Automated Mechanical Testing Integration

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Introduction

The main goal of this project is to automate the process of testing the mechanical properties of coupons. Instead of a human placing each coupon into the test stand, the robotic arm must be able to load coupons into the test stand accurately and repeatedly.

The robotic arm also needs to be able to store data such as pictures of the coupon before and after testing, DIC imaging, and results from mechanical testing.

Our focus was on the fine tuning of the previous groups accuracy and repeatability of the robotic arm, as well as being able to interface with the robotic arm and the Instron test stand.

The Robotic Test Stand Arm project is sponsored by the National Aeronautics and Space Administration (NASA).

Project Specifications

ASTM E8 Standard Test Methods for Tension Testing of Metallic Materials

This ASTM standard is a test method for metallic materials through tension. Through this test are able to calculate yield strength, tensile strength, yield point elongation, and reduction of area. For this project specifically this standard dictates the test coupon size we are using. Specifically the 0.500 in. wide standard sheet-type dogbone.

ASTM E1856 Standard Guide for Evaluating Computerized Data Acquisition Systems Used to Acquire Data from Universal Testing Machines

This ASTM standard will assist us in the calculation/evaluation of the data that will be acquired by the test stand. This standard will return our desired values in SI units. It has been recommended that anyone acquiring data from a universal testing machine to use this standard, so it is in our best interest to use this standard for our project.

Project Phases

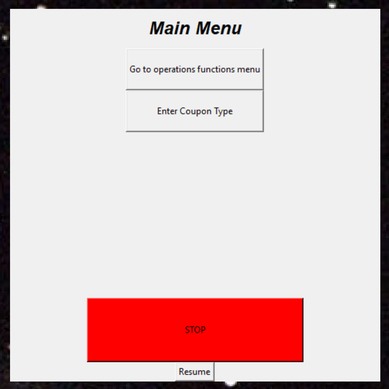
Spring 2022
- Coupon dispenser designed and fabricated
- Debug code from previous group

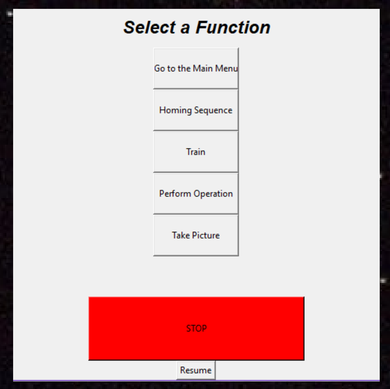
Summer 2022
- Produce a transportable product

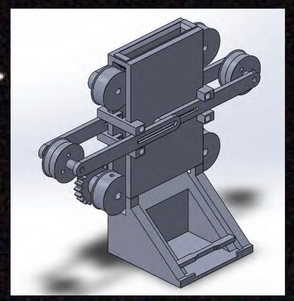
Fall 2022
- Establish communication by using MQTT
- Refine the repeatability and locational accuracy of the robotic arm

User Interface

The Graphical User Interface (GUI) allows the user to perform functions such as teach the robotic arm where the test stand is, perform a homing sequence to reset the robot's sensors, walk through the various steps of testing the coupon, and finally begin autonomously testing coupons. Once autonomous testing is initiated, the robot will be able to test 10 coupons without any interaction from the technician, after which the technician will load in more coupons and start the autonomous test again.

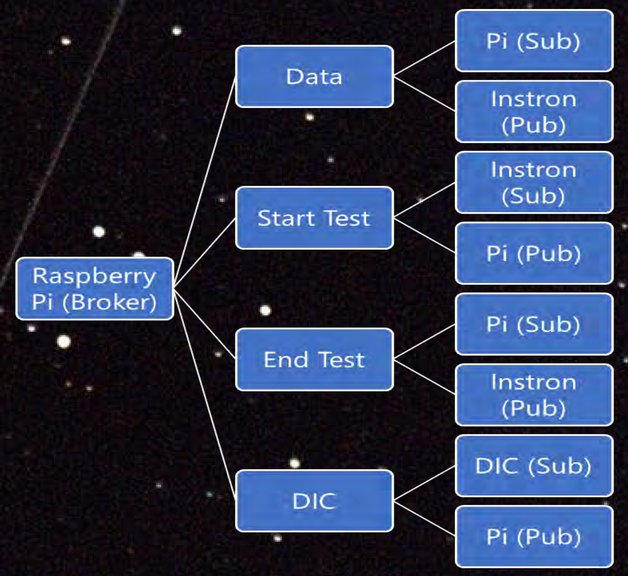






Message Queuing Telemetery Transport (MQTT) Testing

The design requirements for our project required a non-internet based communication protocol between a DIC machine, an Instron Test Stand and the robot arm controlled by a Raspberry Pi. We used the open source mosquitto MQTT broker to build an ethernet based IOT network. Each machine subscribed and publish to various defined topics to initialize testing sequences, transfer data and communicate statuses.



Bluehill API

Communicating with the Instron was essential to a successful project. Using the Bluehill Universal API we used a C# script to control the test stand and access data. Data was then passed from our C# application to the raspberry pi as a JSON string via the MQTT

Conclusion

The robotic arm is able to communicate effectively with the Instron test stand via MQTT. This allows for the storage of data files in an HDF5 format, which will contain the results from mechanical testing, pictures of the coupon before and after testing, and DIC imaging.

Future Work

This project will be used to test and report the material properties on 100 welded titanium coupons that will be provided by NASA.