EcoTower- A Smarter, Taller, Tower of plants

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Hydroponics is the science of giving a plant the necessities for growth and longevity. Farmers who go into this field controls the nutrition, supply of water and sunlight, in the amount that it needs. This will ensure that the plant will be grown as healthy as genetically possible. Hydroponics plants are grow in an inert growing medium which we used rockwool dirt. Rockwool Dirt consist of basalt rock and chalk for its nonabsorbent properties which allows water to flow through and hold nutrients for the plants. Carefully monitored pH adjusted nutrient solution is used to nourish the roots in a highly soluble form. Allowing the plants in hydrofarms to take its food without the roots putting into much effort to search out the nutrients and extract them in regular soils. That way more energy can be used for growth and vegetation.

Software Application was used for a wireless communications from the EcoTower to a mobile device. This allowed us to control the functions of the tower from a distance. The idea was to use wifi made possible with the wifi shield kit for arduino, but opted to use the bluetooth addition instead. The technology we used to do the bluetooth is adafruit bluetooth le, alongside its complimentary app bluefruit. This connection assigned all functions to buttons and displays, so that we can both monitor and control the tower.

Renewable Energy that the EcoTower used is solar. By utilizing the sun through solar panels, the tower was able to get sunlight during the day while charging it’s battery. During the night the battery would power the Ultra-Violet lamp for night operations. This way the EcoTower maintains a cycle of energy that will supplement the plants continuously, day or night. This tower aims to create an autonomous hydroponic that can be monitored, self-sufficient, and controlled through applications at will. Data will be collected from the tower, transmitted to the the software application, and then presented for the users use of data. The use of electricity will also serve an importance to the project. The solar panels and batteries can only power some applications for the tower. This creates the need for controlling what power is needed at what time, through timers, low energy hardware, and switches.

The Hydroponics tower needs to be monitored for the data that it outputs. Information like the pH levels and the total dissolved solids play an important role in plant growth and its health on vegetation. A pH was tested using a meter that specifically gauged pH in a solution. The total dissolved solids was monitored through testing the water for its purity and conductivity. What needed to be controlled for this tower was its water and light management. The water and light application was controlled with a timer set by the user which will run continuously until the user manually triggers them. The pump and the lamp was controlled using a switch which had been connected to the arduino and manipulated there. All the controls were sent to the arduino as inputs and outputs, while monitored applications were used as analog. The software we used to bridge the tower to the user was bluetooth. Adafruit provided a Bluetooth Low Energy solution that was put on the central hub of the EcoTower which consisted of the switches made for water and pump, and also the pH tester and total dissolved solids meter. This allowed all data to be transmitted to the users phones and also give commands to the tower. Bluefruit was the application we used to monitor and control the tower. The analog data was presented and switched were being manipulated accordingly.

Difficulties that this project faced were wiring, connection, leakage, and coding. The wiring for arduino consist of many connectors (Male-male > Female-male [x3]), thus making the connections very weak and prone to disconnect at multiple points. Having the arduinos inside boxes and waterproofed, made it a challenge to pull out the central hub and place it back without disconnecting the wires. Tapes and elevation for the central hub assisted the need to reach in tight spaces to pull or put wires. To make the tower wireless would make the project stationary as the set needed to be connected to an ethernet cable. A solution was to use bluetooth as the “wireless” communicator. Although the process disconnected when idle, and requires an reupload of the code to enable bluetooth access, the EcoTower responded well to the module over some distance. The tower also had leakage when there were open spots wherever plants were supposed to be. The holes were then filled with temporary cups and the openings were superglued to contain the water. Another difficulty we faced was coding a custom app for the bluetooth. Bluefruit was open source but due to time and difficulties, the EcoTower team could not reformat the app for personal use. The Bluefruit app itself served the functions required for the EcoTower, so many other issues were the priority.

**Functional Working Process:**

The EcoTower is a project with one sole purpose in mind, and that is to grow food wherever you want. From that one goal, we thought of the best way to go and do that by providing a working prototype that is energy efficient, that can collect data for the user, and that can present the data in a simple and easy manner . While there were a lot of hiccups on the way to accomplish this, The goals we set out to achieve was reached into a working prototype for someone to bring to their home to use.

The way that the tower works is pretty simple and easy for household use. First the solar panels on top of the tower collect energy that power a battery in either of the the transistor boxes. From there the energy can either of the Adrunos that we used in the prototype. The first one we used to power a switch that ran a timer on how often the pump would turn on or off.This switch we also made it Bluetooth connected so individuals can either turn on or off the Tower by connecting the Tower to their phones. The other Arduino in the prototype would be connected to a TDS probe and a pH meter. This would read the water in the bucket to see the condition of the water and whether the water needed more nutrients or what the acidity of the water would be.The way they would read it, would be by either Bluetooth or a 4 char display on the lid near the solar panels. Since the project is a prototype, we didn’t completely flesh out the bugs in the code.However, This would allow the user to get a reading of what the condition of the water would be and allow them to best service the tower.

**Electrical Workings:**

The issue of power consumption was a problem that we had to face early on in our project. We had to find out how much power was the EcoTower going to need in order to work properly. We had to power not one, but two Arduino’s and a pump powerful enough to pump the water to the top of the tower, which stood at 4 and a half feet. Since we wanted to be self sufficient we choose to use Solar panels, since the tower would be facing sunlight constantly, it was an obvious choice. Well the power from that went to a transformer that both charged a battery, since the solar panels would be useless at night, and to power a USB port. We chose a USB port because from that port, we connected it to one of the Arduino’s and the cord is a USB adapter. The biggest hurdle that we had to overcome, was powering the pump. We overcame that by instead of making the pump run on solar energy, we had it run on regular AC from the wall,but we put the pump on a timer so that it wouldn’t have to run all the time. This allowed the EcoTower to be as energy efficient as possible while ensuring the functionality of the Tower remained intact.

Examples for companies and products that work in the fields of hydroponics and things alike:

Edenworks

* Edenworks is a Vertical Hydroponics Farm based in Brooklyn, New York.
* Edenworks had a revenue of under $500,000, but was profitable enough in 2014 that he quit his day job as a landscape architect to farm full time. He now has three employees and sells his greens to about 50 restaurants in the Seattle area, a local grocery chain and four weekly farmers’ markets.
* Edenworks produces more than 5000 lb. of mixed vegetables to local restaurants, grocery stores, and businesses.
* They currently do not use pesticides and use far less water and fertilizer than traditional farms, while producing vegetables that last 20-30% longer than traditional forms of farming. Even with factory farming, the usage of trucks, crop dusters, and harvesting machines do not compare to control the environment while harvesting the plants.
* The space required to build this hydroponics farm required as much space as his garage, which is a far smaller form factor than requiring acres of space. This is important because while this business utilizes very little space, each hydroponics setup is very scalable, which includes being able to have one set-up within an urban environment as a floor.

Hydrofarm

* Major Manufacturer for Hydroponics items, In business for 39 Years with 7 Nationwide Distribution Centers. Hydrofarms offer many options and tools for personal hydroponic plans, which is a possible means for our EcoTower to prosper. We could use the Hydrofarm as a vendor for distributing the parts we require to build a personal set.
* Hydrofarm acts as a vendor for Edenworks, or any hydroponics / aquaponics-based businesses.

Building onto EcoTower for future groups would be to add more sensors outside of the tower to monitor the environment in case of weather issues. For example, if there is rain outside, stop the timer for the pump so that the plants do not die from drowning in liquids. Or if there is not enough sunlight for the ideal plant growth, so turn on the Ultra Violet lamp to adjust accordingly. The EcoTower also requires users to mix in the required nutrients when it is depleted. Adding in an autonomous nutrient dispenser and mixer would better the independency of EcoTower. Another addition would to access the Bluefruit open source app to be customized for this specific projects needs, while also having online capabilities. That way information is kept in databases to be viewed for graphs or comparisons with other users alike.