Irrigation Monitoring App Design Document

Dec1717

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1 Introduction

1.1 Project Statement

This senior design project is focused on the improvement of crop irrigation monitoring. Existing products on the market are overpriced systems that utilize wired technology that is inconvenient for a farmer to use. Because of this, many farmers are resistant to the idea of computerized monitoring systems; instead, they simply probe the soil with their fingers and guess when the next watering time should be. Our efforts for this project are centered around a development of a low cost, easy to use, wireless monitoring system that guarantees soil moisture accuracy. This way a farmer is equipped with the best knowledge of when to water his or her crops.

1.2 Purpose

The client, Dr. Ajay Nair, a professor in the department of horticulture at ISU, has been working with farmers and researchers for several years. He has noticed a need for farmers to accurately monitor their crops, but many are resistant to it because of the high prices and difficulty using the technology. Our project is intended to alleviate both of these concerns so that farmers will save on irrigation costs. This helps the environment by reducing water consumption as well as reducing the grower's water bill. It also ensures healthier crop, since the crop will be properly hydrated at all times. Healthier crop also allows the grower to receive higher profit margins.

1.3 Goals

The goal for our project is to deliver a fully-functional product that has been demonstrated to work in fields. This task is not accomplished without several smaller goals which include but are not limited to: designing a successful prototype, developing a fully featured application, sustaining battery life to last an entire season, and writing useful documentation on how to use the product. Those are our goals for the product, and we also have several goals for ourselves. By the end of senior design, we hope to have obtained valuable experience in the design process of a marketable product, increased communication skills between group members and the client, and learned new technology that is being used in industry today.

2 Deliverables

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

3 Design

3.1 System Specifications

3.1.1 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%

3.1.2 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

3.1.3 Standards and Constraints

- Team members have limited time, knowledge, and resources
- Implementation of effective device communication while buried
- Implementation must conform to Bluetooth 5 standards

3.2 Proposed System

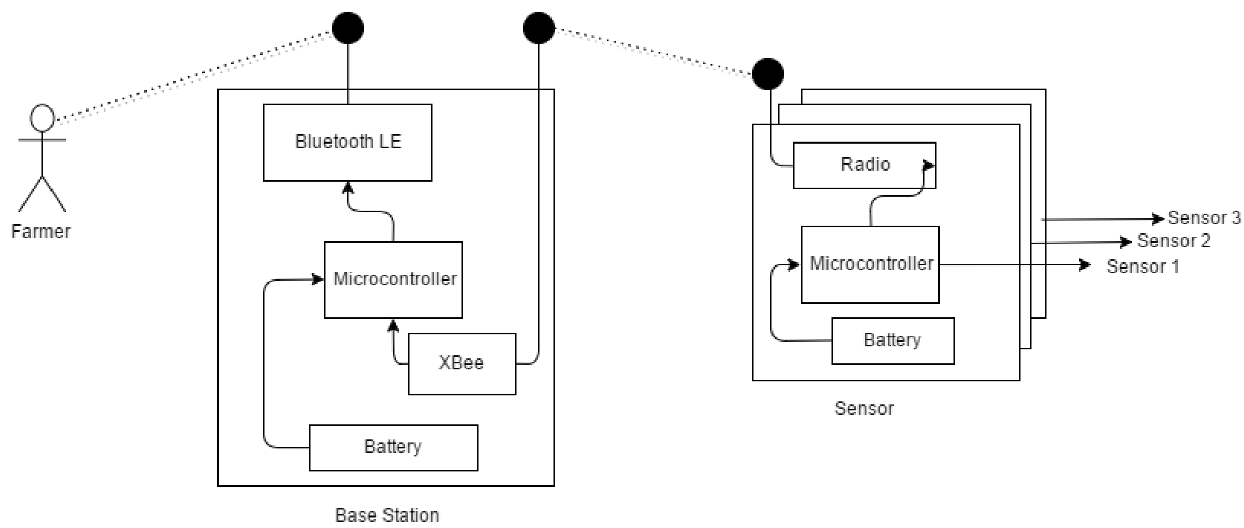


Figure 1: An architectural diagram of our system

As shown above, the design is intended to work so that the soil moisture sensor is buried into the dirt. It will then relay the information with a bluetooth microcontroller above soil. When the farmer visits the field, they will press a button on the Base Station that will signal all of the sensors to relay their data. The microcontrollers will then wirelessly relay their information to the Base Station using 433Mhz radio. The Base Station will then transmit the data to the smartphone application using Bluetooth.

3.3 Design Analysis

So far, we have created a working prototype using a SparkFun soil moisture sensor, BLE transceiver, CH340G NANO microcontroller, and a 2600 mAh battery. This prototype was placed in a greenhouse for testing. This prototype relayed information over WiFi about the soil moisture, however the battery only lasted a single day. Based on these results, we concluded that there would need to be major changes made for this prototype in order for it to last a full growing season in the field.

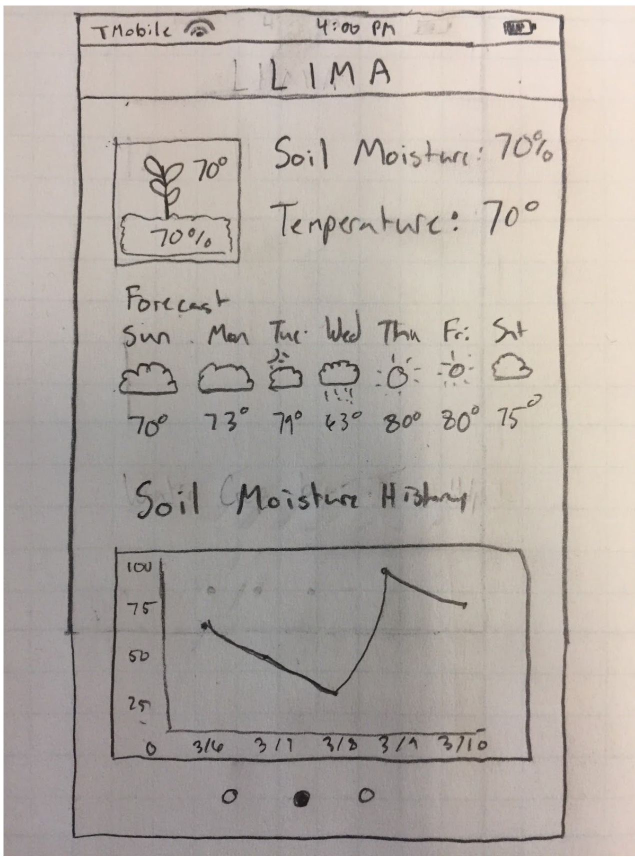
4 Testing/Development

4.1 Interface Specifications

In this design, there are several points where separate devices need to communicate with one another. The base station needs to send and receive messages with a client's mobile device and with other sensors deployed in the client's field. Communication between the client's mobile device and the base station will occur wirelessly via bluetooth. All messages broadcasted between the base station and the client will be structured with serialized JSON. Communication between the deployed sensor nodes and the base station will be driven by 433Mhz wireless serial radios.

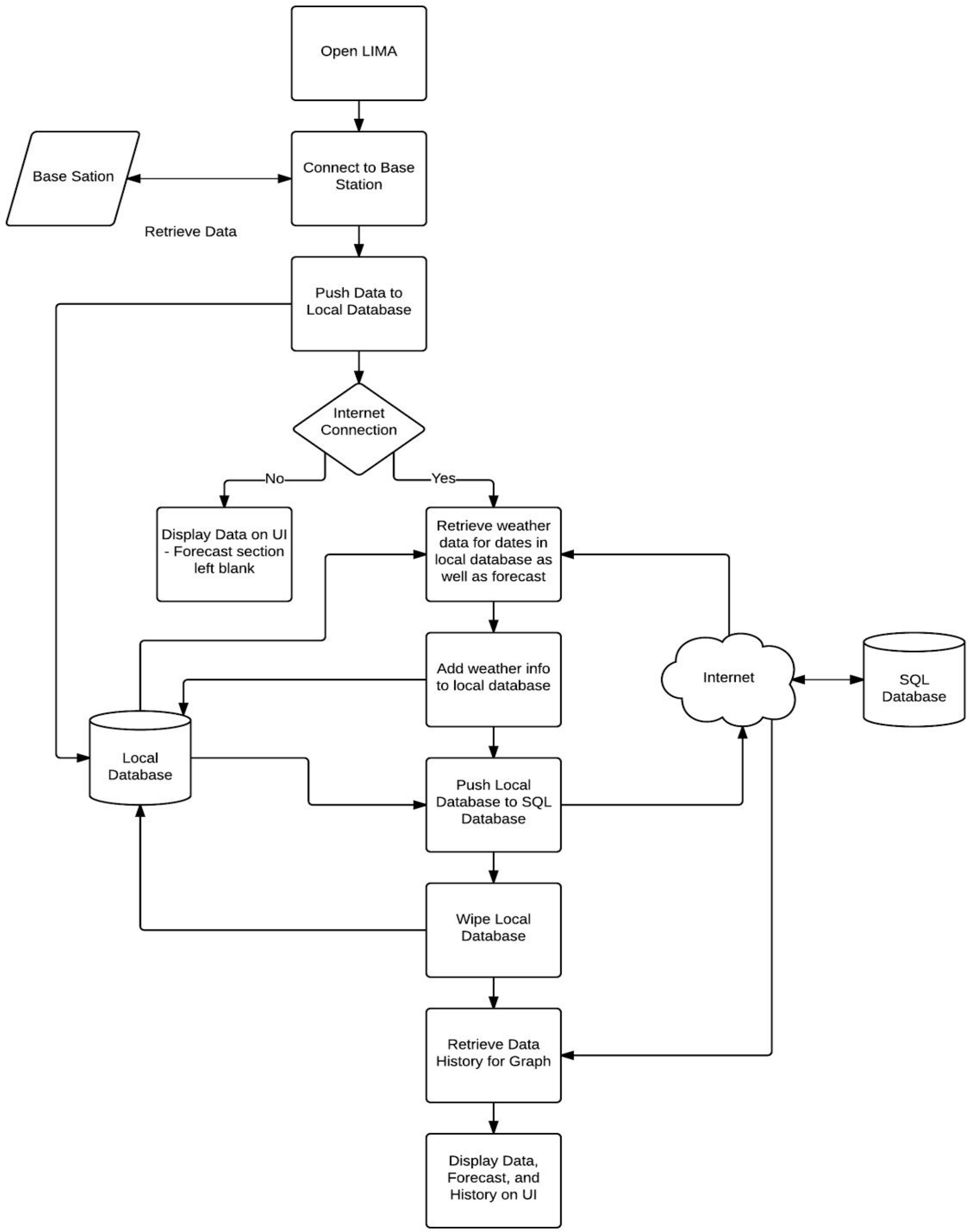
4.2 Hardware/Software

4.2.1 Software UI Mockup



This is a mockup of what the welcome screen will look like after connecting to the base station and internet. This screen will include information such as the soil moisture content, the temperature, and the soil moisture history.

4.2.2 Software UML Diagram



As the diagram illustrates, the software works in conjunction with the soil moisture data from the base station and weather data from the internet to provide a complete overview of crop irrigation. We chose to use both an internet-based database to ensure that data loss would not occur if a farmer would happen to use multiple devices in the field and the local database is to ensure data collection still occurs when the farmer is disconnected from the internet. The forecast and temperature is pulled from the internet as a way to reduce water consumption. On cold or wet weeks the farmer should not need to water the crops as often; temperature is also used by some of the soil moisture sensors when making sense of the data.

4.3 Test Plan

4.3.1 Sensor Test

In order to test each method, we will examine each of them individually. First, we will continue to test our proposed sensor against the current version, and will then analyze the results to come to a decision. If we plan to move forward with the proposed sensor, we will use the analyzed data for sensor calibration. We plan to test use the same microcontroller on both sensor setups to ensure that there are no other factors involved.

4.3.2 Communication Test

When testing the communication, we will examine both the radio connection between the nodes and the base station, as well as the bluetooth communication between the base station and the user’s mobile application. First, to test radio, we will place our base station in an unobstructed field. We will then move the nodes away from the base station, testing when the nodes and base station are no longer in range. Next, we will repeat the same test while obstructing the line of sight between the components.

To test the bluetooth connection, we will perform a similar test, but on a smaller scale. We will set up the base station, then test the bluetooth range using a smartphone when the line of sight is obstructed and unobstructed.

4.3.3 Application Test

When testing the application, we will check all components and features operate as intended, both on an emulator and actual device. We will then test the application in the field to ensure the bluetooth connection and communication with the base station operates as intended.

4.3.4 Integrated System Test

Finally, to test the entire system, we will put all devices out in the field. We will then test the ability of the application to retrieve reliable information at a satisfactory speed. We will again examine signal distance and any issues with obstructions. Finally, we will take a look at the battery life of the system.

5 Results

So far in the testing phase, we have obtained data from our proposed sensor as well as the current sensor version. We placed these two sensors together in a plant, and then compared the data after 16 hours of testing. Below are the results.

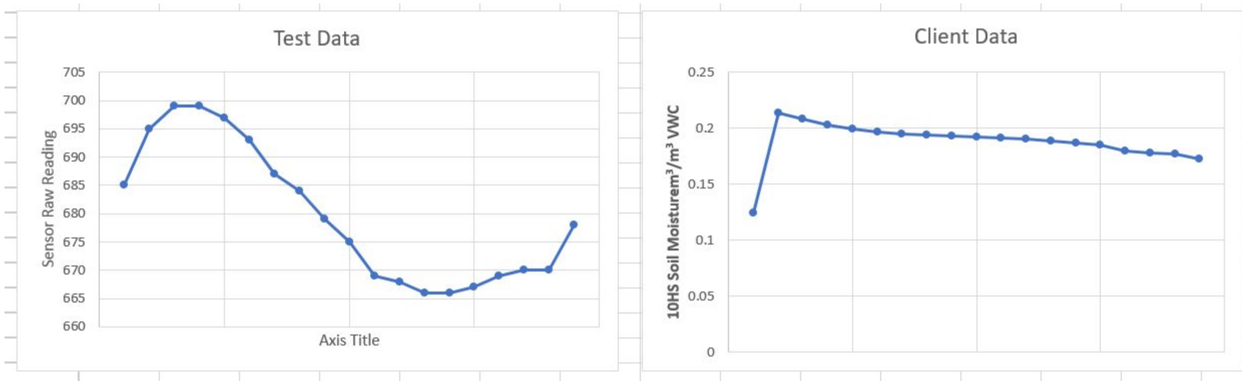


Figure 1: Data from our proposed sensor (Test Data) compared to data from the current sensor version (Client Data)

Based on these results, we would like to do more testing to see if our proposed sensor is accurate enough to move forward with. We will be testing these two sensors together over a longer period of time to determine if our proposed sensor is still a viable option.

6 Conclusion

The goal for our project is to deliver a fully-functional irrigation monitoring application that has been demonstrated to work in fields. In order to accomplish this goal, we will be: designing a successful prototype, developing a fully featured application, sustaining battery life to last an entire season, and writing useful documentation on how to use the product. By using our resources and following our scheduled plan, we will be able to produce a fully functioning irrigation monitoring application by the end of Fall semester.

7 References

7.1 Hardware Links

- CHIP
- HC-12 Radio
- CH340G NANO
- Moisture Sensor

7.2 Guides

- CHIP 433Mhz
- Nano 433Mhz