Smart Farming

Project for Accurately Monitoring the Current Environment Conditions and the Factors which affect Plant Growth and Yield

Team Details

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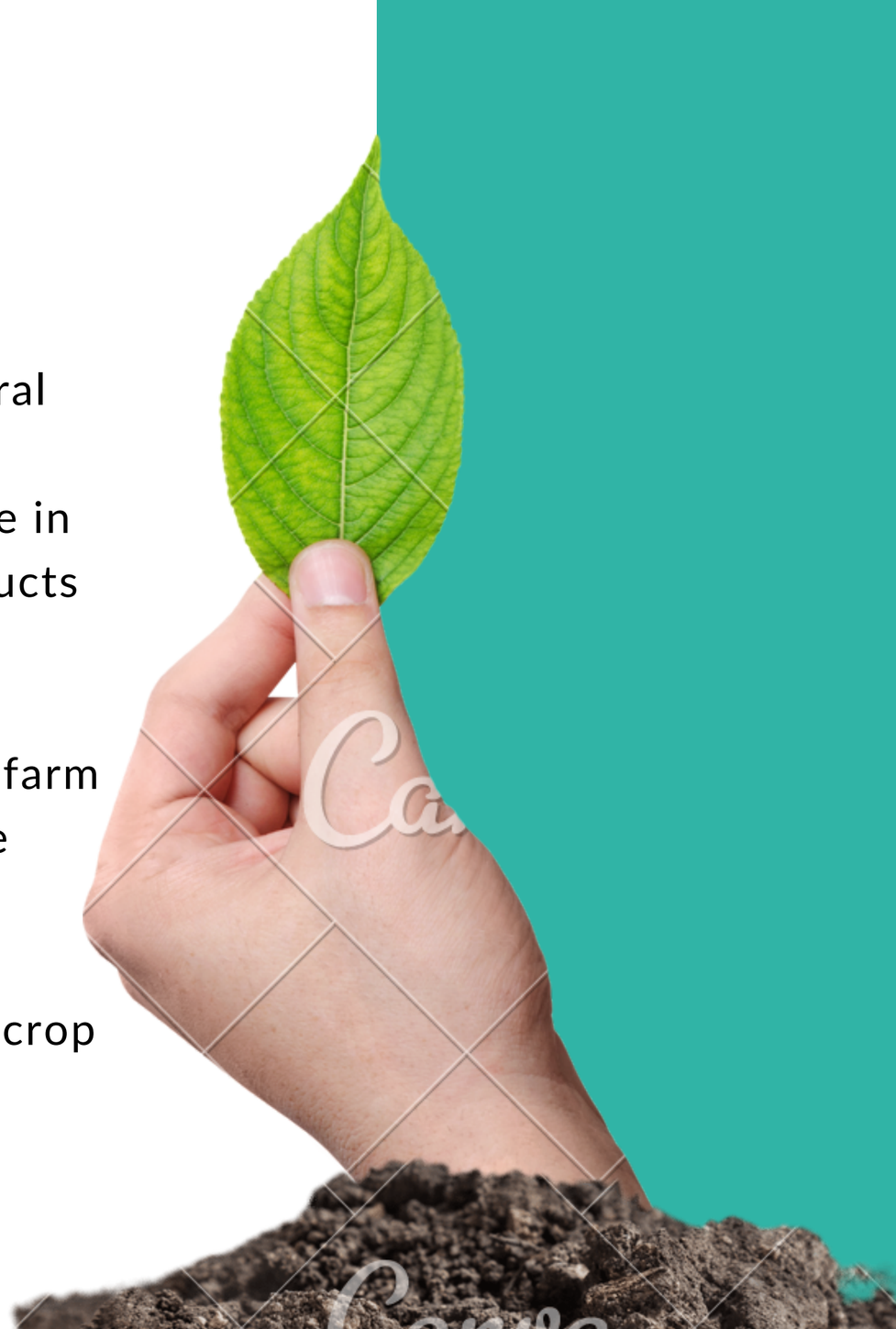
Motivation

- Smart farming refers to an upcoming concept that combines conventional farms with new technologies such as IoT. The purpose of Smart farms is to increase the quality of agricultural products whilst optimising human intervention.
- To address the challenges of farmers, efforts and research are in place to improve the quality and quantity of agriculture products by making them ‘connected’ and ‘intelligent’ through “smart farming”.
- The IoT technology uses a data-driven approach and enables farm managers to keep a detailed check on their crops. It helps the farmers take appropriate actions against unwanted pests and protect their crops from various diseases.
- The smart farming solution keeps an eye on every activity of crop production, which triggers instant alerts about its health, condition, and temperature requirement, and displays all the details on the interconnected smart gadgets.



Implementation Overview

IoT devices installed on a Farm collects and processes data in a repetitive cycle that enables farmers to monitor the emerging issues and changes in the ambient conditions. This Way they can remotely access the Farm's Live Condition from Anywhere in the World.

The driving force of smart farming is IoT—connecting machines and sensors integrated on farms to make farming processes data-driven and automated and much more Efficient.

Observation

Sensors Record Observational data from the Soil and the Atmosphere to Monitor the Live Weather Conditions and Status about the health of the Plant with respect to surrounding conditions

Diagnostics

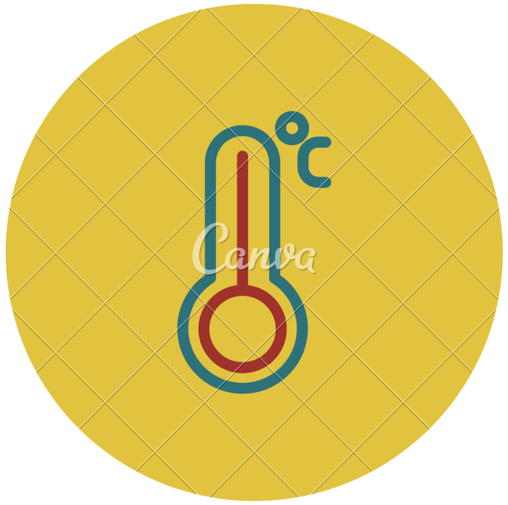
The Sensor Values are Fed to a cloud-hosted IoT platform with predefined decision rules and models. The Data is Simultaneously is updated in the Data Base.

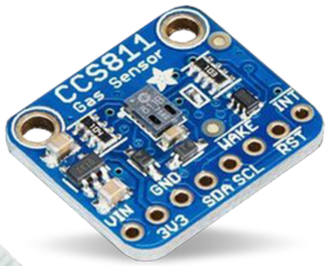
Data Storage

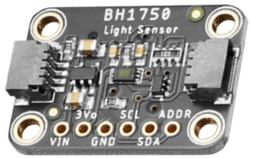
Data collected over the past 1 or 2 month will be stored in a Data Collection Middleware (like MongoDb) for further Analysis of Growth of plant and previous " Medical History "

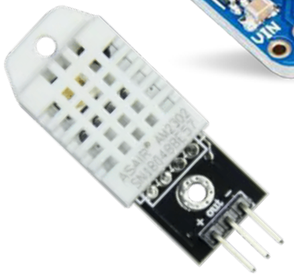
Data Analysis

There will be an interactive Filter - Included dashboard to Analyse the data collected from plant to predict which Plant Flourishes is which Conditions and which type of Plants are optimal for this type of Weather Conditions.









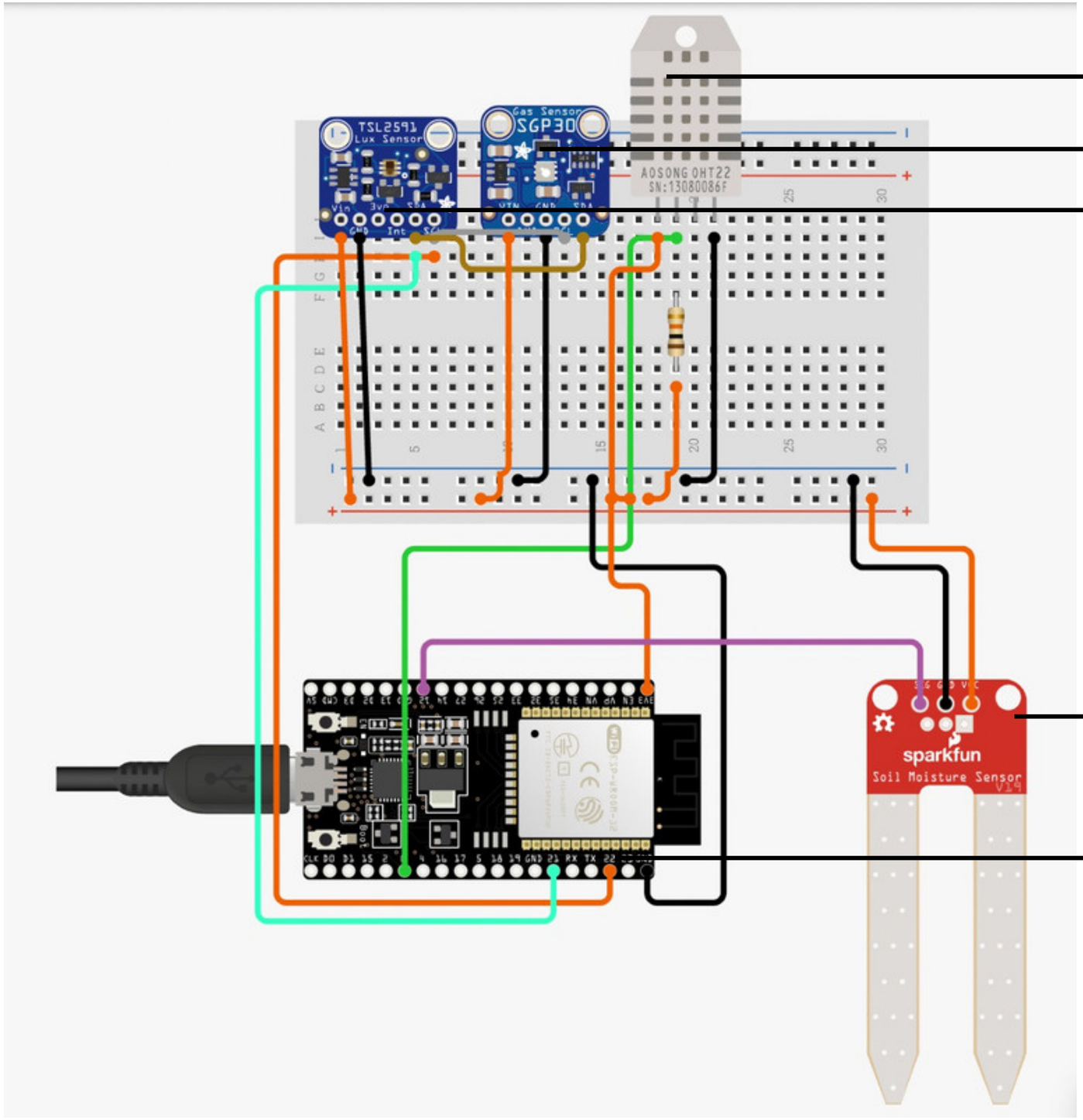
Sensors Used

1) Capacitive Soil Moisture Sensor
2) PRANA AIR (CO2 level in air)
3) BH 1750 (Light intensity Sensor)
4) DHT - 11/22 (Temperature and Humidity Sensor)

Positioning and Placement

- A soil Moisture Sensor will be placed near the Roots of the Plant.
- Rest all the sensors will be soldered and placed in a protective container near the plant to detect atmosphere attributes like Sunlight, CO2 levels, etc.

Circuit Diagram



DHT 22

CO2 Level Sensor

Light Intensity Sensor

Capacitive Soil Moisture Sensor

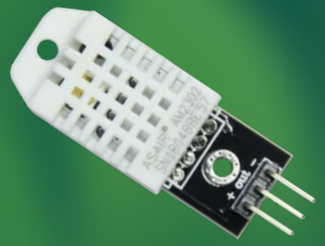
ESP 32

Working of Sensors

A capacitive moisture sensor works by measuring capacitance changes caused by the changes in the dielectric. It does not measure soil moisture directly (as pure water does not conduct electricity well), instead it measures the ions that are dissolved in the moisture

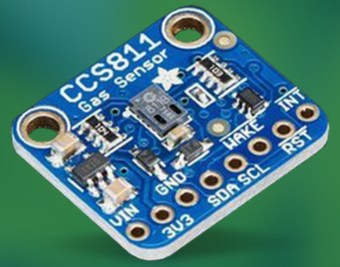
Capacitive soil moisture Sensor v1.2

DHT -11/22 uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed).



Temperature and humidity sensors DHT - 11/ 22

Working of Sensors



Carbon Dioxide Sensors
CCS 811 / SGP 40 Sensors

CCS 811 sensor uses a metal oxide sensor (MOX) paired with a microcontroller unit (MCU), with an analog to digital converter (ADC) and an I2C interface

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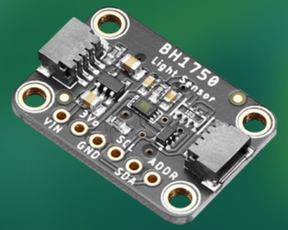
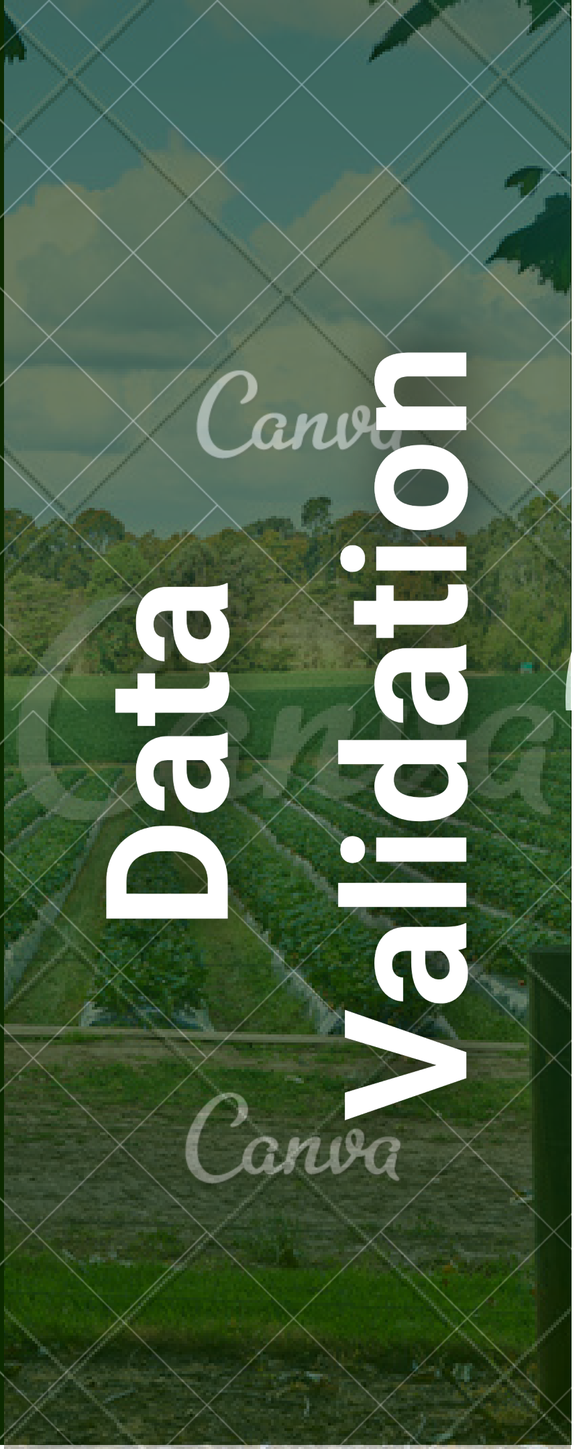


Light intensity Sensor
BH 1750 Sensor

BH 1750 sensor has an ADC to convert analog light intensity to digital LUX values. This sensor uses the I2C communication protocol to send data to the microprocessor



DATA CALIBRATION

- Data Calibration can be used to provide correction of measured data or perform uncertainty calculations.
- For calibrating the data, we found the extreme values provided by the sensors.
- For the soil capacitive sensor, we found the value that the sensor gives when it is kept in air and when it is placed in water separately.These values were treated as the minimum and maximum values of the moisture that the sensor can give. The values which we got when the sensor was in soil were then mapped to a value b/w 0-100% based on these extremes found.
- For all the other sensors, the ranges were given in their datasheet.

DATA CLEANSING

- Based on the known extreme values of the sensors, the sensor data is checked for consistency and accuracy.
- Range :- We check if the data value lies in the range of the sensor values and filter it out if it doesn't.
- Null values :- Sometimes the sensor sends the NAN data or the values are not properly sensed by them. It is made sure that no NULL value is pushed to ThingSpeak or OM2M.

METHODOLOGY

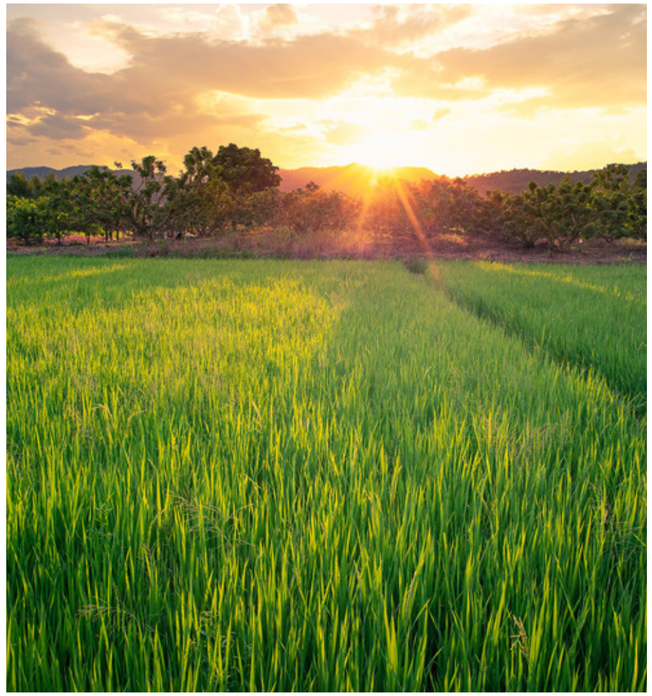
Smart Farming

Choosing OneM2M & ThingSpeak :

- The main reason to choose OneM2M is its interoperability which makes the interaction seamless.
- Soldering: The connections were made permanent by soldering them.
- After successfully obtaining the readings from the individual sensor we compiled and integrated the code for all the individual sensors and added the Things Peak and OneM2M components to the code.

Choosing Sensors and Microcontroller

The sensors have been chosen considering range, sensitivity and resolution attributes.ESP32 was choosen because it provides I2C ,SPI needed for sensors and WiFi service to uplaod the data on online databses.



Field Deployment

Finally, the setup was enclosed in a box along with all the sensors soldered to the PCB and placed in the garden area for collecting real data values.The values were continuously pushed to the ThingSpeak and Om2M .

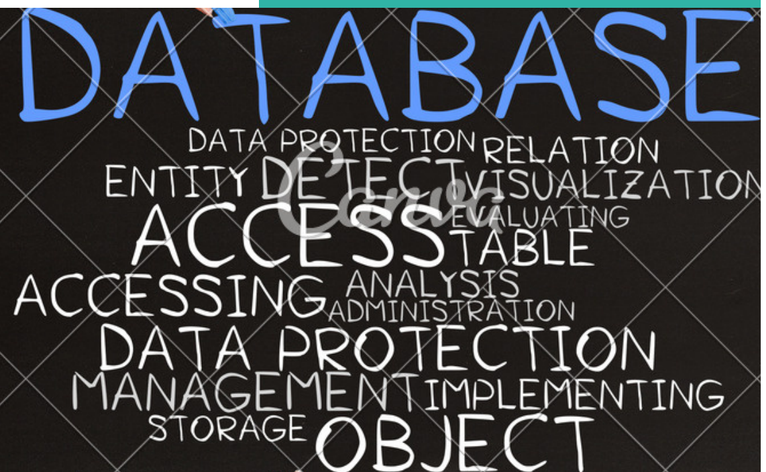
Deployment Campaign

- The hardware was first deployed in a potted plant and tested for the correct values. Arrangements were made for the power connection and stable Wi-Fi so that data can continuously be uploaded to Thing Speak and OneM2M .
- The system was installed to monitor the change in plants value, it was deployed at the central garden area of Nigiri. The sensor enclosure box was kept on the ground near the plants and the soil moisture sensor was buried in the soil nearby. System was provided power using a powerline adapter.
- After tackling little issues like the WiFi not connecting, the system was up and running with the code uploaded and data being sent on ThinkSpeak and OneM2M .

Diagnostics

- The Data Recorded by the Sensors is Updated Live to the Things Speak Channel , OneM2m Server and the Data Base hosted Locally.This Data is Also Updated live in the Dashboard.
- The Predefined Decision Making rules are Implemented here which tell us the Remedy or the Solution to the Current Stress that the Plant may be Experiencing due to various Environmental Factors.
- These Rules are already Pre-defined based on the Crop currently under Observation and the Prevailing Weather Conditions. For Example :- The Plant Growth gets hampered when the Plant Experiences High or Low Temperature Stress.

mongoDB

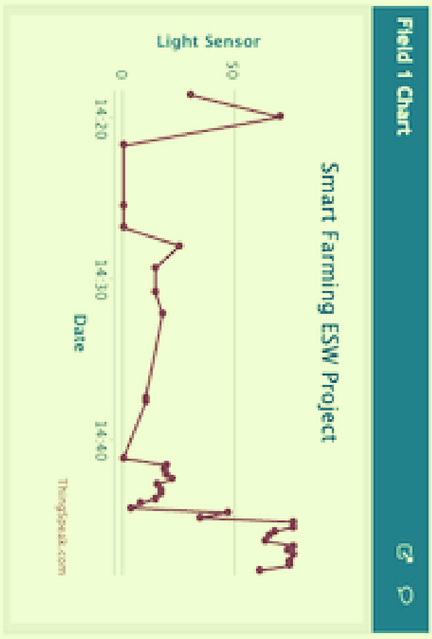


Data Storage

- MiddleWare Used - MongoDb
- Data for the Past 1 or 2 months is Stored for Analysis in the Long Term and provides Medical History of the Farm.
- Used to Simulate conditions as required for the experiment.
- Extremely Useful in Diagnosis and An Extra "Feature" for the User.

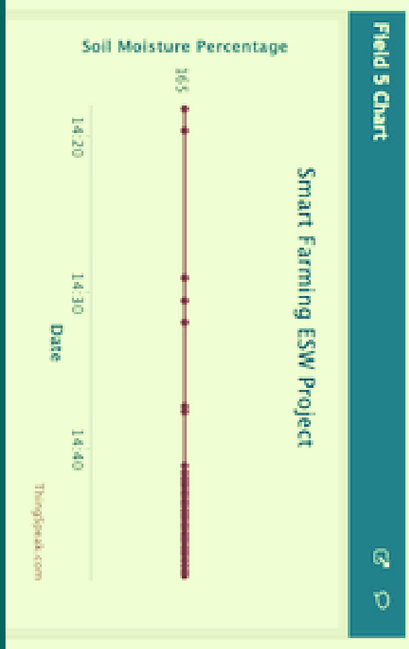
SMART FARMING

BH1750 LIGHT SENSOR

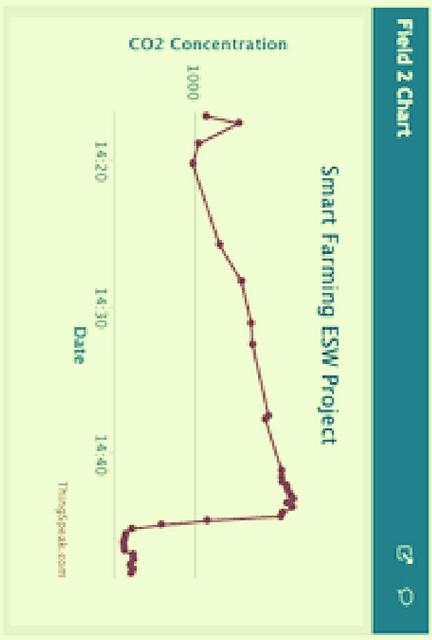


DHT22 TEMPERATURE

CAPACITIVE SOIL MOISTURE



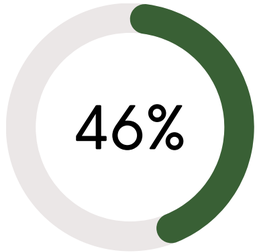
CO2 SENSOR



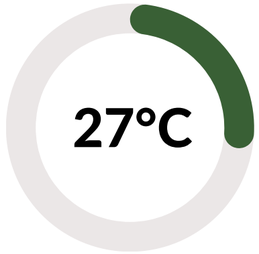
DHT22 HUMIDITY

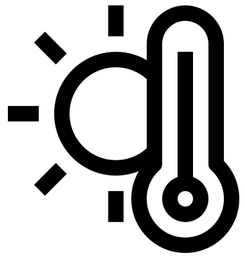
Data Analysis

Observation



- We have seen periodic changes in all parameters except soil moisture this tells us about the stability of weather during current season
- We have also observed that humidity around the stressed plant is lower than the optimal/normal value
- CO_2 conc increases with decrease in light intensity, at night CO_2 conc is more than that at day
- Air humidity is least at around 12 noon because of high sunlight and temp,light intensity is highest at that time
- Air humidity also drops midnight but not as much as during noon
- Temperature and light intensity vary synchronously
- Lower air humidity reduced both the plant growth and activities of photosystems I and II under prolonged heat stress



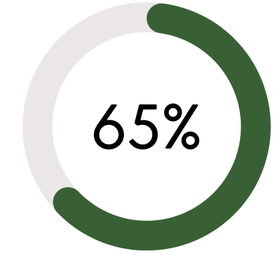


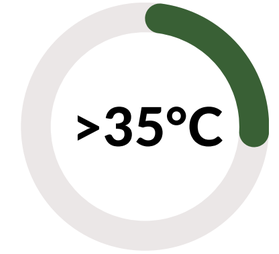
Analysis

- Some crops require certain high or low temperatures to start their germination and continue further development. So according to the average temperature we can recommend farmer which crop to sow
- We can determine rate of photosynthesis and what factors affect photosynthesis and by the information about photosynthesis we can predict plant health.When the sunlight is more CO_2 conc decreases predicting increase in CO_2 , similarily we found out that as humidity was increased, photosynthesis increased, transpiration expressed per unit of vapour pressure difference increased.
- Optimal humidity as found from our data is 46% (between 40 % to 60 %)
- Optimal temperature range was found to be between 25 to 35 degree Celcius (27 degree Celcius)
- As we increase the temperature, rate of photosynthesis increases but after it has reached the optimal temperature (27°C) it starts decreasing. We have concluded all this through our reading of the CO_2 sensors

Data Analysis and its Use

- We also found that the soil moisture of around 50 percent is good for plant health.
- CO_2 conc of about 450ppm works fine for plants but we observed that when we increase the CO_2 levels to about 1000ppm photosynthesis rate increases considerably
- We can perform weather detection based on which, farmers can plan times for sowing, protection, harvesting, and other field activities in order to avoid negative weather effects and yield losses.
- On the other hand, temperatures in combination with humidity are often used to predict various insect pest and disease occurrences.
- Climatic conditions which lead to pathogen production in soil,so we can just analyze our sensor values and alert the farmers that the conditions for pathogena nd pest attack are arising so he could measures to save his crops by adding pesticides and others. Also he will get an idea about how a pesticides affects the plants through our project
- High temperatures above 35 degree Celcius and high humidity above 65 percent along with high CO_2 levels make the conditions suitable for pests and pathogens
- With the data about soil humidity when can implement self-controlled sprinkler which work when soil humidity below certain level
- Various case studies can be done with our project like at which place which crop is better and we could also predict the reasons by thorughly analyzing the data





AGRICULTURE

Use of IoT security tools in your project

Https server

Https is a primary protocol used to send data between a web browser and a website. Https is encrypted in order to increase security of data transfer. Https uses an encryption protocol to encrypt communications . This protocol secures communications by using what’s known as an asymmetric public key infrastructure . This type of security system uses two different keys to encrypt communications between two parties , the private key and the public key .

Login page security

The Dashboard data is accessible only to users with the right access Id and API key .

CHALLENGES

Initially since we were not sure of the pins, soldering wasn't done hence connections were getting loose hence it caused little trouble.
In light sensor data communicatio occurs via I2C communication for which GPIO pins for SDA and SCL were fixed hence rest connections have to set according to it

Since we didn't have any prior experience in soldering, we faced primarily issues in soldering.

Some components were showing faulty behavior such as soil moisture It will be difficult in future to select particular parametrer for growth of plant

Issue was faced to assure all sensors get updated at common time stamp .We also had account for data callibration and that we also get the valid and accurate data for which we made some code changes.

The issue was faced while integrating the codes for all parts and assembling all parts properly on PCB.

FUTURE PLAN

Local Agricultural Industry Owner

In future we hope to extend the project such that it can monitor plants' growth, its water consumption, air consumption. We can take account of its yield.

We can monitor health of plant using image processing and ML Algorithm.
Also we will include the notification system in our dashboard where incase there is abrupt change in values the farmer is notified.

THANK YOU !