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Leaf Node Modules

PROJECT PLAN

Contents

1 Introduction

1.1 Project statement

Our project is to make a network of nodes to relay sensor data and relay that data to a webpage for a user to interface with. Each node will collect information on temperature, pressure, soil moisture etc. This information is sent to a "home" node with 3G cellular enabled, and be able to upload data to an off-site web application. The data can then be interpreted by the user. The field hardware will be designed to last up to 8 months on a battery. The modules will be cheap and biodegradable so that there is no need for collection.

A new moisture sensor is also being developed and tested for this project. This sensor is using a confidential material that should have dielectric properties that will give information about soil moisture.if the testing of the new sensor is successful, the new sensor will be integrated with the nodes of the project and will be used to monitor soil moisture.

1.2 purpose

In the immediate future, this project will benefit farmers. The cheap wireless nodes will be able to send data about soil moisture, temperature, and anything else obtainable by a sensor. With this information, the farmer can know which areas of their farm needs to be watered or why crops may be performing better in some areas rather than others. The decision based on the data from the sensors would entirely be made by the farmer. In the future, this project with minimal alteration could be extended to military use. The nodes could be modified to send information about the motion of people or military vehicles. Although the project is based on soil content monitoring, its application can extend to other fields.

1.3 Goals

Our goal is to create network of nodes that can relay sensor data. These sensors will be able to send the data no matter the configuration of the sensors, whether they are in a straight line or clustered together. As a stretch goal, one of these sensors will be a hygroscopic, 3D printed, compostable sensor. These nodes will be wirelessly sending the information and will then be sent up to the cloud through a 3g module. A website will then display this information for the user in an informative and simple interface.

For the leaf node, we will create a PCB that can house the microcontroller, batteries and also allow for a smaller and cheaper module as compared to an Arduino with loose wire connections. This PCB will have inputs for sensors such as temperature, humidity, etc. The PCB will be created so it will be as energy as efficient as possible and will be scalable so they can quickly assemble however many will be necessary for this system to work.

In the design of the "home node", a receiver would be used to receive sensor data from the leaf node. The received data would then be transmitted using a 3G module. Both the Receiver and the 3G module would be controlled by a microcontroller.

The goal for our server, is to model it to be able to receive and display any type of data that is being sent to it. With this type of open ended design, we could potentially extend our project to far more than just soil moisture sensors. As mentioned above, there could potentially be military, or space exploration applications for this project. As long as a sensor exists to collect the data, our node network will be able to compile it, and our server will be able to record and display it.

2 Deliverables

At the conclusion of this project we expect to have at a minimum of three nodes, each with two sensors that can relay information to each other. We will have one 3G module that will receive all of this information and send that data to a web server that can display the data that was received. We also expect to have a completed sensor that will have dielectric properties measured that can then be related to soil moisture. This will allow for a cheap, small, and biodegradable sensor that can be used to measure soil moisture.

3 Design

The 5 Step Problem Solving Approach [5]

1. **Identify problem:** To design and implement a network of nodes to relay sensor data to a simple web user interface. Each node will collect information on temperature, pressure, soil moisture etc. This information is sent to a "home" node which will be 3G enabled, and can upload data to an off-site web application. The data will be easily interpreted by the user. Creating a new soil moisture sensor that has not been developed or tested.
2. **Identify plan:** The project is divided into different parts and assigned the members of our group with different responsibilities. The different components of the project will be tested separately and then merged together at the completion of the project. We will also meet with advisors in the Agricultural department to discuss how best to implement a soil moisture sensor.

3. **What might happen if :** If after merging the project and there are any glaring issues, we will try to resolve it by tracing the issue back to the different project components. Once knowing the source of the problem, we will work as a group to fix the issues with our diverse areas of expertise.
4. **Work the strategy:** We will test the different sensors and nodes to make sure they are communicating with the "home" node. Our group will also make sure the home node is communicating with the web application and that the web application is receiving and displaying the data correctly.
5. **Measure:** We will test the sensors with known values and make sure the web application is receiving the correct values. Once we know this works, we will test the sensors on our Advisor's small farm which resembles the real life application of this system. For the soil sensor, we will work as a group to test the sensor.

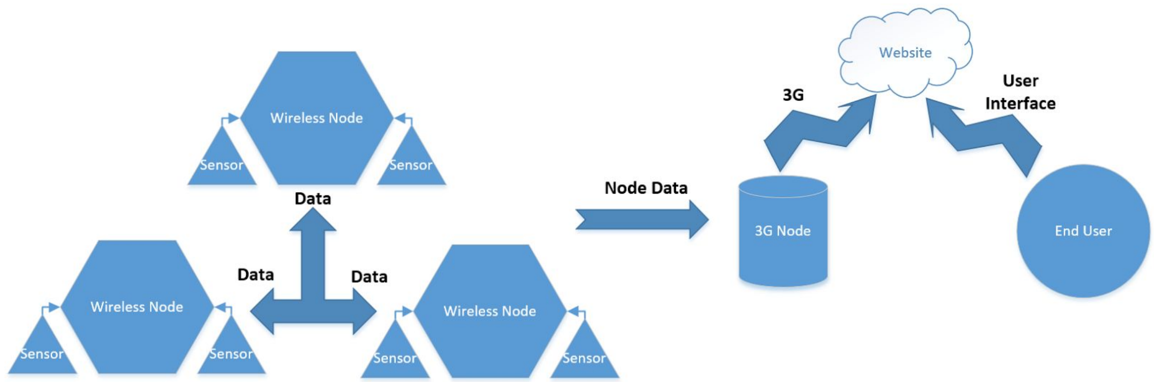
3.1 Previous work/literature

The SureCross MultiHop have a line of product used for wireless sensor monitoring of farm conditions. The specifications of the different products varies. The diagram of the different products are shown below. The specifications of the products can be found on the website in the reference section.

® Banner Engineering Corp. "Wireless I/O & Data Radios | Products for Industrial & Process Automation." Banner Engineering. Banner Engineering, n.d. Web. 21 Feb. 2017.

3.2 Proposed System Block diagram

The system will have three or more leaf nodes, each with two sensors attached. No matter the configuration the nodes will be able to collect all of the information and send it to the 3G node. For example, if one of the leaf nodes is out of range of the 3G node, and thus cannot communicate directly to it, that node will pass its data onto a neighboring leaf node, which would in turn pass the data to the 3G node. The 3G node will upload the data to the website which the user will be able to interface with.



®The Block Diagram above shows the system for the completed project.

[1]

In the appendices there is an example of how to tie all of the nodes together for this project. The example shows how all of the nodes need to be connected together for the system to receive all of the information correctly.

3.3 Assessment of Proposed methods

Option 1: For this option, we would all work on the individual components of the system. That would entail that all the members of the group would be working on the same component of the system at any given time. This would create slowdowns for the project because the team would have to wait for either one person or one part of the project before moving onto the next part.

Option 2: In the second option, our team could divide the system into different components and assign the design and implementation of those components to subgroups. This will allow the team to work faster and more efficiently as the subgroups can work in parallel and get more done. A higher quality project will come of this as each subgroup can focus on their specialty.

Preferred Option: The Sensor Web team decided to follow through with Option 2. This option will ensure that the project is done in an adequate amount of time. It will also ensure that all members of the group can contribute at the same time. This allows for a higher attention to detail of the individual components of the project.

3.4 Validation

Our solution will be tested in a field owned by Sensor Web's advisor. This field is in a rural location and models that of where the device would operate naturally. This real life simulation will be an experiment to see how our solution holds up to environments stresses. These stresses will be accounted for in accelerated life testing of the devices as well as testing power regulation benchmarks.

The soil moisture sensor will also be tested in the field along with the leaf nodes. The testing done in the lab and measurement of the dielectric properties will allow for the sensor to have the highest probability of operating correctly in the field. Once the soil moisture sensors are connected to the leaf nodes, the team will also be able to test their efficiency in the field.

4 Project Requirements/Specifications

4.1 FUNCTIONAL

- The system shall include a parent node with wireless capabilities to receive data and send it to a remote server.
- The system shall include child nodes with short range (200ft-800ft)wireless capabilities to send data to the parent node.
- A soil moisture sensor will be developed and tested to gather soil information. This sensor will be cheaper and smaller than current solutions as well as being biodegradable.
- The system shall include a server to receive data from the parent nodes.
- The system shall include a web interface to display the collected data to the user.
- The system shall provide an informative project-focused website to outline methods and processes used to complete the system.

4.2 NON-FUNCTIONAL

Spreadsheets of data collected from testing 3D print materials will be submitted. CAD drawings of the hydroscopic probe along with annotated drawings will be submitted as well. Both of these non-functional documentation relates to the sensors attached to each leaf node.

4.3 STANDARDS

Our project does not currently possess any practices that would be considered unethical by organizations such as IEEE, ABET or others. Our goal is to help society and more specifically farmers by increasing their crop yield with the information that they receive from the sensors. Standards can be beneficial so other students could pick up and continue our project. It also allows for the students currently working on the project to understand industry standards defined by IEEE and ABET.

- The System shall follow the standard REST protocols (POST and GET) in the web application.
- The System shall follow javadoc in the implementation of the microcontroller for the 3G node.
- The System will follow I2C protocols for some of the hardware operations.

5 Challenges

The first challenge to the system is power management. Our hardware is required to run for up to 8 months. The next concern regards the accuracy in the hydroscopic sensors. We are putting a significant amount of time into researching the new material that is not on the market and seeing how it would work as a sensor. Seeing as these sensors have not been developed, our group will be creating the sensors and testing protocols to test these sensors and see if they can operate as a sensor. Another challenge is synchronizing the data call between the home node and the sensor nodes. In order for the leaf nodes to receive information, they must be turned on and will be consuming power. This quickly becomes a power issue when a few hundred sensors have a limited power bank but must be turned on in order to be sending and receiving data. The Sensor Web team will be working together to see if there are sleep options or other solutions to allow for energy savings while the nodes are turned on. In order to keep the cost to minimum, we try to implement only one 3G node (parent) to retrieve the data from the sensors (child). This will be explored more when the hardware is constructed.

6 Timeline

6.1 First Semester

Spring 2017

Have web app with API, visuals, and login for nodes to send data to, and users to view that data.	Begin testing materials and methods for prototype sensors.	Utilize radio signals to output data from the child nodes and receive data on the home node.	Have a completed prototype of both a child node and a home node that can communicate to some degree.

January **February** **March** **April**

6.2 Second Semester

Fall 2017

Have user login and registration completed. Begin designing PCB for leaf nodes. [2]	Have a completed algorithm that maps nodes to a graph. Order PCB for leaf nodes.	Have complete user interface with data display, and user management. Put together and test PCB for leaf node.	Have child and parent node communication and user interface completed. Have functioning prototypes, and execute field tests.

September **October** **November** **December**

7 Conclusions

In this system, the team wishes to construct a network of nodes to relay sensor data. A soil moisture sensor will be developed and tested for the leaf nodes. Each node will collect data from sensors that will be sent to a "home" node to be upload to an off-site web application. After which the data is able to be interpreted by the user. Our team has the goal of designing the hardware to last up to 8 months on a battery. After that time the modules will biodegrade so that there is no need for collection.

8 References

[1] Miner, Andrew. "Networks 2." Lecture.

[2] Tuttle, Gary, Barebones Arduino.Print

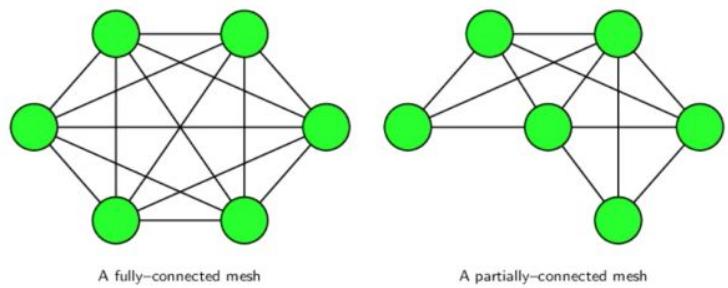
[3] TempuTech, "Wireless Sensor Monitoring," TempuTech, [Online]. Available: http://www.temputech.com/26-home/slider/113-wireless-sensor-monitoring. [Accessed 21 02 2017].

[4] Banner Engineering Corp. "Wireless I/O & Data Radios | Products for Industrial & Process Automation." Banner Engineering. Banner Engineering, n.d. Web. 21 Feb. 2017.

[5] The 5 Step Problem Solving Approach, "eba," eba, 2016. [Online]. Available: http://www.educational-business-articles.com/5-step-problem-solving/. [Accessed 21 02 2017].

9 Appendices

- Mesh network



  - central nodes are connected to one or more other nodes
  - data must be "routed" to its destination
  - often used for wireless networks

[1]