Lima: Lovely Irrigation Monitoring Application

Dec1717

Client: Dr. Ajay Nair, ISU Dept of Horticulture
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Team Members:
Daniel Albers: Key Idea Concept Holder
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Seth Lightfoot: Key Idea Concept Holder
Sierra Lucht: Team Leader
Landon Woerdeman: Team Communication Leader

Outline

Project Description

"The overarching goal of this project will be to develop a low cost smartphone application based irrigation monitoring system so that vegetable growers can efficiently manage their drip irrigation systems"
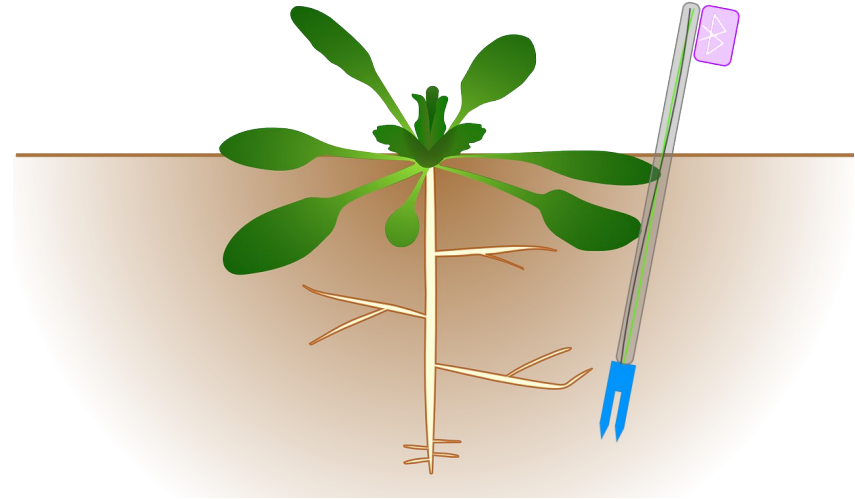
Requirements

Non-Functional

- Easy to understand and use
- Near to real time data response

Functional

- Probe buried 18-24 inches in soil
- Sensor data accessible on smartphone
- Operable under growing weather conditions
- Adequate battery life

Existing System Cost

Sensor

$139 x5 = $695

Setup 1
5 Sensor Total: $1,170

$475

Data Logger
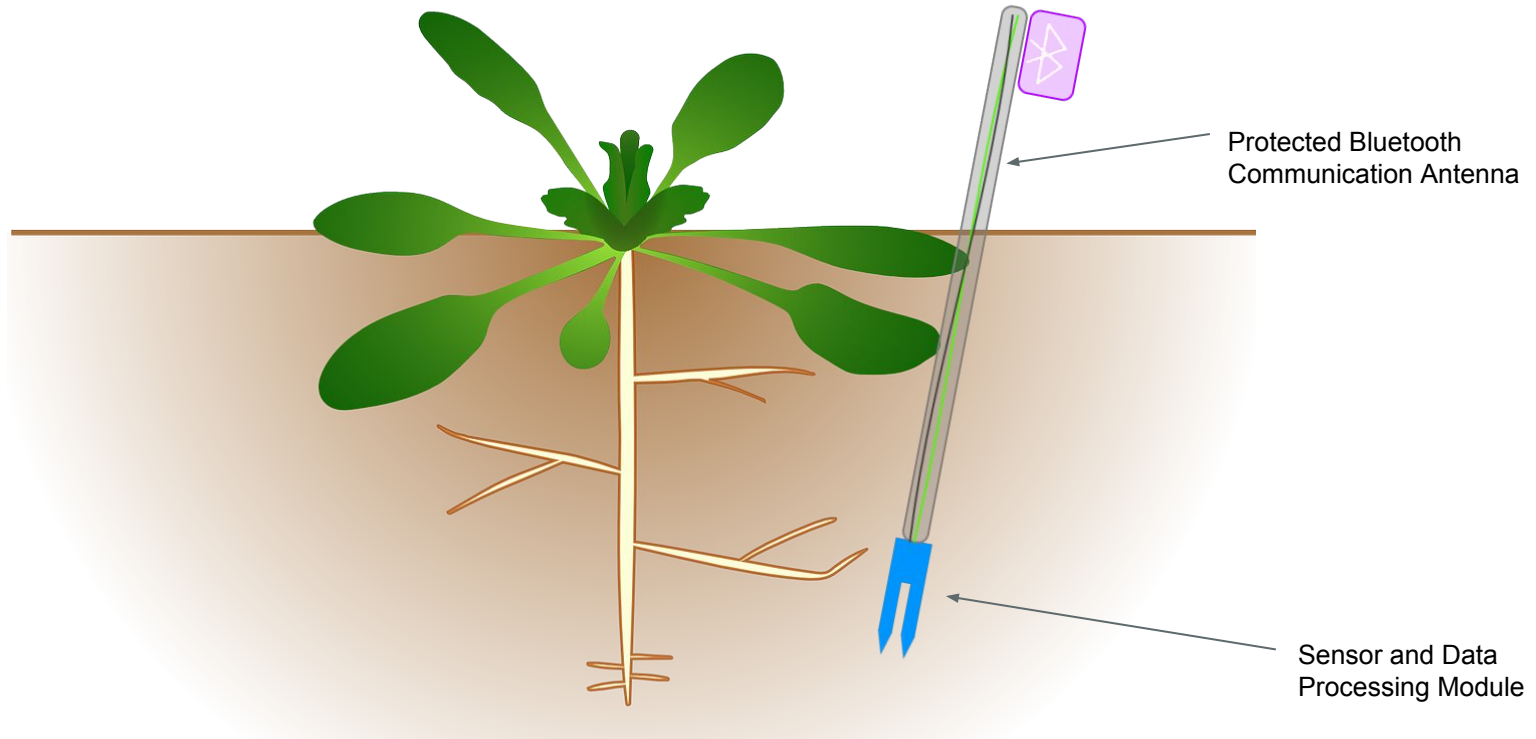
$79 x5 = $395

$279

$36 x5 = $180

Watermark Soil Moisture sensor (Item 6450) requires Adapter (Item 6450FSADPT) for FieldScout Soil Sensor Reader connection.

Setup 2
5 Sensor Total: $854

Our Goal: < $800.00

Existing System

Prototype I – Conceptual Design

Protected Bluetooth
Communication Antenna

Sensor and Data
Processing Module

Prototype I – Software Conceptual Design

Key Attributes

User Facing - LIMA Application

- Mobile Application
- Bluetooth v4.2
- Current Reading & History

Backend - Sensing Node

- C++/C Application
- Time Based Data Collection
- Bluetooth v4.2

```
/**
 * moistureSensor.ino - This program reads from 2 seperate se
 * The program takes a sample from each sensor every hour. This
 * 1) If WifiClient fails to create TCP connection with Host,
 * 2) if printToHost timesout.
 *
 * This program was created by CPR E 491 Senior Design Group D
 */

#include <ESP8266WiFi.h>

// Wifi Information
const char* ssid     = "ISU-CARDINAL"; // ISU-CARDINAL IASTATE
const char* password = "";

// Webpage for Hosting Data
const char* host = "dec1717.sd.ece.iastate.edu";

// Timing Constants
const int HOUR = 3600000;
const int SECOND = 1000;

/*
 * the setup function runs once when you press reset or power
 */
void setup() {

  // Initialize IO
  pinMode(LED_BUILTIN, OUTPUT);   // digital pin LED_BUILTIN i
  pinMode(12, OUTPUT);            // digital pin D6, (GPIO 12)
  pinMode(13, OUTPUT);            // digital pin D7, (GPIO 13)
  pinMode(A0, INPUT);             // analog pin A0 is sensor i
  Serial.begin(9600);            // initialize serial
  delay(100);

  // Turn off both sensors
  digitalWrite(12, LOW);
  digitalWrite(13, LOW);

  // Connect to Wifi Network
  Serial.println("Starting Network");
  connectWifi();
}

/**
 * the loop function runs over and over again forever. In here we log a data point from each
```
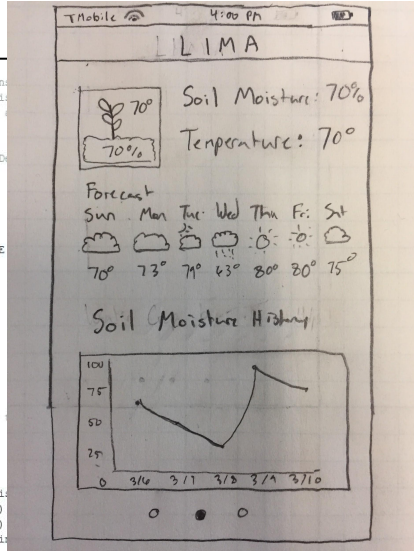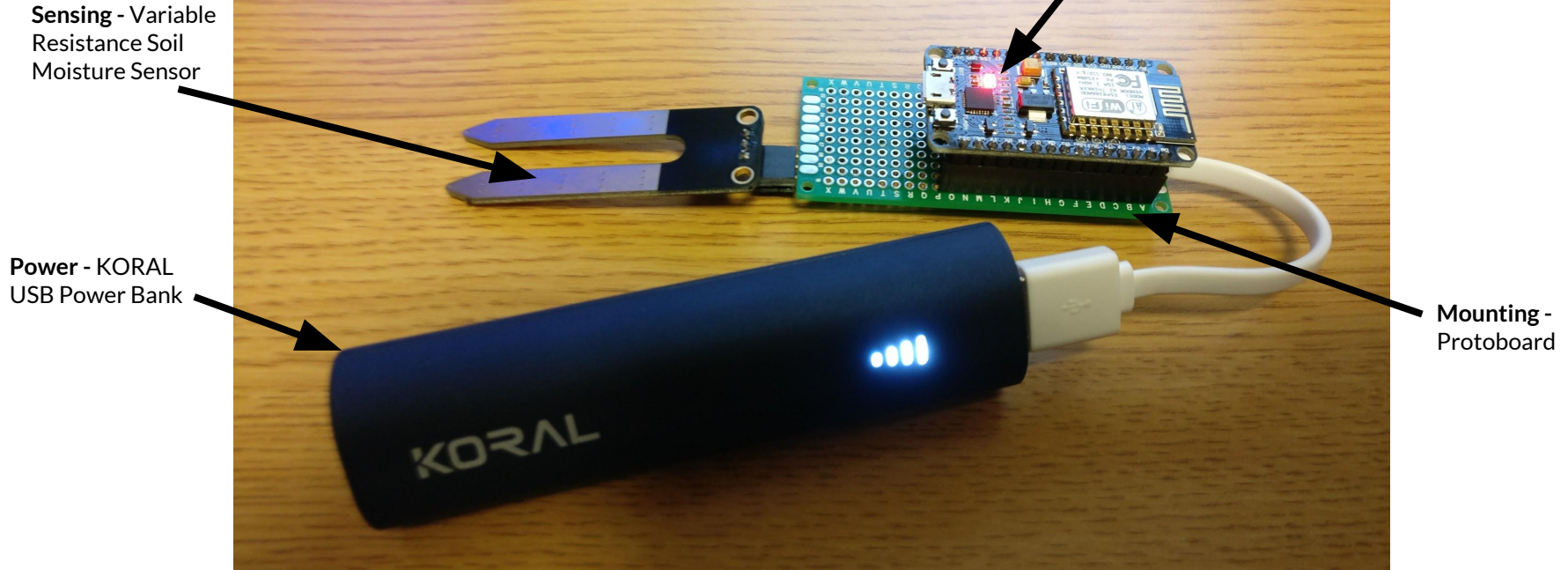
Prototype I

Prototype I – Pricing

Item	Unit Price	Quantity	Sub-Total
Moisture Sensor	$4.70	5	$23.50
NodeMCU	$8.79	5	$43.95
Battery	$4.80	5	$24
Enclosure	$.87	5	$4.35
		Price Per System:	$19.16
		5 System Total:	**$95.80**

Prototype I – Hardware

Processing - NodeMCU

Sensing - Variable Resistance Soil Moisture Sensor

Power - KORAL USB Power Bank

Mounting - Protoboard

Issues with Prototype I

- **Battery life**

  24 hour operation
  Limited data collection

- **Signal**

  Relied on WI-FI connection
  Per-Node connection

- **Sensor**

  Sensor precision low
  Sensor accuracy low

Senior Design Page for dec1717

Connected successfully

ID	Sensor	Raw Reading	Timestamp
1	ourSensor	4	2017-03-07 16:18:10
2	theirSensor	36	2017-03-07 16:18:11
3	ourSensor	4	2017-03-07 16:20:55
4	theirSensor	37	2017-03-07 16:20:55
5	ourSensor	4	2017-03-07 16:21:57
6	theirSensor	36	2017-03-07 16:21:57
7	ourSensor	5	2017-03-07 16:22:59
8	theirSensor	37	2017-03-07 16:22:59
9	ourSensor	4	2017-03-07 16:24:01
10	theirSensor	3	2017-03-07 16:24:01
11	ourSensor	4	2017-03-07 16:25:04
			2017-03-07 16:25:04
			2017-03-07 16:27:22
			2017-03-07 16:27:22
			2017-03-07 16:28:24
			2017-03-07 16:28:24
			2017-03-07 16:29:26
			2017-03-07 16:29:26
			2017-03-07 16:30:28
			2017-03-07 16:30:28
			2017-03-07 16:32:32
			2017-03-07 16:32:32
			2017-03-07 16:33:34
			2017-03-07 16:33:34
			2017-03-07 16:34:36
			2017-03-07 16:34:36
			2017-03-07 16:35:38
			2017-03-07 16:35:38
			2017-03-07 16:36:29
			2017-03-07 16:36:29
			2017-03-07 16:37:05
			2017-03-07 16:37:05
			2017-03-07 16:38:37
			2017-03-07 16:38:37

Prototype II – Hardware Conceptual Design
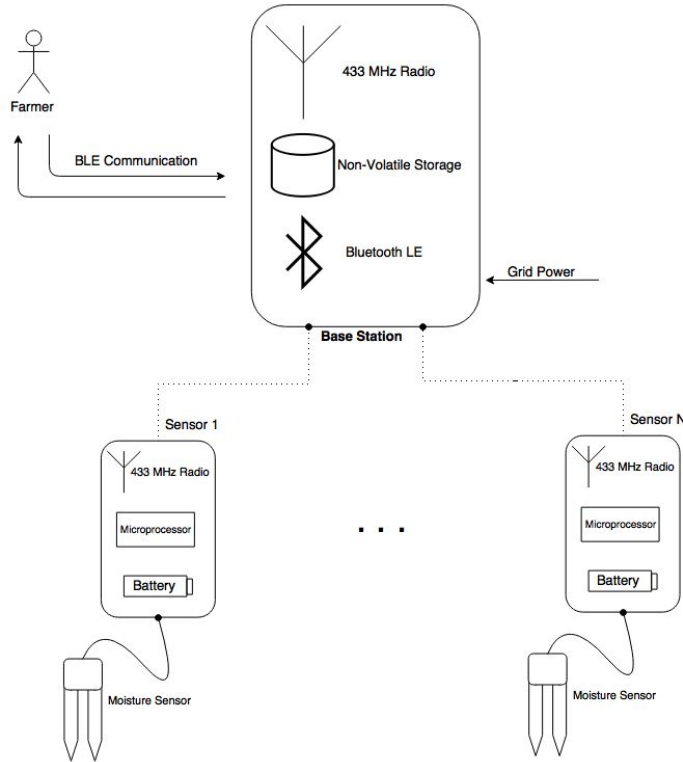
Main differences from Prototype I:

- Distributed Sensing
- 433MHz Radio
- 'Always On' Base Station
- Bluetooth Low Energy
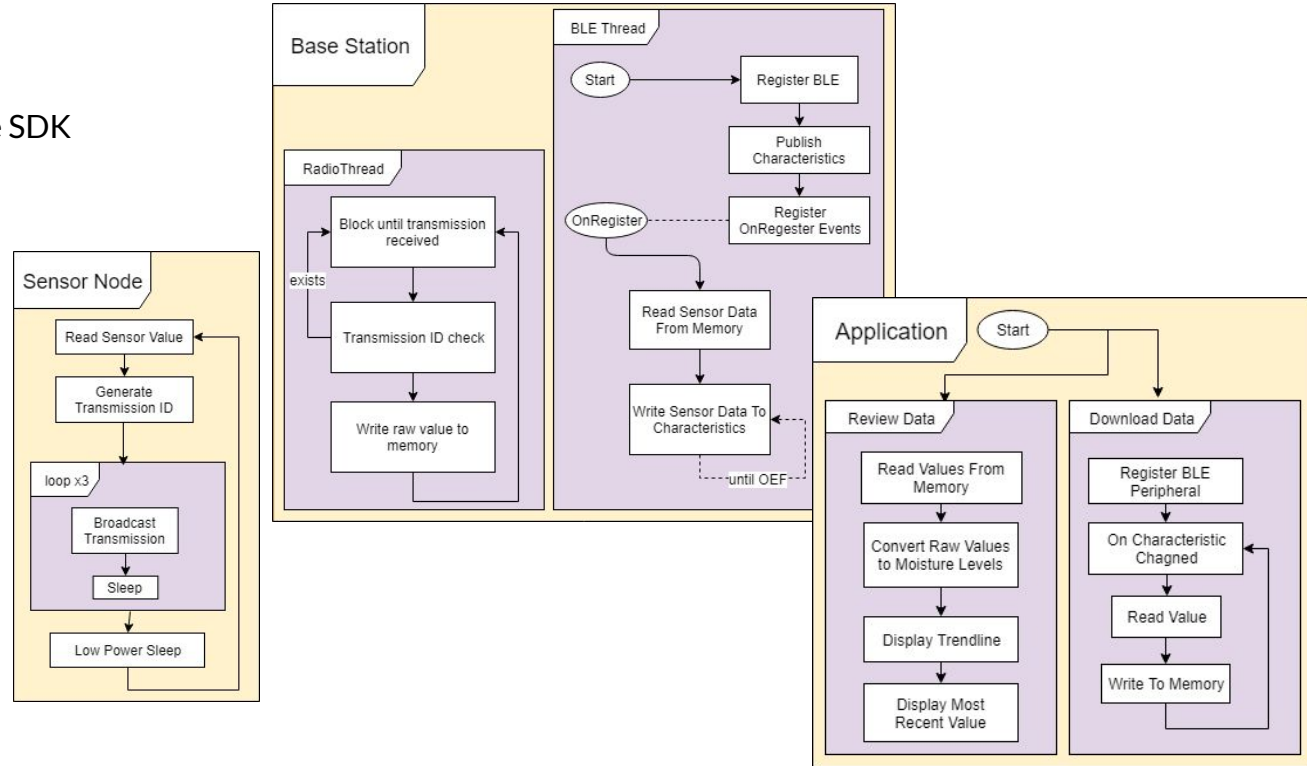
Prototype II – Software Conceptual Design
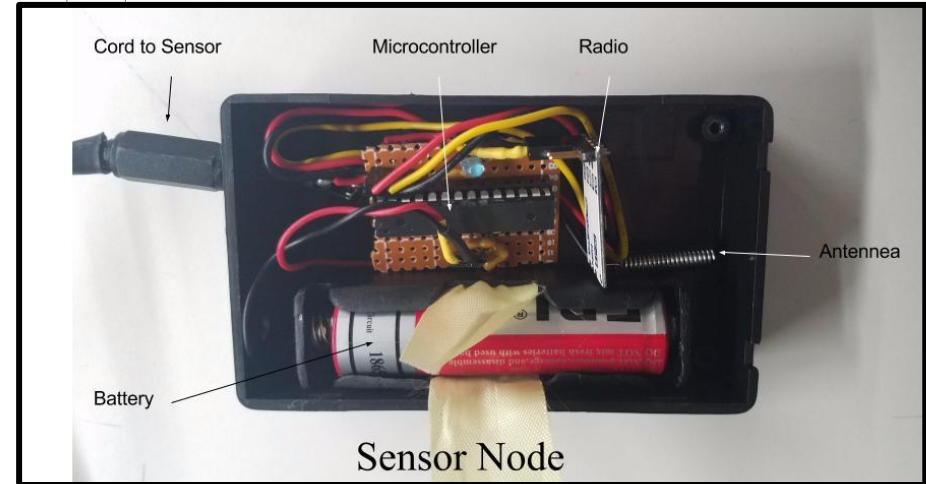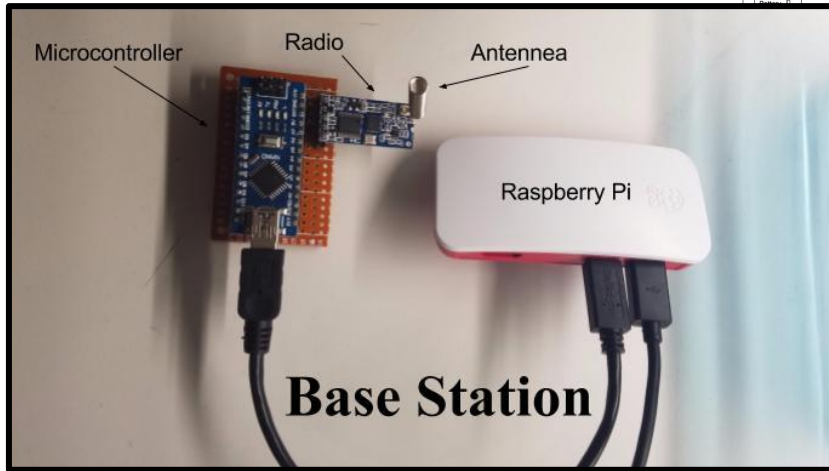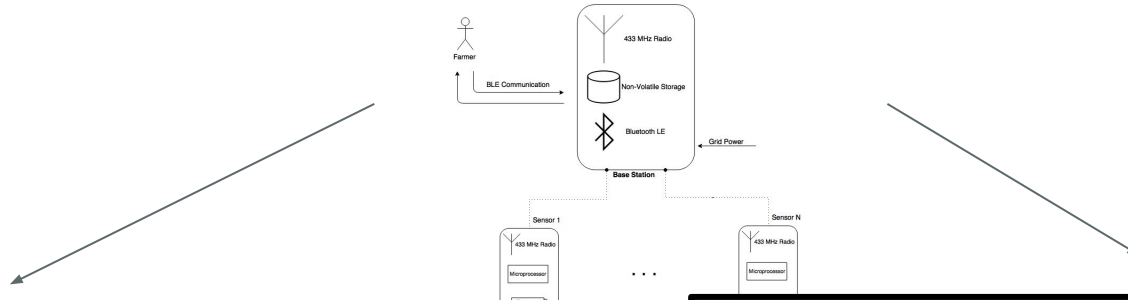
Application Differences

- Flutter - Cross Platform Native SDK
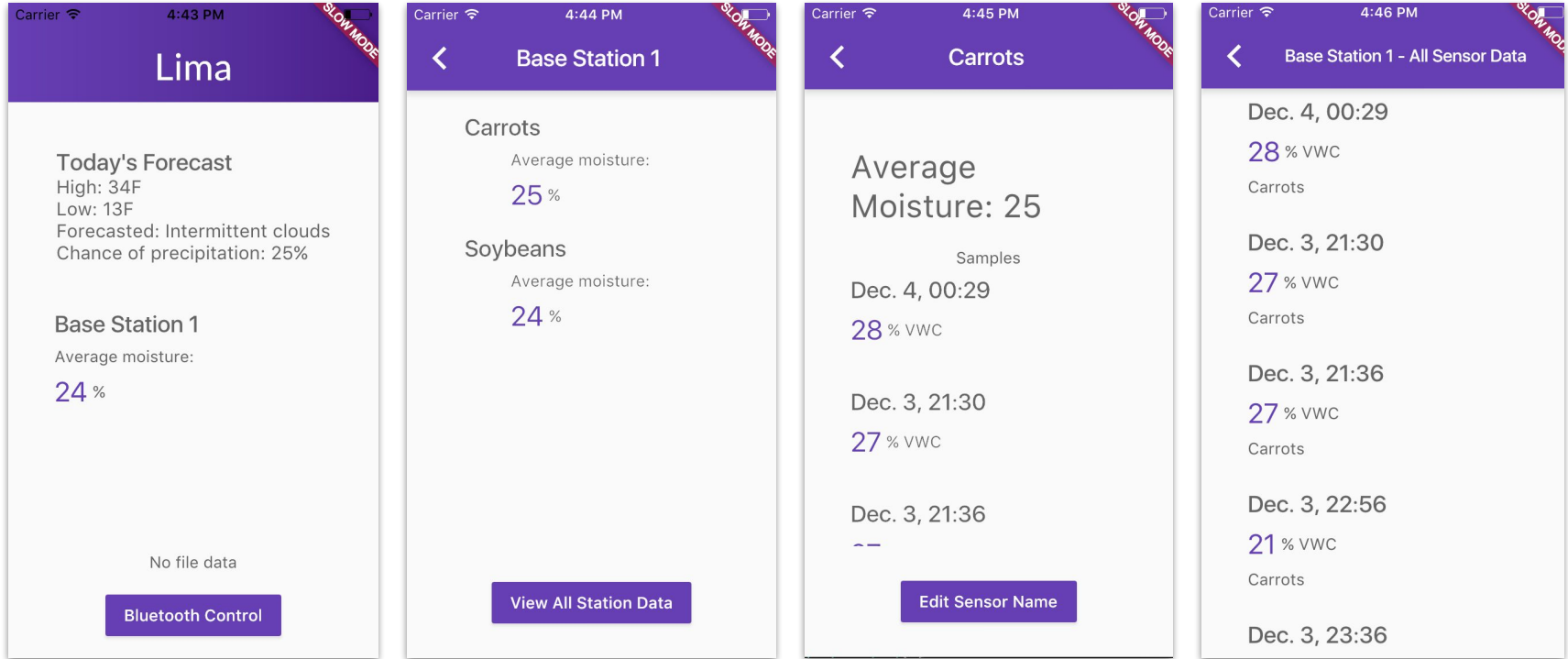- Bluetooth LE

New Embedded Software

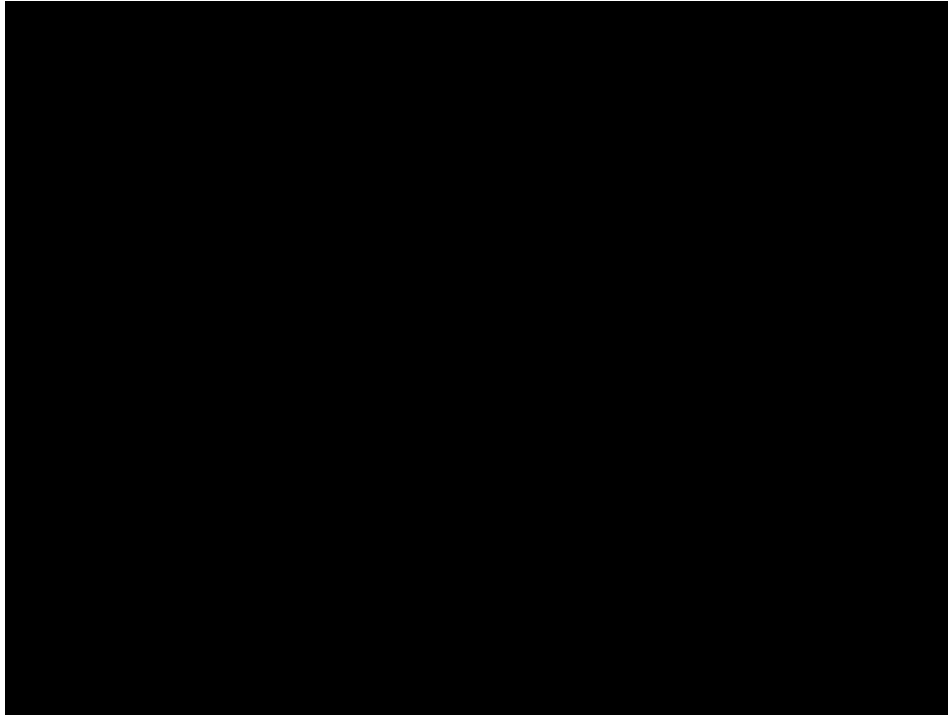- Dual Thread Base Station
- Multi-Transmission Nodes

Prototype II – Hardware Implementation

Prototype II – Software Implementation

Prototype II – Demo

Prototype II Pricing – New Sensors

| Item	Unit Price	Quantity	Sub-Total
10HS Soil Sensor	$139	5	$695
Raspberry Pi Zero W	$10	1	$10
SD card	$3	1	$3
CH340G NANO	$2.90	1	$2.90
Arduino (IC)	$2.18	5	$10.90
Battery	$1.50	5	$7.5
Enclosure	$.87	5	$4.35
Radio	$4.00	6	$24
Add. Electrical Components	$20	1	$20
		Base Station Price:	$20
		Price Per Node:	$151.53
		5 System Total:	**$777.65**

Prototype II Pricing – Existing Sensors

| Item	Unit Price	Quantity	Sub-Total
Raspberry Pi Zero W	$10	1	$10
SD card	$3	1	$3
CH340G NANO	$2.90	1	$2.90
Arduino (IC)	$2.18	5	$10.90
Battery	$1.50	5	$7.5
Enclosure	$.87	5	$4.35
Radio	$4.00	6	$24
Add. Electrical Components	$20	1	$20
		Base Station Price:	$20
		Price Per Node:	$12.35
		5 System Total:	**$82.65**
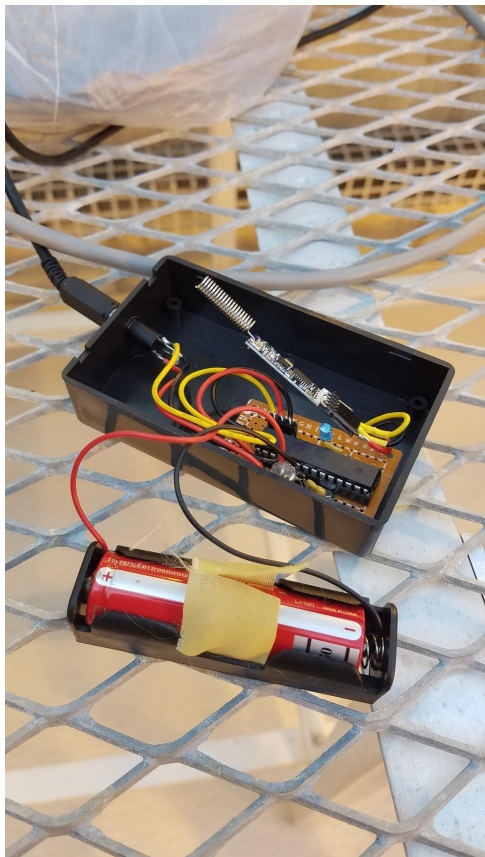
Testing

Testing

Sensor Reliability Test

Sparkfun vs. 10HS sensor
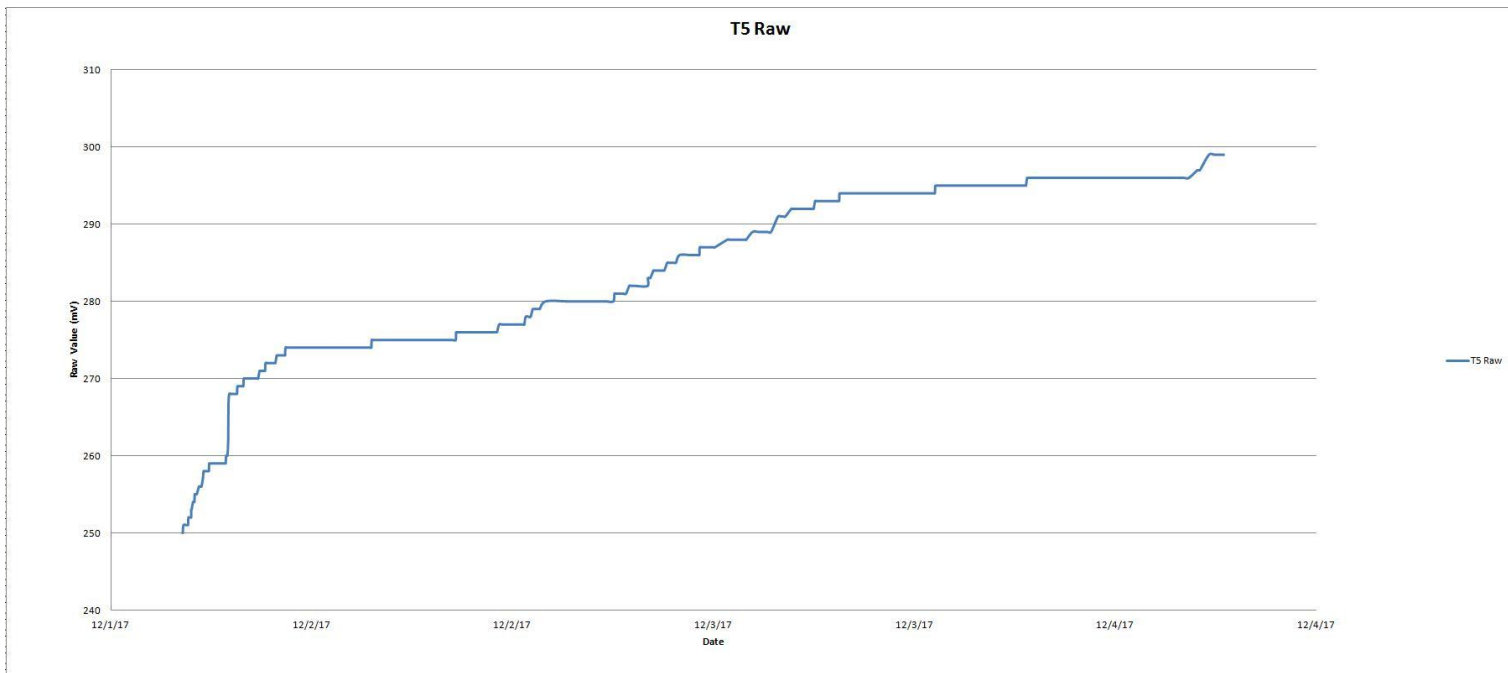*10HS much more reliable*

Comparative Test

Existing system + 10HS sensor vs. new system + 10HS sensor
Similar results
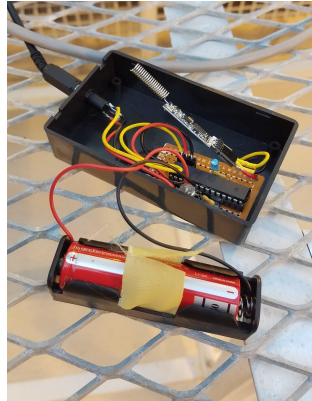
Results

- Greenhouse
- 4 days
- 2800 samples

T5 Raw

$$ABS(2.589E\text{-}10 * mV^4 * \text{-}5.010E\text{-}7 * mV^3 + 3.523\,E\text{-}4 * mV^2 - 9.135E\text{-}2 * mV + 7.457)/2 + 20$$

Results

LIMA Data Collector vs. Current Data Logger w/ 10HS Sensor

Figure 9 - T5 Raw ADC Value
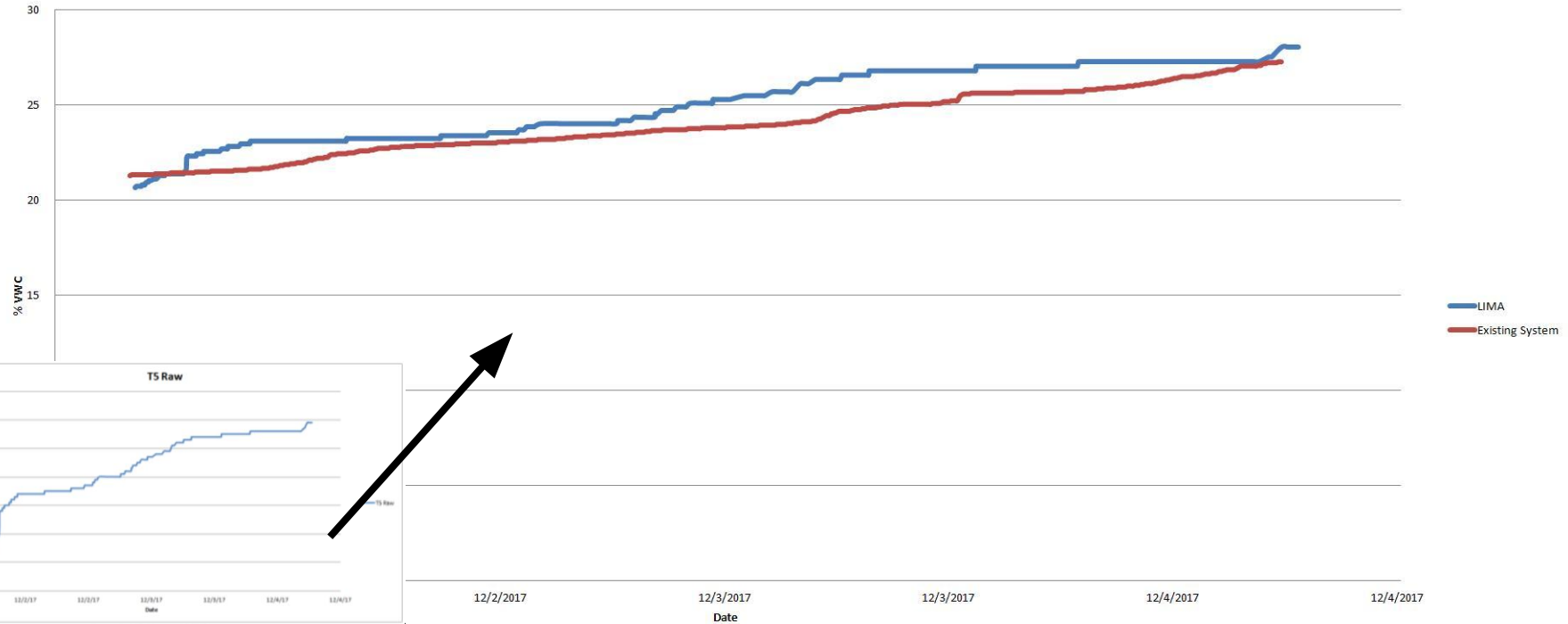
- Equation from sensor data sheet

Expanding

- Integration of control hardware
  - Turn on irrigation system when moisture levels are low
- Solar panels
  - Longer battery life
  - Environmentally friendly
- Power Management
  - Mosfet to control sensor's regulator
- Metrics
  - Identify trends
  - Make educated decisions about crops

Conclusions

- Similar results to existing system

- Lower cost

    - Total system cost

    - Easy expansion from five to ten sensors

- Mobile capabilities

Questions?

Initial Project Testing

Test Type	Status
Sensor Testing	In Progress - Concludes in Summer
Communication Testing	In Progress - Concludes in Summer
Application Testing	Scheduled for Fall
System Integration Testing	Scheduled for Fall

Updated Project Testing

Test Type	Status
Sensor Testing	Completed
Communication Testing	Completed
Application Testing	Completed
System Integration Testing	Completed

Initial Goals for Fall 2017 Semester

Number	Deliverable	Date	Status
D1	Sensor Prototype	3-30-2017	Completed
D2	Application Prototype	4-28-2017	In Progress
D3	Fully Functioning Sensor and Application	11-10-2017	Planned
D4	Comprehensive Documentation	12-1-2017	Planned

Updated Goals for Fall 2017 Semester

Number	Deliverable	Date	Status
D1	Sensor Prototype	3-30-2017	Completed
D2	Application Prototype	4-28-2017	Completed
D3	Fully Functioning Sensor and Application	11-10-2017	Completed
D4	Comprehensive Documentation	12-1-2017	Completed

Risks

- Team members have limited knowledge about mobile development
  - Mitigation: Extensive research will be done into mobile development, and the team will begin early as to create a flexible schedule

- Team members have limited knowledge about irrigation and plant life
  - Mitigation: Extensive research will be done into irrigation, and all questions and issues will be promptly communicated with the client

Useful Links

10HS Moisture Sensor
https://www.metergroup.com/environment/products/

Watermark Moisture Sensor
https://www.specmeters.com/soil-and-water/soil-moisture/soil-moisture-sensors/watermark-soil-moisture-sensors/

Sparkfun Moisture Sensor
https://www.sparkfun.com/products/13322

NodeMCU - Prototype I
http://www.nodemcu.com/index_en.html

Draw.IO - Diagrams
https://www.draw.io/

Raspberry Pi Zero W Info
https://www.raspberrypi.org/products/raspberry-pi-zero-w/

Wireless Radio
https://www.seeedstudio.com/433Mhz-Wireless-Serial-Transceiver-Module-1-Kilometer-p-1733.html

Flutter - Application
https://flutter.io/