E-Farm

Summary:

This system is designed to automate watering, lighting, and sensor data collection for household or small community greenhouse farming. It can be easily monitored and controlled through any internet-connected device. Powered by four ESP-32 devices, the system collects environmental data, processes it using moving averages and low-pass filters for accuracy, and sends this data to other devices to activate watering and lighting systems as needed. Users can customize the frequency of data collection, ranging from once a day to every 15 minutes, optimizing power usage based on plant care needs. The data is sent to Adafruit IO which graphs all data, this can be analyzed and be used to improve the system itself.

The system includes four key ESP-32 units. SS.ESP handles sensor data collection and sends it to the rest of the system. H.ESP activates the watering system based on sensor readings, ensuring plants receive the correct amount of water. L.ESP manages the lighting system, providing the lights turn on at a fixed time each day. Sunflower tracks the sun's position by adjusting its motor to align with the azimuth and elevation of the sun, using monthly average data from a sun-tracking website. This feature makes the system self-sufficient. The 3D model design of sunflower has leaves sticking out from the stem similar to an actual sunflower.

Links

Code: https://github.com/Cmd-8/ESP-Farm-System

YouTube: www.youtube.com/@Cmd.8

Parts:

4x ESP-32
1x BME280
2-5x Capacitive soil moisture sensor
1-2x Relay Module
1x Peristaltic Liquid Pump or 1x Plastic Water Solenoid Valve
1x l298n motor driver
1x Solar panel
2x waterproof Nema 17 or 23 motor
1x Power station or some form of power system
1x CNC Sheild and 2x DRV8825

Method:

I will provide a tutorial video for all the customizing for all the different systems.

The case design for components should not be used exclusively for outdoor environments and must include additional protection. For example, a box to put the electronics in can be used alongside the case design to safeguard the components. The case design is intended for indoor use within a greenhouse, ideally placed in an elevated location. Users should be aware that thicker walls or certain materials may interfere with data transmission. **3D printed** cases or parts should be using ASA material, as it provides heat and UV protection, preventing warping due to temperature changes or UV exposure.

When setting up the soil sensor, it is recommended to use larger sections of soil rather than multiple smaller ones for vegetables, maximizing the use of one sensor per type of vegetable. This approach works well because soil moisture doesn't fluctuate significantly over short distances unless physically separated.

The water pump can source water from a rainwater recycling system or use a water valve. A relay or motor driver can be used to control the valve or pump, with a relay being the preferred option for this application. Set up a cup to measure how much water it gets for each timer setting.

To set up Adafruit, you must create an account with Adafruit, which will provide an API key. This key should be written into the code where specified. Wi-Fi information should also be configured, as outlined in the code. Both L.ESP and SS.ESP require both Adafruit and Wi-Fi connections, while H.ESP only requires Wi-Fi. S.ESP and H.ESP must have the same interval time to sync together. For example:

```
#define TIME_TO_SLEEP 900
```

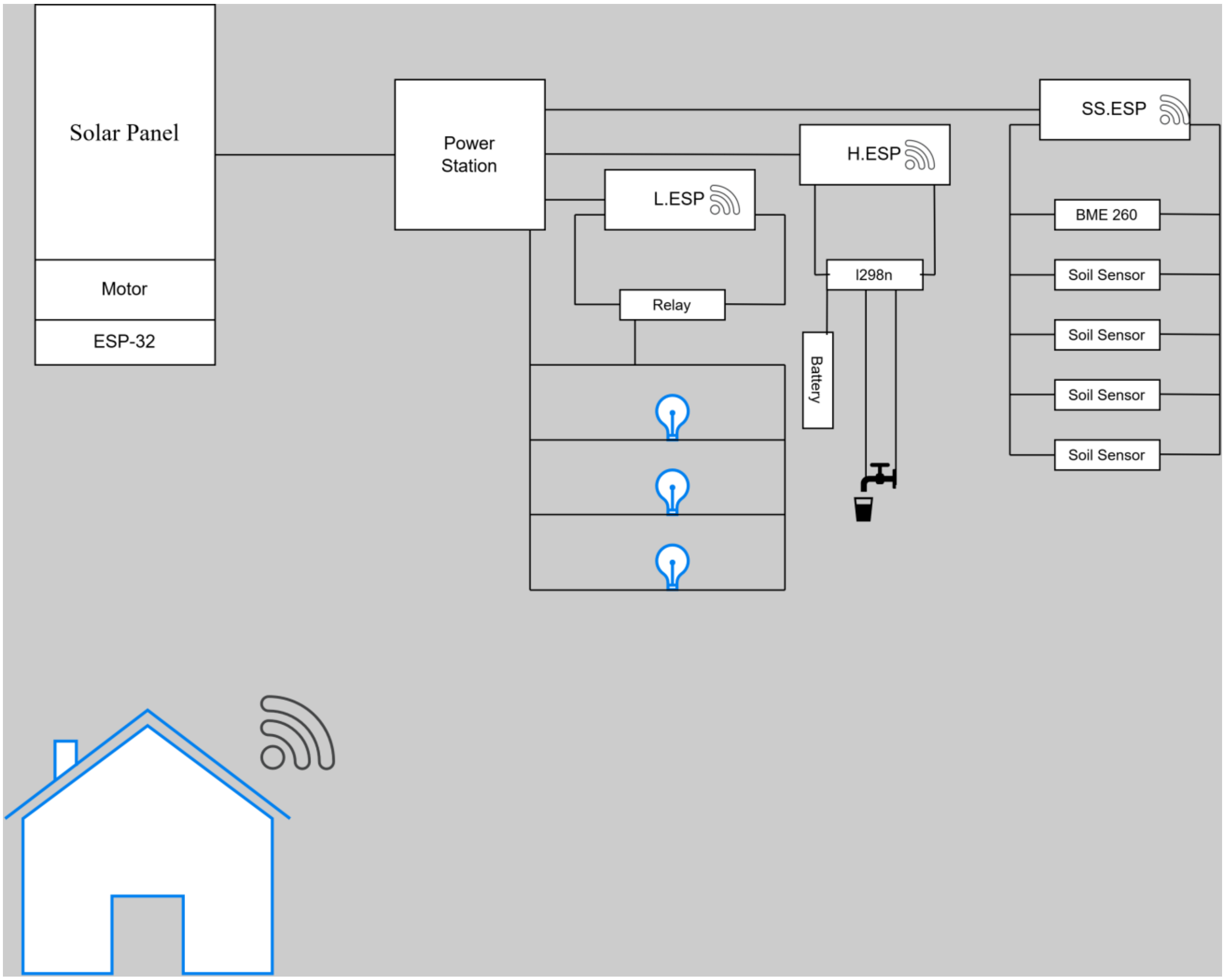
This value represents 15 minutes in seconds. After the data is taken, the system will enter deep sleep for 15 minutes before repeating the process. Both must use the same value to remain synchronized.

The Sunflower system has a weight limit of 3.0 lbs for the solar panel from the X-motor. Users can obtain the sun path for their location from a website and average the monthly data. The code is designed for easy customization, allowing users to adjust settings as needed. 3D scanning the leaves and features on sunflowers can provide for a more realistic look!

L.ESP can be used with full spectrum light bulbs for additional light in seasons where there’s not a lot of sunlight, this allows vegetables to grow all year round. It uses a relay switch that enables and disables current flow to light bulbs. Light bulbs should be in parallel cause the light bulb in series will cause the voltage to go over the relay limit instead use parallel for amperes, the limit being 10A and I got around 4/6 light bulbs with it.

Electrical Use:

The average cost for electrical power is 1kilowatts for $0.14.
The running time for SS.ESP is 1-2 milliseconds with ~600 milliamps/hour but deep-sleep uses 5-10 microamps, and always 5 volts.
H.ESP and L.ESP use around ~300 milliamps/hour when activated and the same deep sleep power consumption.



Technical:

Communication between ESP-32 devices utilizes the ESP-NOW protocol, which relies on the MAC address of each device. It ensures 100% data transmission up to 220 meters, though it can extend to 1,000 meters with some data loss. The ESP data filter processes 10 sensor readings, averages them and applies a low-pass filter before sending the data. For more accurate results, you can increase the sample rate beyond 10 and adjust the low-pass filter by modifying the alpha value ($0 < a < 1$). Additional improvements can be made by using a hardware low-pass filter, applying EMI protection to the wires, and using an external 16-bit ADC for sensors.

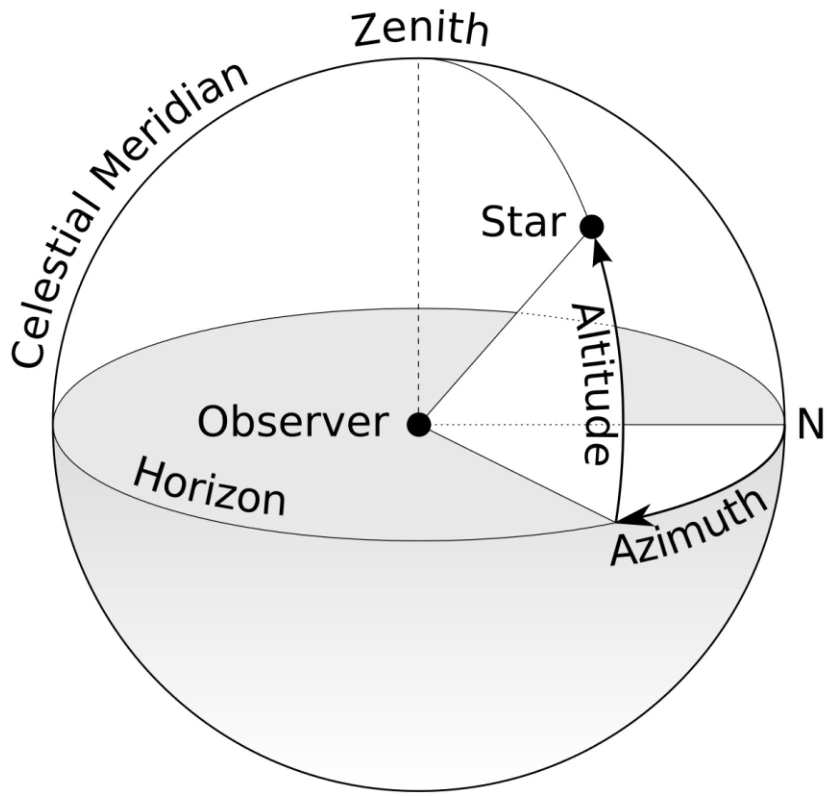
Adafruit IO allows up to 30 data points per minute and 10 feeds (e.g., "Temperature feed") in the free version. The paid version increases this to 60 data points per minute and offers unlimited feeds, making it suitable for large-scale greenhouse farming. Adafruit also provides a graphical interface to display the data, enabling users to analyze trends and make improvements, which contributes to the system's self-improvement over time.

The sensors and lights are connected in parallel due to the low current draw of each device. Each relay typically supports a maximum load of AC 250V / 10A or DC 30V / 10A and can be used with 4-6 full-spectrum lights that promote plant growth. Capacitive soil sensors are preferred due to their reliability compared to other types that may rust over time. However, the exposed electronics on the top of the sensor should be protected with a 3D-printed case for enhanced durability.

The water valve can be powered by a power station or an external source such as a battery. The ESP-32 receives soil moisture data through the ESP-NOW protocol and can be customized to control watering based on specific plant requirements, using a timer (e.g., `Delay(1000)`).

The Sunflower system uses two waterproof Nema 17 stepper motors and a CNC Shield with two DRV8825 drivers. The power supply is 12/24V ~3A, which can be connected to an outlet, power station, or external battery. The Sunflower system activates every hour to move the two motors, with the X-motor adjusting the azimuth and the Y-motor controlling the elevation. The data averages the sun's position for azimuth and elevation each month. The system's accuracy has an error range of ±1.8 degrees, as each step is 1.8 degrees, and the stepper motor only moves in whole steps, rounding the values during calculation.

The weight limit for the solar panel on the X-motor is 3.0 lbs, lighter panels reduce power consumption, as less torque is required to move the panel. Lower torque means less current is needed to move the motor. To accommodate a heavier solar panel, the acceleration and speed can be adjusted to provide more torque.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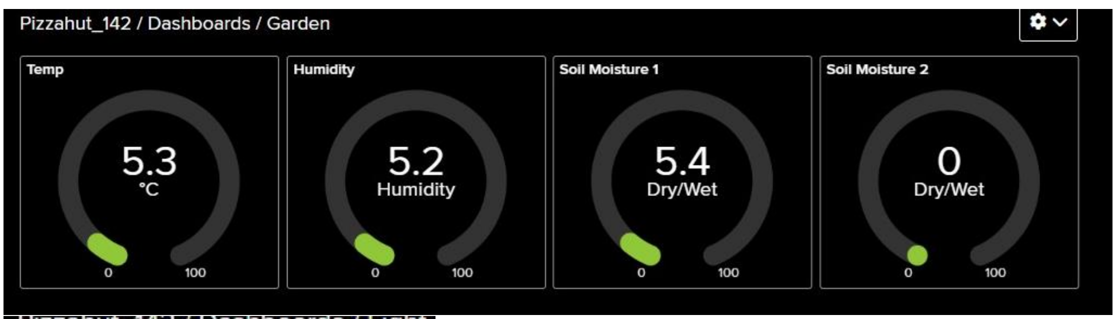
Pizzahut_142 / Dashboards / Garden
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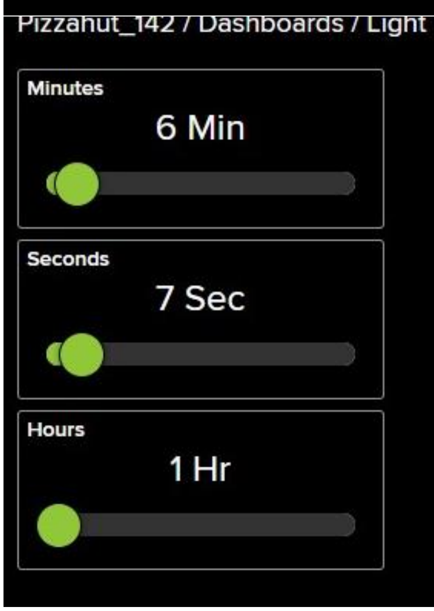
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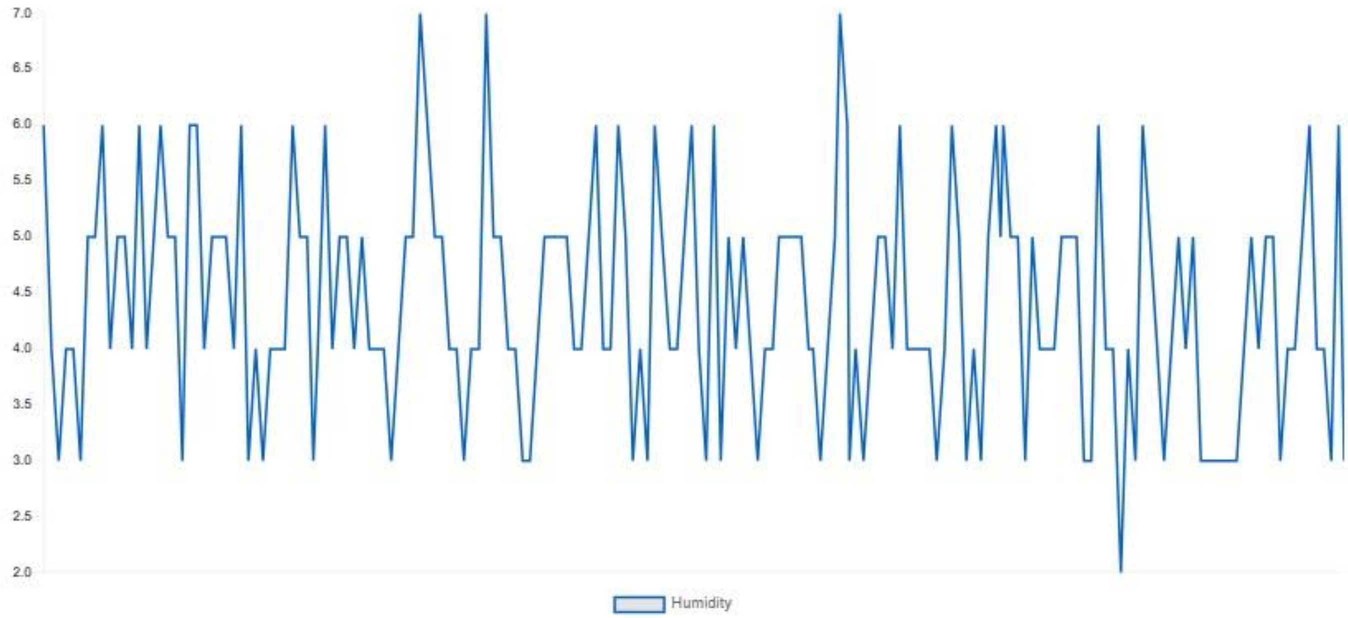
Pizzahut_142 / Feeds / Humidity



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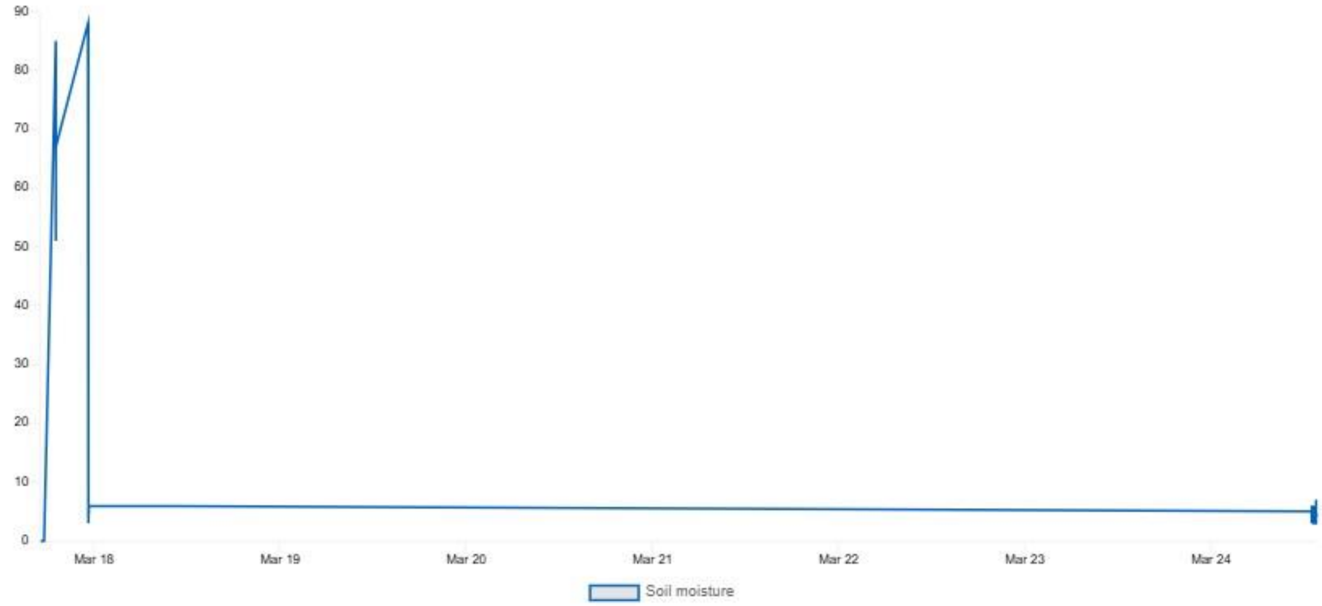
Pizzahut_142 / Feeds / Soil moisture



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