Irrigation Monitoring Application

Dec1717

Client: Dr. Ajay Nair, ISU Dept of Horticulture
Advisor: Dr. Manimaran Govindarasu, ISU Dept of ECpE

Team Members:
Daniel Albers: Key Idea Concept Holder
Sam Jackson: Webmaster
Seth Lightfoot: Key Idea Concept Holder
Sierra Lucht: Team Leader
Landon Woerdeman: Team Communication Leader

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

- Application must be easy to use and understand
- Application must have adequate response time
- Sensor will report battery level, will notify if below N%

Functional

- Sensors will be buried in 18-24 inches of soil
- Sensors must relay information back to a mobile application
- Sensors must be able to operate in wet soil conditions
- Sensor battery will last the growing season
- Application links sensor’s MAC address to application record
- Application allows for easy sensor pairing

Existing System Cost

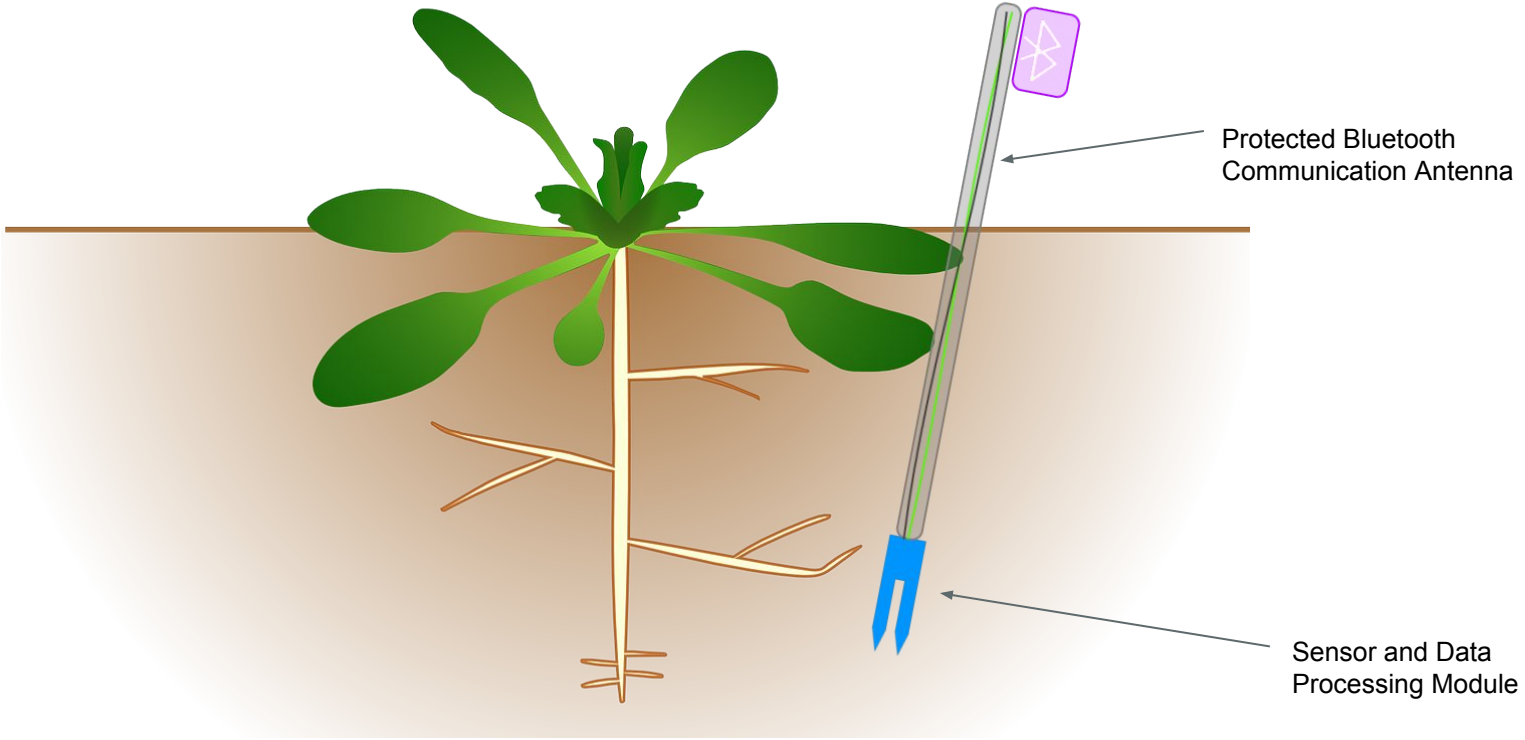
Item	Unit Price	Quantity	Sub-Total
Watchdog Soil Moisture Sensor	$36	10	$360.00
FieldScout Soil Sensor Reader	$279	1	$279.00
		Price Per System:	$63.90
		10 System Total:	**$639.00**

Sensor

Handheld Data Logger

Our Goal: < $400.00

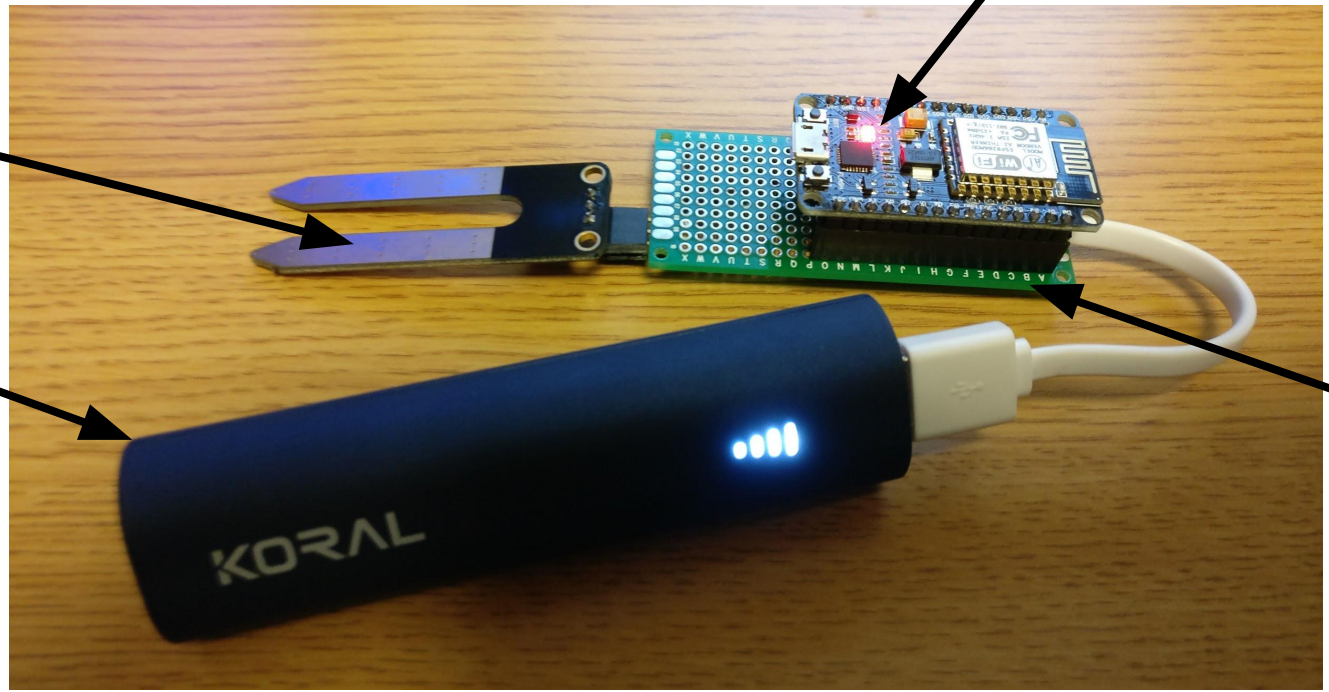
Prototype I - Hardware Conceptual Design



Prototype I - Hardware

Processing - NodeMCU

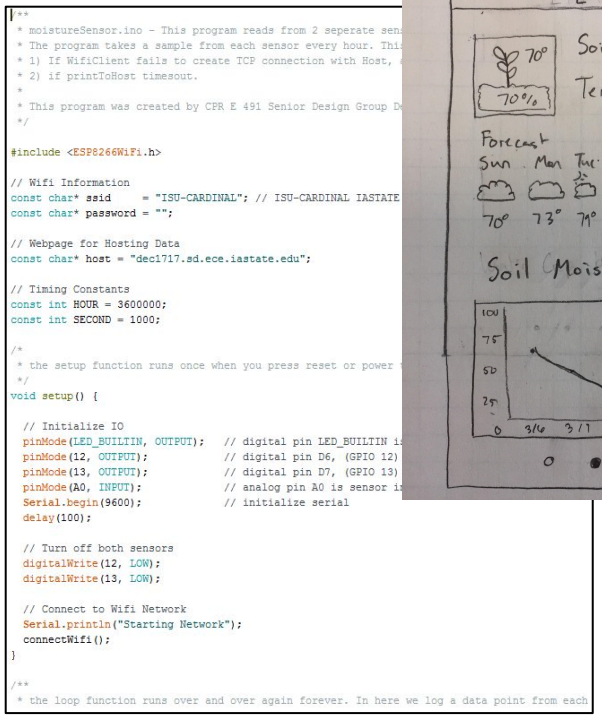
Sensing - Variable Resistance Soil Moisture Sensor



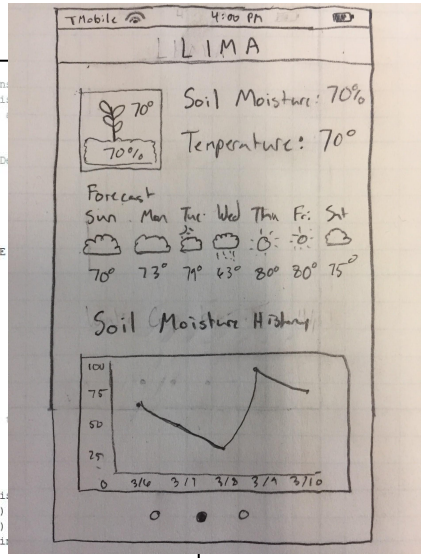
Power - KORAL USB Power Bank

Mounting - Protoboard

Prototype I - Software Conceptual Design



```
/**
 * moistureSensor.ino - This program reads from 2 seperate sen
 * The program takes a sample from each sensor every hour. Thi
 * 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
```



Key Attributes

User Facing - LIMA Application

- Swift iPhone Application
- Communicates with sensing module via Bluetooth v4.2 or higher
- Displays all information pertinent to user

Backend - Sensing Node

- C++/C Arduino Application
- Collects sensor data on a timer
- Makes data available to LIMA via Bluetooth v4.2 or higher

Prototype I - Pricing

Item	Unit Price	Quantity	Sub-Total
Moisture Sensor	$4.70	10	$47.00
NodeMCU	$8.79	10	$87.90
Battery	$4.80	10	$48.00
Enclosure	$.87	10	$8.70
		Price Per System:	$19.16
		10 System Total:	**$191.60**

Issues with Prototype I

- **Battery life**
  Unit lost power within 24 hours of test start
  Limited data collection

- **Signal strength**
  Mobile application development was not ready
  Unit was setup to use university wifi network ISU-CARDINAL
  Network connection would timeout unit has no way to reconnect

- **Sensor reliability**
  Sensors must be vetted against working system
  Regression analysis must be conducted, code should compensate

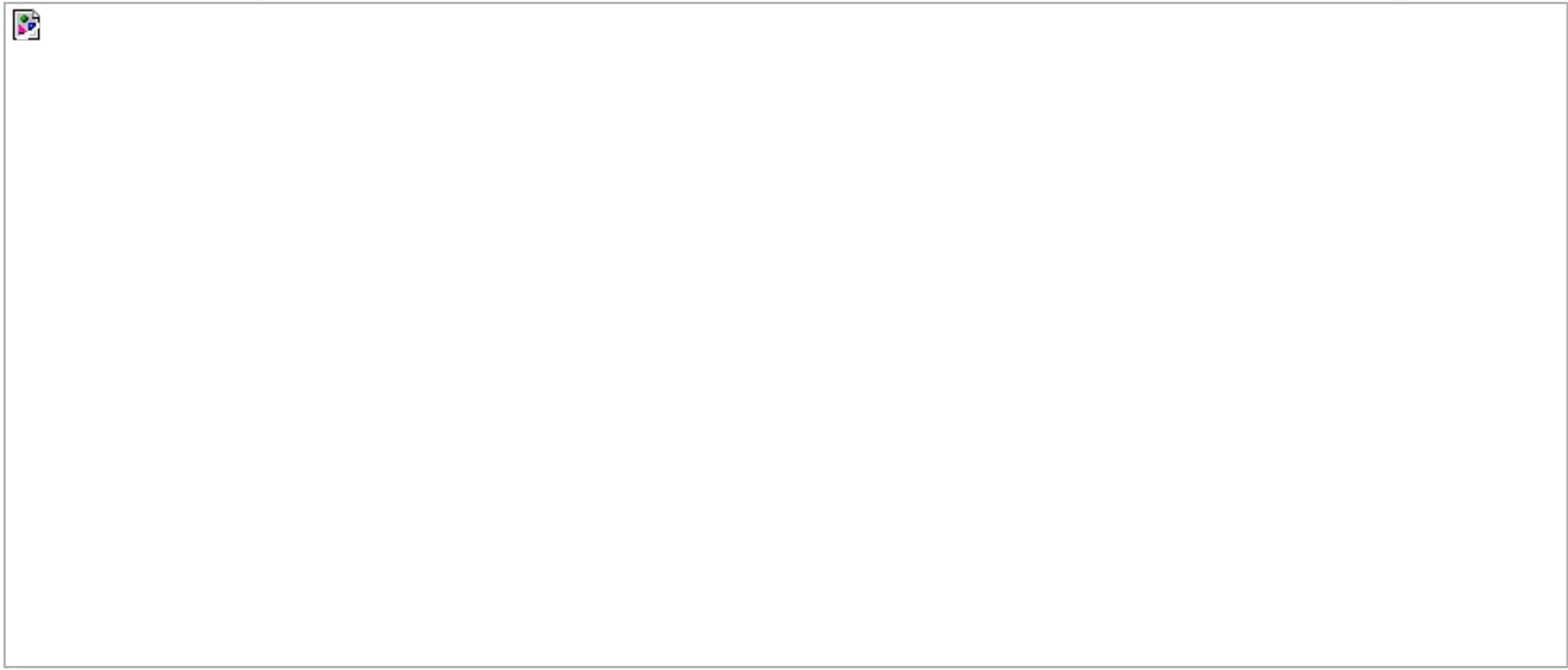
- **Weather**
  Due to the nature of this being a first test, we did not set up proper packaging
  Ziploc bag was used and provided limited protection of the unit

Senior Design Page for dec1717

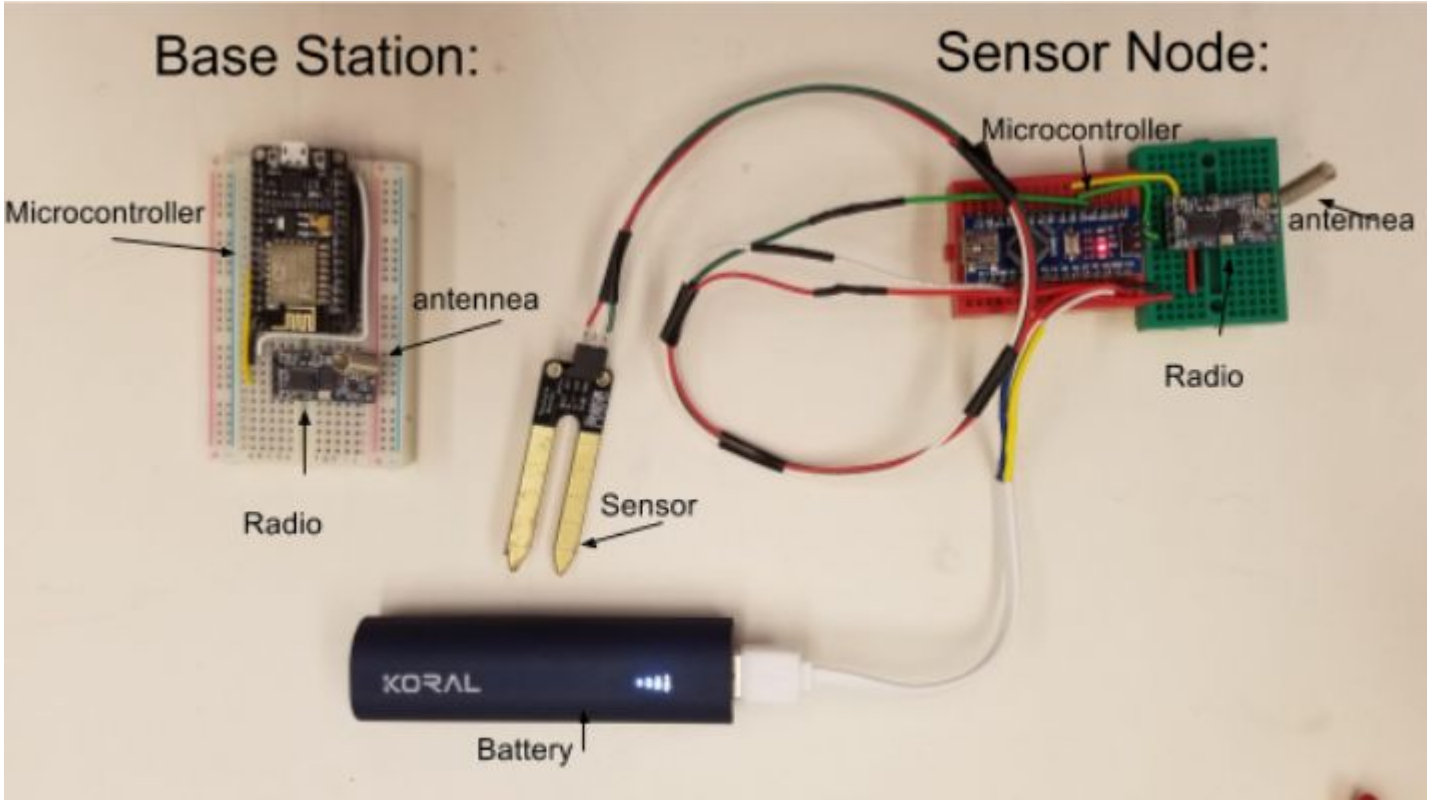
Connected successfully

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
			-03-07 16:25:04
			-03-07 16:27:22
			-03-07 16:27:22
			-03-07 16:28:24
			-03-07 16:28:24
			-03-07 16:29:26
			-03-07 16:29:26
			-03-07 16:30:28
			-03-07 16:30:28
			-03-07 16:32:32
			-03-07 16:32:32
			-03-07 16:33:34
			-03-07 16:33:34
			-03-07 16:34:36
			-03-07 16:34:36
			-03-07 16:35:38
			-03-07 16:35:38
			-03-07 16:36:29
			-03-07 16:36:29
			-03-07 16:37:05
			-03-07 16:37:05
			-03-07 16:38:37
			-03-07 16:38:37

Prototype II - Hardware Conceptual Design



Prototype II - Hardware



Prototype II - Software Conceptual Design

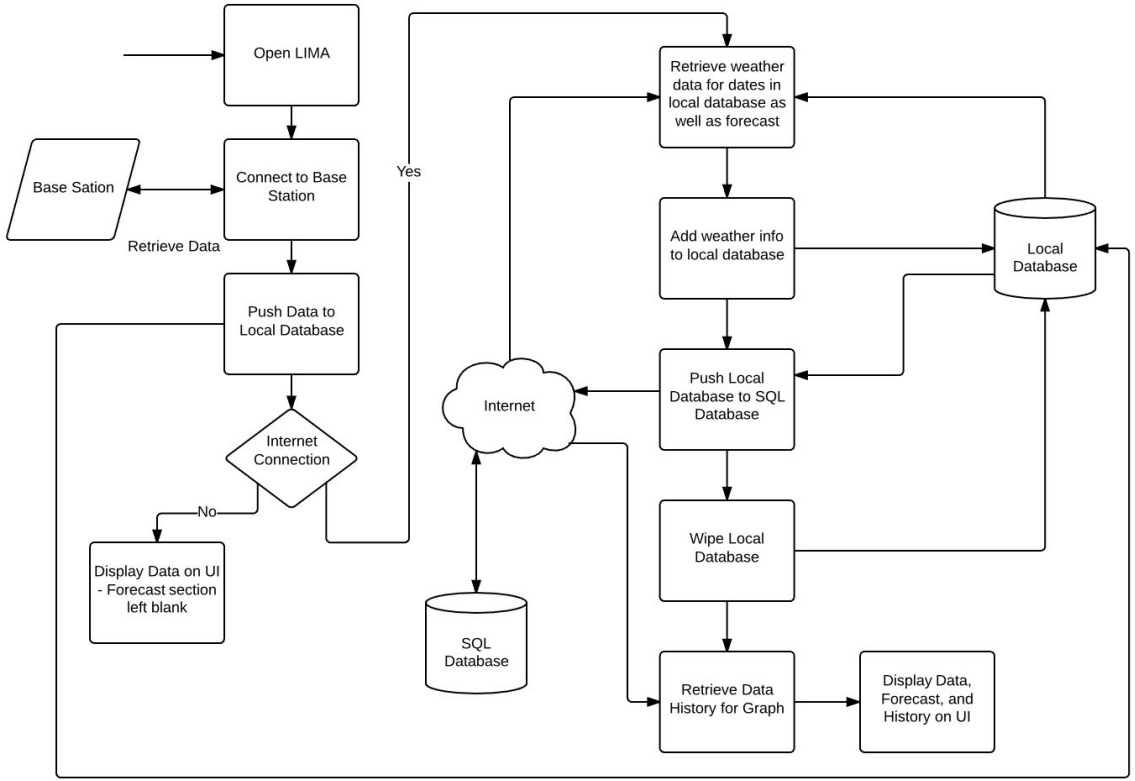
Key Attributes

Backend - Base Station

- Communicate with Sensing Nodes over Radio Frequency
- Serve up data to user via Bluetooth 4.2 or higher
- Handle saving and databasing old data

Sensing Node now serves data to Base Station via Radio connection

Mobile Application attributes remained the same



Prototype II Pricing

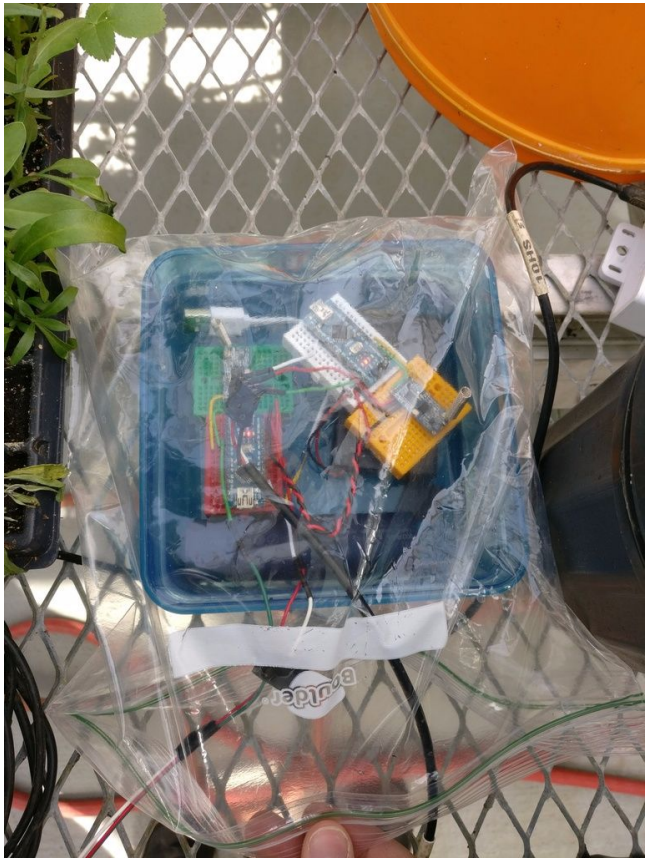
Item	Unit Price	Quantity	Sub-Total
Soil Moisture Sensor	$4.70	10	$47.00
Raspberry Pi Zero W	$10	1	$10
SD card	$3	1	$3
CH340G NANO	$2.896	10	$28.96
Battery Enclosure	$1.50	10	$15.00
Enclosure	$.87	10	$8.70
Radio	$4.00	11	$44.00
Wire	$1.81	11	$20
		Base Station Price:	$19.68
		Price Per Node:	$15.77
		10 System Total:	**$173.66**

Issues with Prototype II

- **Battery life**
  Unit lost power shortly after test start
  Battery was replaced shortly after
  Reduced power consumption research in progress

- **Signal strength**
  Mobile application development is still not ready
  Unit set up for use with ISU-Cardinal
  Reconnection code has been implemented

- **Currently in Test**
  We are still conducting this test in the greenhouse
  More results to come upon completion



Latest Testing Results

Sensor and **Communication Test Phases** are currently being conducted in the Greenhouse.

They will conclude in **Summer 2017.**

Upcoming Project Testing Phases

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

Initial Timeline

Objective	Date	Status
Project Assignment	1-20-2017	Planned
Research Solutions	2-10-2017	Planned
Prototype I	3-1-2017	Planned
Testing + Revision	3-20-2017	Planned
Prototype II	4-1-2017	Planned
Testing + Revision	4-18-2017	Planned
Semester Close	4-25-2017	Planned

Updated Timeline

Objective	Date	Status
Project Assignment	1-20-2017	Completed
Research Solutions	2-10-2017	Completed
Prototype I	2-20-2017	Completed
Testing + Revision	3-20-2017	Completed
Prototype II	4-1-2017	Completed
Testing + Revision	4-18-2017	Completed
Semester Close	4-25-2017	Completed

Deliverables

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	In Progress
D4	Comprehensive Documentation	12-1-2017	In Progress

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	In Progress
D4	Comprehensive Documentation	12-1-2017	In Progress

Questions?

Test Data

Senior Design Page for dec1717

Connected successfully

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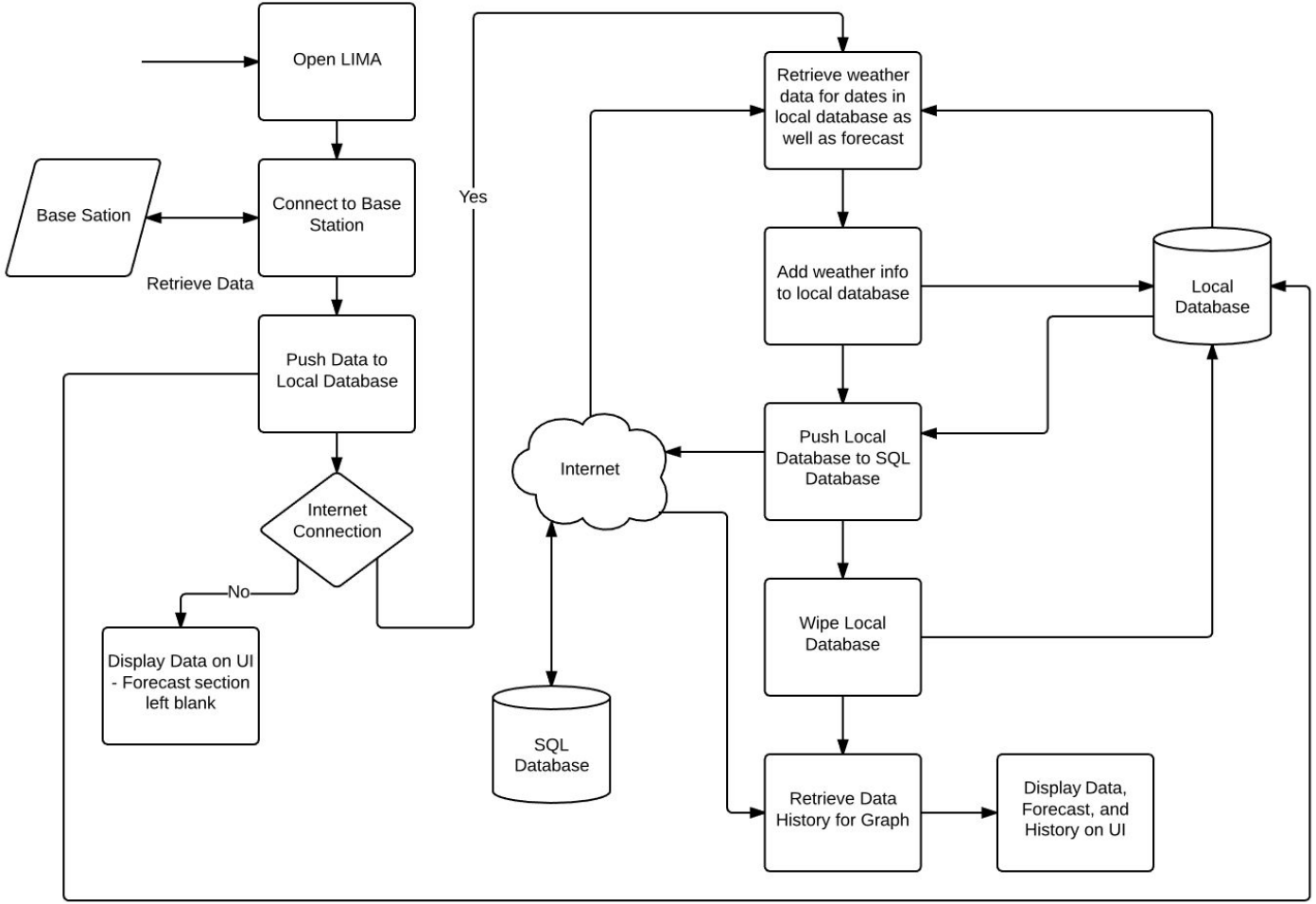
11	ourSensor	4	2017-03-07 16:25:04
12	theirSensor	3	2017-03-07 16:25:04
13	ourSensor	578	2017-03-07 16:27:22
14	theirSensor	11	2017-03-07 16:27:22
15	ourSensor	581	2017-03-07 16:28:24
16	theirSensor	10	2017-03-07 16:28:24
17	ourSensor	583	2017-03-07 16:29:26
18	theirSensor	6	2017-03-07 16:29:26
19	ourSensor	584	2017-03-07 16:30:28
20	theirSensor	7	2017-03-07 16:30:28
21	ourSensor	5	2017-03-07 16:32:32
22	theirSensor	38	2017-03-07 16:32:32
23	ourSensor	4	2017-03-07 16:33:34
24	theirSensor	37	2017-03-07 16:33:34
25	ourSensor	4	2017-03-07 16:34:36
26	theirSensor	36	2017-03-07 16:34:36
27	ourSensor	4	2017-03-07 16:35:38
28	theirSensor	37	2017-03-07 16:35:38
29	ourSensor	4	2017-03-07 16:36:29
30	theirSensor	36	2017-03-07 16:36:29
31	ourSensor	4	2017-03-07 16:37:05

1088	theirSensor	97	2017-04-24 11:11:00
1089	ourSensor	101	2017-04-24 11:11:05
1090	theirSensor	97	2017-04-24 11:11:05
1091	ourSensor	99	2017-04-24 11:11:10
1092	theirSensor	97	2017-04-24 11:11:10
1093	ourSensor	93	2017-04-24 11:11:15
1094	theirSensor	97	2017-04-24 11:11:15
1095	ourSensor	94	2017-04-24 11:11:21
1096	theirSensor	97	2017-04-24 11:11:21
1097	ourSensor	98	2017-04-24 11:11:28
1098	theirSensor	97	2017-04-24 11:11:28
1099	ourSensor	101	2017-04-24 11:11:31
1100	theirSensor	97	2017-04-24 11:11:31
1101	ourSensor	103	2017-04-24 11:11:36
1102	theirSensor	97	2017-04-24 11:11:36
1103	ourSensor	114	2017-04-24 11:11:41
1104	theirSensor	97	2017-04-24 11:11:41
1105	ourSensor	106	2017-04-24 11:11:46
1106	theirSensor	97	2017-04-24 11:11:46
1107	ourSensor	110	2017-04-24 11:11:51
1108	theirSensor	97	2017-04-24 11:11:51
1109	ourSensor	113	2017-04-24 11:11:56
1110	theirSensor	97	2017-04-24 11:11:56
1111	ourSensor	114	2017-04-24 11:12:02
1112	theirSensor	98	2017-04-24 11:12:02
1113	ourSensor	115	2017-04-24 11:12:07
1114	theirSensor	98	2017-04-24 11:12:07
1115	ourSensor	116	2017-04-24 11:12:12
1116	theirSensor	98	2017-04-24 11:12:12
1117	ourSensor	118	2017-04-24 11:12:27
1118	theirSensor	98	2017-04-24 11:12:27
1119	ourSensor	119	2017-04-24 11:12:32
1120	theirSensor	98	2017-04-24 11:12:32
1121	ourSensor	120	2017-04-24 11:12:37
1122	theirSensor	98	2017-04-24 11:12:37

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


Open LIMA
Base Sation
Connect to Base Station
Retrieve Data
Push Data to Local Database
Internet Connection
No
Display Data on UI - Forecast section left blank
Yes
Retrieve weather data for dates in local database as well as forecast
Add weather info to local database
Local Database
Internet
Push Local Database to SQL Database
Wipe Local Database
SQL Database
Retrieve Data History for Graph
Display Data, Forecast, and History on UI

Links

CHIP

HC-12 Radio

CH340G NANO

Moisture Sensor