IoT Based Smart Agriculture System

A Project report submitted in partial fulfilment
of the requirements for the degree of B. Tech in Electrical Engineering

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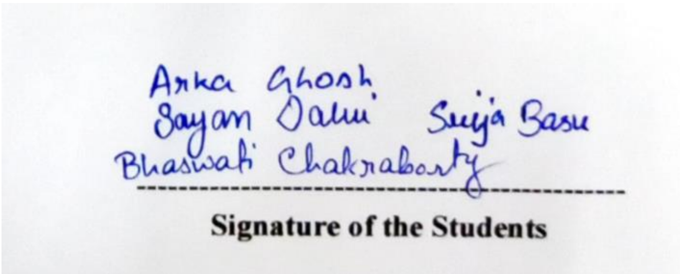

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CERTIFICATE

To whom it may concern

This is to certify that the project work entitled “IoT Based Smart Agriculture” is the bona fide work carried out by **Arka Ghosh, Sayan Dalui, Bhaswati Chakraborty and Srija Basu** , a student of B.Tech in the Dept. of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year 2021-22, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and this project has not submitted previously for the award of any other degree, diploma and fellowship.

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List of Acronyms

°C - Degree Celsius

BI - Business Intelligence

BL - Pin Backlight of the display

CE - Cheap Enable

CLK - Clock

cm - Centimeter

DC - Data/Command

DHT - Digital Humidity and Temperature

DIN - Data In

ESP - Encapsulating Security Payload

GND - Ground

Hz - Hertz

I/O - Input/Output

IoT - Internet of Things

IT - Information Technology

LCD - Liquid Crystal Display

mA - milliampere

mm - Millimeter

RST - Reset pin type

RST - Reset Restart

RxD - Receive Data

TxD - Transmit data

UART - Universal Asynchronous Receiver Transmitter

UN - United Nation

V - Volt

VCC - Common Collector Voltage

Wi-Fi - Wireless Fidelity

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Abstract

Smart farming, precision agriculture and Agriculture 4.0 all involve the integration of advanced technologies into existing farming architecture. The goal is to increase production efficiency and product quality, as well as reducing overall costs. To this end, the inclusion of Smart technologies into Irish agriculture has been inevitable with increased pressure being placed on farming practices to remain profitable, as well as adhere to environmental regulation.

The global Smart Agriculture Solution Market is said to have stood at around US $10.2 Billion in 2016, and is projected to reach a valuation of US $38.1 Billion by the end of 2024. The growing adoption of advanced technology in farming, from agricultural drones, precision seeding systems, auto-steering, automatic feeding systems and fruit-picking robots (amongst others), have all incentivised traditional agri-companies to invest in smart agriculture technology. The deployment of advanced agri-tech has the potential to allow for an increased focus on non-profitable tasks, such as farm maintenance and environmental practices. The reduction of heavy labour and tedious tasks can also lead to improvements in the health and work/life balance of farming staff.

CHAPTER 1: INTRODUCTION

With the exponential growth of world population, according to the UN Food and Agriculture Organization, the world will need to produce 70% more food in 2050, shrinking agricultural lands, and depletion of finite natural resources, the need to enhance farm yield has become critical. Limited availability of natural resources such as fresh water and arable land along with slowing yield trends in several staple crops, have further aggravated the problem. Another impeding concern over the farming industry is the shifting structure of agricultural workforce. Moreover, agricultural labor in most of the countries has declined. As a result of the declining agricultural workforce, adoption of internet connectivity solutions in farming practices has been triggered, to reduce the need for manual labor.

IoT solutions are focused on helping farmers close the supply demand gap, by ensuring high yields, profitability, and protection of the environment.

The approach of using IoT technology to ensure optimum application of resources to achieve high crop yields and reduce operational costs is called precision agriculture. IoT in agriculture technologies comprise specialized equipment, wireless connectivity, software and IT services.

BI Intelligence survey expects that the adoption of IoT devices in the agriculture industry will reach 75 million in 2020, growing 20% annually. At the same time, the global smart agriculture market size is expected to triple by 2025, reaching $15.3 billion (compared to being slightly over $5 billion back in 2016).

Fig 1. IoT based smart agriculture will be the future

Smart farming based on IoT technologies enables growers and farmers to reduce waste and enhance productivity ranging from the quantity of fertilizer utilized to the number of journeys the farm vehicles have made, and enabling efficient utilization of resources such as water, electricity, etc. IoT smart farming solutions is a system that is built for monitoring the crop field with the help of sensors (light, humidity, temperature, soil moisture, crop health, etc.) and automating the irrigation system. The farmers can monitor the field conditions from anywhere. They can also select between manual and automated options for taking necessary actions based on this data. For example, if the soil moisture level decreases, the farmer can deploy sensors to start the irrigation. Smart farming is highly efficient when compared with the conventional approach. IoT have the potential to transform agriculture in many aspects and these are the main ones.

Data collected by smart agriculture sensors, in this approach of farm management, a key component are sensors, control systems, robotics, autonomous vehicles, automated hardware, variable rate technology, motion detectors, button camera, and wearable devices. This data can be used to track the state of the business in general as well as staff performance, equipment efficiency. The ability to foresee the output of production allows to plan for better product distribution.

Agricultural Drones Ground-based and aerial-based drones are being used in agriculture in order to enhance various agricultural practices: crop health assessment, irrigation, crop monitoring, crop spraying, planting, and soil and field analysis.

Fig 2. Agricultural drone

Livestock tracking and geofencing farm owners can utilize wireless IoT applications to collect data regarding the location, well-being, and health of their cattle. This information helps to prevent the spread of disease and also lowers labor costs.

Fig 3. Livestock tracking becomes very easy with IoT application

Smart Greenhouses - A smart greenhouse designed with the help of IoT intelligently monitors as well as controls the climate, eliminating the need for manual intervention.

Fig 4. Smart greenhouse can be designed with IoT applications

Predictive analytics for smart farming Crop predication play a key role, it helps the farmer to decide future plan regarding the production of the crop, its storage, marketing techniques and risk management. To predict production rate of the crop artificial network use information collected by sensors from the farm. This information includes parameters such as soil, temperature, pressure, rainfall, and humidity. The farmers can get an accurate soil data either by the dashboard or a customized mobile application.

Fig 5. Production quality and quantity increases with proper predictive analytics and corresponding actions.

Farmers have started to realize that the IoT is a driving force for increasing agricultural production in a cost-effective way.

Because the market is still developing, there is still ample opportunity for businesses willing to join in.

CHAPTER 2: WORKING PRINCIPLE

The aim of the project is to improve the agricultural system by introducing IOT sensors which are capable of providing information about agriculture fields. We have proposed an IOT and smart agriculture system using automation.

2.1 Block Diagram

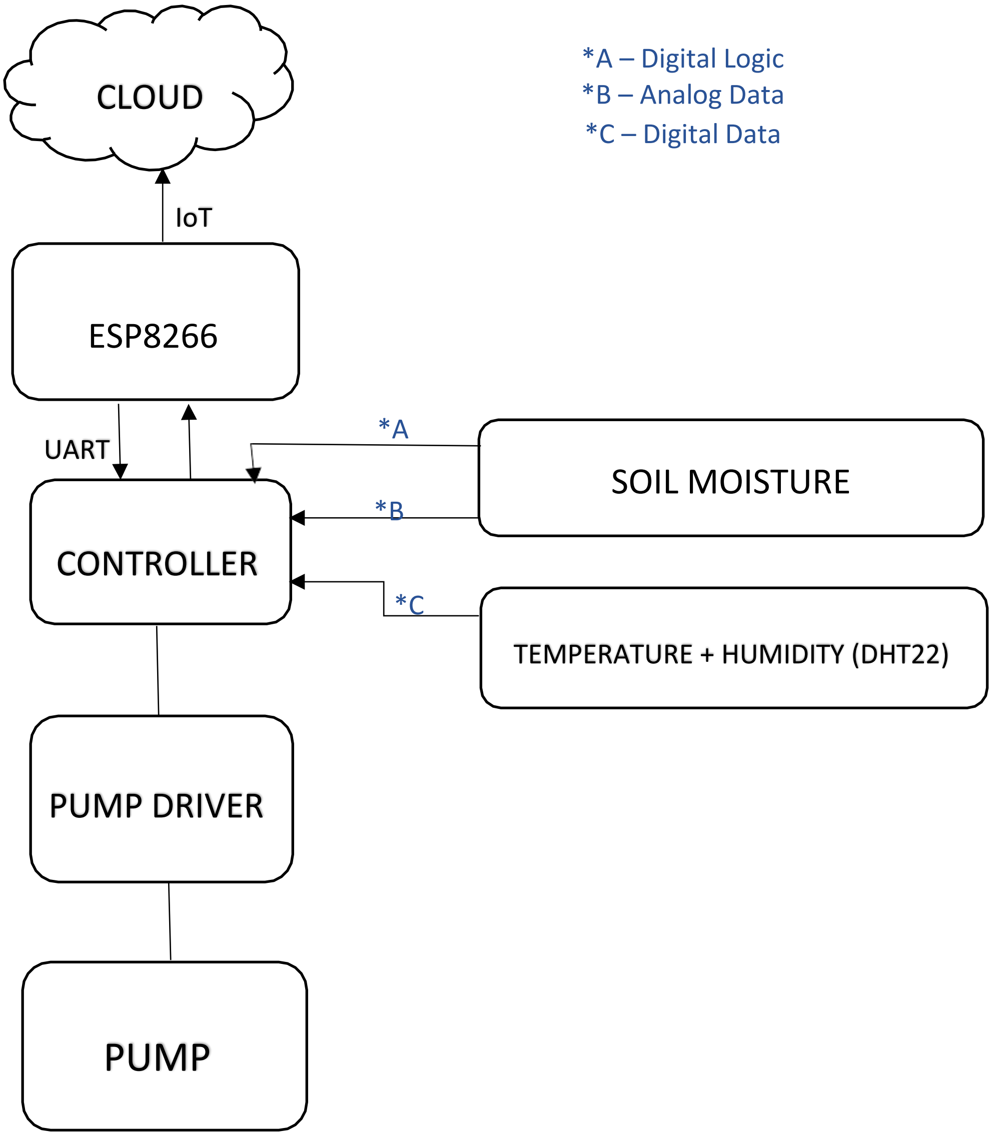

Fig. 6 Block diagram

2.2 Circuit Diagram

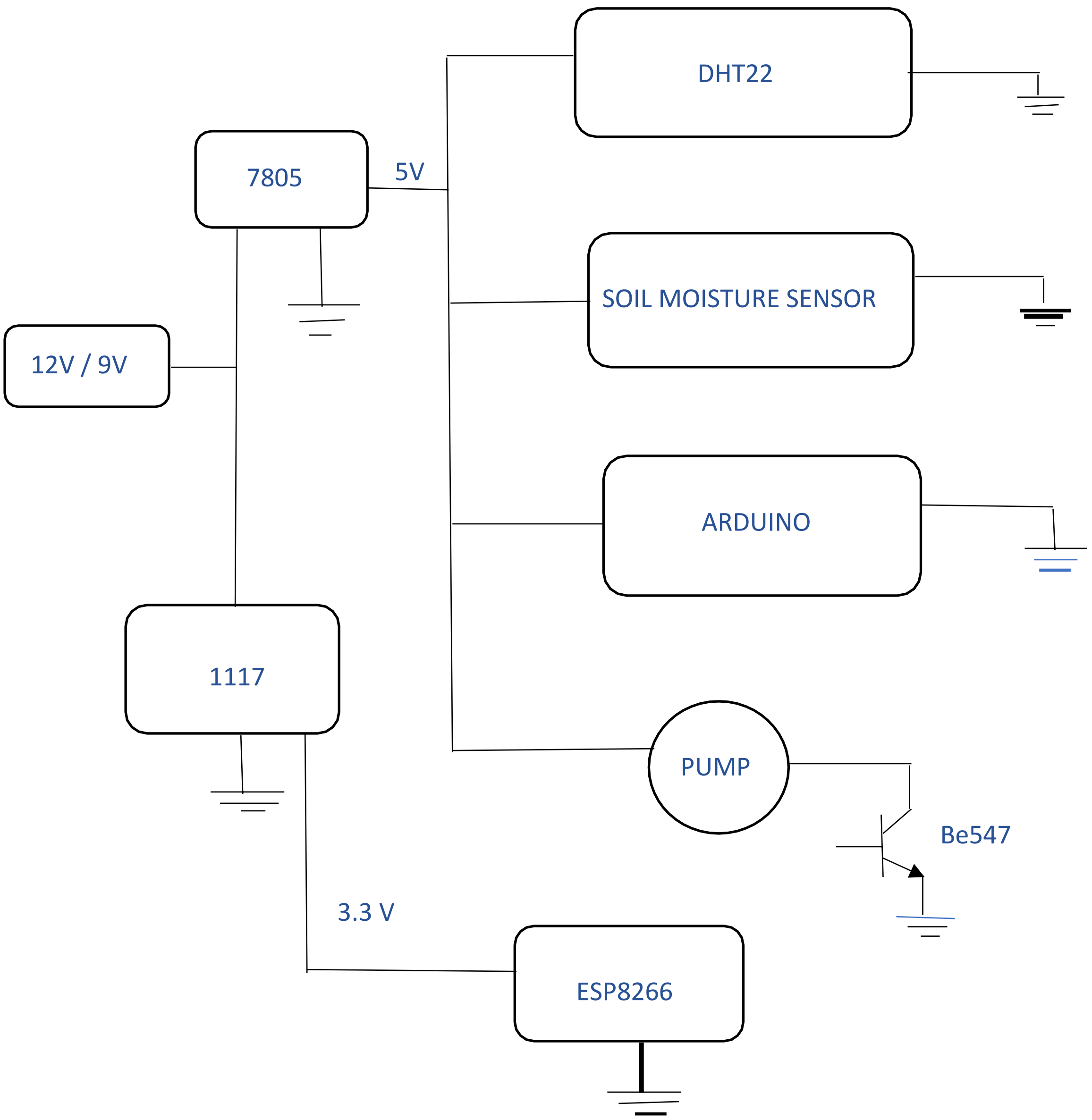

Fig. 7 Circuit Diagram

CHAPTER 3: FARM MONITORING SYSTEM

The farm monitoring system is a mixture of hardware and software additives. The hardware part includes embedded systems and software program is the Arduino ide. The Arduino ide displays readings from sensors are inserted using the hardware. The special sensors used are temperature and humidity sensor and soil moisture sensor. The facts gathered with the aid of the sensors is sent to the Arduino UNO microcontroller. The gathered information may be displayed in an Arduino IDE. An ESP-01 module is hooked up with the Arduino to facilitate notifying service which updates the farmers each 10 seconds approximately the climate conditions of the subject. This project is aided with many hardware. This proposed technology is an amalgamation of different sensors, microcontroller and communication medium to help the farmers to work on their farms.

3.1 Arduino uno

Arduino is a microcontroller to control the working of the sensors and manage the working of the device. The Uno version of Arduino is implemented in this project. It was developed by Arduino CC. The Arduino board comes with various number of pins. The pins are categorized as output and input pins. The input pins accept digital as well as analog pins. It has 14 digital pins and 6 analog pins. It accepts 7 to 20 volts of power for working. It also has an USB port. The Uno was the first version of Arduino to be introduced in the Arduino family.

Fig 8. Arduino uno

3.2 Soil Moisture Sensor

The Soil Moisture sensor is used to sense moisture content in the soil. It checks the volume of water content or moisture present in the soil. The calculations are done in the soil moisture sensor through coefficients. It estimates the volume of water content in the soil. It detects the water content in the soil and gets and sends the analog signals which is shown digitally. It transmits the signals containing information or data or values of the condition of soil to Arduino to further process it and display.

Fig 9. Soil Moisture Sensor

3.3 Nokia 5110 LCD Display Interface with Arduino

This LCD device is mainly used in Arduino but it can be connected with any 3.3V controller. These LCDs are used in Nokia 3110/5110 cell phones. It is a very cheap monochrome LCD module made of 84 x 48 pixels. It can be used to display graphics and text together. This display is based on the PCD8544 driver.

Fig 10. LCD Screen

Pin configuration of this device is almost like the 16x2 LCD module only instead of 8 data pins one serial data in (Din) pin and one clock are there.

The list of the pins and their description are listed below.

RST: Pin type active low, so 0V Resets the LCD

CE: Cheap Enable is used to enable the device before sending anything to the LCD

DC: Data/Command is used to select between Rata Register or Command Register

DIN: Data In is used to send information serially to the display. It could be Data or Command

CLK: Clock is used to synchronize the display with the controller

VCC: To power, the pin 5V or 3.3V is applied here

BL: This pin is used to power the Backlight of the display

GND: This is used to ground the device.

Things we need

- Nokia 5110 Display
- Arduino
- Resistors
  1. 1k Ohms x 5 Nos.
  2. 330 Ohms / Potentiometer 1k
- Jumper Wires
- Bread Board

Connection Diagram:

pin 7 - Clock (CLK)

pin 6 - Data In (DIN)

pin 5 - Data/Command select (D/C)

pin 4 - Chip Enable/select (CE/CS)

pin 3 - Reset (RST)

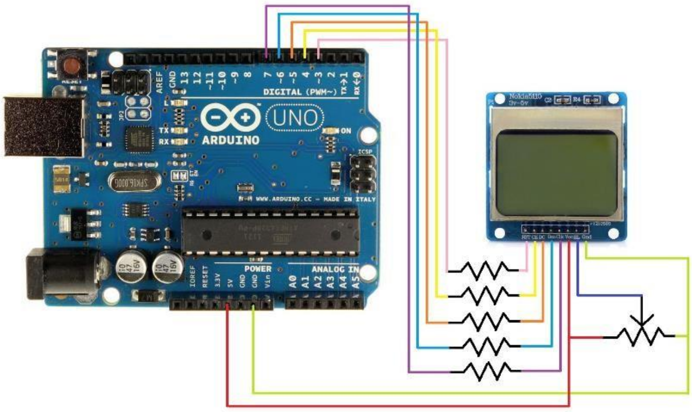

Fig 11. Connection of the LCD screen with the Arduino

3.4 ESP-01

ESP-01 Module is basically a low-cost esp8266 module, with built-in WIFI. It was created as an Arduino WIFI module but it can also be programmed to work as standalone. Although this module is cheap but working with it is a little difficult. As it is not a breadboard-friendly module it would be a bad choice for a beginner.

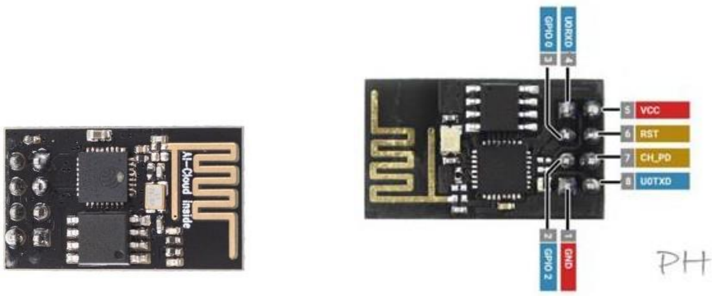

Fig 12. ESP-01

Less I/O pins make it a little difficult to use in standalone mode in projects.
It has 8 pins.

- Pin1: Ground Pin

- Pin2: GPIO2 Pin
- Pin3: GPIO0 Pin
- Pin4: RXD is UART data receive pin.
- Pin5: Vcc is for powering the Module. Only 3.3V power is required.
- Pin6: RST is for external reset. It's active Low in nature.
- Pin7: CH_PD is an active-high pin for Chip enable.
- Pin8: TXD is UART data send pin.

3.5 DHT22

This project is about the interfacing of a DHT22 module with Arduino UNO. The data for temperature and humidity are displayed on the Serial Terminal.

Components Required:

1. Arduino Uno
2. DHT22 Module
3. Data Cable
4. Jumper wires

DHT11 and DHT22 sensors are very basic and slow but are great for hobbyists who want to do some basic data logging. The DHT sensors are made of two parts, a capacitive humidity sensor, and a thermistor. There is also a very basic chip inside that does some analog to digital conversion and spits out a digital signal with the temperature and humidity. The digital signal is fairly easy to read using any microcontroller.

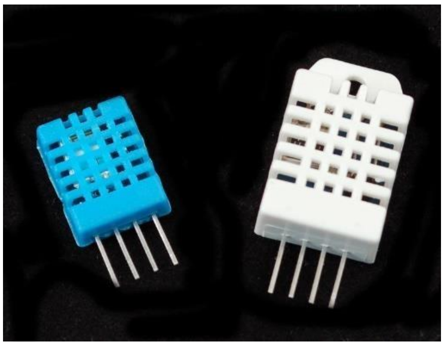


Fig 13. DHT 22

There are two versions of the DHT sensor, they look a bit similar and have the same pinout, but have different characteristics. Here are the specs:

DHT11:

- Ultra-low-cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 20-80% humidity readings with 5% accuracy
- Good for 0-50°C temperature readings ±2°C accuracy
- No more than 1 Hz sampling rate (once every second)
- Body size 15.5mm x 12mm x 5.5mm
- 4 pins with 0.1" spacing

DHT22:

- Low cost
- 3 to 5V power and I/O
- 2.5mA max current use during conversion (while requesting data)
- Good for 0-100% humidity readings with 2-5% accuracy
- Good for -40 to 80°C temperature readings ±0.5°C accuracy
- No more than 0.5 Hz sampling rate (once every 2 seconds)
- Body size 15.1mm x 25mm x 7.7mm

- 4 pins with 0.1" spacing

As you can see, the DHT22 is a little more accurate and good over a slightly larger range. Both use a single digital pin and are 'sluggish' in that you can't query them more than once every second or two.

Pinout: VCC supplies power for the module. You can directly connect it to the 5V pin on the Arduino. Data pin transmits the temperature and humidity data in digital form. GND is the Ground Pin and needs to be connected to the GND pin on the Arduino.

3.6 DC Motor

DC motors are a key component for many agricultural applications, often offering a most efficient form of motion, particularly when solar and battery power is utilised. Some of our own drives are relied on under challenging conditions - for example, they have been in use on Mars for years (although not for agricultural purposes, yet). But DC motors also function in tough agricultural conditions flawlessly and efficiently. Motors, gearheads, sensors, batteries and controllers all constitute the basic building blocks for complex applications. Our own mobile apps include cloud connectivity and give our customers access to a range of functions, including retrieval of current driving data and positions, customisation of parameters and fleet management. All components are verified by our specialists and then perfectly matched to each other. This allows us to offer users a system solution from a single source.

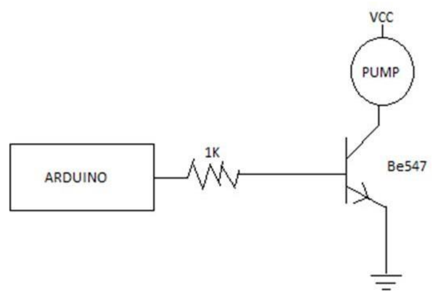

Fig. 14 Circuit Diagram of DC motor

CHAPTER 4: FLOWCHART

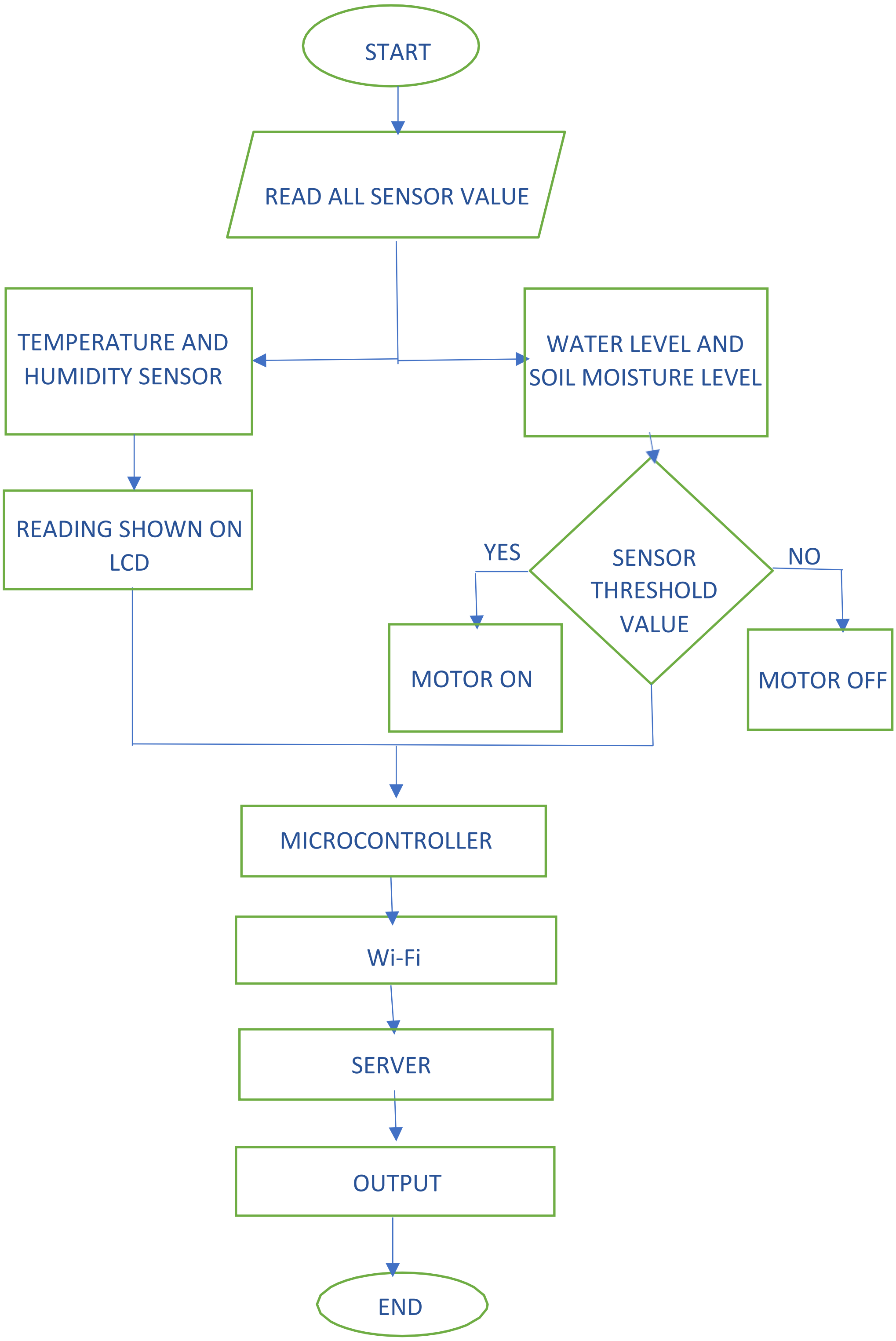

Fig. 15 Flowchart of the project

4.1 WORKFLOW

In the power circuit, 9v power comes from the adaptor, and flows to two channels first a 7805 regulator and a 1117 regulator. From the 7805 regulator 5v current passes to DHT22 sensor, soil moisture sensor, Arduino and the pump. While from the 1117 regulator 3.3 v passes to ESP8266 device.

Digital and analog data is fed from the soil moisture sensor and the temperature and humidity sensor to the controller, the controller processes the data and primarily has 3 outputs. temperature readings and moisture levels are displayed on the lcd device while the data is also pushed into ESP8266 device with the help of UART scripting and then it is fed into the cloud, while the controller controls the pump through a npn transistor which is the third from of output.

CHAPTER 5: SOFTWARE PROGRAM

```
#include <SPI.h>
#include <Adafruit_GFX.h>
#include <Adafruit_PCD8544.h>
#include <DHT.h>
float t, h, m1,  m2;
Adafruit_PCD8544 display = Adafruit_PCD8544(6, 5, 4, 3, 2);
#define DHTPIN 12
#define DHTTYPE DHT22
DHT dht (DHTPIN,  DHTTYPE);
void setup()
{
  Serial.begin(9600);
  while (!Serial) continue;

  display.begin();
  display.setContrast(35);
  display.clearDisplay();
  display.setTextSize(1);
  display.setTextColor(BLACK);
  display.setCursor(0, 0);
  display.println(" IoT Based");
  display.println("Smart Farming");
```

```
  display.display();
  delay(2000);
  display.clearDisplay();
  display.display();
  pinMode(13, OUTPUT);
  pinMode(11, INPUT);
  digitalWrite(13, LOW);
  dht.begin();
}
void loop() {
  float h = dht.readHumidity();
  float t = dht.readTemperature();
  float m = abs(100-(analogRead(A0)/10.23));
  if (isnan(h) || isnan(t)) {
    Serial.println("Failed to read from DHT sensor!");
    return;
  }
  int it = t*100;
  int ih = h*100;
  int im = m;
  bool pc = digitalRead(11);
  digitalWrite(13, pc);

  display.clearDisplay();
```

```
  display.setCursor(0, 0);
  display.println("Smart Farming");
  display.print("Temp: ");
  display.println(t,1);
  display.print("Hum: ");
  display.println(h,1);
  display.print("Soil: ");
  display.println(m,0);
  if (pc == 1)
  display.print("Pump on");
  display.display();

  // Send Data to Cloud
  StaticJsonDocument<200> doc;
  doc["it"] = it;
  doc["ih"] = ih;
  doc["im"] = im;
  doc["pc"] = pc;
  serializeJson(doc, Serial);
  delay(500);
}
```

CHAPTER 6: OBSERVATION AND READING

You can see Fig. 16 and Fig. 17 shows the picture of the final prototype.

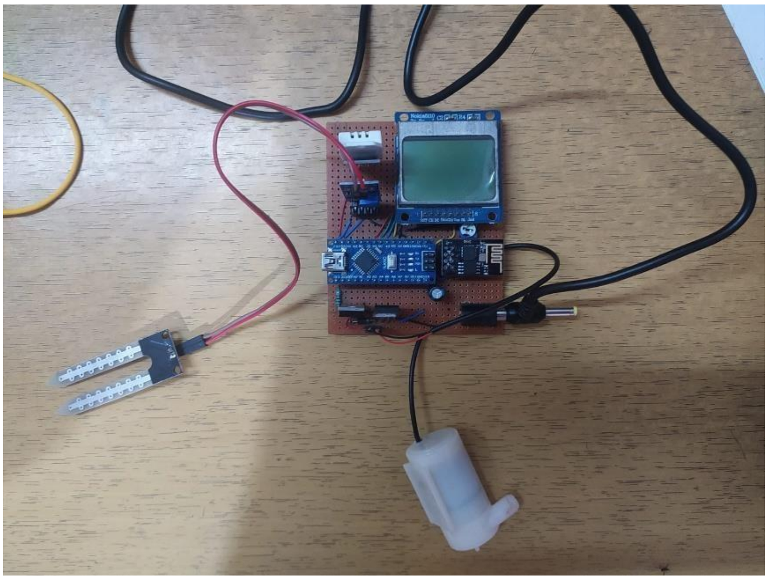

Fig 16. Prototype in off condition

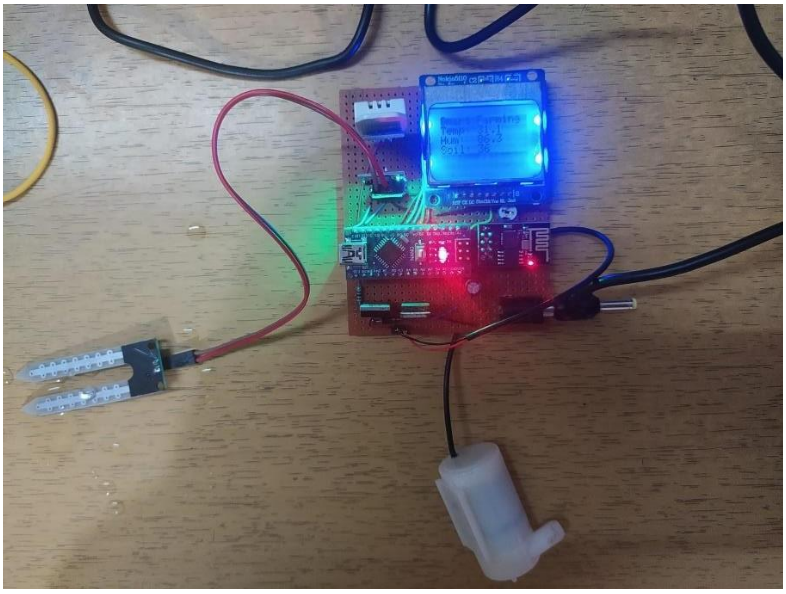

Fig 17. Prototype in on condition

6.1 Basic Operation

The ESP-01 of the prototype at first connects to UART website through Wi-Fi. Here, we are connecting it with the website ThinkSpeak (https://thingspeak.com/pages/learn_more). ThingSpeak™ is an IoT analytics platform service that allows you to aggregate, visualize and analyze live data streams in the cloud. ThingSpeak provides instant visualizations of data posted by your devices to ThingSpeak. With the ability to execute MATLAB® code in ThingSpeak you can perform online analysis and processing of the data as it comes in. ThingSpeak is often used for prototyping and proof of concept IoT systems that require analytics.

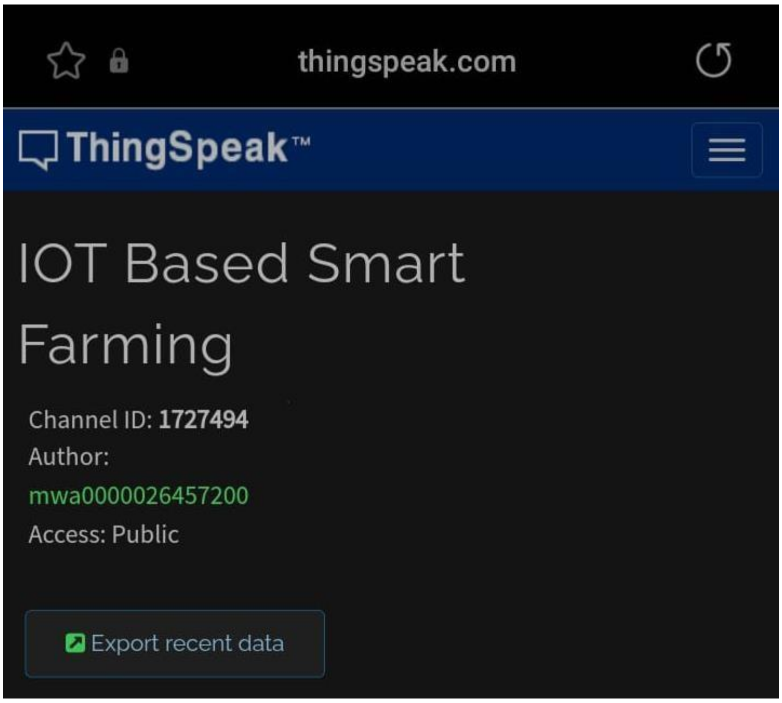

Fig. 18 ThinkSpeak provides a user-friendly platform

6.2 Operation 1: Temperature and Humidity Reading

The DHT-22 helps us to get the temperature and humidity value at any particular time. Keeping a check in the temperature and humidity value will help the user in taking care of livestock and special plants. From DHT22, the signal gets passed to ESP8266 which further passes the signal to the website from where the user can get notified even when away from the field.

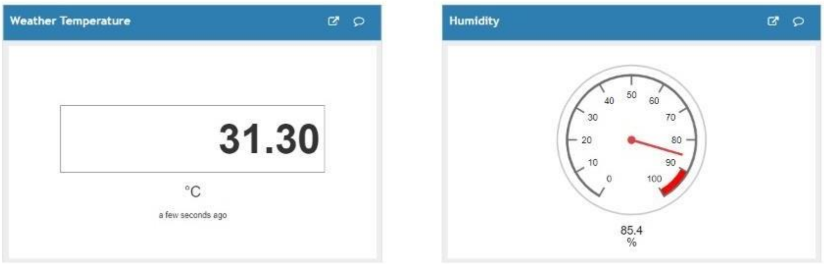

Fig. 19 Record of temperature and humidity

Fig. 20 Temperature and Humidity Graph

6.3 Operation 2: Soil Moisture Determination

The soil moisture sensor determines the moisture content of the soil. If the value is below the threshold value, it sends signal to the DC motor i.e., the pump and automatically the pump gets on and waters the field.

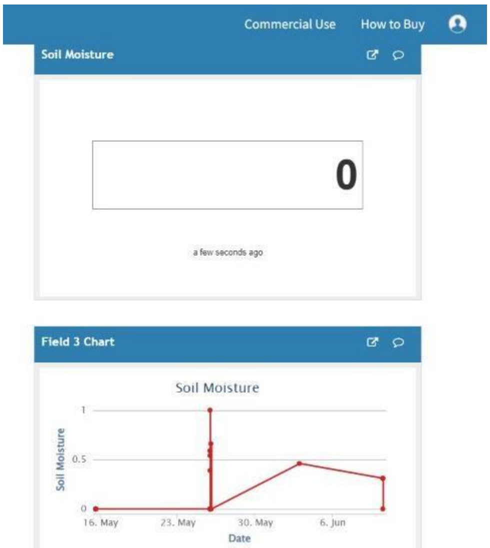

Fig. 21 Moisture content of the field along with the graph

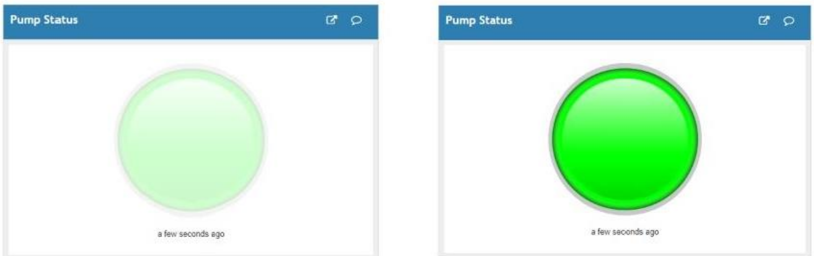

Fig. 22 Pump automatically gets on when the soil moisture content is below the threshold level.

CHAPTER 7: CONCLUSION

The Farm Monitoring System can be used for destiny factors of agriculture. This would be a relief for farmers since it decreases the load of manual efforts A gadget to screen moisture levels within the soil changed into constructed and the assignment furnished a possibility to take a look at the prevailing structures, at the side of their features and downsides. The stated gadget may be used to turn on/off the water sprinkler in keeping with soil moisture levels thereby automating the technique of irrigation that is one of the most time ingesting activities in farming. Agriculture is one of the most effort-consuming hobby. The device makes use of statistics from soil moisture sensors to irrigate soil. The proposed assignment may be further greater with the aid of including pump to the machine to facilitate computerized irrigation. The automated irrigation device may be triggered when the moisture content of the soil is going under the brink stage. The threshold degree can be decided in the code written for Arduino. So, whenever the fee for moisture goes under the brink degree, the pump gets mechanically on and irrigation is performed to an ok degree. To improve the efficiency and effectiveness of the machine, the noted recommendations can be placed into attention. Alternative of controlling the water pump may be given to the farmer by way of which they are able to turn on or off the pump to be able to start or prevent the manner of irrigation without being there on farm at that gift time. The farmer can know earlier about the negative climate situations. In such instances farmer might also want to forestall the machine remotely or routinely. The concept of the usage of IOT for irrigation can be prolonged in addition to other tasks in farming together with farm animals' management, fireplace detection and climate manage. This could limit human intervention in farming sports.

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