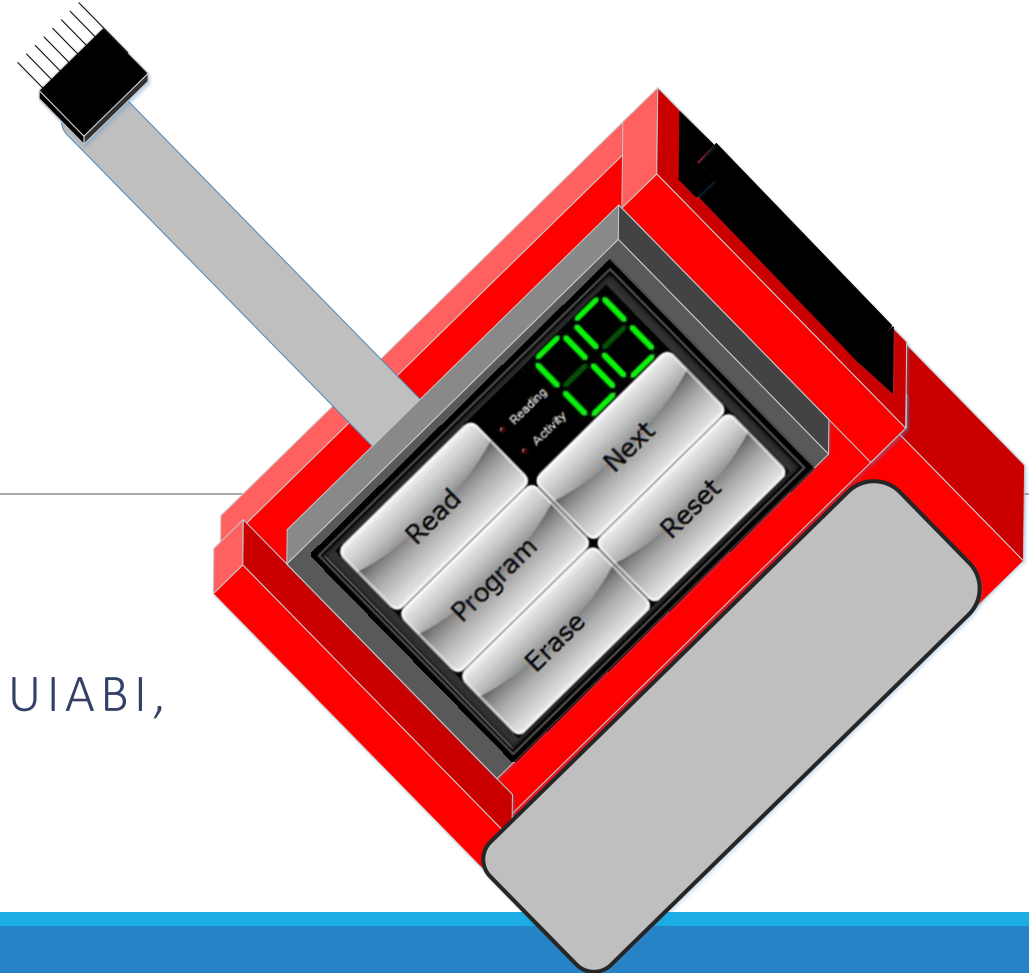
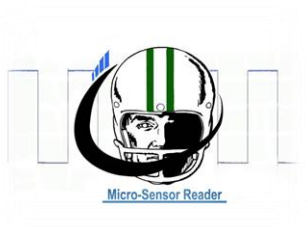




Piezo Micro-Sensor Reader



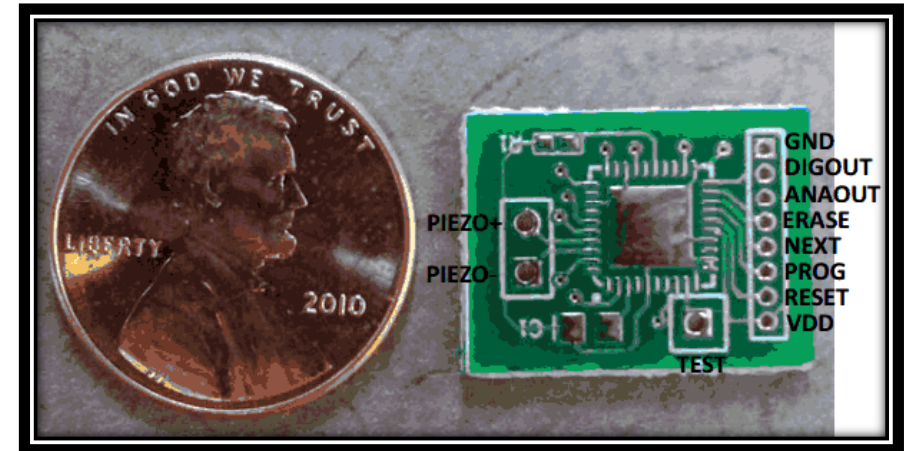
DESIGN TEAM 1

BRETT JOHNSON, RON RAZALAN, THAMER ALSHUIABI,
EVAN GARDETTO, YUVAL LEVENTAL

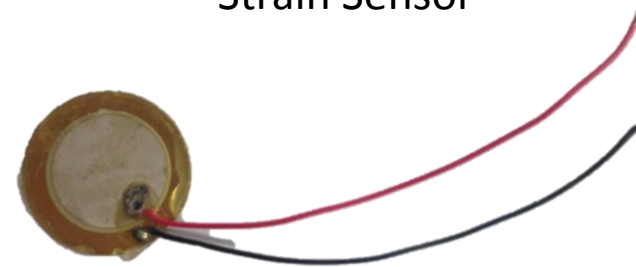
Piezoelectric Research at MSU

Sensor developed by MSU Adaptive Integrated Microsystems Laboratory (AIMLab)

- Accurately records strain data
- Roughly the size of a penny
- Extremely Low Power (1uW)
- Harvests 100% of power from piezo membrane
- this means little to no maintenance



Strain Sensor



Piezoelectric Membrane

Real World Application

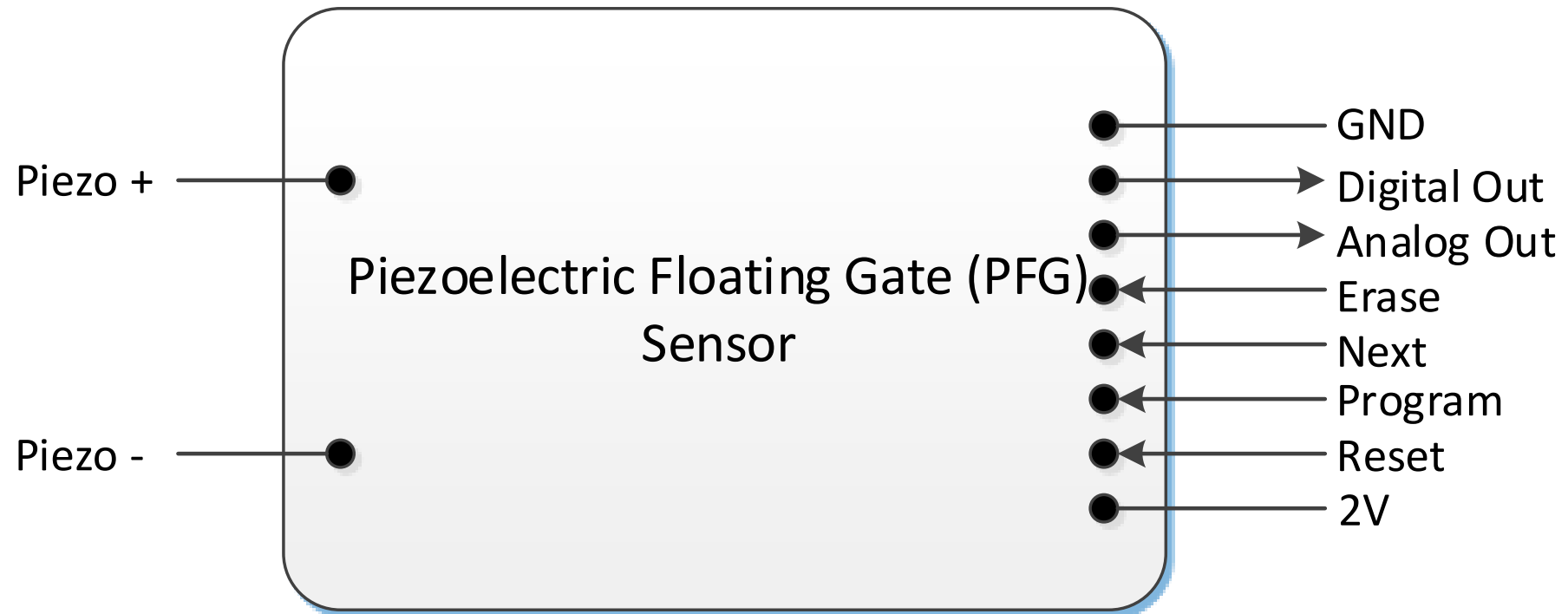


- Concussions among athletes has become a serious area of concern over the last few years
- Implant the sensors into athlete's helmets
- Sensors can predict if a player has suffered a head injury

Interfacing with Sensor



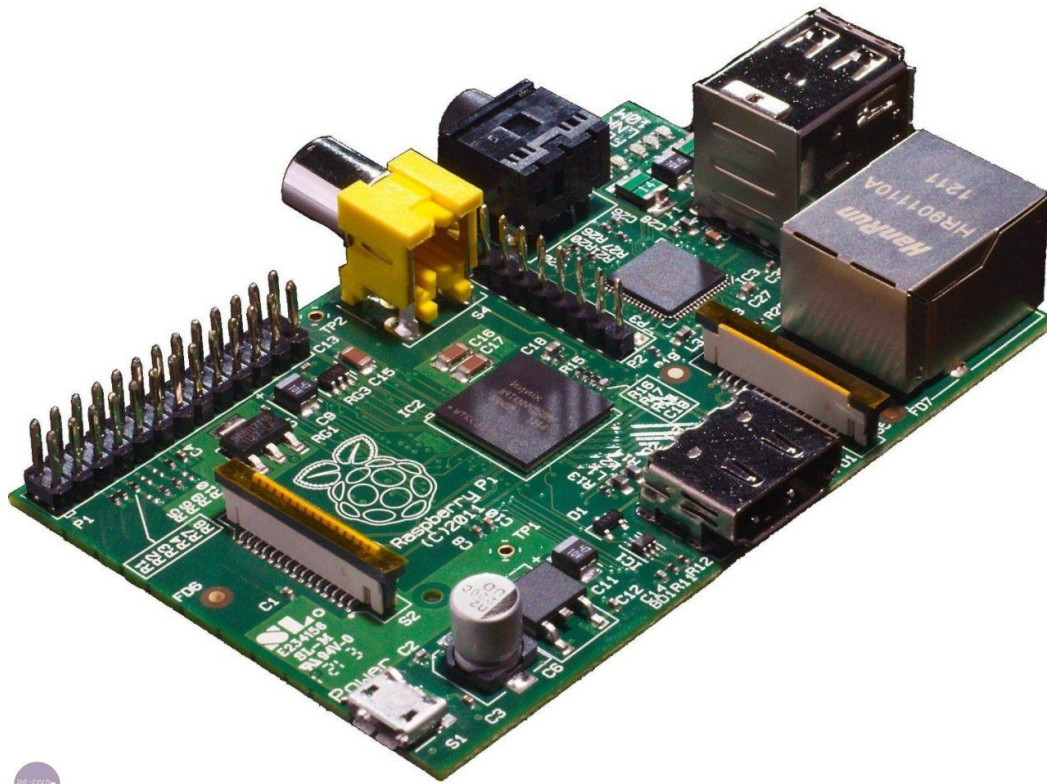
Sensor Pinout



Design Specifications

- Initiate sensor functions via input/output commands
- Log and organize retrieved data into a universal format
- Voltage applied to sensor must be regulated between 1.8-2.5 V
- Portable design
- Develop a plug-and-play connector that can connect to the 8 sensor pins

Design Solution: Raspberry Pi



Characteristics

- Low Cost Minicomputer (\$35)
- 700 MHz CPU
- 512 MB RAM
- General Input/Output Pins
- 2 USB 2.0 Ports
- Programmable in Python or C

Additional Components



4D Systems 3.2" TFT LCD Display

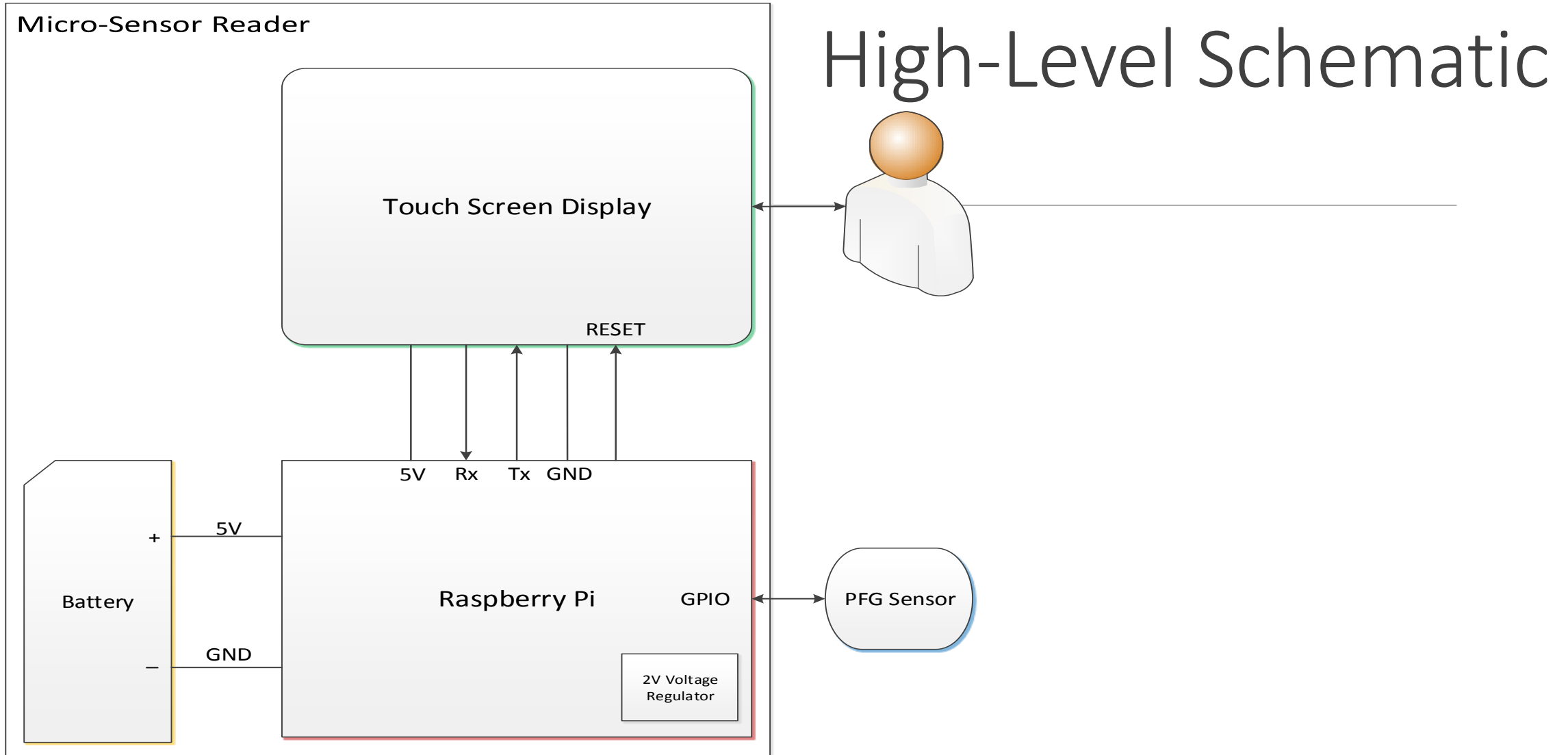
- Resistive Touchscreen
- Developed specifically for Raspberry Pi
- Programmable smart screen

Adafruit 4400 mAh Battery Pack

- 5V @ 1A (13 Hour lifecycle)
- USB port

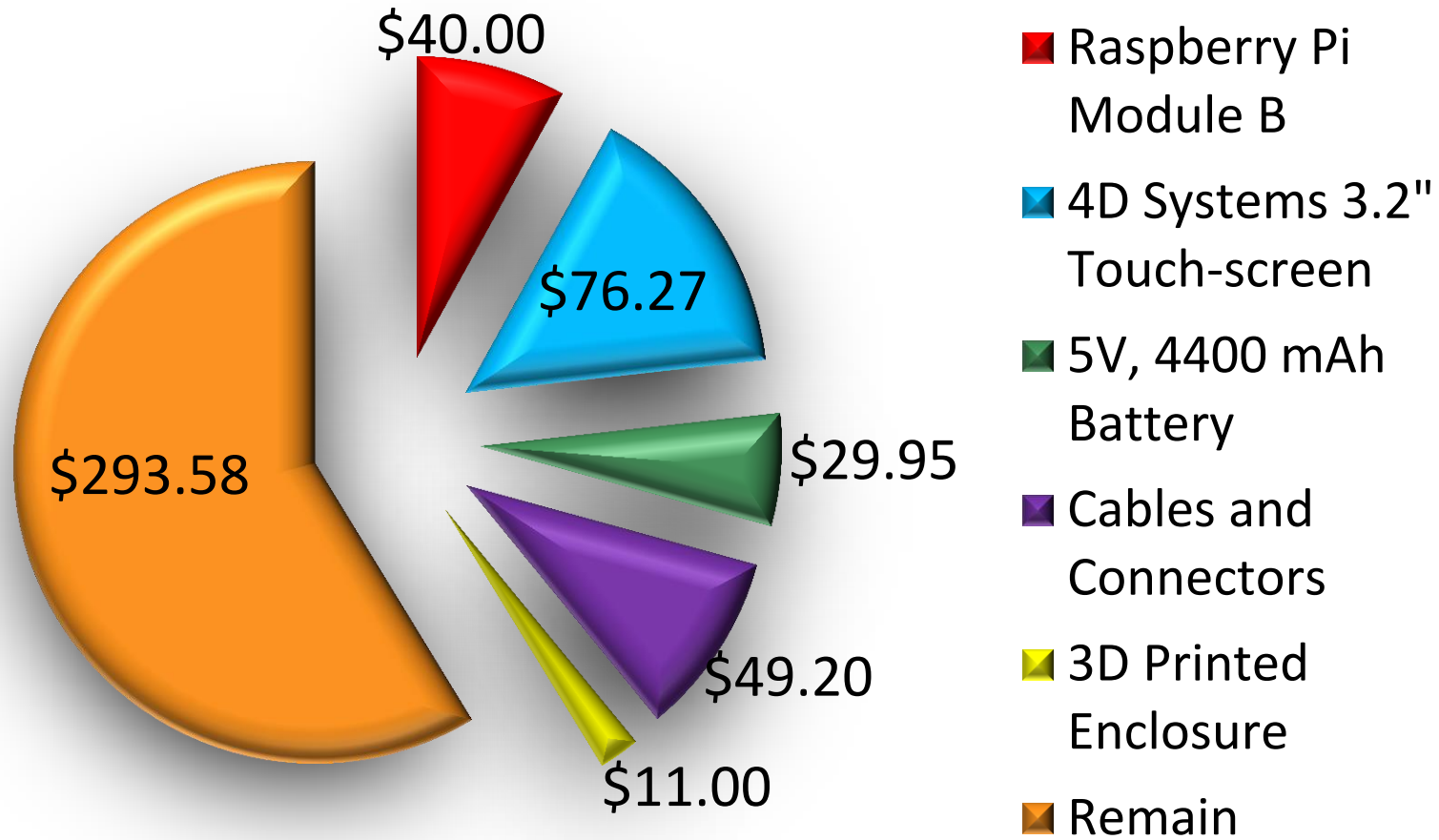


Micro-Sensor Reader



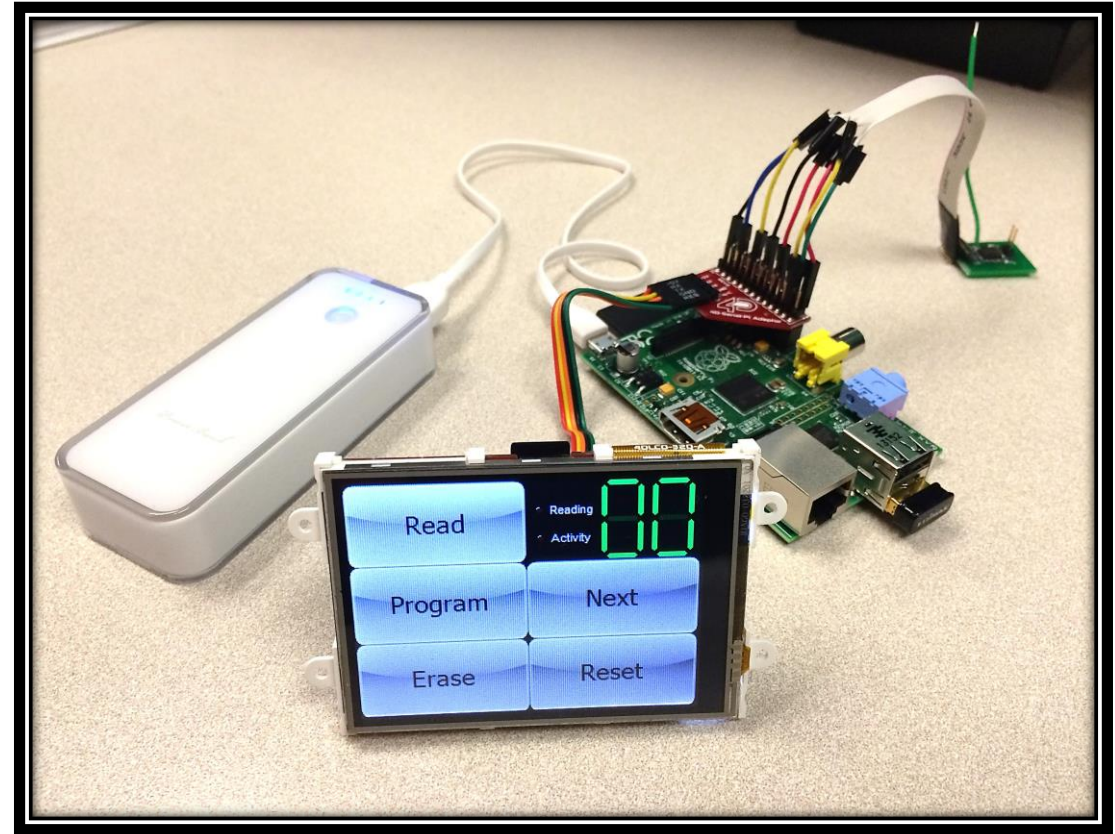
Material Costs

Total Prototype
Cost : \$206.42



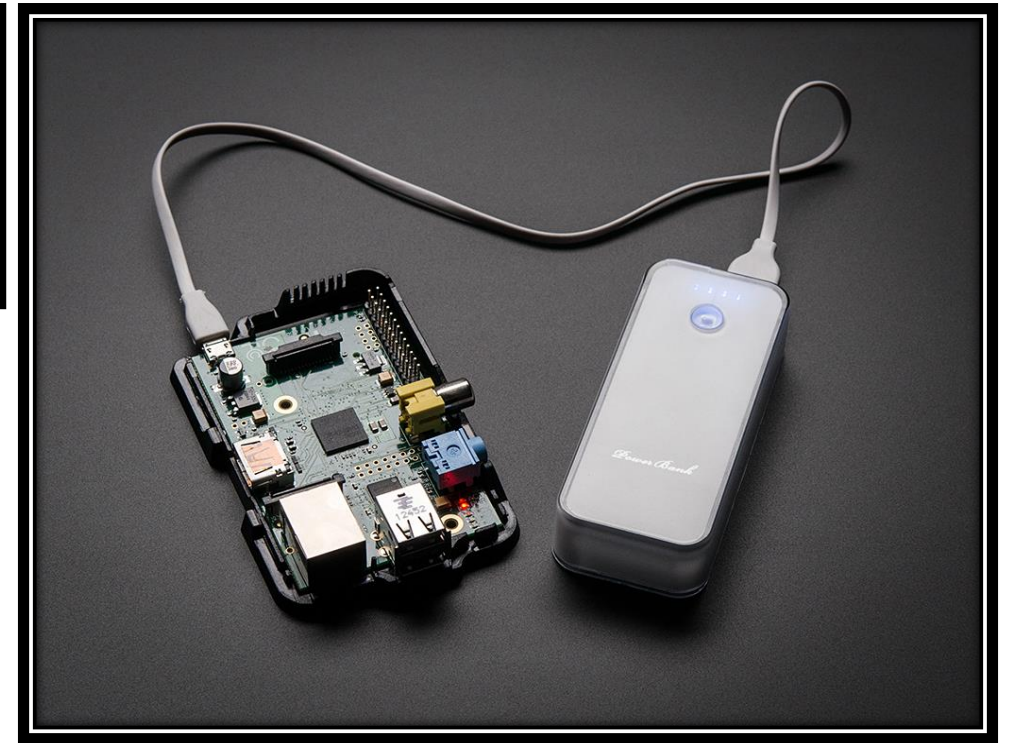
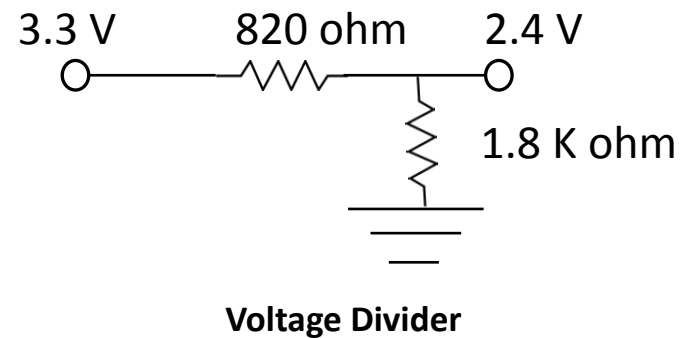
Prototype Production Overview

- 1) Power Distribution
- 2) Software Development
- 3) Enclosure



1) Power Distribution

- Battery Provides 5 V
- Raspberry Pi pin outputs 3.3 V
- Voltage divider produces 1.8 V – 2.5 V to power the sensor
- Sensor connected via 8-pin ribbon cable



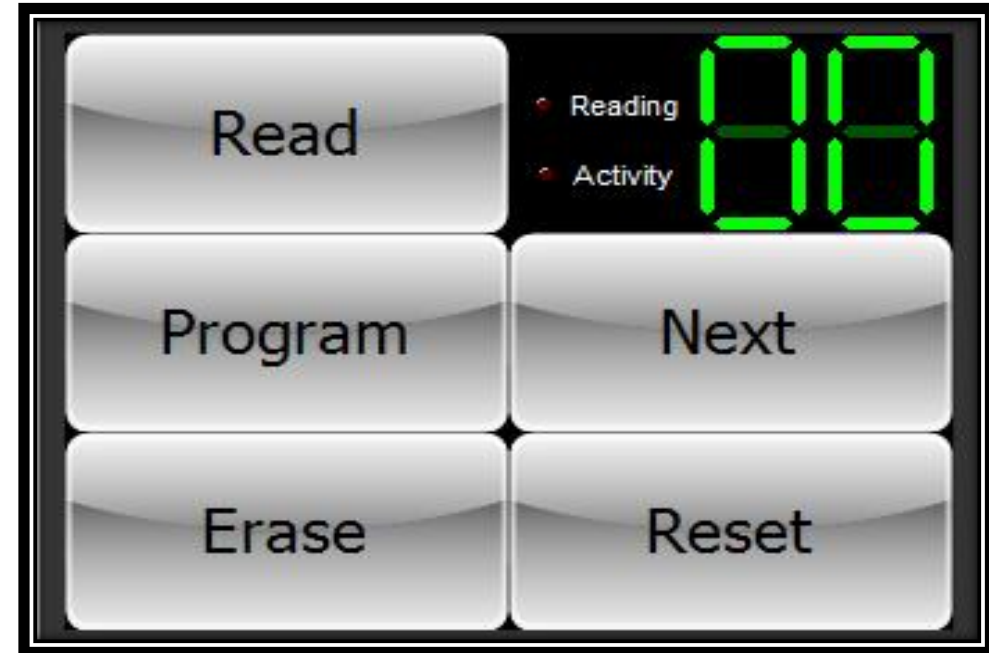
1) Power Distribution

2) Software Development

3) Enclosure

2) Software Development

- 4D Systems touchscreen to interface with the Raspberry Pi
- Press function buttons → C – Program → output data to file → Analyze data via Matlab etc.
- Algorithm samples current pin state (logic high/low) and records the value to a file
- Matlab can analyze leading edge of each pulse

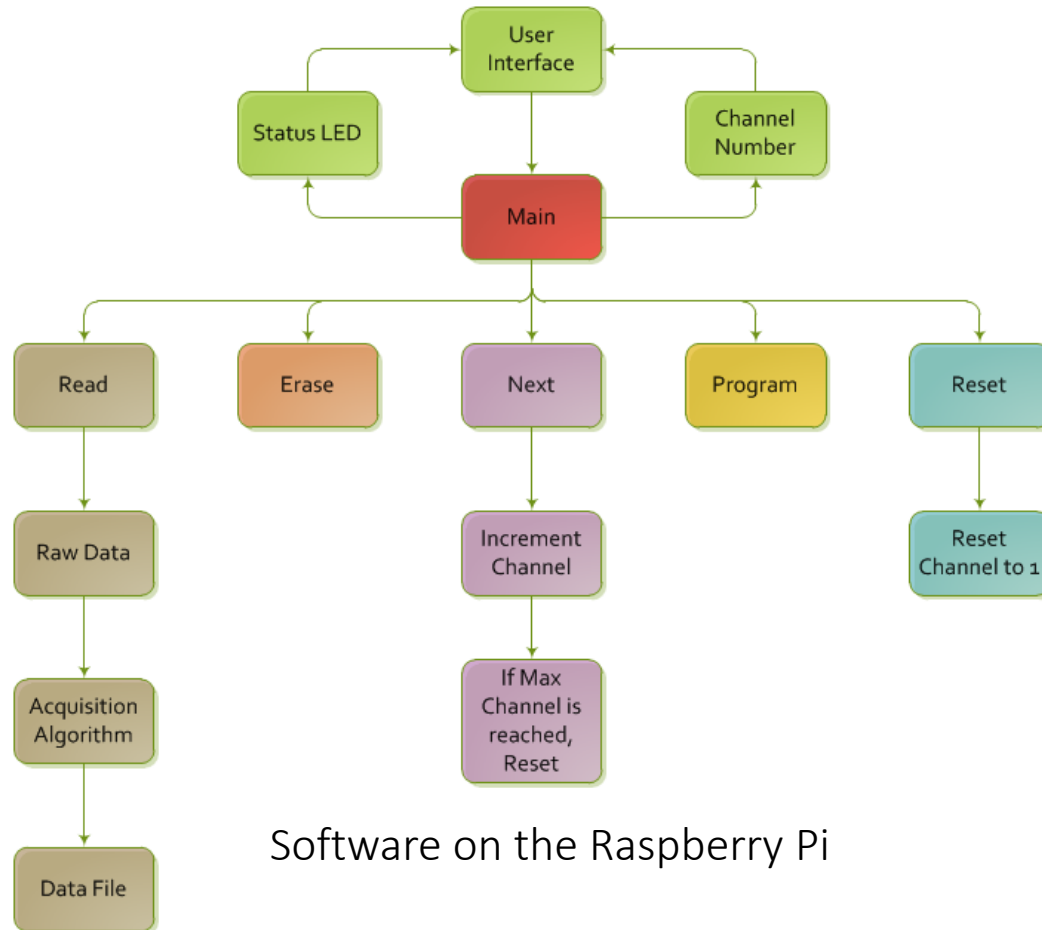


1) Power Distribution

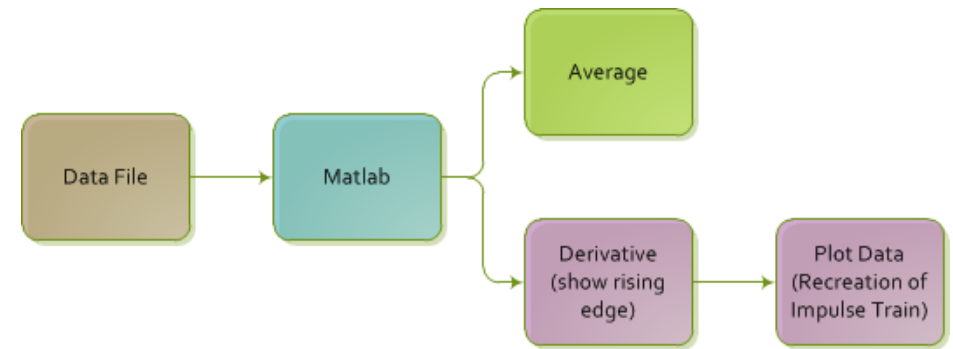
2) Software Development

3) Enclosure

Software Flowchart

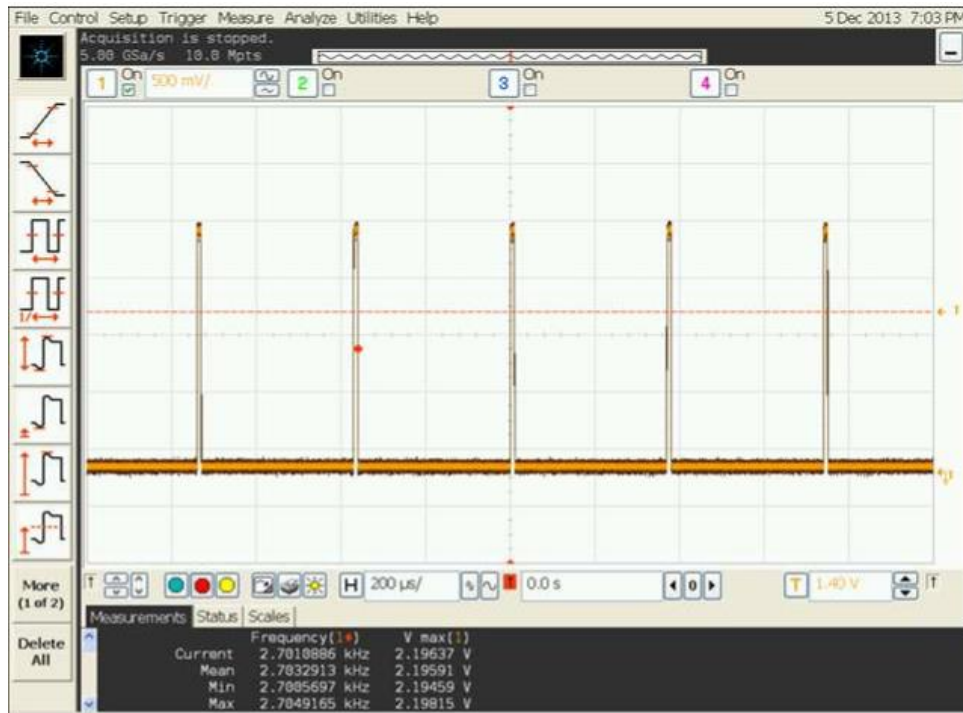


Software on the Raspberry Pi

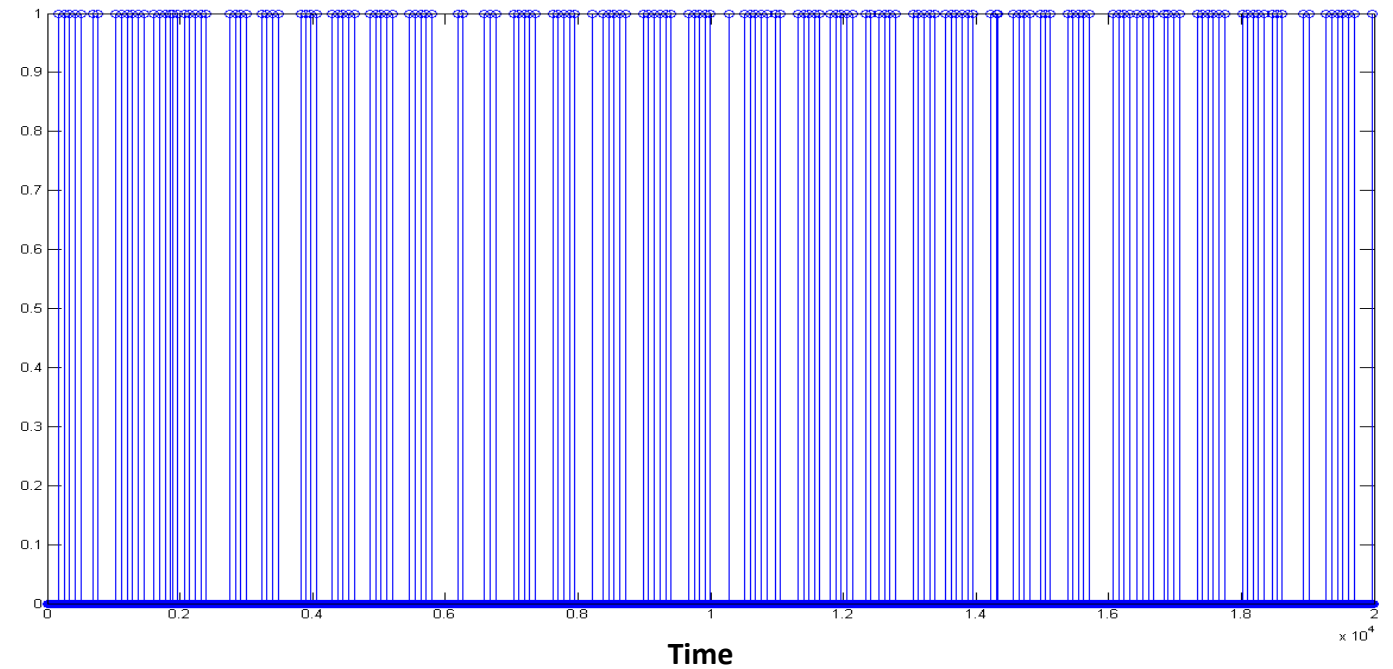


Data Analysis on a Matlab enabled computer

Data Acquisition Algorithm



Measurements of each individual sample of the sensor



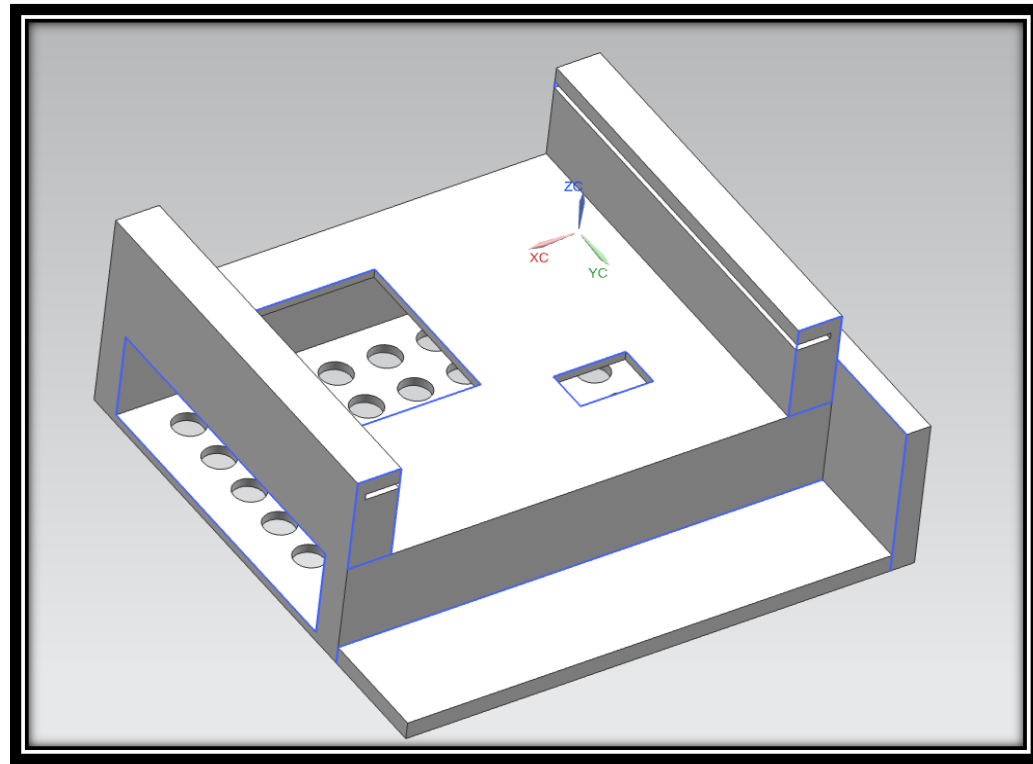
Total data coming out of the sensor (10K samples)

3) Enclosure

- Digital design create in Siemens NX 8.5 CAD software
- Capable of housing all reader components in a compact design

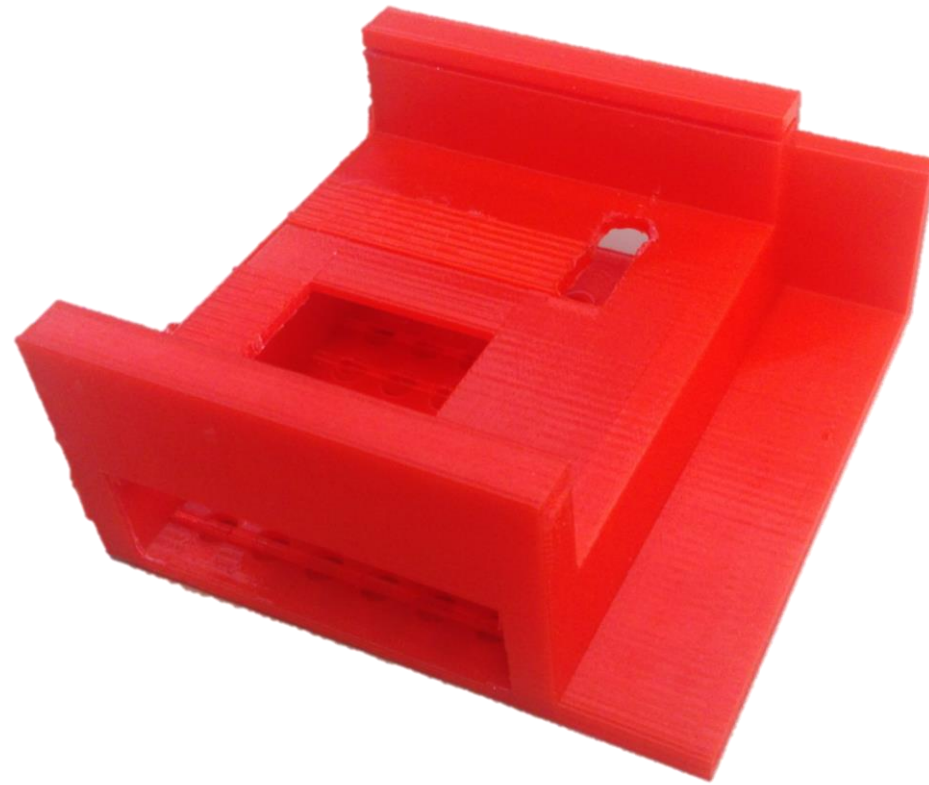
- 1) Power Management
- 2) Software Development

3) Enclosure



3) Enclosure

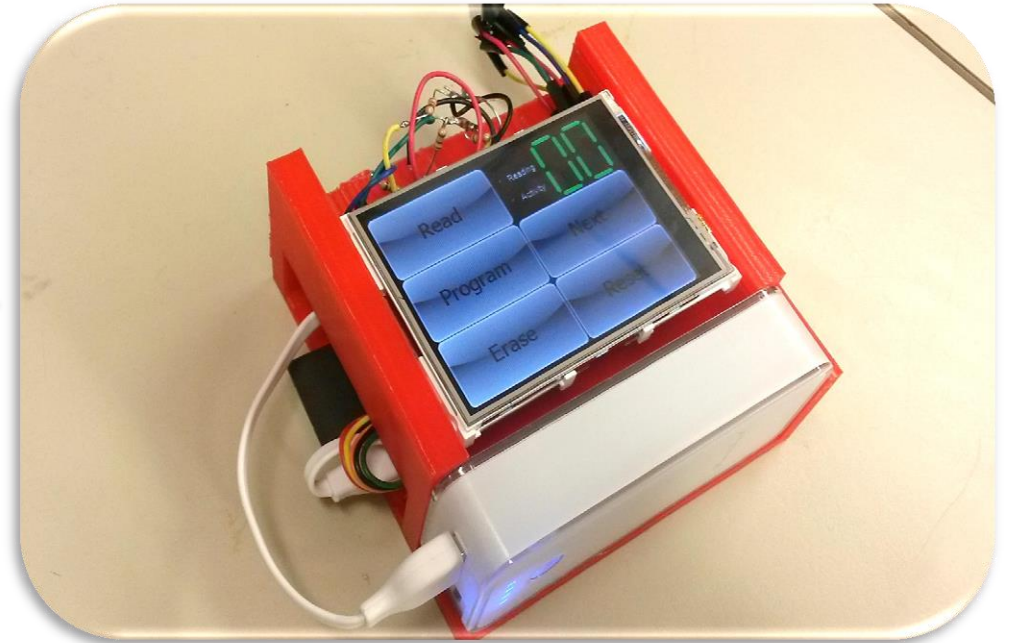
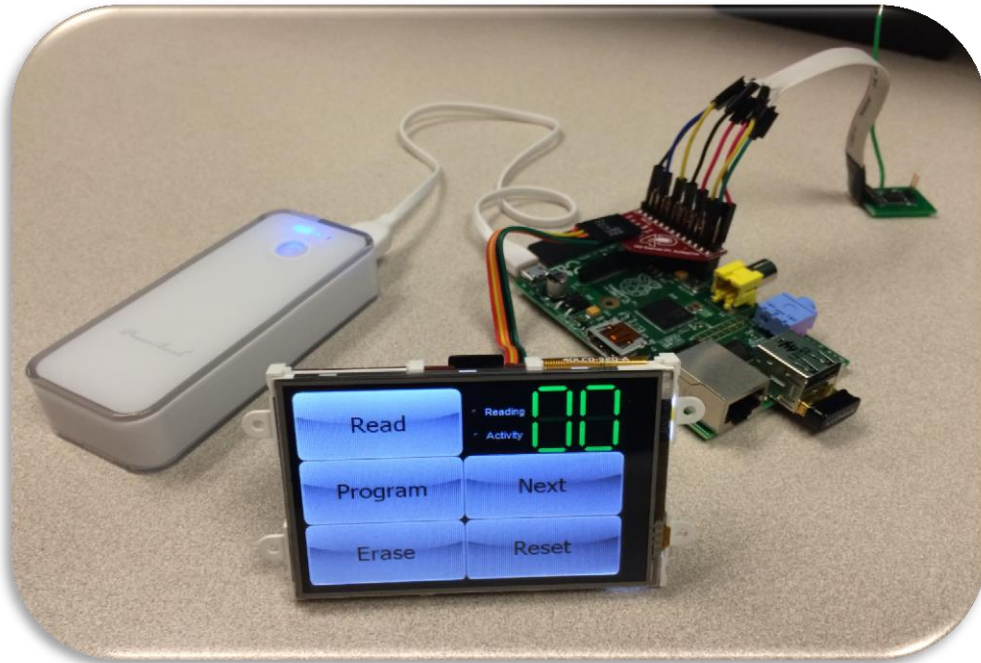
- Printed using Makerbot 3D printer
- Composed of PLA plastic



- 1) Power Management
- 2) Software Development

3) Enclosure

Completed Sensor Reader



Customer Requirements Revisited



- ✓ Interface with sensor pins
- ✓ Log and organize retrieved data into universal format
- ✓ Voltage applied to sensor must be regulated between 1.8-2.5 V
- ✓ Portable design
- ✓ Develop a plug-and-play connector that can connect to the 8 sensor pins
- + Wireless access to the Raspberry Pi

Project Conclusions

- The reader is a standalone device that requires fewer components compared to the current method of data acquisition
- More practical for real world implementation
- Device maintains all functionality of its predecessor, but reduces overall size and improves portability
- Promotes future innovation in the health research field

Demonstration
