Precision Time Protocol Test Bench

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Purpose

The purpose of this project was to design a test bench for determining overhead associated with a device under test (DUT) utilizing the Precision Time Protocol (PTP), IEEE 1588.

Background

Clock drift can occur in a computer network, and PTP has been designed to synchronize these clocks. It is used in areas such as measurement and control systems, however Intel specifically uses it for audiovisual. The PTP standard is accurate below the microsecond level, however implementations of PTP can be slowed down by things such as operating system scheduling and interrupt latency.

The test bench to be designed would allow Intel to attach a chosen DUT that utilizes PTP, and see how much overhead affects the system. The test bench would determine how the chosen DUT adheres to PTP across multiple aspects.

Implementation

A Raspberry Pi 3B is used as the simulated DUT for the testing, running Raspian. A CompactRIO is used as the master, telling the DUT what tests should be performed and when, and then performing calculations to determine the added overtime. This overtime represents the DUT's adherence to PTP.

A chassis was designed out of 80/20 aluminum to house all the parts for the tests, with magnets to be an actuator for the acceleration test. A custom PCB is used for implementing all pieces.

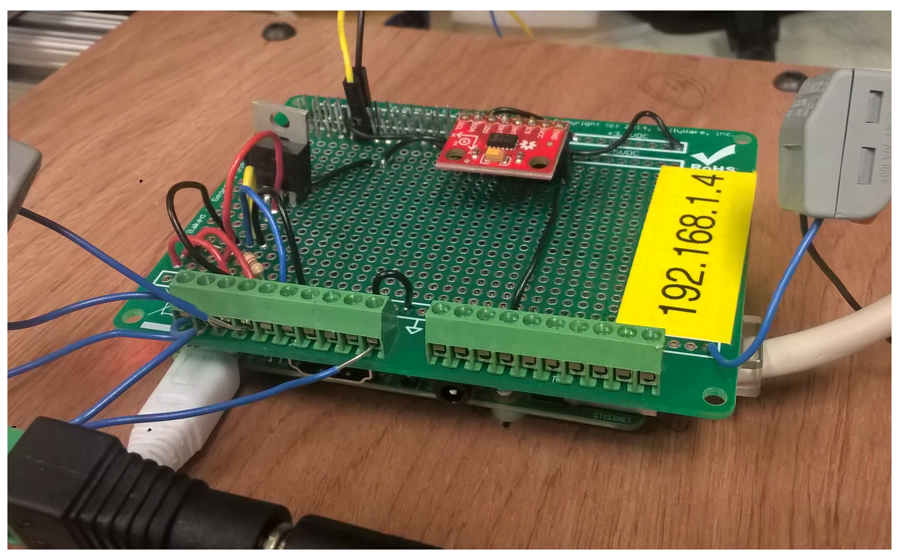


Figure 1. Raspberry Pi.

Figure 2. CompactRIO.

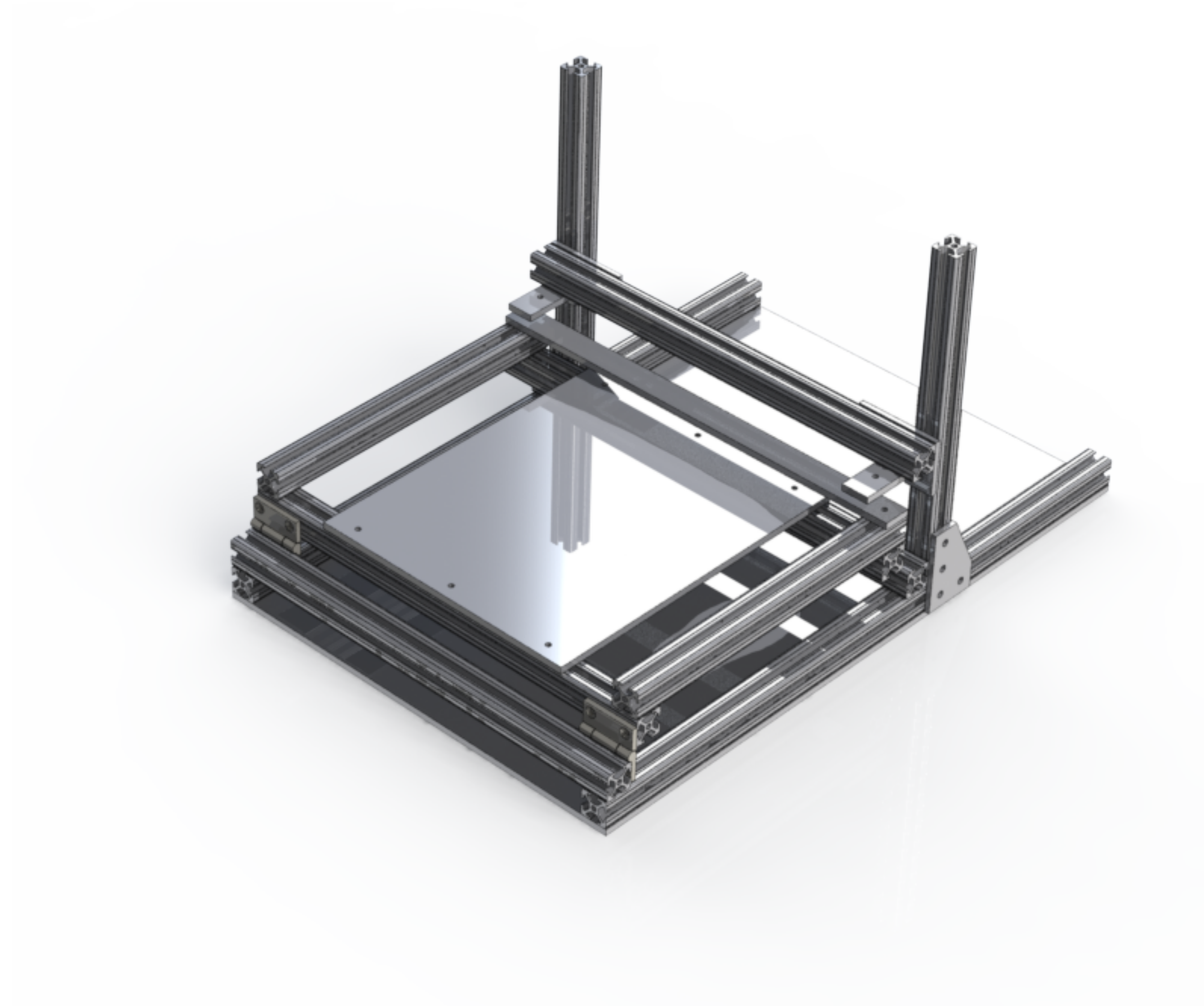


Figure 3. Model of final chassis.

Test Scenarios

Rising Edge
- A GPIO logic level is measured. This is the most basic of the tests, requiring the DUT to simply raise a pin high at the appropriate time.

Motion Detection
- A detected acceleration is measured. The cRIO activates the motion at the given time, and indicates when the motion is detected.

Sound Detection
- An electric signal output from an audio connection is measured to determine when a sound occurs. The DUT detects when the CompactRIO begins outputting sound.

Light Detection
- Light emitted goes through a transducer to be detected. The CompactRIO emits the light, to be detected by the DUT.

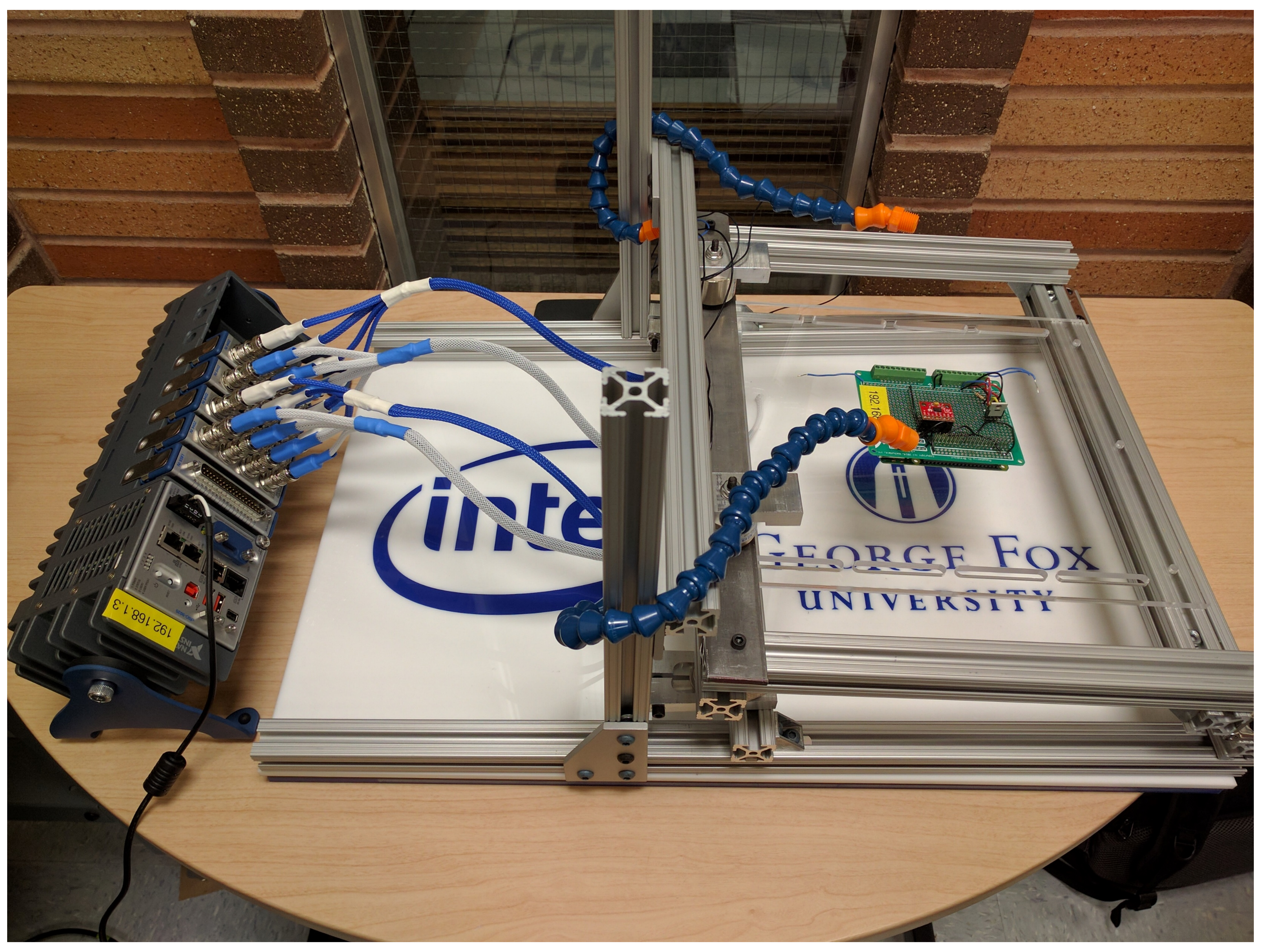


Figure 5. Final design.

Final Design

Rising Edge
- A simple rising logic edge is activated. A feedback loop is used to determine how much time is taken by the CompactRIO in reading and writing a signal.

Motion Detection
- A magnet-controlled tilt table is activated by the cRIO. The DUT indicates when acceleration has also been detected by an accelerometer. The CompactRIO verifies this time when the motion breaks and then reconnects an electrical circuit.

Sound Detection
- An auxiliary cable is used to bring the sound output from the DUT to the CompactRIO. Sound is detected when a signal is received.

Light Detection
- An IR LED is used along with an IR phototransistor. The phototransistor is turned on when the LED is activated.

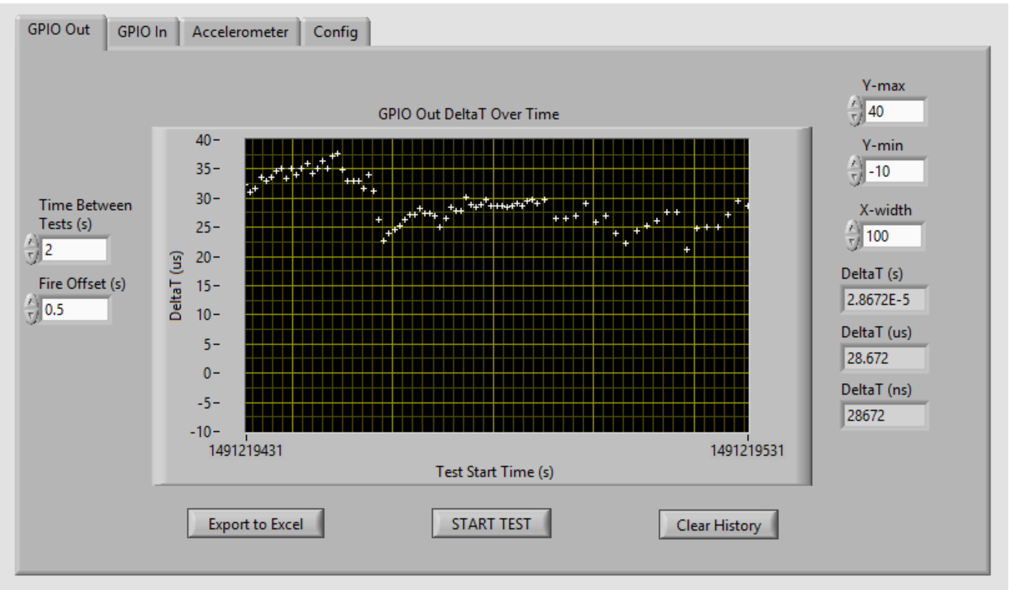
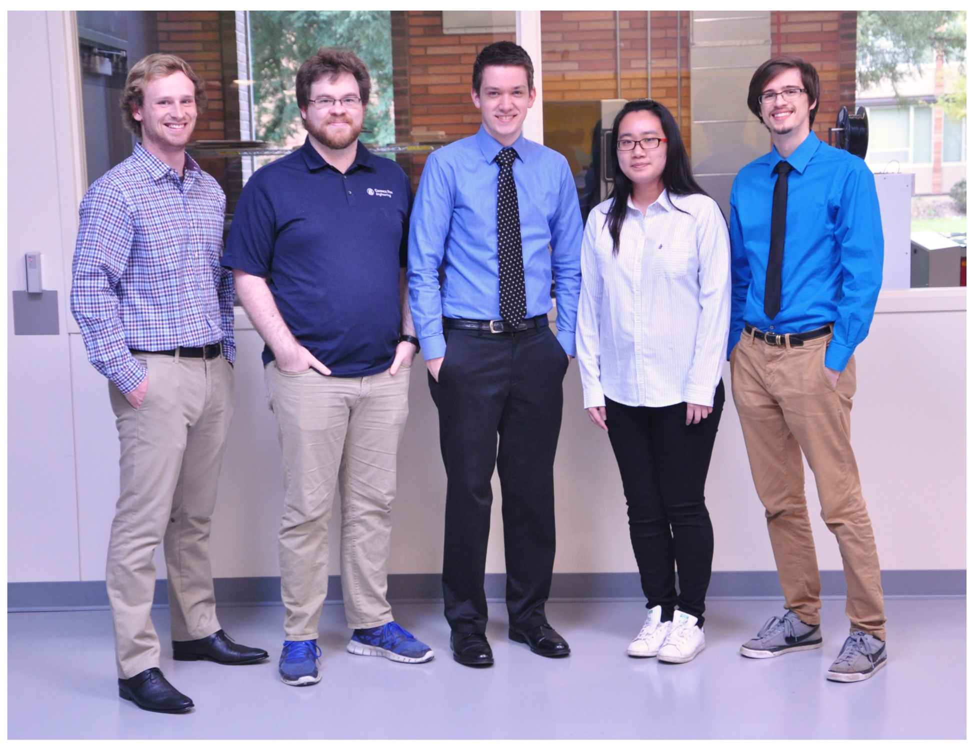


Figure 6. The user interface.

Team



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