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Team: Soil Analyzer
ECE 445: Project Proposal

Objective

Throughout the last century, small farms have become far and few between, while corporate farms seem to continue to grow larger and larger. The United States average farm acreage is 444 acres, but there are hundreds of farms that are triple this acerage. With such a large area to manage, there is no possible way for a farmer to know the condition of their entire crop. To put an end to this issue, we plan to space modular devices throughout an entire field that will collect useful data about the soil. All of these modules will send data back to a specified hub that will be accessible to a farmer from the comfort of his own home. By doing this, the farmer will be able to receive useful data from his entire crop versus just testing one acre of 400 acre crop.

Background

Farming is essential to any nation's food supply. Our device will boost farming effectiveness, reduce water waste, and ensure that crops survive during uncertain weather patterns. Not all farms are the same. Farms can be placed in areas where there is an excess or limit to water. In addition, multiple different crops can be placed on farms that require different moisture levels. Our device would ensure that no matter where these farms are located, it would enable the farmer to always have an idea of the soil moisture level. With this information, they can record which moisture level had the largest yield to increase farm effectiveness in the future, as well as avoid over watering to help conserve water.

High-Level Requirements List

1.The system will be able to communicate wirelessly through 4 separate nodes to the main hub.

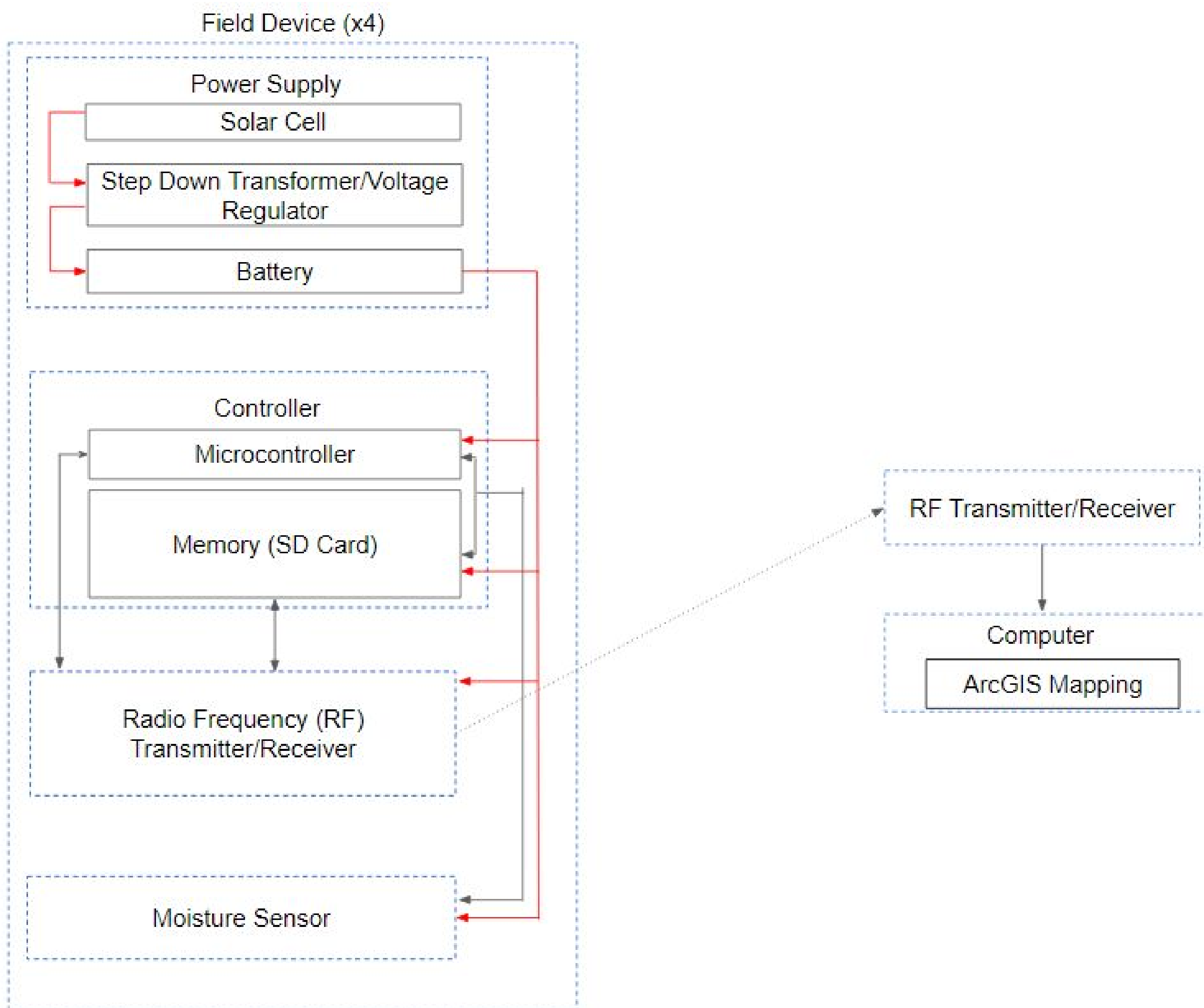
2.Communicate data to other nodes at least 5 ft away, so as to spread data collection across the entire field wirelessly.

3.Each individual node will be solar powered, and maintain power daily.

Block Diagram

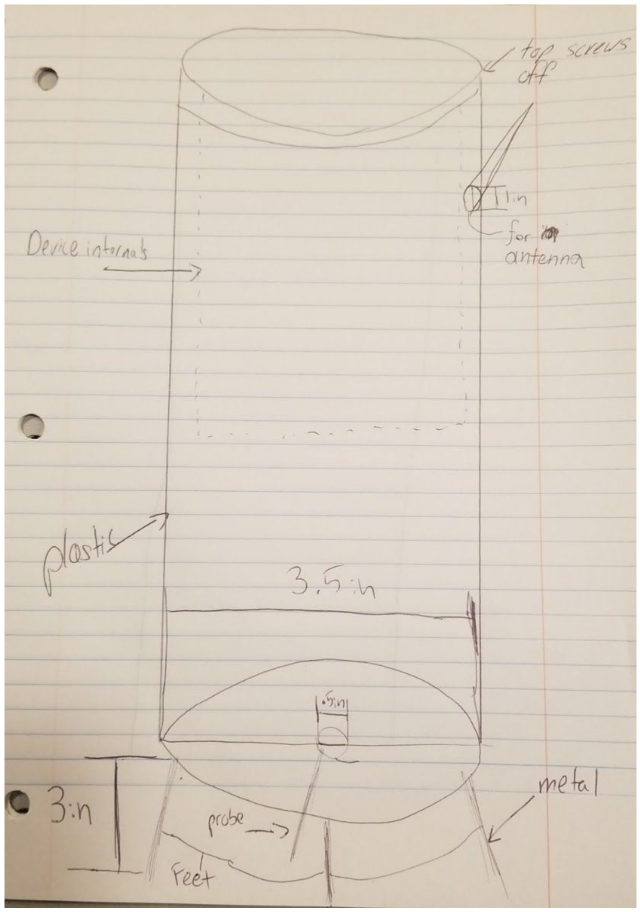
This project will be able to communicate wirelessly between each other and to the hub by using the RF Transmitter/Receiver implemented on each device as well as the central hub. We will have the microcontroller controlling when data is sent, as well as storing the data. The antennas on the RF Transmitter/Receivers should be strong enough to be able to communicate at least 5 ft. away. The power supply setup should allow for constant power, as well as safe charging by using a voltage regulator and step down.

POWER
DATA



Physical Design

We plan to have our device shaped as a cylinder. We will have all the electrical components inside the waterproof container. The device will be stabilised by 3 metal prongs that will be inserted into the soil. In the center of the device, the probe will be inserted into the soil below the 3 metal legs. Near the top, we will have an antenna enabling us to communicate between other devices and the hub. The top of the device will screw off to provide easy access.



Functional Overview

Power Supply: The power supply should provide constant power to the device. A solar panel will collect energy from the sun, pass it through a regulator/step down, so that it can charge the battery safely. The battery should then be able to provide consistent power to the rest of the project.

Requirements: Must be able to supply between 3-5 volts to the entire device.

Solar Cell: The solar cell will capture energy from the sun and then pass it through to the voltage regulator/step down so that the battery can be charged.

Requirements: Needs to provide >500mA and ~5volts to charge the battery.

Step Down Transformer/Voltage Regulator: The voltage regulator/step down should be able to take an inconsistent voltage and current from the solar cell and then smooth out the voltage to 6V for the rest of the circuit.

Requirement: Needs to supply a constant current to our battery if our solar cells current is not steady.

Battery: The battery must be large enough to provide power even when the solar panels are unable to provide a charge to them.

Requirement: Needs to be able to supply 3-5 Volts to our device, and hold enough power to supply this voltage for 10-12 hours.

Controller: This block is responsible for controlling the other parts of this project including the transmitter/receiver, memory, and sensory functions.

Requirements: Has to be able to manage sensor data, RF communications, and data 24/7.

Microcontroller: We are picking between using the STM32 and STM8 chips. We hope to have this chip control the data communication, and memory access of this device. We would also like to have it responsible for accessing the data output of the probe.

Requirement: Needs to have an internal clock, I/O capabilities, and an ability to allocate memory to an SD card.

Memory(SD):The microSD card will store the data after each probe. It will also allow the device to perform the other functions.

Requirement: Needs to be able to hold at least 3GB at one time.

RF Transmitter/Receiver Node:Data will be sent between devices and the hub by using RF signals. It will be used to make an array out of the devices so that the devices can be spread out across a field to maximize data collection.

Requirement: Be able to intercept and transmit ~1GB of data that contain moisture levels and position.

Moisture Sensor:This will collect all the data from the ground. It will be used to probe at certain intervals during the day for weeks.

Requirement: Must be able to provide data asynchronously, whenever it is called from the microcontroller

RF Transmitter/Receiver (Hub):This will receive data from all the devices. It should transfer the data to the computer so that it can be used for later.

Requirement: Be able to intercept and transmit ~1GB of data that contain moisture levels and position.

Computer:Will be able to collect data from the receiver at the hub. The computer will then host ArcGIS to create maps of the data collected.

Requirements: Must be able to communicate with our RF receiver and have the ability to run the ArcGIS software.

ArcGIS Mapping: This program will collect the data the computer receives and then lay the data to form a map of the moisture in the field.

Requirement: Must be able to display crop map, and host data points for each node.

Risk Analysis

We feel that the greatest risk to our project is the wireless communication. We had trouble picking a form of communication that wouldn't be obstructed by the crop around it. In addition to obstruction resistance, it had to also have a far broadcasting range. Needing to broadcast this far immediately ruled out RFID and bluetooth methods. WiFI appeared to be easily obstructed. This left RF methods which have been seen to be able to broadcast for miles. In addition to this we are concerned about the method we will use to transfer data over RF. We think that if anything were to fail, it would be the ability to link the hubs to the hub. If this happens we would still be able to show the probes working by showing the data collected on the SDcards manually. We could also demonstrate the data being charted to a map on ArcGIS.

Ethics and Safety

We plan to create a device enclosure that is created from plastic. We are concerned that the toxic plastic from this device might leech into the environment. To remedy this we will research a type of plastic that may be more environmentally friendly. We could also try to use a recycled composite that is also non toxic. Additionally, we are also concerned about the possibility of electrical shock while handling the device. To remedy this we plan to create a device that is waterproof to prevent water entering or leaving the device. One final concern is fire resistance. We are worried that if a device would happen to short unexpectedly, it would be a great risk to all the combustible crop around it. This could also be fixed by using a plastic that meets the standard of V-0 Flame-Retardant. For our battery we are worried about the hazards that come with including them in our design. After some research, we discovered that lithium ion batteries are safer than lead acid batteries. Not only are they safer, but they are also more environmentally friendly. The reason why they are more environmentally friendly is because if our data nodes break open in a severe weather storm, we will not be leaking lead into the crops of the consumer. This would cause the crops around our device to become unsellable and dangerous for human consumption.

References

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