Connected Thermometer

A WiFi connected waterproof temperature gauge and database for hydroponic growing systems.

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Abstract

Almost two years ago when I retired from the Marine Corps I decided I wanted a different lifestyle and chose to become a farmer. After receiving a good portion of usable land I started a quest. This quest was taken away due to unforeseen issues. This made me rethink what I wanted to do. Falling into local sustainable hydroponic growing has changed the way I view things. Due to the vast complexities of hydroponic growing a way to monitor the health of the growing media was needed. Out of this need came a solution. A scalable database collecting thermometer that transmits over WiFi. This thermometer has basic needs that are better created than buying an already assembled item that wouldn't do what was needed in the first place. For example, being waterproof and transmit data as well as be duplicated in the future then connected seamlessly.

Keywords
Database, Thermometer, Waterproof, Arduino, WiFi, Uno, Hydroponic, Sustainability, Programming, Computer.

Background Information and Prior Art

Computer Science is a field that can incorporate a vast array of technology based systems and bring them together in a wonderful mesh of human accomplishment. Technology can be anything from microprocessors to hand axes used for chopping down trees. Originally in days gone past my degree path was to become a game programmer. Changing degrees for a more open field to allow a variety of work experiences I have come across an impasse that has directly affected this project. My original Student Innovative Project was to create a game. As this is not in my interest, nor in my current degree path an improvisation needed to be made. This brings about my need for something new and innovative for my current situation. Upon my travels a need has arisen for controlling the environment around me in a monitored state, specifically in hydroponic growth systems. Looking forth to the already growing field, I was amazed that the amount of systems one could buy for monitoring growth media in hydroponics were either too little or way too elaborate for the needs of the small home based systems. This is where the current innovation excels. The ability to easily scale is the added bonus which will be provided with the use of a microprocessor named Arduino.

Project Description and Innovation Claim

Hydroponic growing is simply growing crops in a water based media instead of utilizing the conventional way of soil growing. The benefits of hydroponic growing in my eyes far outweigh the cons of the system. For example, water efficiency these systems utilize a significantly less amount of water than conventional growing with the addition of faster growth, no pesticide use and a the enjoyment of complete control of the system. With complete control, monitoring is key to understanding the health or specific issues in water based systems. The simple breakdown of the innovative system is a waterproof temperature sensor connected to an Arduino Uno microprocessor that will be submersed into the growing system. The microprocessor will be programmed to send temperature readings every hour over the current home based WiFi system to a database that can be recalled at anytime to see the water temperature over the span of the plant's lifecycle. Living in Phoenix, Arizona, one of the unlimited factors that we currently possess is heat from the sun. While this is great for a number of reasons, a small confined system has the potential to overheat is not good for living things thus the need for a constant temperature monitoring system. Current home based temperature systems are self contained systems that do not have the ability to transmit to the internet. More elaborate commercial based systems do this, but cost far more than the weekend gardener is willing to spend. Growtronix is a monitoring system that is set up for more of a commercial based farmer. This system has the ability to monitor nearly every aspect of the plant's life cycle, but at the additional cost. A basic entry model to this system costs $500. Using the Arduino processor, a small simple system can be easily affordable with the added bonus of expansion to something larger in the future if a second system or tenth comes into play. The current cost of my system is $30. Each additional unit will cost the same utilizing the same parts.

Usage Scenario

A typical family that would like to dive into the wonderful world of vegetable gardening, but doesn’t have too large of a backyard (or even none at all) could benefit from the efficiency of hydroponic growing. Once the initial research is completed for how to build one’s very own system and what he or she wants to grow in it, one will come across the issue of water temperature. Trying to resolve the issue, many ways can be attained, but how does one know if the system is too hot or too cold? This home based monitoring system is perfect for this ideal scenario. Knowing the ailments of one’s system will ensure a successful bounty all year round.

The system works by inserting a waterproof temperature probe into the growing system. The probe is connected to an Arduino microprocessor that transmits over the user’s current WiFi infrastructure through the use of an ESP8266 HUZZAH development board. This will enable the user to monitor the water temperature and adjust the current system accordingly. The innovation claim is that this system is for the home based gardener that wishes to keep small or possibly expand to something larger and become a small local farmer in the current area. Due to its size, and portability, the system can literally go anywhere without the additional cost.

Evaluation Criteria

Measurable, time based and attainable will eventually be initial goal of evaluation criteria. Due to the fact that the major was changed from game programming to advancing computer science, the original evaluation criteria is not applicable. This project will utilize some of the cornerstones of advancing computer science like database building, programming and hardware congruency to establish a self working system for a primary purpose.

Project Logic Model

Goal – To establish a self working system utilized in hydroponic growing systems to provide answers for temperature scenarios.

1. **Objective** – Design a simple dutch bucket hydroponic system to be utilized with the innovative temperature gathering system.
    a. **Activities** – Physical stage of creating buckets to allow water flow from a reservoir to four buckets and back to the reservoir to complete the cycle flow.

2. **Objective** – Design a prototype of the temperature system using the Arduino microprocessor.
    a. Activity - Using the Uno board and a waterproof temperature probe, attach the wires to the correct pinout location to be programmed.
    b. Activity- Programming phase; using the Arduino IDE correctly program the Arduino processor so that it may function properly displaying the temperature.
    c. Activity- Attach and program Arduino shield to allow for WiFi Connectivity.

3. **Objective** – Design a database in MySQL that will accept Arduino Microprocessor (not completed yet)
    a. Activity- Design database that will allow the temperature controller to communication between board and computer.
    b. Test PHPmyAdmin database for proper connectivity.

4. **Objective** – Test and run system over home based WiFi
    a. Activity- Arguably the hardest part, ensure all components run smoothly with efficiency.

Prototype Implementation

I have utilized a breadboard for quick and easy prototype implementation. Once everything is connected properly and the system runs without a hitch, the layout diagram will be easily transferable to a more permanent solution for longer future use. For the means of prototype implementation an Arduino Uno will be utilized connected to an ESP8266 HUZZAH board from Adafruit. Connected to the ESP8266 is a DS18B20 waterproof sensor. The ESP board is programmed as a wireless web server. When the Hydroponic system runs its scheduled watering times, the Arduino activates the ESP8266 WiFi web server to output a ip address. This ip address can then be typed into any internet enabled device to read the temperature. The current system runs through an API to log the data. Once the entire system is finalized an app in the form of a widget will be added to my current website so that anyone viewing the website will be able to know what temperature the hydroponic system is running at.

Evaluation

This project will utilize some of the cornerstones of advancing computer science like database building, programming and hardware congruency to establish a self working system for a primary purpose. I will evaluate myself in terms of connectivity and application implementation. Being the fact that hardware is being used for this project, seamless implementation will be on my top priority as well as the ability to expand for future use. The completed prototype will be evaluated on formative assessment, summative assessment and process assessment.

A formative assessment implies that the results will be used in the formation and revision process of an education effort.[H] This entire process has been a lesson in education and time management. The original prototype was changed out at the last minute due to not having the ability to transmit results over the internet. A new development board was needed at this moment. Once the new development board was added, the original UNO was not needed in such a capacity, that the board will be utilized as a future project, or an addon project to the current project.

A summative assessment is used for the purpose of documenting outcomes and judging value.[H] The value of knowledge is priceless. Having the knowledge of what temperatures the growing media is currently at, will allow the for the additional ability to cool or heat. This will give the ability to grow plants outside of the normal growing season making the harvest more abundant. Once an entire season is documented, additional features can then be implemented.

Process assessment begins with the identification of project milestones to be reached.[H] Just as in the agile process, sprints dictate specific outcomes of the project. The original sprint was accomplished ahead of it’s timeline. A hardware failure ultimately delayed this milestone to be reached. Having reached the ability to connect to the web server and display a temperature allowed the evaluation of the assessment.

Project Completion Assessment

Managing Blue – *what is the subject? What are we thinking about? What is the goal? Can look at the big picture.*

Currently the build is finalized. Programming of the ESP8266 HUZZAH WiFi Web Server is completed with accurate connection to the internet. Anyone with the code and the correct equipment can program through the Arduino IDE to get the desired result. Schematic and wiring diagrams are built as well.

Information White – *considering purely what information is available, what are the facts?*

The connected thermometer is built utilizing an ESP8266 HUZZAH breakout board that transmits on a 2.4GHz range over a 802.11b/g/n network. It is currently powered by an Arduino UNO. Project completion will connect power through 3.3V connector via Arduino UNO board to utilize the power distribution to plug into a wall socket. The main goal of this is to allow the board to be controlled by the current timer set up. The connected thermometer will only run when the entire system is running it's scheduled watering cycle to conserve energy requirements.

Emotions Red – *intuitive or instinctive gut reactions or statements of emotional feeling (but not any justification*)

I have changed the the project at last minute because I realized that the original SIP was not innovative enough and even not what I want to do anymore. This project will help in my home based business as well once up and running, so I have a vested interest on accomplishing it! The only downfall to this project is that I do not have the soldering skills I thought I possessed. The solder connection on the grounding for the waterproof sensor broke resulting in a short, which ultimately broke the sensor. I am currently in the waiting phase of the post office to get a new one which I will plug back into the socket to continue running.

Discernment Black – logic applied to identifying reasons to be cautious and conservative. Practical, realistic.

Realistically thinking the idea has been accomplished before by others however, it is not something that you can just pick up from a store, or even follow along a tutorial to build one. All aspects of this build are usually kept secret from the masses due to people making a living off of the current idea or implementations to it. Total build cost excluding development tools is $30. This is a more practical solution to the $500 dollar solutions currently active on the internet.

Optimistic response Yellow – *logic applied to identifying benefits, seeking harmony. Sees the brighter, sunny side of situations.*

Now that the prototype is finished and works as expected, the process will now move to a more permanent solution of soldering all loose wires together and gone through a sealing process.

Creativity Green – *statements of provocation and investigation, seeing where a thought goes. Thinks creatively, outside the box*

The expansion ideas are endless for a fully well built system. From this point I will create an app to connect the database, to my phone so that no matter where I go I could look at the system health. Utilizing the Arduino will also aid expansion later on after this course for other implementations like humidity gauges. All in all the project was innovative and fun to accomplish!

Appendices

Appendix A: Breadboard
Appendix B: Arduino Board
Appendix C: Sensor
Appendix D: Shield
Appendix E: ESP8266 Breakout
Appendix F: Arduino Learning
Appendix G: Arduino IDE
Appendix H: Teaching + Learning Lab
Appendix I: Wiring Diagram
Appendix J: Wiring Schematic