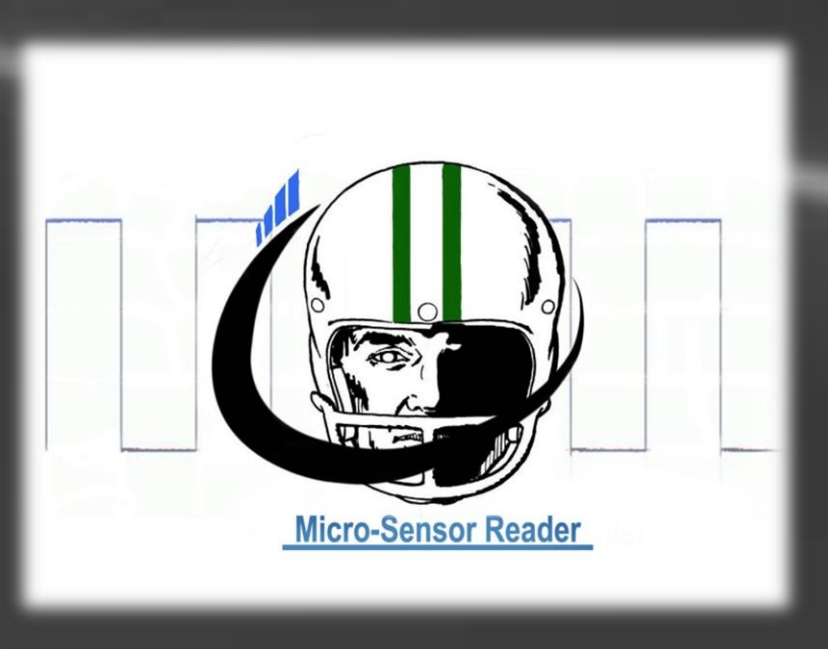




Portable Micro-Sensor Reader

Design Team 1 – Fall 2013



Abstract

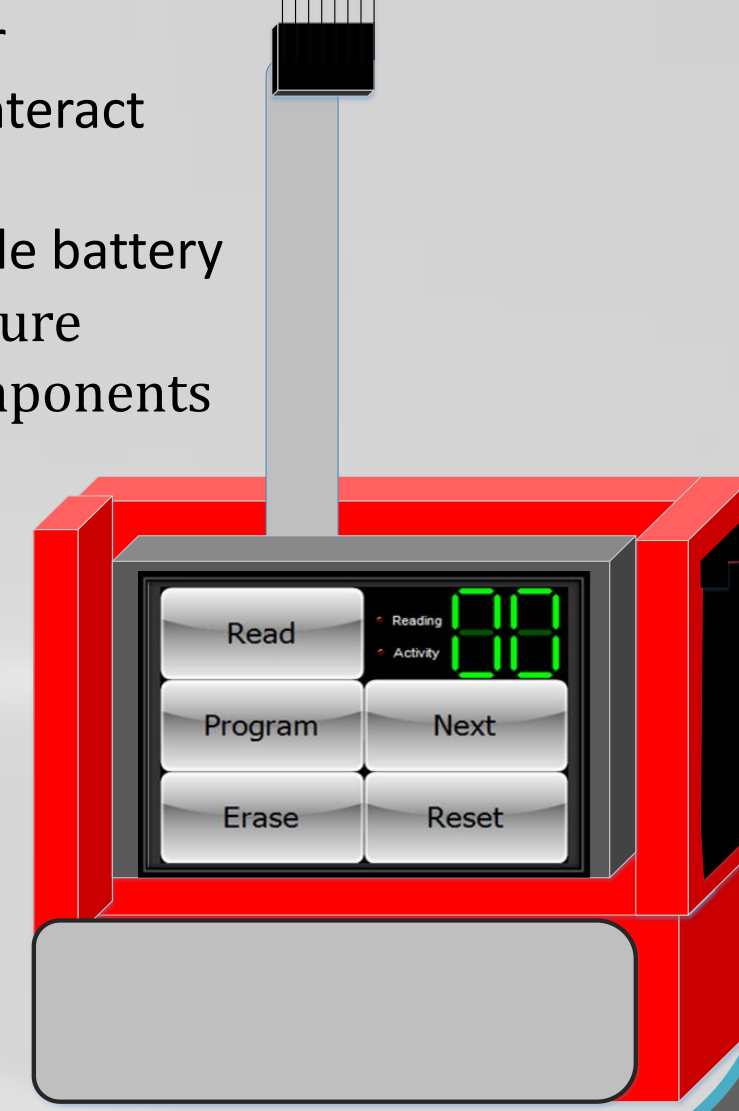
Sensors are useful devices for collecting data about the world around us. Over the course of seven years, the Michigan State Adaptive Integrated Microsystems Laboratory (AIMLab) has developed a self-powered sensor that can accurately measure strain forces. These sensors will be implanted into athletic equipment, so that researchers can analyze the data in order to better understand the causes and effects of impact injuries.

This sensor module stores the data that it collects via on-board flash memory. Over time, the information accumulates on the sensor and it is ready to be retrieved. A device needs to be designed that could connect to the custom input/output pins on the sensor module and pull the data off the memory. The reader needs to be portable, self-powered, and cost-effective. Design Team 1 developed a custom, low-cost solution that exceeds all design specifications.

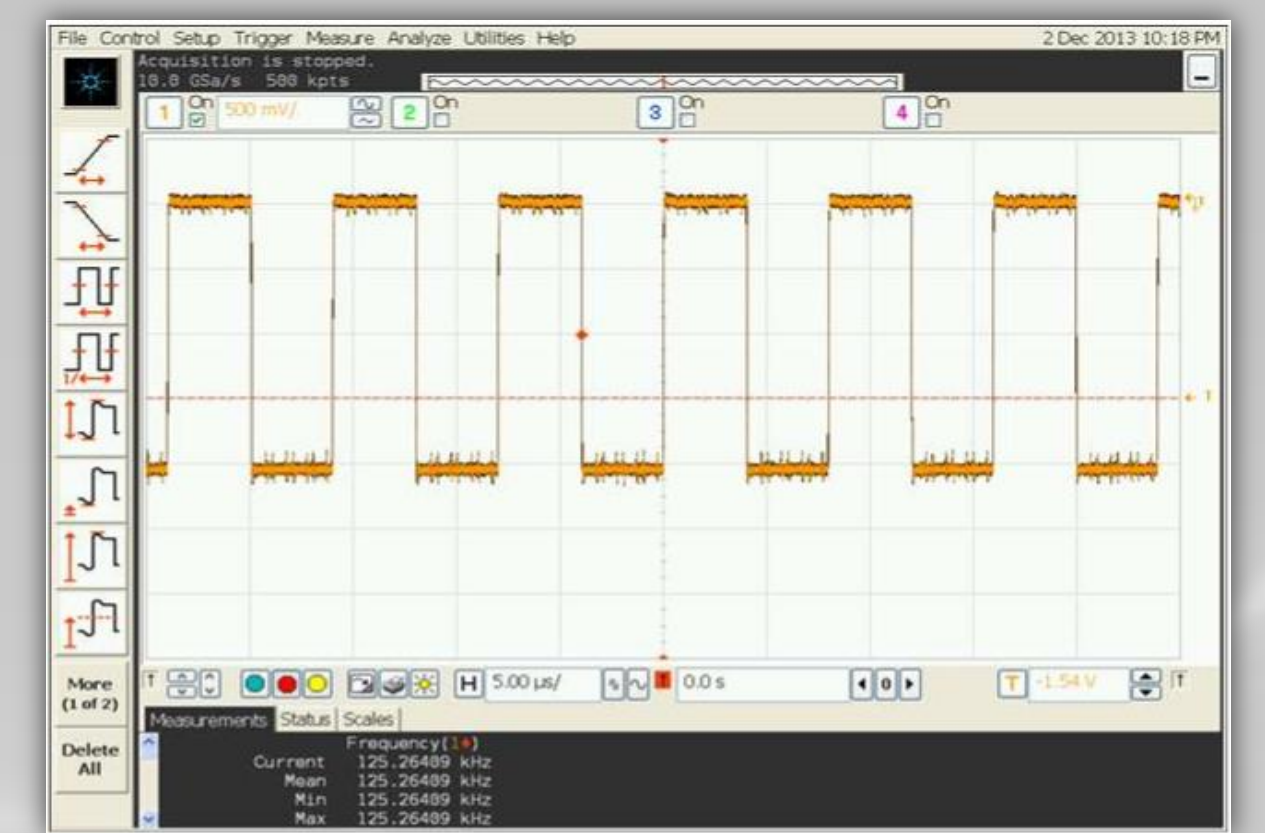
Final Design

Micro-Sensor Reader Components:

- Raspberry Pi minicomputer
- 3.2" LCD touch-screen to interact with the Raspberry Pi
- 5 V, 4400 mAh rechargeable battery
- 3D printed custom enclosure that protects internal components
- Wireless connection to transfer data between a host computer and the reader
- 8-pin plug-and-play connector

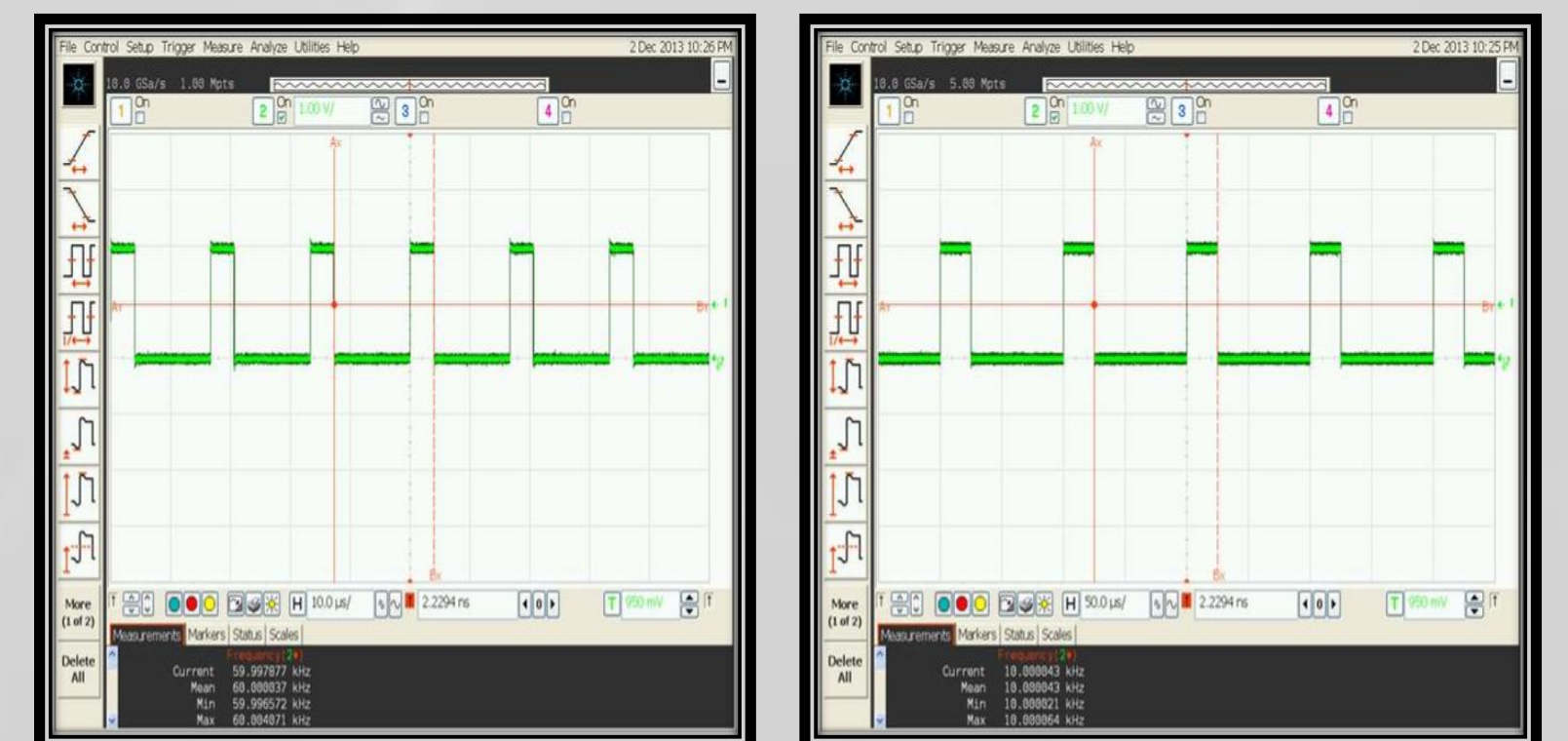


Testing and Results



The oscilloscope capture above shows the square wave output of the PFG sensor's clock, which operates at 125 kHz. This confirms that the sensor is receiving power and is operational.

After the sensor is receiving power, sending a 10ms pulse to any of the input pins on the sensor starts the designated sensor function. A user inputs their function selection with the touchscreen and the Raspberry Pi automatically initiates communication to the sensor.



When a pulse is received by the sensor, it outputs both analog and digital representations of the data stored on the specific channel.

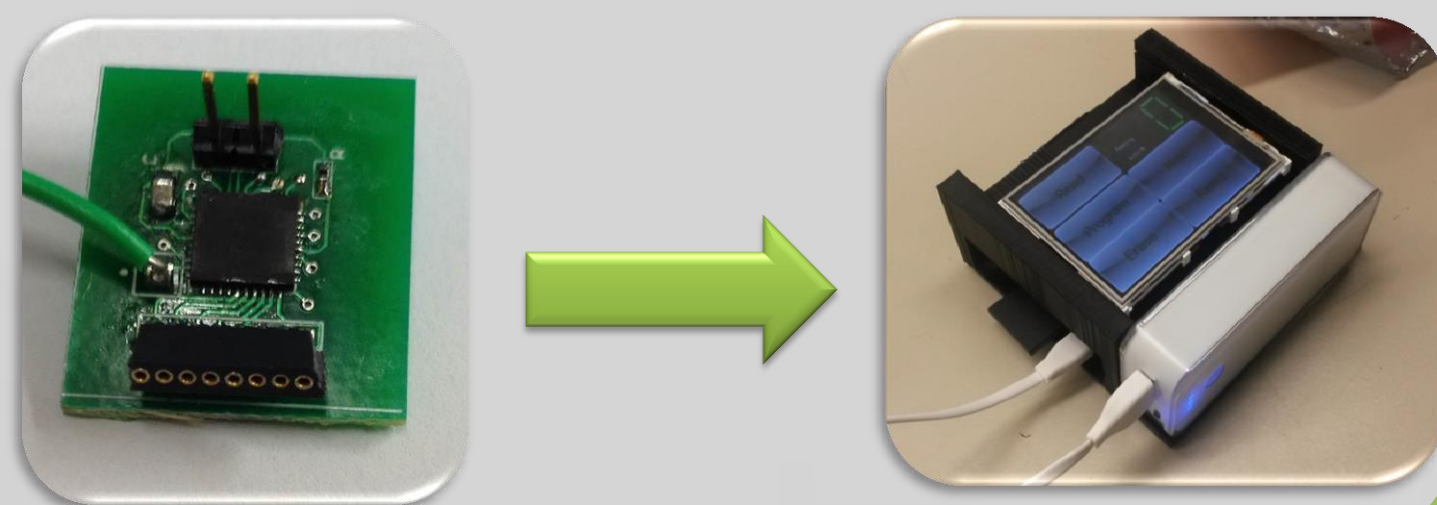
The captures above show how a major impact is represented when outputted from the digital out pin on the sensor. The higher the strength of the impact, the higher the frequency of pulses outputted by the sensor. The frequency of an impact is approximately between 10 kHz – 60 kHz (1/2 of the sensor clock).

Introduction

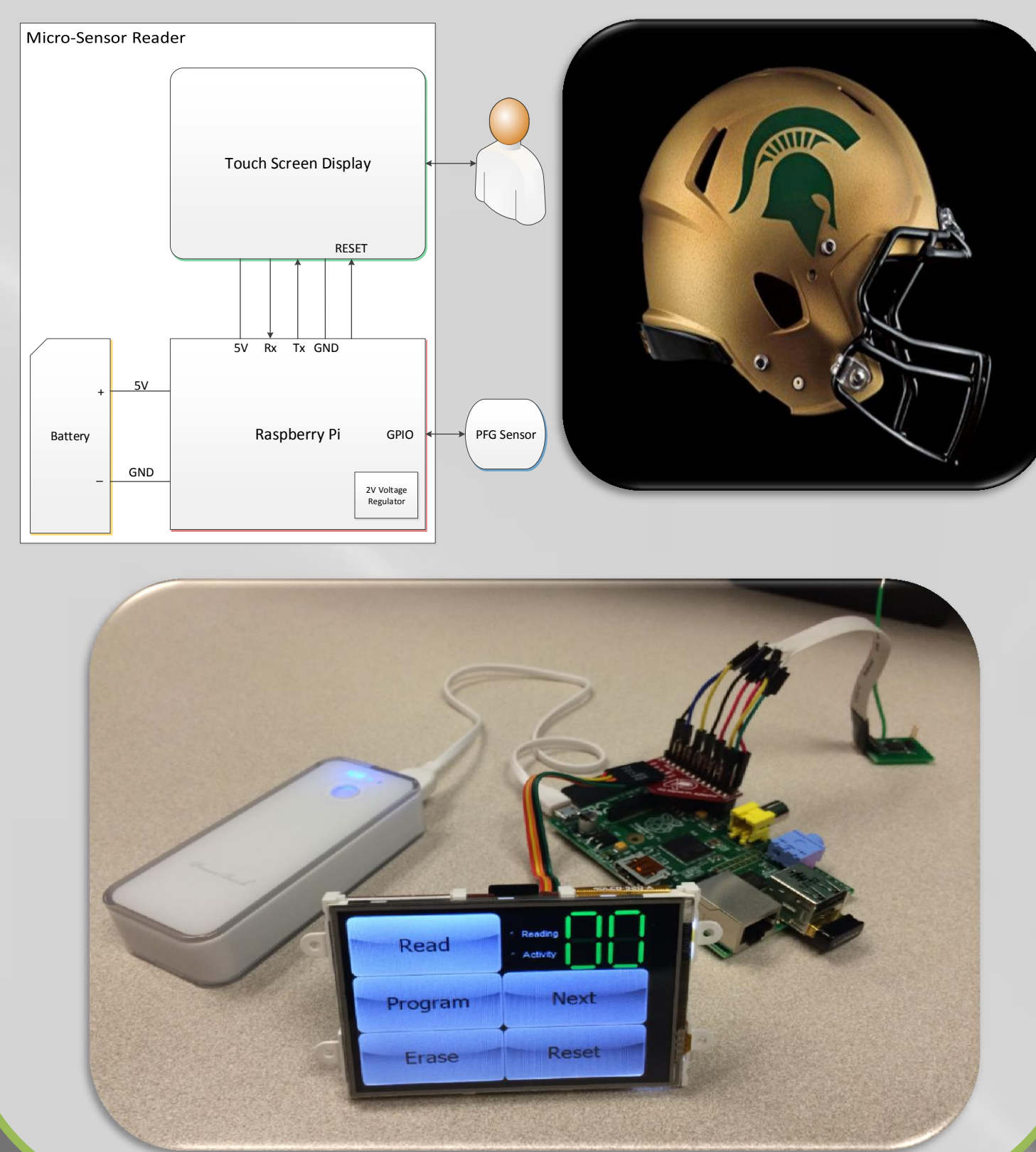
Project Description

MSU Technologies and the National Science Foundation requested a micro-reader that can extract data from the strain sensors that they developed. The current design utilizes an expensive data acquisition device and a computer running MATLAB computational software to acquire the sensor data.

The team designed a portable, cost effective micro-reader that can interact with the stress sensors' pins and provide reliable operation in the field. The chosen design is a battery-powered unit based around the Raspberry Pi platform. This Pi is programmed to interact with a touchscreen display peripheral, which has a simple to use graphical user interface for inputting commands.



Overall System



Design Requirements

Objectives

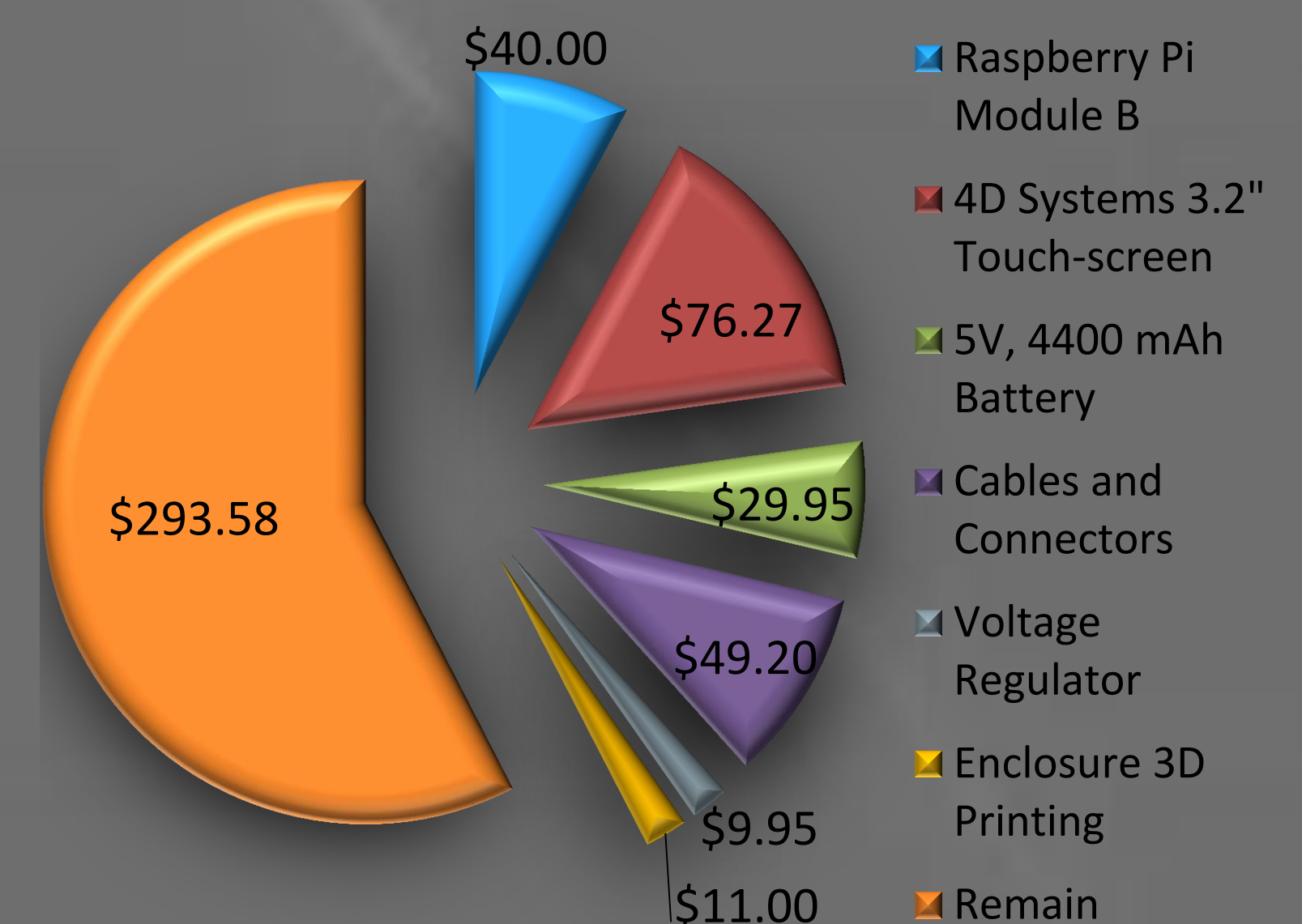
- Develop an all inclusive and self-sustaining system
- Engineer reader with as few components as possible
- Lower power consumption than existing data acquisition devices
- Create product that is durable and dependable under various environmental conditions
- Minimize material costs by exploring all solutions and comparing benefits of different devices
- Attract consumers with an innovative and original product solution that will promote future research

Constraints

- Communicate with the pins on the sensor to initiate sensor functions
- Log and organize retrieved data into universal format for future analysis
- Voltage applied to sensor must be regulated between 1.8-2.5 V to prevent damage
- Portable design that can easily be transported for usage at different locations
- Develop a plug-and-play connector that can connect to the 8 sensor pins without compromising the integrity of the I/O pins on the chip

Budget

MSU provided the team with a maximum budget of \$500 to build the prototype. Total material costs were \$206.42, omitting the components that were ordered but not used in the final design. This represents approximately 41% utilization of the total budget.



Team 1



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