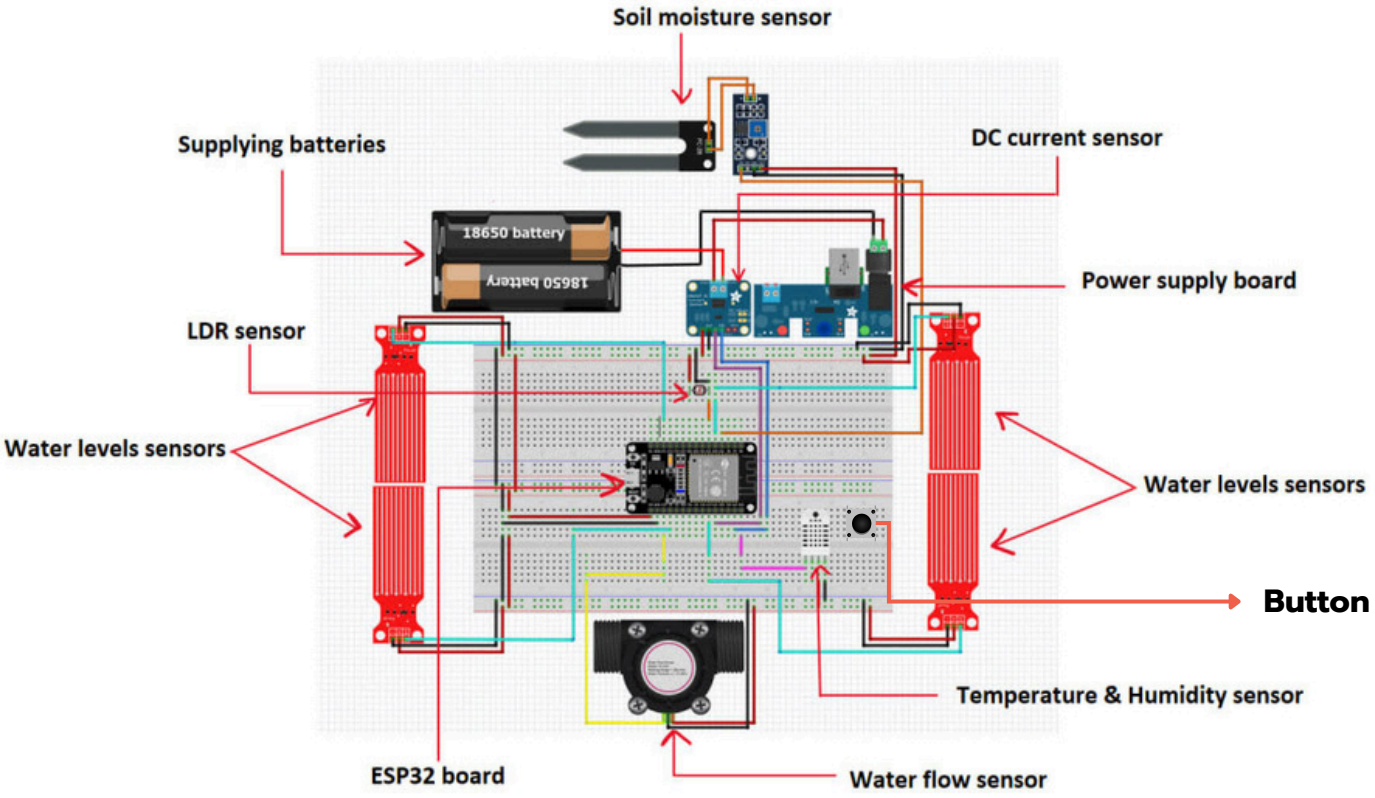
Sensors Integration

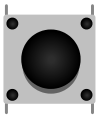
This section explains how the sensors are integrated into the system to monitor key environmental parameters. Each sensor is carefully chosen and connected to ensure accurate data collection for soil moisture, temperature, humidity, light intensity, and water levels, forming the foundation for effective irrigation management.



Energy Efficient System

Deep Sleep Mode

Deep sleep mode is the stater where the ESP32 (Microcontroller), doesn't operate with the full power as a result of swithching off some characterestics in the microcontroller. The deep sleep mode contributes to the battery life of the system

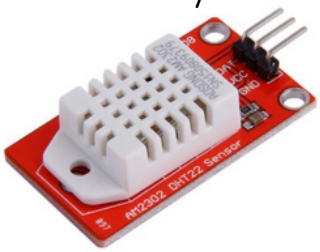


Button

Button is used in the system to control the switching off and on of the water levels. This contributes to both of current and battery life of the system.

Signal Interpretation Techniques

This section elaborates how each sensor interprets the signals inside the system



DHT22 (Temperature sensor)

- **The DHT22 detects the changes in temperature and humidity in the surrounding air. The sensor sends this data as a digital signal to the microcontroller.**
- **The microcontroller interprets the signal as digital data. The temperature and humidity are converted into meaningful values to Celsius and percentage respectively.**
- **The temperature and humidity values are used to determine whether the temperature is too high or low, or the humidity is too dry, affecting irrigation decisions or plant growth.**

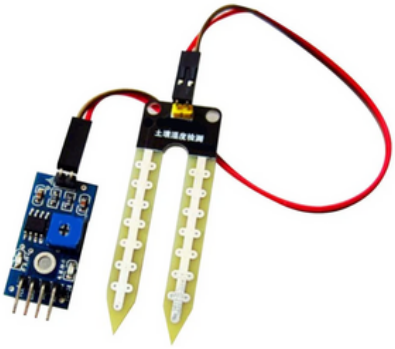
water level sensor

- **This sensor detects the water level in a tank or container. It works by detecting the resistance between different water levels.**
- **The microcontroller processes the water level data by reading the change in resistance and converting it into a signal that indicates whether the water level is low, medium, or high.**
- **The sensor's readings are used to ensure sufficient water for the irrigation system. If the water level is too low, the system can trigger an alert or adjust the irrigation cycle.**

Ina219 (Current Sensor)

The INA219 sensor measures the current flowing through a connected circuit, specifically for monitoring the current consumed by the irrigation system or pumps. It detects small voltage drops across the load.

The microcontroller converts readings of INA219 into the corresponding current value. The system can calculate power consumption by also considering the voltage readings as well as calculating the battery consumption



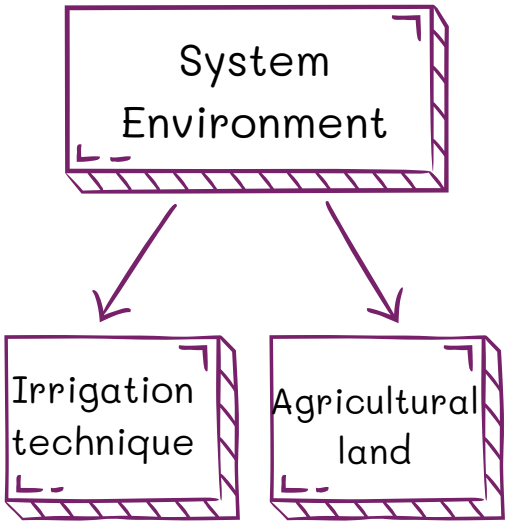
Water Soil Moisture

This sensor measures the conductivity between two probes. The higher the moisture content, the lower the resistance between the probes.

The microcontroller reads the changes in resistance as the moisture level changes. This is processed into a digital signal that indicates whether the soil is dry, moist, or wet.

The moisture level readings determine when irrigation should occur. If the soil is too dry, the system triggers irrigation; if it's moist or wet, the system reduces or stops watering.

System Performance



Agricultural land

The Agricultural basin is divided into 4 sections. In each section, there is a water level sensor to measure the distribution uniformity of the water.

Irrigation technique

Revolving a pipe around the 4 sections of the basins laterally.

Quality and reliability of measurements

Precision

The average of water level values was calculated to reduce the random error which affect the precision of values.
Statistical Moving Average (SMA) was used to measure current along a period of time.

Accuracy

High Accuracy Sensors were used with to reach the most reliable data.
Large Agricultural area is used to measure the Distribution Uniformity with (# x #) cm2 to increase the accuracy of water level measurements

Uncertainty

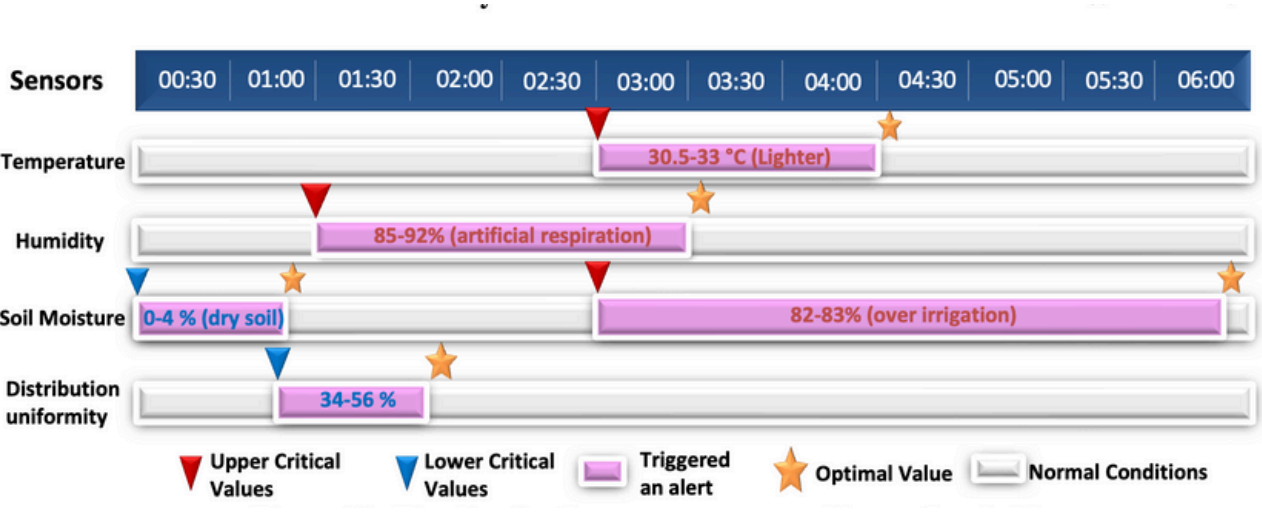
Standard Deviation was used to calculate the uncertainty of the measurement which indicates whether the measured value may exceed or recede by a certain value.

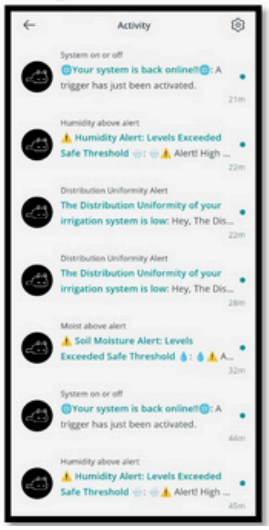
Triggers

Triggers are used for notifying and warning the user from exceeding or receding the measured the optimal value. The following table illustrates the essential values that will face the system

P.O.C	Optimal Range	Upper critical point	Low Critical points	Precision
Temperature	14°C => 24°C	30°C	8°C	0.2575821
Humidity	20% -> 70%	80%	10%	0.23498515
Soil Moisture	20% -> 70%	80%	10%	1.5069821
Water level Sensor	No	No	No	0.77896377
Current Sensor	No	No	No	1.7647337

The following graph describes the triggers of the system and each sensor in the system.





QR code for more details about the project. (Project Website)