Creating an automatic greenhouse control system

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Introduction

Farming and other horticulture based businesses rely heavily on greenhouses to start growing seedlings and other sensitive plants in a controlled environment. While large operations were able to use automated systems to control their greenhouses, small businesses and farmers were often not able to afford them (Jones, 2010). This project focused primarily on designing an efficient and inexpensive control unit capable of monitoring and responding to conditions found in the greenhouse. The system was created around the Arduino microcontroller which acted as the central control unit for the system. The system received data from three different types of sensors: a temperature sensor, a humidity sensor, and a soil moisture sensor. The control unit was intended to operate features such as vents and irrigation based on the sensor inputs which it received. It was also able to send any data collected from the Arduino’s sensors to an attached computer. A graphical user interface (GUI) was also designed to allow the user to access any data collected.

Materials and Methods

Initial research was conducted on current greenhouse control systems and the features that a standard greenhouse comes equipped with. The basic layout of the system was drawn out, showing how major components would be positioned. Individual components such as temperature and moisture sensors, set up in figure 1, were tested to gain a better understanding of their function. The Grove Moisture Sensor was calibrated in order to convert the voltage received by each prong of the sensor into a soil moisture percentage. The moisture sensor was tested by incrementally adding water to a know amount of soil until the soil was saturated. The collected data was graphed and a line of best fit was acquired using linear regression analysis. Code was written to allow the Arduino Microcontroller and the sensors to communicate information accurately. The Xbee® Radios were connected to an Arduino and a computer to test the link between the two. A MAX232 serial converter chip was used to convert the TTL serial protocol from the Arduino to the standard RS-232 protocol used by the computer. Once a connection was established, code written, that enabled the transmission of words and short phrases between all the components, relaying information.

Results

The anticipated outcome of this project was an inexpensive and accurate automated greenhouse control system. Although this initial goal was not completed, it has the potential to be completed given more time. It was also found that the system was much cheaper than commercially available ones because of the low control unit price.

One of the first problems encountered was with the RHT03 temperature and humidity sensor. The sensor used a Maxim one-wire protocol to transmit data to the Arduino. After an initiation from the Arduino, the RHT03 would send a 40 bit transmission in response seen in Graph 1. However, the Arduino would receive only half of the transmitted bits. This problem was with the clock speed of the Arduino. The internal clock did not oscillate quickly enough to receive every bit sent from RHT03. To fix this problem, more efficient code was found that could be processed in the time between each bit of transmission.

Unlike the RHT03 which used a digital signal, the Grove soil moisture sensor used a simple analog reading to give a soil moisture percentage. The Grove Moisture Sensor measures the resistance in the soil to determine the percentage of water. This is a relatively accurate measurement process, but can be interfered with by electrolytes present in the soil, which decreases resistance. A conversion equation had to be made to convert the analog reading into a usable number. From this, a linear regression analysis was performed on the points to find an equation of best fit (Graph 2). Using the conversion equation, the Arduino was able to output the relative soil moisture content. This process will have to be repeated each time the sensor is placed in a new soil type.

In the future this system can be modified to include more sensors and additional features. Additional features include a database and a response system that opens and closes physical features such as vents and watering systems.

Conclusions & Discussion


References