

Greenie: The Smart Irrigator

Group 10

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Project Narrative Description

Motivation

Irrigated agriculture has become one of the most important sectors of the U.S. economy while being the largest consumer of consumptive water. Methods of using water smartly have been looked into because of this reason. In hopes of aiding this situation, our team has decided to design a **smart irrigation system using the Internet of Things technology**, or IoT.

A smart irrigation system could be of great help in managing water utilization. We have chosen to implement a more local approach with our project, giving individuals the chance to help their communities and the global population by growing herbs from the comfort of their homes.

Goals and Objectives

The goal of this project is to create an easy-to-use and portable smart irrigation system using IoT. Our product, Greenie, is going to allow users to monitor and irrigate herbs remotely, making the gardening process hassle-free. Given that the system will be compact, it can be placed anywhere inside a home or an outdoor garden.

The user is going to have access to a web app that tracks the plant's data. The application, which the user can access comfortably from anywhere, would be available on any mobile device through the use of a link, making our device as easy to use for any type of user, whether they are beginners, intermediate, or advanced gardeners.

Functions Outline

Hardware

Using our hardware, the user will be able to acquire various information regarding:

- Watering times
- Soil moisture preference
- pH level preference
- Ideal humidity and temperature from air/room

Software

Using our software, the user can:

- Water their plant automatically through their mobile device or voice
- Tap on their screen to either select automatic watering or water their plants manually
- Observe herb's data on LCD

Specifications

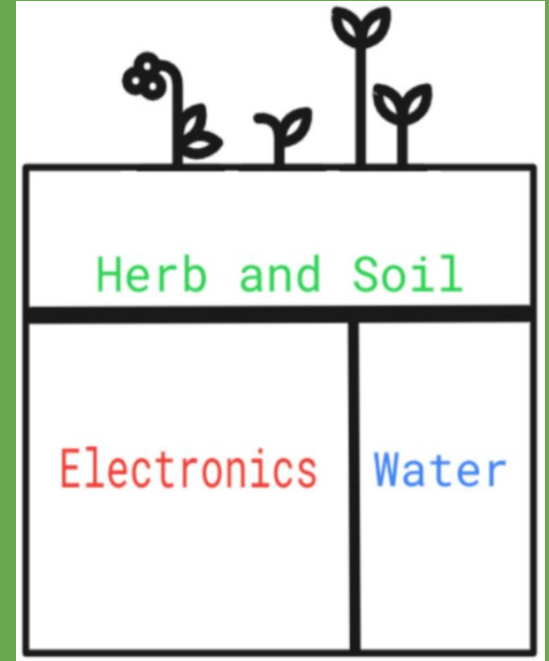
Attribute	Description
Dimension	20" x 20" x 20" (should not exceed)
Weight	15 lbs. (should not exceed)
Power Supply	Range needed for microcontroller: 7 V - 12 V Duration: At least 12 hours
Microcontroller	I/O pins: 10 (min) Operating voltage: 5 V
LCD	16 Character x 2 Line
Sensors	3 soil moisture sensors 1 rain sensor 1 humidity and temperature sensor 1 pH sensor
Sensor Measurements	1 per hour or on demand by the user

Relay Module	Voice Response Time (Alexa) <= 5 seconds
Water Source	24 fl oz water container
Water Pump	Pump head: 2.5 M / 8.2 ft (min) Flow rate: 240L/H 63.4GPH (min)
Interface	< 5 seconds response time
Plants Supported	10 herbs total 1 supported at a time
Alexa Commands	At least 3 unique commands
Communication Protocol: System	Wi-Fi
Communication Protocol: Sensors	UART SPI I2C

Design

Product Design: Front View

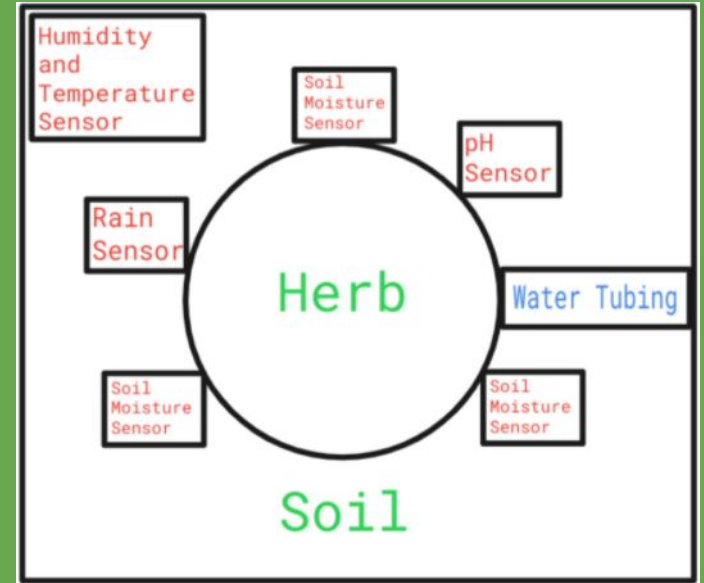
The prospective design of Greenie takes into consideration aesthetics as well as small-garden efficiency. Greenie will consist of three different sections enclosed in one rectangular container. These three different sections are the “Herb and Soil” encasement, located at the top of the container, the “**Electronics**,” located on the left side, and the “**Water**” enclosure, located on the rightmost side of the container.



Product Design: “Herb and Soil” Compartment

This compartment is going to house the user’s selected herb out of the ones supported by our software as well as all of our sensors and the outlet tubing of our water pump.

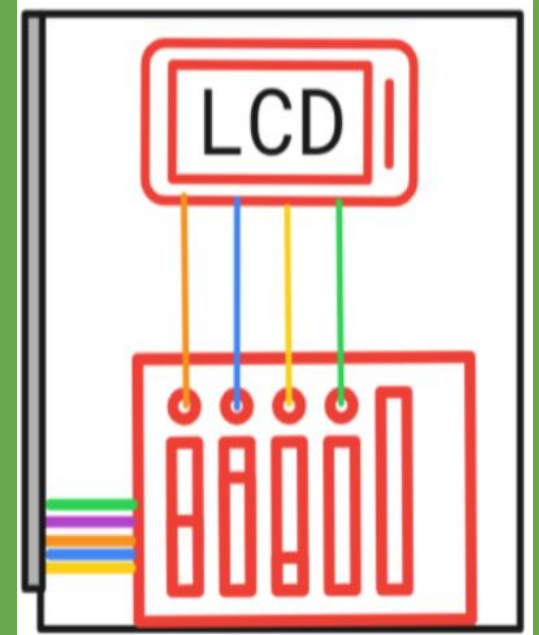
- Three soil moisture sensors
- One pH sensor
- One rain sensor
- One humidity and temperature sensor
- Outlet water tubing



Product Design: “Electronics” Compartment

In this compartment, the parts and components required for our project to function are going to be placed.

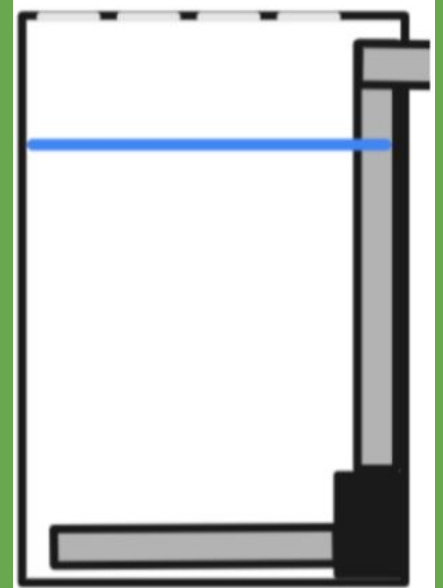
- PCB
- MCU
- LCD
- Wi-Fi module
- Relay modules
- Voltage regulators
- Any other common electronic parts needed



Product Design: “Water” Compartment

In this compartment, the water required to irrigate the herb is going to be contained as well as our inlet/outlet water pump. To make sure that the herb is properly watered, we are going to be drilling a hole the size of our water tubing on the upper, rightmost side of the container. The hole will be drilled in the upper, rightmost part of the planter to allow our water tubing to reach the herb located above and allow as much water as possible to be contained.

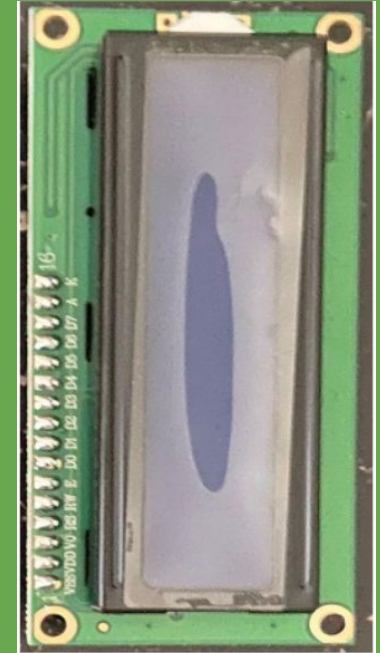
To prevent rotting from occurring to the user’s plant, we are going to be drilling small holes on the bottom of our “Herb and Soil” encasement. These tiny holes are going to be located on the rightmost part of the enclosure, to ensure that the water flows from the soil to the water encasement and not the electronics.



Parts

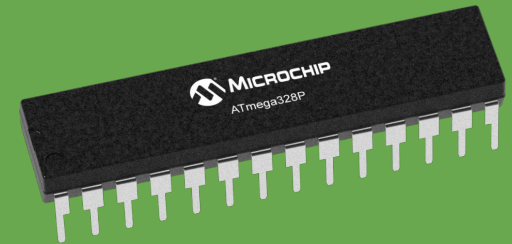
Liquid Crystal Display (LCD)

Attribute	LCD-013-420	LCD1602	0.96" OLED Module
Communication Protocol	I2C	I2C	I2C
Text Dimensions	4 x 20	2 x 16	128 x 64 OLED
Text Color	White	White	White
Address	0x27	0x27	0x3C
Cost	\$6.99	\$0.00 (owned)	\$9.99



Microcontroller (MCU)

Attribute	Atmel ATmega328P	Texas Instruments ARM Cortex-M3	Texas Instruments MSP430
Communication Protocol	UART, SPI, I2C	SCI, SPI, I2C	UART, SPI, I2C
Memory	32 KB	256 KB	128 KB
Maximum I/O Pins	23	52	83
Operating Frequency	20 MHz	50 MHz	16 MHz
Operating Voltage	5 V	2.5 V	3.3 V



AC/DC Power Adapter

Attribute	Corporate Computer Power Supply Adapter	SmoTecQ Store Power Supply Adapter	TMEZON Power Adapter Supply
Input Voltage	110 V AC	240 V AC	240 V AC
Output Voltage	9 V DC	12 V DC	12 V DC
Current Rating	1 A	2 A	2 A
Polarity	Positive center,	Positive center,	Positive center,
Dimensions	negative sleeve	negative sleeve	negative sleeve
Connector	5.5 x 2.1 mm	5.5 x 2.1 mm	5.5 x 2.1 mm
Cost	\$6.99	\$11.99 for 2	\$7.99



Soil Moisture Sensor

Attribute	SparkFun Soil Moisture Sensor	Adafruit STEMMA Soil Sensor	KeeYees LM393
Arduino Compatibility	Yes	Yes	Yes
Number of Prongs	2	1	2
Operating Voltage	3.3 - 5 V	3 - 5 V	3.3 - 5 V
Output Type	Analog	Analog	Analog and Digital
Cost	\$5.95 for 1	\$7.50 for 1	\$7.99 for 5



Rain Sensor

Attribute	FC-37	FC-37	MH-RD
Manufacturer	ACROBOTIC	HiLetgo	Teyleten Robot
Output Current	15 mA	15 mA	15 mA
Operating Voltage	3 - 5 V	3 - 5 V	3.3 - 5 V
Output Type	Analog and Digital	Analog and Digital	Analog and Digital
Cost	\$8.99 for 1	\$5.99 for 3	\$5.88 for 3



Humidity and Temperature Sensor

Attribute	RHT03	DHT11	AM2302
Range	0 - 100% RH 40 - 80 °C	20 - 80% RH 0 - 50 °C	0 - 100% RH -40 - 80 °C
Maximum Current	1 - 1.5 mA	2.5 mA	2.5 mA
Operating Voltage	3.3 - 6 V	3 - 5 V	3 - 5 V
Measurement Accuracy	± 2% RH ± 0.5 °C	± 5% RH ± 2 °C	± 2% RH ± 0.5 °C
Cost	\$12.95 for 1	\$8.88 for 5	\$18.49 for 4



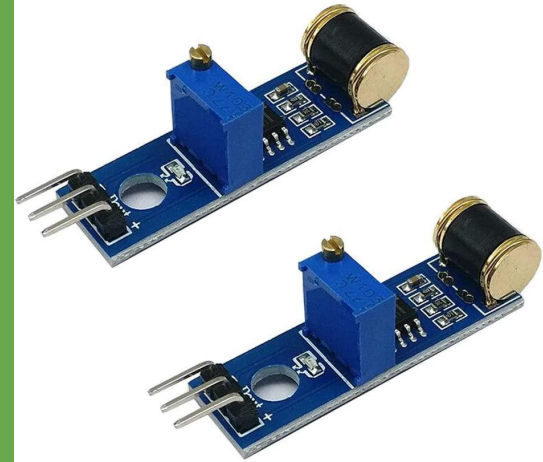
pH Sensor

Attribute	DONGKER pH Sensor Module	GAOHOU PH0-14 Sensor Module	BOOTOP PH0-14 Sensor Module
Range	0 - 14 pH 0 - 60 °C	0 - 14 pH 0 - 80 °C	0 - 14 pH 0 - 80 °C
Working Current	5 - 10 mA	5 - 10 mA	5 - 10 mA
Operating Voltage	5 V	5 V	5 V
Zero Point	7 ± 0.01 pH	7 ± 0.25 pH	7 ± 0.25 pH
Cost	\$36.99 for 1	\$35.59 for 1	\$35.19 for 1



Piezoelectric Vibration Sensor

Attribute	HiLetgo Analog Ceramice	HiLetgo Vibration Sensor	HiLetgo 801S
Operating Voltage	3.3 - 5 V	5 V	3 - 5 V
Working current	< 1 mA	~15 mA	5 - 10 mA
Interface type	Analog output Signal	Digital Output Switching	Analog output signal
Operating Temp	-10 - 70 °C	0 - 80 °C	0 - 70 °C
Cost	\$8.49	\$5.99	\$7.75



Relay Module

Attribute	HiLetgo 5V	WINGONEER KY-019 5V	KeeYees 5V Relay Module
Operating Voltage	5 V	5 V	5 V
Maximum AC	AC 250 V / 10 A	AC 250 V / 10 A	AC 250 V / 10 A
Maximum DC	DC 30 V / 10 A	DC 30 V / 10 A	DC 30 V / 10 A
Cost	\$5.98 for 2	\$8.49 for 5	\$9.99 for 5



Water Pump

Attribute	LEDGLE	Mavel Star	MOUNTAIN_AR K
Rated Voltage	DC 12 V	DC 12 V	DC 12 V
Rated Power	3.6 W	4.8 W	4.5 W
Lift	3 M / 9.8 ft	3 M / 9.8 ft	3 M / 9.8 ft
Flow Rate	240L/H 63.4GPH	240L/H 63.4GPH	240L/H 63.4GPH
Current	300 mA	350 mA	400 mA
Cost	\$8.99	\$12.99	\$10.99



Smart Speaker

Attribute	Apple HomePod Mini	Amazon Echo Dot	Google Nest Mini
Released In	2020	2020	2019
Voice Assistance	Siri	Alexa	Google Assistant
Microphones	4	4	3
Dimensions	97.9 x 84.3 mm	100 x 100 x 89 mm	98 x 42 mm
Weight	0.76 lbs (345 g)	0.75 lbs (341.3 g)	0.4 lbs (183 g)
Cost	\$99.00	\$0.00 (owned)	\$49.00



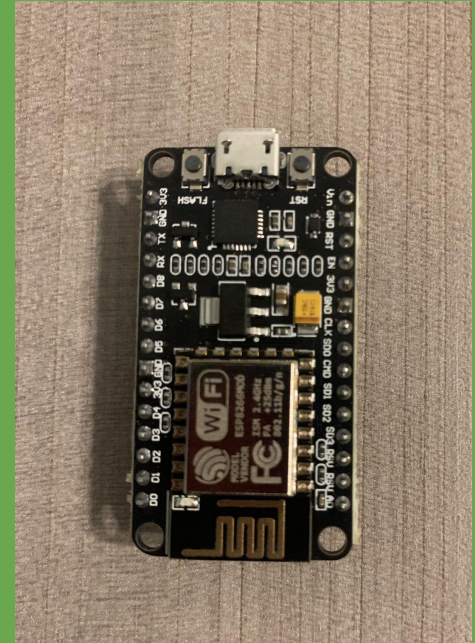
Solenoid Valve

Attribute	Digiten	Kako	NPT
Rated Voltage	12V DC	110V AC	12V DC
Working Temp	0-70C	23-176 F	-5 - 85 C
Pressure	0.02-0.08 Mpa	0 - 145 Psi	15 - 70 Psi
Material	Plastic	Brass	Copper
Size	¼ inch	1 inch	¼ inch
Cost	\$7.69	\$32.99	\$15.69

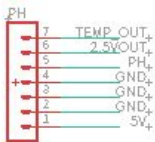
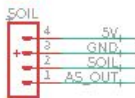
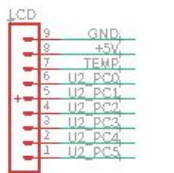
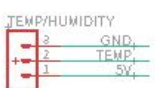
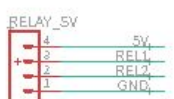
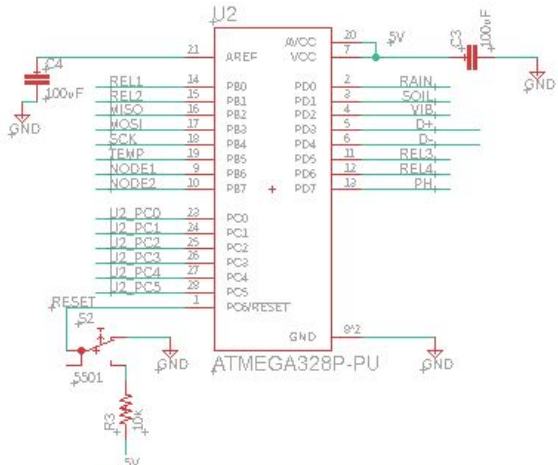
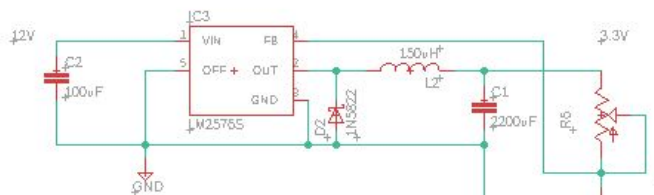
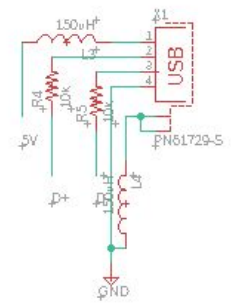
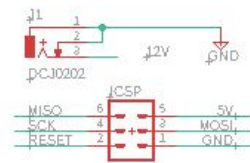
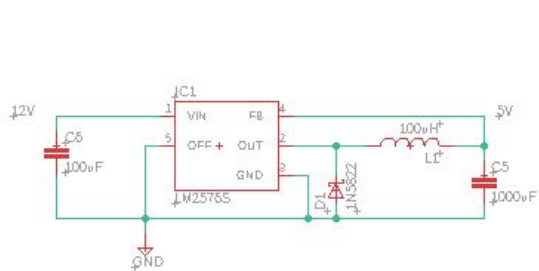


Wi-Fi Module

Attribute	ESP8266 NodeMCU	ESP32	Bolt IOT Module
Wi-Fi	802.11 b/g/n	802.11 b/g/n	802.11 b/g/n
Operating Voltage	3.3 V	3.3 V	3.3 V
Clock Speed	80 MHz	160 MHz	80 MHz
Bluetooth	X	Bluetooth 4.2 and BLE	X
Cost	\$6.49	\$21.88 for 3	\$150.00



Printed Circuit Board (PCB)



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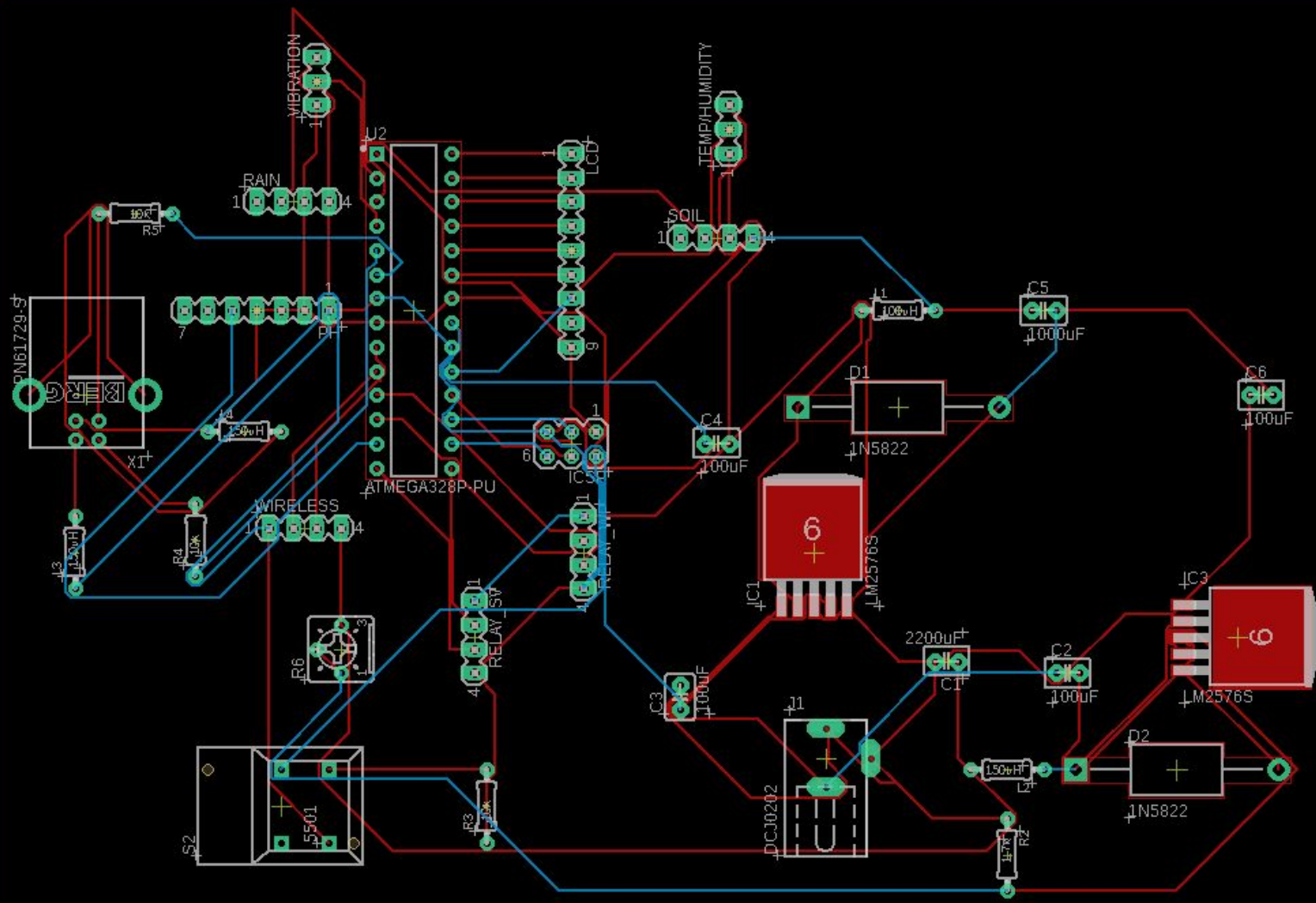
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Design by: Kevin Rodriguez

REV: 1

Date: 9/29/2021 4:47 PM

Sheet: 1/1



Software

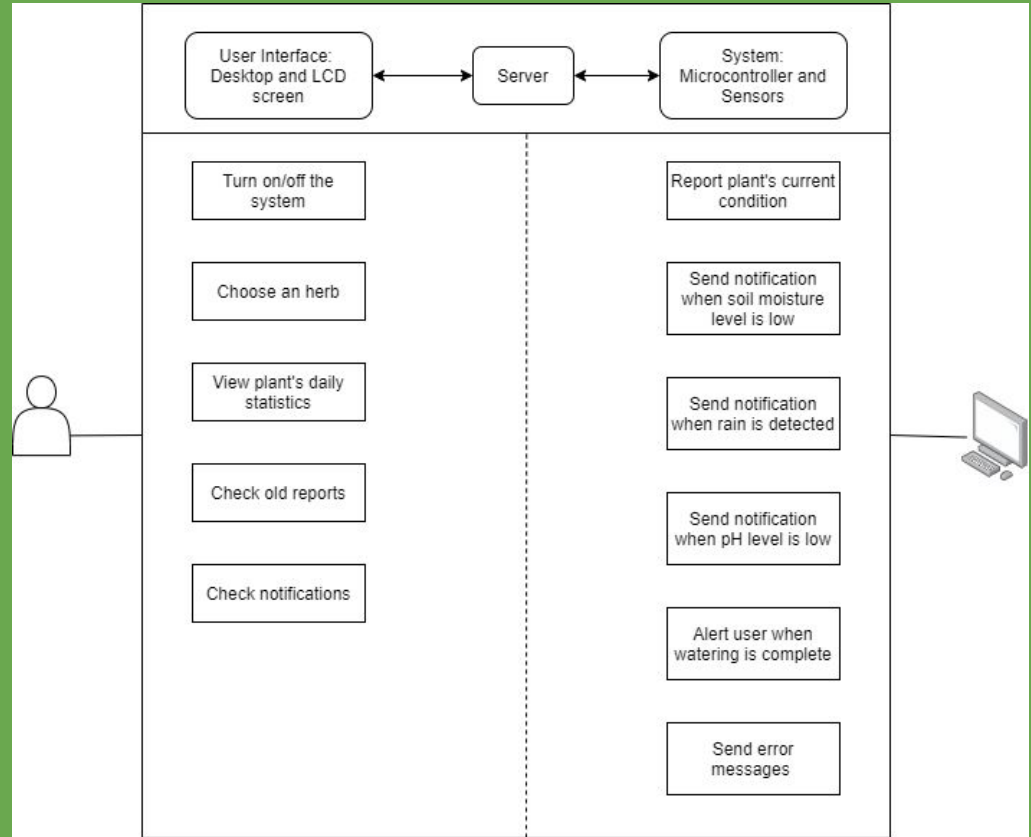
Software Overview

Back End

- Continually collecting data from our sensors and sending to our web server
- Errors and notifications are created
- Data will be stored and pulled from MongoDB

Front End

- User can remotely control the system
- View data on demand
- Receive notifications



Web Application – Home

- The home page displays the sensors current readings
- There's also a button for users to manually turn on the water pump (i.e. Watering something other than 10 herbs)
- Weather Information to be added

The screenshot shows the home page of the GREENIE web application. On the left is a dark green sidebar with a close button (X) at the top. Below it, the text 'GREENIE' is displayed in large white letters, followed by the tagline 'The Smart Irrigator' in smaller white text. The sidebar contains four menu items: 'Home' with a house icon, 'Herbs' with a plant icon, 'History' with a circular arrow icon, and 'About' with a person icon. The main content area is white and features a 'PUMP ON/OFF' button at the top center. Below the button, the pH sensor reading is shown as 'pH Sensor Reading: 7.0'. Further down, the soil sensor reading is 'Soil Sensor Reading: 500 (Well Drained Soil)'. At the bottom, the temperature and humidity sensor reading is 'Temperature/Humidity Sensor Reading: 72F ; 50%'. In the top right corner, there is a box labeled 'Today's Forecast' which is currently empty.

Web Application – Herb Selection

10 Herbs Available

- Information on each herb and its watering schedule is provided
- Selecting an Herb begins its automatic watering schedule

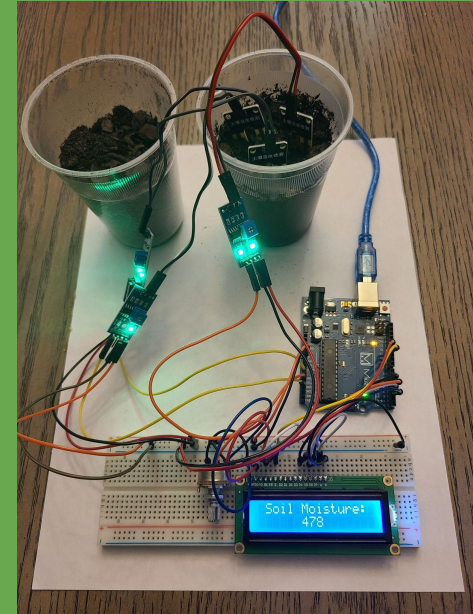
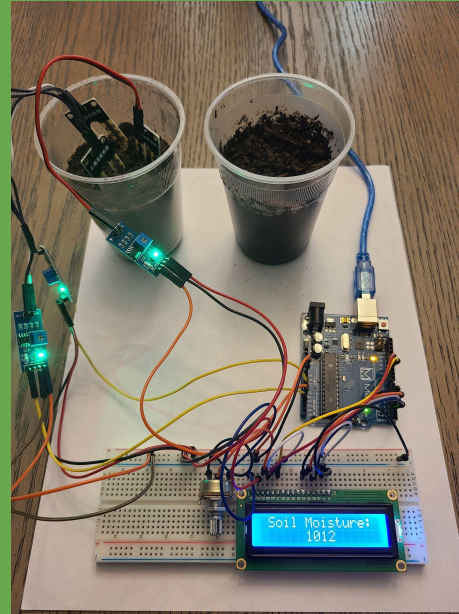
Herb Selection

Herbs Supported	Watering Requirements	Soil Preference	Ideal Humidity	Ideal Temperature	Ideal pH	
Basil	Every Day	Well Drained	40-60%	70-90 F	5.5-6.5	ADD
Thyme	Every 2-3 Days	Moist/Well Drained	40%	60-70 F	5.5-7.0	ADD
Bay Leaf	Every 2-3 Days	Well Drained	40%	> 20 F	6.0-7.0	ADD
Lemongrass	Every 2-3 Days	Well Drained	40%	65-80 F	6.5-7.0	ADD
Oregano	Every 2-3 Days	Moist/Well Drained	40%	50-70 F	6.5-7.0	ADD
Mint	Every 2 Days	Moist/Well Drained	70%	60-70 F	7.0-8.0	ADD
Sage	Weekly	Well Drained	40%	60-70 F	5.5-6.5	ADD
Rosemary	Every 2 Days	Well Drained	45-55%	55-80 F	5.0-6.0	ADD
Chives	Every 2 Days	Well Drained	40%	40-85 F	6.0-7.0	ADD
Cilantro	Every 2 Days	Moist/Well Drained	75%	40-75 F	6.5-7.0	ADD

Testing

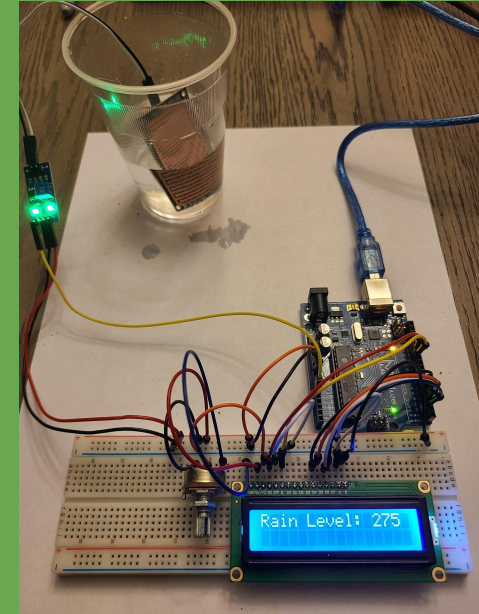
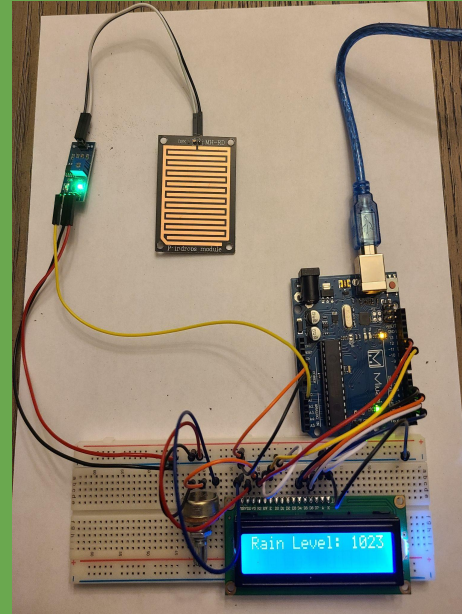
Testing: Soil Moisture Sensor

- Determines whether the water pump will be turned on or off
- 3 sensors will be used to read the average soil moisture of the plant
 - Wet Soil: 0 - 350
 - Well-Drained Soil: 351 - 650
 - Dry Soil: 651 - 1023
- Test Results
 - Dry soil \approx 1012
 - Soil with water \approx 478



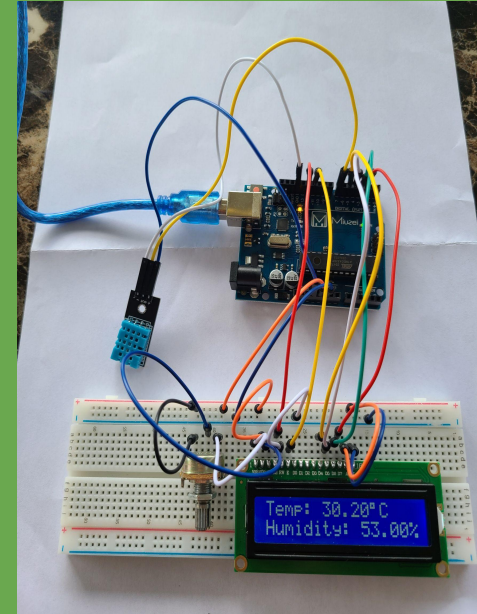
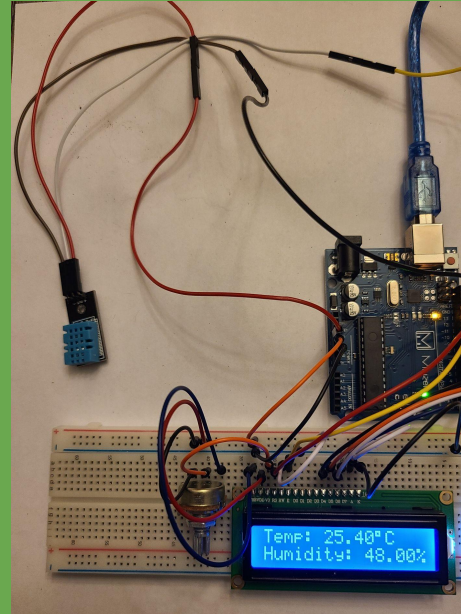
Testing: Rain Sensor

- 1 sensor will be used to monitor the amount of rainfall
 - Raining: 0 - 400
 - Not Raining: 401 - 1023
- Test Results
 - Completely dry \approx 1023
 - Sprinkle of water \approx 471
 - Soaked in water \approx 275



Testing: Humidity and Temperature Sensor

- Reads data from the environment to maintain plant's health
- Current humidity and temperature will be compared to the plant's ideal humidity and temperature
- Test Results
 - (Indoor) Temp = 25.4 °C
 - (Indoor) Humidity = 48 %
 - (Outdoor) Temp = 30.2 °C
 - (Outdoor) Humidity = 53 %



Administrative Content

Budget and Financing

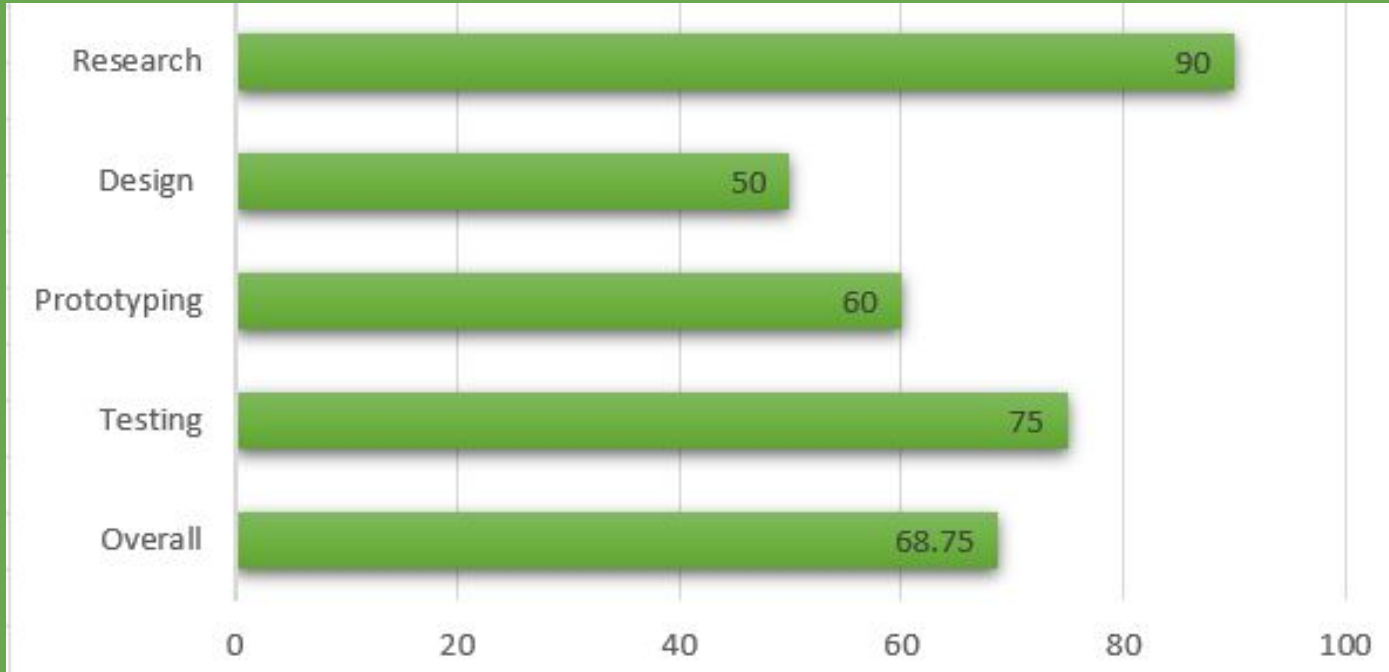
- Self-funded by the group
- Budget: \$500
- PCB will be ordered soon
- Materials for the enclosure will be ordered soon

Number	Item	Cost
1	ESP8266 Development Board (3)	\$ 6.49
2	Atmega 328P	\$ -
3	LCD1602	\$ -
4	Soil Moisture Sensor	\$ 7.99
5	Rain Sensor	\$ 5.88
6	Temperature and Humidity Sensor	\$ -
7	Solar Power Bank	\$ 28.99
8	Voltage Regulator Kit	\$ 13.99
9	Silicone Tubing	\$ 12.99
10	Water Pump	\$ 8.99
11	5V Relay Module (2)	\$ 5.98
12	PH0-14 Sensor Module	\$ 35.59
	TOTAL	\$ 126.89

Work Distribution

Task	Primary	Secondary
Design	Angelica	Kevin
Sensors	Angelica	Patricia
Power Supply	Kevin	Angelica
PCB	Kevin	None
Database	Elliott	None
Wireless Communication	Elliott	None
User Interface	Patricia	None
Web Application	Patricia	Elliott

Work Progress



Future Plans

- Web Application - History Page, About Page, Weather Integration, More User Interface Changes
- Alexa integration working with the web server
- Ship out PCB (1st Iteration)
- Build physical design

Questions?