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Project Proposal: Garduino

Abstract

Although plants are conventionally grown in soil, they can be much more efficiently grown in nutrient rich water. Soil is a substrate that contains nutrients and when it is watered, the nutrients dissolve into it and is then taken up by the roots of the plant. Therefore, it is not the soil but the nutrient rich water that works to promote plant growth. Hydroponics eliminates the soil from this equation and instead directly supplies nutrients by having the roots submerged in water. This leads to less wasted water (the water is not evaporating as it does in soil) and increased growth rates.

However, hydroponic systems need to be closely monitored. Although soil reduces the maximum achievable growth rate for a plant, it serves as a great buffer and thus small fluctuations in temperature or pH do not cause harm to the plant. The same is not true of hydroponics and using sensors to loop and continuously read these important values is extremely crucial to the success of such a system.

I already have built a prior version of such a system before and thus have experience in this field. The following was my final design in my EK 210 product engineering course.

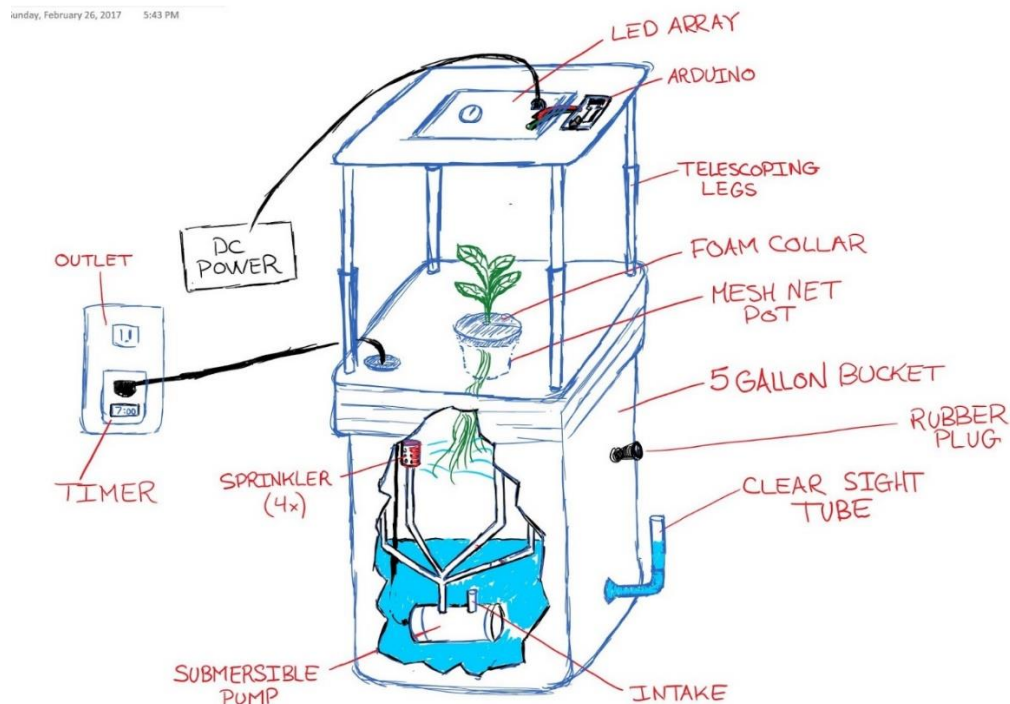


Figure 1: My previous EK 210 final project design.



Figure 2: Photo of my final project. LED's on top are PWM controlled and the plastic tub houses a submersible pump that sprays nutrient rich water on the roots of the plant.

It is important to note that this old design I made uses aeroponics (spraying water on the roots versus submerging them) however many of the design principles are the same. Additionally, I placed a lot of emphasis on using PWM on the LED lights and that was the only component that was controlled by the Arduino.

For this current project, I will not be adding any grow lights. Instead, I will be focusing my efforts on adding more sensors to measure various water parameters (such as pH and water temperature) and having them read by an Arduino. The Arduino will output these values to a display and while acting on this data to control two peristaltic pumps to add pH high or pH low solutions to the water depending on the pH that was read in. The Arduino will also control a small air pump to oxygenate the water. Finally, I will opt for a smaller form factor by eliminating the overhanging LED's and opting to submerge the roots of the plants in water instead of spraying them as I did in the previous prototype.

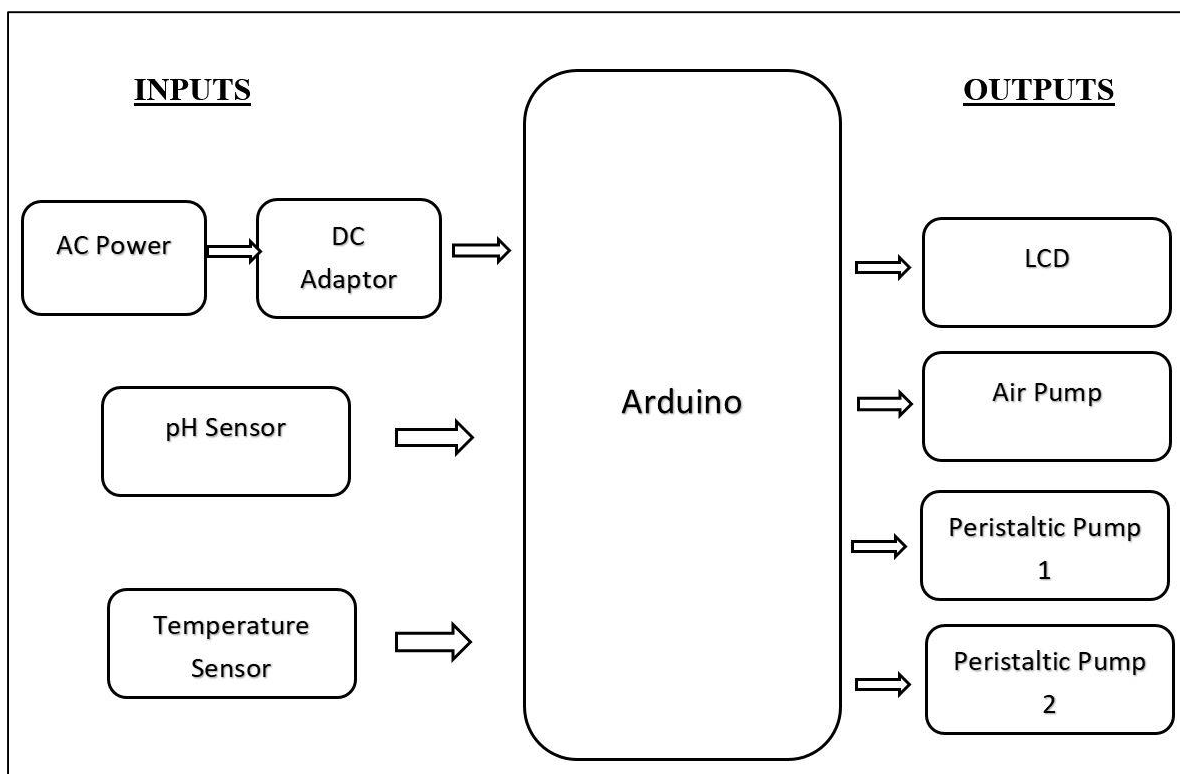


Figure 3: Block diagram for the Garduino. Inputs are fed in on the left and outputs are on the right.

Bill of Materials

Part	Quantity	Description	Do I have it already?	Price
Arduino Uno	1	Microprocessor to control everything	yes	
LCD	1	Displays sensors' values	yes	
Air pump	1	Pushes air through air stone	yes	
Air stone	1	Oxygenates water	yes	
Vinyl tubing	1	Connects pump to air stone	yes	
Plastic box	1	Reservoir for nutrient rich water where the plants' roots will be submerged	yes	
DC adaptor for arduino	1	Run Arduino without computer	Yes (elab has it)	
Relay Shield	1	Control high voltage outputs such as pump	yes (elab has it)	
12V DC Peristaltic Pump	2	Pump pH high and Ph low solutions to water (peristaltic is required because the motor	NO https://www.amazon.com/Dosing-Pump12V-Peristaltic-Aquarium-	\$28.00 (each

		components cannot be in direct contact with these acidic and basic solutions or they would be damaged)	Analytical/dp/B077M3TF24/ref=sr_1_1?s=industrial&ie=UTF8&qid=1522840857&sr=1-1&keywords=peristaltic+pump	pump is \$14)
pH sensor	1	Measures pH of nutrient water and this value then determines if pH high or pH low solutions needs to be added to increase or decrease pH	NO https://www.dfrobot.com/product-1025.html Or https://www.amazon.com/DFROBOT-4330265782-Analog-Meter-Kit/dp/B01BNG41KO/ref=sr_1_9?ie=UTF8&qid=1522841322&sr=8-9&keywords=pH+sensor+arduino	\$29.50
2" Mesh Net Pots	6	Holds plants	NO https://www.amazon.com/Round-Orchid-Hydroponics-Slotted-Net/dp/B004HXF0VU/ref=sr_1_13?ie=UTF8&qid=1522840673&sr=8-13&keywords=2+inch+mesh+net+pot	\$4.09
DS18B20 Waterproof temperature sensor	1	Reads water temperature	NO https://www.amazon.com/Gikfun-DS18B20-Temperature-Waterproof-EK1083x3/dp/B00Q9YBIJI/ref=sr_1_1_sspa?s=electronics&ie=UTF8&qid=1522841992&sr=1-1-spons&keywords=waterproof++temperature+sensor&psc=1	\$8.98
			Total Cost	\$70.57