Garden Automated Rain/Daylight Executed by Near-Infrared Sensing

Nicholas Chitty, Brendan College, Scott Pierce, Justin Pham-Trinh

University of Central Florida, Dept. of Electrical and Computer Engineering, Orlando, Florida, 32816-2450

***Abstract*—This paper will show the application of near infrared spectroscopy and how it can measure electromagnetic waves from the emission of soil. Near infrared spectroscopy is an absorption spectroscopy method that can help determine the chemical composition of a substance through the radiation the substance gives off. Soil itself is a mixture of organic and inorganic substances that all together directly contribute to a garden's environment. We are starting with soil with unknown qualities, so comparisons will be made between our soil and soil of known qualities to match and ensure that our plant is in a healthy and suitable environment.**

I. Introduction

IN the past year, we have seen a great increase in remote sensing, wireless communication, API integration, and so much more. All of which have been made more available and economical. The internet has also seen its share of "DIY" projects and its continuing growth.

In the agriculture industry, there have been new advancements in technology with high performance water distribution, network communication, and remote sensing. This research is intended to advance the field by producing a system that can maintain a suitable environment for a plant to grow. In the environment, there will be sensors that will help modify the conditions within the environment. In addition to this system, it will feature a web interface for notifications and the ability for the user to set settings.

Monitoring soil isn't always the most fun or the easiest task, because things could get dirty or we might forget about our plant. This project will feature an on-the-rise technology in the form of a spectrophotometer. Smart systems nowadays are big learning machines that are constantly aware of its surroundings. For a smart agricultural system, it would need to determine variables such as moisture levels, nutrient content, pH levels, and so much more. This paper will introduce near infrared spectroscopy as another method to soil sensing that may prove to be more beneficial over traditional products or techniques.

This project will also present other fields such as system controls, power, and web, all to provide a "set it and forget it" home gardening experience. A home gardening experience where the garden bed can communicate with the user and the user can provide instruction of what to do, but also at the core, this is a microcontroller project that anybody can do with just slight knowledge and understanding of digital communications. Like any smart device too, the internet plays an important role in making this as hands-off as it can be. There are many different communication protocols such as Bluetooth, Zigbee, Thread, and even short-range/long-range protocol. For this project we decided to go with WiFi because of its decreased bandwidth and that we aren't expecting to produce or receive large amounts of data.

An important aspect to a lot of devices as well is data storage and web usage. This is important so that we can look back on previous information and make observations and conclusions. With our microcontroller, the web system is going to communicate with it through transmission control protocol. Transmission control protocol is a standard on how to establish and maintain a network connection to exchange data. The web system will also have 16gb database to store data and have the ability to support multiple garden beds in a scaled solution. As mentioned before, the web system will have a feature to allow the user to set settings but also read the data that is stored. Lastly, an important factor to any garden is the weather and knowing when it might be cold, hot, or even rain outside. As a part of our web system, it will communicate using HTTP requests with a weather service to receive updates on the weather.

Solar power has been a growing source of energy for the past years and still continues to be with new developments and breakthroughs with solar technology. A lot of systems nowadays are solar powered but these products are not constantly in use, they have to turn of eventually. When the product is off the solar panel can still collect energy which is stored in a battery for conservation. In this paper, we will demonstrate our system running independently, battery powered but charged through solar panels.

In all, this paper will present how near infrared spectroscopy can be used to monitor a plant's environment and notify users with information of its health. Generating and guiding electromagnetic waves into a housing, scanning the substance, and then converting this optical power into a voltage that can be read and analyzed. It is then the microcontroller will communicate with the web system, storing the information and deciding on if anything needs to be done and notifying the user.

A. Goals

The following are the goals the team set for themselves with this project. Starting with non- negotiable goals:

1) A spectrometer that operates in the 400nm to 1700nm band with a spectral resolution less than 50nm and signal-to-noise ratio greater than 2.
2) The ability to automatically feed water into the garden bed.
3) Serve data to the user.

Moving on, the team had goals they hoped to accomplish:

1) Power the garden bed completely from solar and battery power.
2) Serve data to the user via a website.

II. High-Level Design

Based on the goals listed in subsection I-A this section will discuss the high-level thought process the team undertook in achieving those goals.

A. Spectrometer

In most instances, spectrometers are designed using charged couple devices in an array which some component such as a prism or diffraction grating will shine upon breaking the source into its components. This approach would be prohibitively expensive for such a consumer-oriented garden bed. The solution was to use either a photodiode or photoresistor to measure the magnitude of the of optical power in a given area. This sensor could be moved in order to give the effect of shining the source on an array with the only major downside being the duration needed to scan.

III. Major Components

The components found in this section make up the logical boundaries between systems and their subsystems.

IV. Hardare Detail

In section III, a high level overview of components and features were given. This section will discuss the implementation details of the chosen components.

V. Software Detail

The microntroller serves as the glue holding this design together. In this section the means of integrating the various subsystems via software will be discussed.