Automated Temperate-Sensitive Plant Watering System (AT-PWS)

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Introduction

The AT-PWS is an extension of the plant watering system that incorporates temperature sensors, simultaneously with the moisture sensors, to make decisions based on the environment temperature. The system measures the temperature of the plant and turns on an LED if temperatures are too cool. In the event where the environment temperature is possibly fatal for the plant, an alarm is produced to warn that human intervention will be required.

Context

The moisture level of the plant should not be the only consideration when considering the care of the plant; the temperature of the environment as well is important. According to University of Minnesota Extension, the specific plant used for the AT-PWS prefers conditions that are within 65 to 70 degrees fahrenheit, and that temperatures below 50 degrees Fahrenheit (10 degrees Celsius) can be fatal (Weisenhorn, 2020.). Especially considering that Canada is known for its cold weather, vegetation is difficult to grow without heating systems.

Technical Requirements/Specifications

- Device Sensing
    - Can detect the moisture of soil AND convert data to a scale of 0 to 100, where 0 is dry and 100 is moist
    - Can detect the temperature of the environment AND convert data to fahrenheit (the formula to convert from celsius to fahrenheit is to multiply by 9/5, and then add 32)

- Device Output
    - Can turn activate water pump and shut it off
    - Can turn on speaker for a set amount of seconds
    - Can turn on and off LED light

- Code Execution
    - If soil is dry (or sensor detects dryness), then initiate the pump
    - Continually graph moisture and temperature versus time
    - If temperature is less than threshold for “dangerous cold environment”, turn on LED light and sound the Piezo speaker
        - If temperature is colder than ideal, but not fatal, then only turn on the LED light; don’t sound the Piezo speaker
        - If temperature is within the “ideal” range or is warmer than ideal, but not to “dangerous hot environment”, then leave the light off
        - If temperature is past the “dangerous hot environment” threshold, then sound the Piezo speaker

Components List

Component	**Description**
Grove Arduino Board	Microcontroller to interface peripherals with computer running MATLAB
Piezo Speaker	Used as emergency sound maker to call out for human intervention
DHT20 Temperature and Humidity Sensor	I2C device that gives the temperature it senses in degrees celsius. Humidity Sensor is not used.
DC Water Pump	Required to transfer water from a container to the plant soil
Battery	Used to increase voltage so that a water pump

	can actually be run (since a water pump will not run directly from just the microcontroller).
MOSFET	Used to connect batter with pump, whilst still maintaining switch controls to activate/deactivate the pump
LED Light	Is put next to the plant to induce some heating. In an industrial scaled-up version of the AT-PWS, this would be replaced with a more effective and reliable heating system.

Procedure

1. In the context of the Arduino microcontroller's pins, connect:
    a. The moisture sensor to A0
    b. The temperature sensor to an IC2 compatible port
    c. MOSFET to the water pump and a battery, and the MOSFET itself plugged into D2
    d. Piezo speaker to D3 (for some reason, it must be connected to D3 according to MATLAB)
    e. LED to D4

2. Program a wrapper class that allows easy to basic functions necessary in the plant watering system and holds data per object instantiated. For instance, a function to activate the pump and initiate cool down, and a function that draws a graph.

3. Create a main script to instantiate one plant watering system and create an infinite loop that does the following
    a. Update both temperature and moisture graphs
    b. Check if moisture is below threshold and, if so, activate the pump
    c. Check the temperature, turn on light or/and speaker depending on temperature requirements of the plant.

4. (Optionally) Create a function that displays formatted text in the console based on what type of message it is. For instance, one for general information, and another for errors. This helps with debugging.

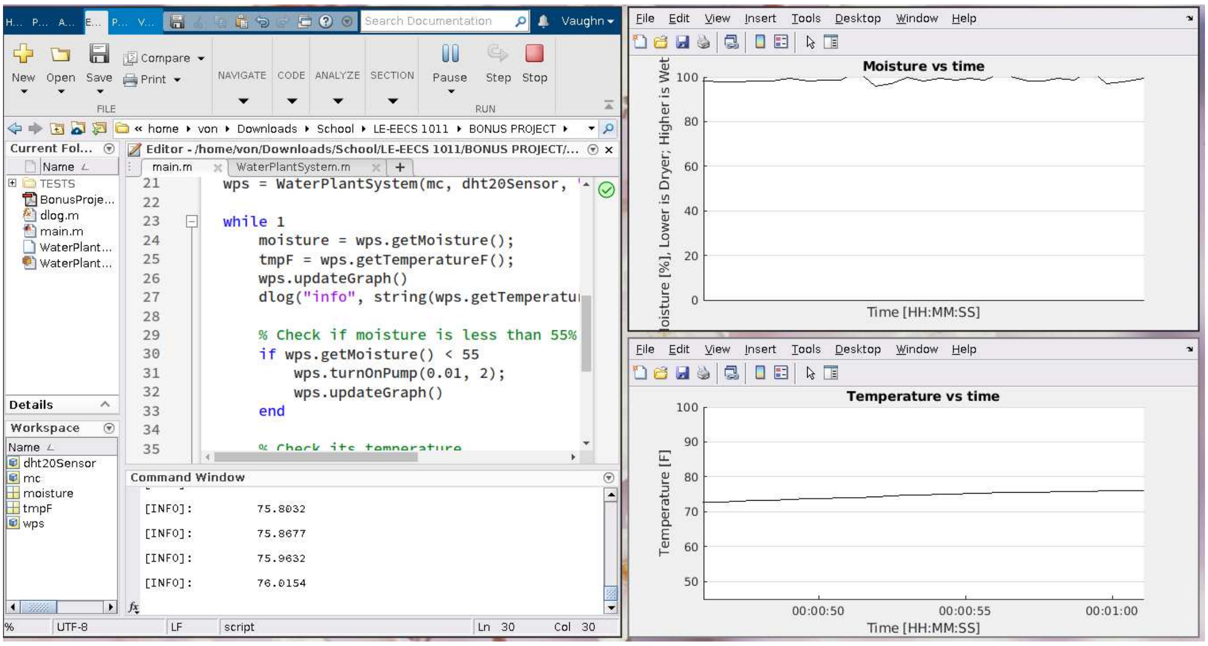
Test

Here are some tests that I have done in order to test if AT-PWS works:

- To test if the moisture sensor data was actually getting moisture data, I put the sensor in a jar of water. AT-PWS detected that moisture was near 100%. Then, I took the sensor of the water, where the system took notice and recorded that moisture had dropped to near 0-10%.
  - This was also used to test if the system would pump water when the sensor is detecting dryness. The system ended up reporting in the command prompt that moisture was below 55%, in which the water pump (which was pumping water from the jar it was in to itself) started flowing

- I had to use trial and error to test what the best angle and how long to run the pump for. The issues caused by not including these factors either caused water to not come completely through the pipe, or the water completely covering my desk. Even when the pump was off, there was still a potential for water to flow through due to capillary action.

- For the temperature, I tested out how the sensor would react first when I put an ice pack on it (I have done this in the video) and when I put my finger on it. In the below image, there is a temperature vs time graph that has a line that is steadily increasing. This is caused by the heat of my finger being on the graph. **[DISCLAIMER:** I recorded the video before adding this second graph, hence why the graph is not shown in my video. The submitted code, however, does contain the code required to make both moisture and temperature graphs**]**



Reflection

The LED utilised does not actually produce much heat such that it would make a difference in the temperature of the environment. Unfortunately, due to time constraints, there was not enough time to come up with an alternative solution, and hence a compromise was created. If more time were permitted, I would consider using resistors as a heating element or find some sort of device that had the potential to warm up the plant.

Additional Material/Conclusion

This project serves to provoke the idea of agriculture in the future, and how technology can be utilised to make machines that can maintain plants at optimal environments year round. Temperature is an especially important consideration owing to the temperatures that Canada inhibits.

With anything automated, there exists public concern for whether or not these machines will take the jobs of farmers, especially those who have specialised far too great into farming. With the AT-PWS, the simple, yet effective, solution to this problem is through implementing a device that requires human intervention. That is, the Pizeo speaker, which alerts operators that the temperature is too extreme. In fact, the AT-PWS could be extended to detect if there is too much moisture, or if the air quality is inhabitable for plants to live in. The fact that human intervention is required means that, although farmers may have to retire their previous life of conventional farming, they will still need to moderate the machines so as to properly do its job.

AT-PWS is not meant to take away jobs, but rather to serve as a tool that will help farmers do their job more easily and quicker. Although my project can be considered a prototype, it is proof that the concept works.

Works Cited

Eric Prandovsky (2023). DHT20 Temperature and Humidity (https://www.mathworks.com/matlabcentral/fileexchange/121792-dht20-temperature-and-humidity), MATLAB Central File Exchange. Retrieved December 5, 2023.

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