones are calibrated hydrophones used in support of underwater acoustic systems, such as sonar and acoustic communications systems. Specifically, reference hydrophones are used to test and measure the performance of the transmit portion of another system. The transmit system is used to generate a "ping", an acoustic transmission, which is received by the reference hydrophone. The reference hydrophone is connected to a data acquisition and analysis system to support testing.

The data acquisition and analysis system is typically part of an acoustic test facility and occupy racks of equipment. The purpose of this Capstone project is to integrate the data acquisition and control functions of a multi-channel test facility into a single-channel capability, transforming the analog reference hydrophone to a digital one. The electronics (with embedded software) will be contained in a small enclosure which provides the interface to an analog hydrophone, provides programmable gain and filtering, analog-digital conversion, two-way synchronization with the system under test, and an Ethernet interface for control and data. Software on a PC will be required to control the electronics and collect the receive data.

Anticipated Best Outcome:

The best outcome of this project would be a working hardware interface to a selected reference hydrophone. This interface would provide programmable gain, programmable filtering, adjustable sample rate, and accept an external trigger. The hardware would provide an industry standard interface (such as Ethernet) to a computer. The computer will provide the command and control functions to adjust the hardware settings. It will also capture the data from the digital hydrophone, store the data in Matlab readable format, and display the time series and FFT of the data.

Project Details:

The Digital Reference Hydrophone (DRH) will be used as a tool in the development and test of Raytheon's own underwater transducers. The DRH will provide a method for Raytheon to synchronously and accurately measure the output of the Unit Under Test (UUT) in a digital format that can be quickly used to assess the UUT performance.

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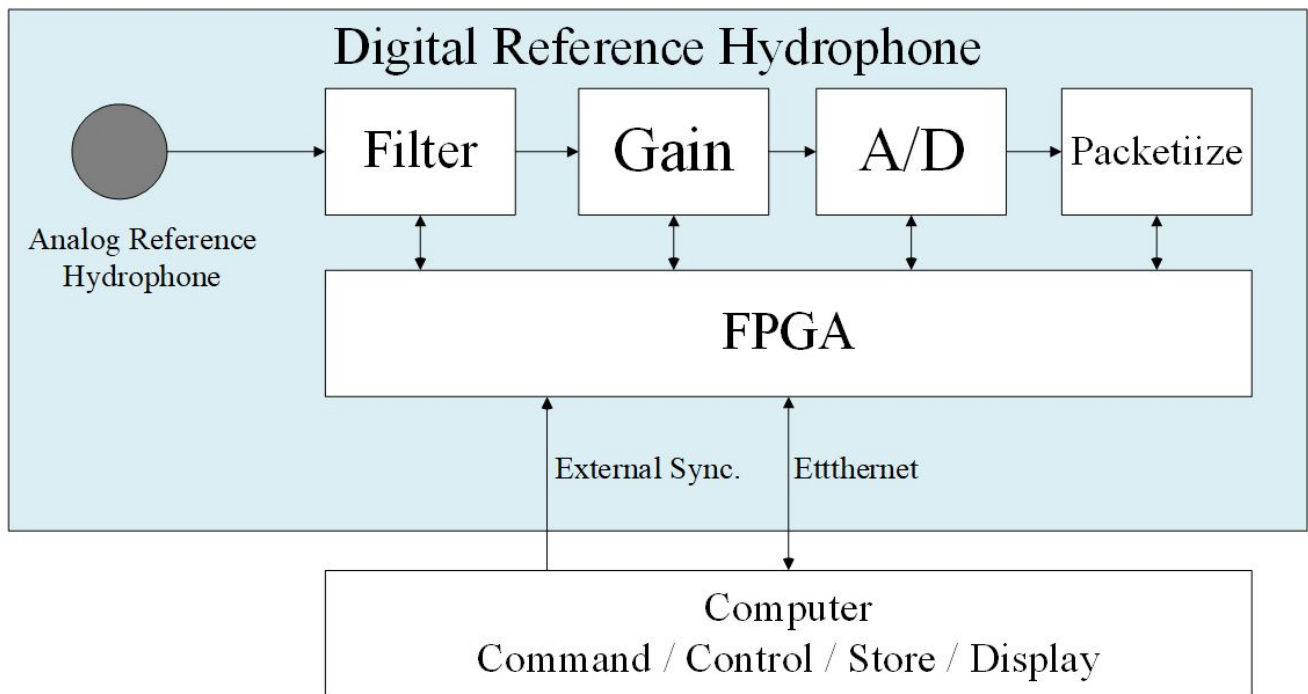
Hardware/Electrical Tasks
- Hardware architecture
- Pre-amplifier design
- A/D conversion design
- Schematic capture, printed wiring board design, prototype build and test
- Integration with software

Firmware/Software/Computer Tasks

FPGA firmware to
- Interface with A/D converter
- Interface with PC software
- Accept external trigger
- Capture digital data, time tag, and create Ethernet packets

Software
- Data Acquisition system (for example LabView) to command and control the FPGA
- Real-Time Display of time series, FFT, etc.

Open Source Tools will be used to the extent possible.

The team will be required to develop a plan, define a schedule of activities, and track the progress to the schedule.

The team will meet at Raytheon's Portsmouth, RI facility every Friday afternoon / evening, where they will be met by the Technical Directors and other Raytheon volunteers. This is also when progress on the schedule will be reported.

All participants must be U.S. citizens.

Composition of Team:

2 Electrical Engineers & 1 Computer Engineer

Skills Required:

Electrical Engineering Skills Required:

- Analog Circuit Design and Testing
- Digital Circuit Design and Testing

Computer Engineering Skills Required:

- Firmware (FPGA) Design and Test
- Software Design and Testing (including graphics and mathematical computation)

Anticipated Best Outcome's Impact on Company's Business:

If Best Outcome is achieved, Raytheon will have the ability to synchronize measurements of Systems Under Test with reference hydrophone measurements. This will enhance our ability to distinguish between test anomalies and true design issues. This will significantly reduce the time required to diagnose and debug issues with ongoing designs, thereby significantly reducing the development cost and schedule for new systems.

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