Evaluating and Improving the Design of Small-Scale Wood Bridges Using Force Sensitive Resistors (FSR) & Single-Board Computers (SBC)

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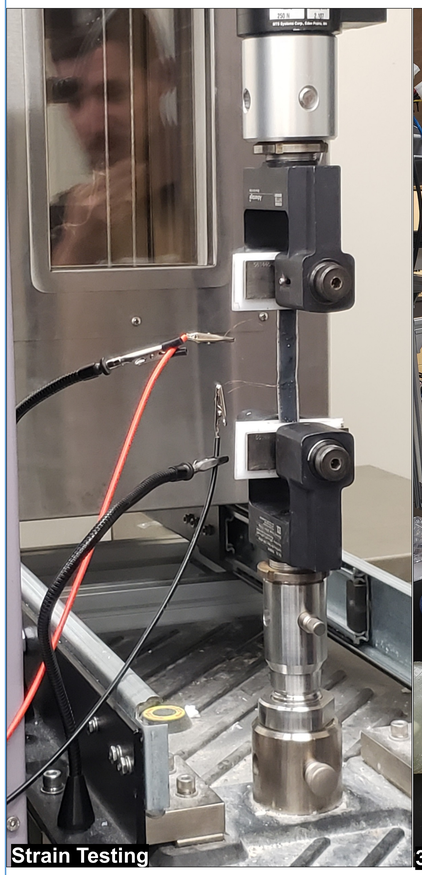
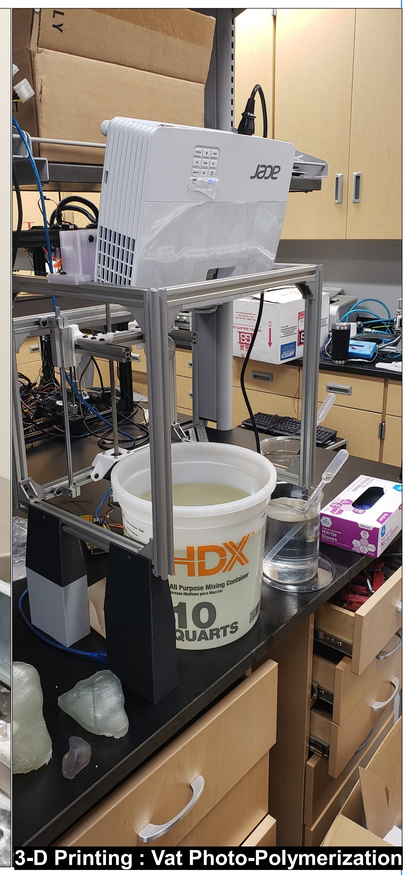
Summary

The Summer RET was broken into three Modules with the overall conceptual theme being centered around IoT (Internet of Things) The purpose of the RET was to give teachers insight into what IoT is, what research is being done in the three conceptual components of IoT (Sensors, Hardware, Software) and how it that information can be implemented to the classroom to encourage future STEM learners.



Strain Testing



3-D Printing : Vat Photo-Polymerization

Research Activities

Module 1, during Weeks 1 and 2, was on sensors, in my own case Flexible Stress sensors. Flexible Stress Sensors use carbon Nanotubes (CNT) to fabricate sensors that when put under stress/strain will change their conductivity/resistivity. These changes can be read and interpreted as Force and recorded in real time. CNTs are the backbone of the research for their properties, they are strong yet flexible, high conductivity, are very Malleable, and can be used to fabricate composite materials without much difficulty. This module also spent time on the various fabrication types of 3-D printers and some research that is currently being done, specifically in the medical field where 3-D printed lungs were made as Pre-Op tools for surgeons to use.

Module 2, during weeks 3 and 4, was focused on the how the hardware (Circuit boards) function as well as their base machine language (Binary and Hexadecimal). Much time was spent covering FPGA (Field Programmable gate Arrays) or Logic Gates. This is the foundation on how singles travel and whether a machine knows what to turn on/off based on the signal(s) being received. We also learned more about the topic of Deep Learning, where computer algorithms can examine thousands of types of information and explore on its own.

Module 3, during weeks 5 and 6, was on Software, how these sensors/circuit boards are communicating and the rules (Protocols) for which they must abide. Various OS systems were discussed such as (Windows, Linux, and iOS). Finally, an introduction to the Raspberry Pi SBC (Single Board Computer), unique in its ability to serve multiple functions but also be inexpensive portable and requiring little operational power.

Lesson Plan

Standard(s):

HS-ETS1-3 : Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

HS-PS2-3 : Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision

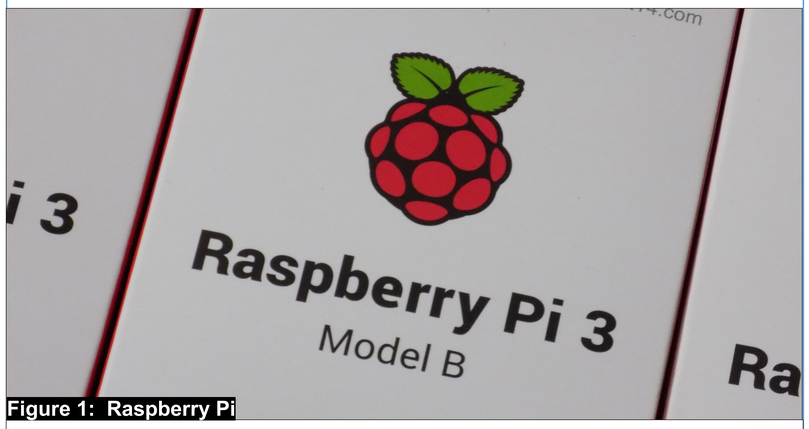


Figure 1: Raspberry Pi

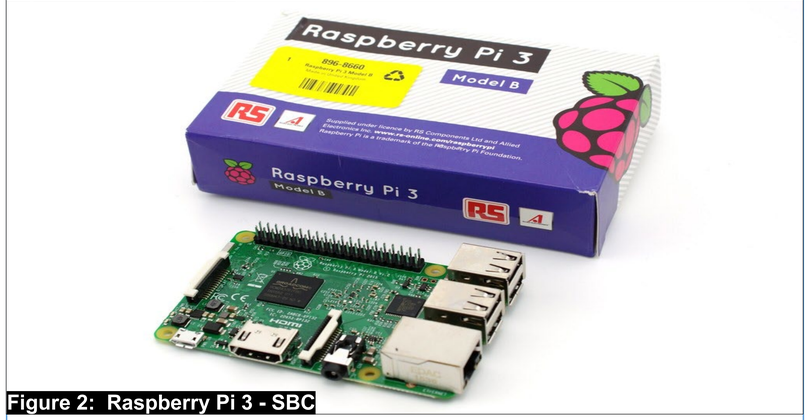


Figure 2: Raspberry Pi 3 - SBC

Objective(s):

- Students will be able to correctly define and describe Scientific Research using terms and concepts related to Inductive & Deductive Reasoning.
- Students will use research methods to evaluate and improve the design of a wooden bridge to double the weight it can hold without breaking.

Pre-Assessment:

Students will construct a small-scales bridge using a limited number of Popsicle Sticks & Glue Adhesive. The bridge will be evaluated on how much force is required to break the bridge or supporting structures. FSR will be attached to various areas of the structure and connected to a Raspberry-Pi SBC to take real time data for students to use in the secondary design phase.

Lesson:

Lecture on Research Methods (Inductive & Deductive)

Post-Assessment:

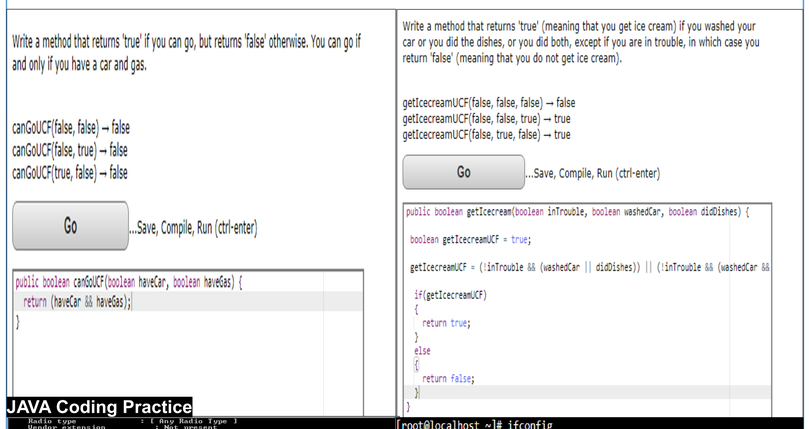
Students will construct a small-scales bridge using Popsicle Sticks & Adhesive while also given an imaginary Budget to simulate a real-world design scenario. The bridge will be evaluated on how much force is required to break the bridge or supporting structures. FSR will be attached to various areas of the structure and connected to a Raspberry-Pi SBC to take real time data for students to use in their experimental conclusions.

Lesson Learned and Assumptions

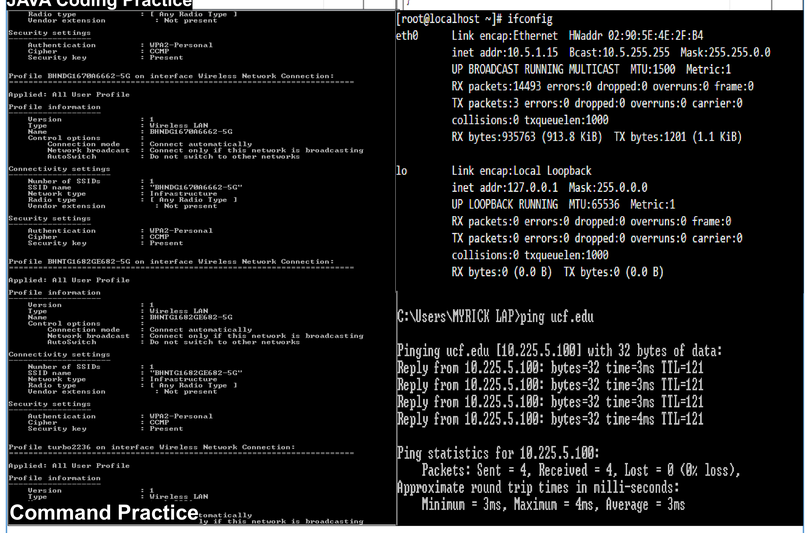
Module 1: Application(s) of Carbon Nanotubes (CNT) for Sensors/Composites & 3-D Printed Models/Sensors

Module 2: Machine Language (Binary, Hexadecimal), Field Programmable Gate Arrays (FPGA), and Software Language (JAVA)

Module 3: Raspberry Pi Single Board Computer (SBC), Device and Networking Protocols



JAVA Coding Practice



Command Practice

Implementation Strategy

The Lesson will be implemented through the Guided-Inquiry Model.

- Pre-Research/Instructional Problem is Presented
- Data and Feedback are Reviewed Post Introduction
- Group Research and Application to Solve new Problem

Acknowledgments

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References

Figure 1: Retrieved from *pexels.com*

Figure 2: Retrieved from *commons.Wikimedia.org*