AUTOMATIC IRRIGATION SYSTEM WITH CROP RECOMMENDATION SYSTEM

RESEARCH INTERSHIP FOR STUDENTS OF OTHER INSITUTIONS

DEPARTMENT OF INFORMATION TECHNOLOGY
SRI SIVASUBRAMANIYA NADAR COLLEGE OF ENGINEERING
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BONAFIDE CERTIFICATE

Certified that project report titled **AUTOMATIC IRRIGATION SYSTEM WITH CROP RECOMMENDATION SYSTEM** is the bonafide work of **ROHETH S (2127200801071 – III YEAR)**, Sri Venkateswara College of Engineering (SVCE), who carried out the project work under our supervision as an research internship project in the Department of Information Technology, SSN College of engineering during July – August 2022.

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ABSTRACT

Water is one of the fundamental needs for life on earth. Due to population growth, water is becoming increasingly scarce. Thus, this is emerging as a common barrier. The outdated irrigation system uses huge water than required; thus, it requires clever methods to lower the amount of water wasted during irrigation. The need for the internet of things has been rising dramatically across all industries, from small and simple applications to large and complicated ones. A superb management system can be built when combined with the internet of things and intelligent wireless sensors. The DTH11 sensor senses the humidity and temperature level around the plant. The Soil Moisture Sensor detects the soil moisture level in a plant's soil; if the moisture level is below the minimum need, water is supplied via a relay. A microcontroller called the ESP8266 NodeMCU collects data from intelligent wireless sensors, processes it, and sends it to its destination using the Message Queue Telemetry Transport (MQTT) protocol.

The primary issue facing Indian farmers is that they frequently fail to select the appropriate crop for their soil. They thus see a significant decline in production. Precision agriculture is used to solve this issue for farmers. Precision agriculture is a cutting-edge farming method that uses research data on soil types, characteristics, and crop yields to recommend the best crop to farmers based on site-specific factors. As a result, crop selection errors will decrease, and production will increase. In order to recommend a crop for the site-specific parameters with high accuracy and efficiency, this problem is solved by proposing a recommendation system through an ensemble model with machine learning algorithms Decision Tree, Random Forest, K-Nearest Neighbor, and Naive Bayes.

Keywords: Automatic Irrigation, Machine Learning, Internet of Things, MQTT protocol, Crop Recommendation.

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LIST OF SYMBOLS AND ABBREVIATIONS

EXPANSION	NAME
GUI	Graphical User Interface
IOT	Internet of Things
K-NN	K-Nearest Neighbor
ML	Machine Learning
MQTT	Message Queue Telemetry Transport

1. INTRODUCTION

Our ability to survive economically, socially, politically, and culturally depends on agriculture. The agriculture sector is currently dealing with a wide range of issues due to the inefficient and careless use of water resources. Agriculture both contributes to and is a victim of water scarcity. Currently, irrigation uses more than 84 percent of the water available in the nation. Field water management contributes most to the environment and the water shortage. While some farmers may have enough rain, it frequently rains when it is not desired and disappears during droughts.

The agriculture industry also has the challenge of meeting India's population is expanding demand while ensuring food safety due to limited land resources. Almost everyone is reliant on agriculture, either directly or indirectly. 70% of the population in India directly depends on agriculture. Making agriculture bright is necessary in the technologically advanced world of today. The development of intelligent agriculture can make use of a variety of contemporary technology.

This report suggests using machine learning techniques in conjunction with the Internet of Things. The Internet of Things (IoT) is a network of physical devices and other objects that are embedded with software and sensors to allow them to collect and exchange data. The Internet of Things enables remote sensing and control of objects through existing infrastructure. The Internet of Things (IoT) is a sophisticated automation and analytics system that uses big data, artificial intelligence, networking, sensing, and sensing technology to give comprehensive systems for a good service. The idea of machine learning in computer science involves feeding a system with much data and then having the system utilize that data to inform future decisions.

The researchers found that the intelligent farming strategy generated the best production, with 97-ninety-nine percent of the most manufacturing and at a lower environmental cost.
IoT is allegedly changing and reinventing everything from business to person-to-person. IoT is a contemporary technology that enables data to be shared across a community without human involvement. The Internet of Things has gained more and more traction, and connected devices have crept into every aspect of our lives. These include agriculture, health and fitness, home automation, transportation and logistics, smart cities, and commercial IoT. Now IoT technology is even being used in agriculture. According to BI research, by 2020, there will be 75 million installations of agricultural IoT tools, growing at 20% each year.

Over the past few decades, agriculture has become increasingly cutting-edge and era-driven. Farmers have gained more control over the crop boom by using various intelligent technology to make it more predictable and efficient. Farmers are traveling more frequently to demonstrate continuous processes, including irrigation, cultivation, harvesting, and crop drying, as well as to examine livestock, operate machinery, and communicate with other community nodes. A number of these tasks might be automated with minimal human involvement if IoT is used in agriculture. Sensors are now employed in practically all IoT applications and are getting smaller and smaller as technology advances. The actuators control pumps based on judgments made from the data that sensors collect on the soil quality. Figure 1.1 illustrates the block diagram of the prototype.

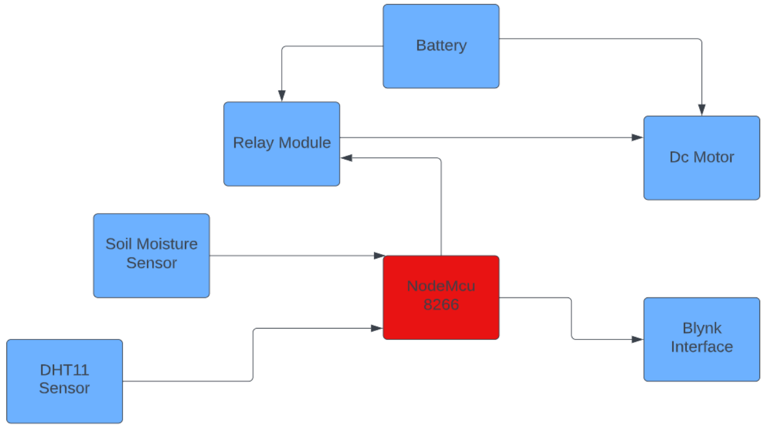

Figure 1.1: Block diagram

We are creating an IoT building irrigation system in this study using the ESP8266 Node multipoint control unit (MCU) module and the digital temperature and humidity sensor (DTH11) sensor. Additionally, a Blynk server is used to monitor the state of the land and determine the soil's moisture content. Sprinkler systems are also irrigation-based systems in which water flows through tubes to provide plants with the required water. The intelligent technology can determine the required water based on the land's environmental parameters, including moisture, temperature, and humidity. The electricity will be on to supply enough water to the plants. The current automated systems have limitations, such as the inability to store data permanently for future use while still sending alert messages or SMS to a mobile device. The study aims to offer automated devices for an intelligent irrigation system and store the data in an IoT cloud. Figure 1.2 illustrates the flow chart of the proposed automatic recommendation system.

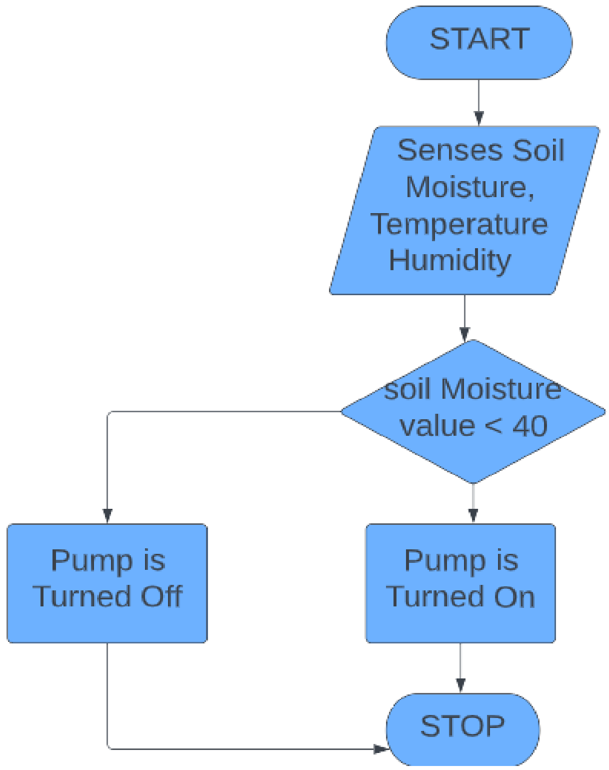

Figure 1.2: Flow chart

Last year, there were significant changes in Tamil Nadu's retail price of Tomatoes. From Rs. 26 per kilo in the year's first half to a staggering Rs. 50 per kilo in August, the price climbed significantly. Many farmers in the state opted to grow Tomatoes on their farms after noticing the sharp price rise to reap enormous profits. While this led to abundant supply in some parts of Tamil Nadu, many other parts of the state saw crop failures because of adverse circumstances for producing Tomatoes.

This example merely demonstrates how a farmer's decision regarding which crop to grow is typically influenced by his intuition and other unimportant factors, such as the desire to make quick money, ignorance of market demand, and exaggeration of a soil's ability to support a particular crop. His foolish choice could severely strain the farmer's family's financial situation. Maybe this is one of the numerous factors contributing to the innumerable farmer suicide cases that the media reports daily. Such a flawed decision would have detrimental effects on not just the farmer's family but also the entire economy of an area in a country like India, where agriculture and associated sectors contribute to about 20.4% of its Gross Value Added (GVA). Figure 1.3 shows the system architecture of crop recommendation system.

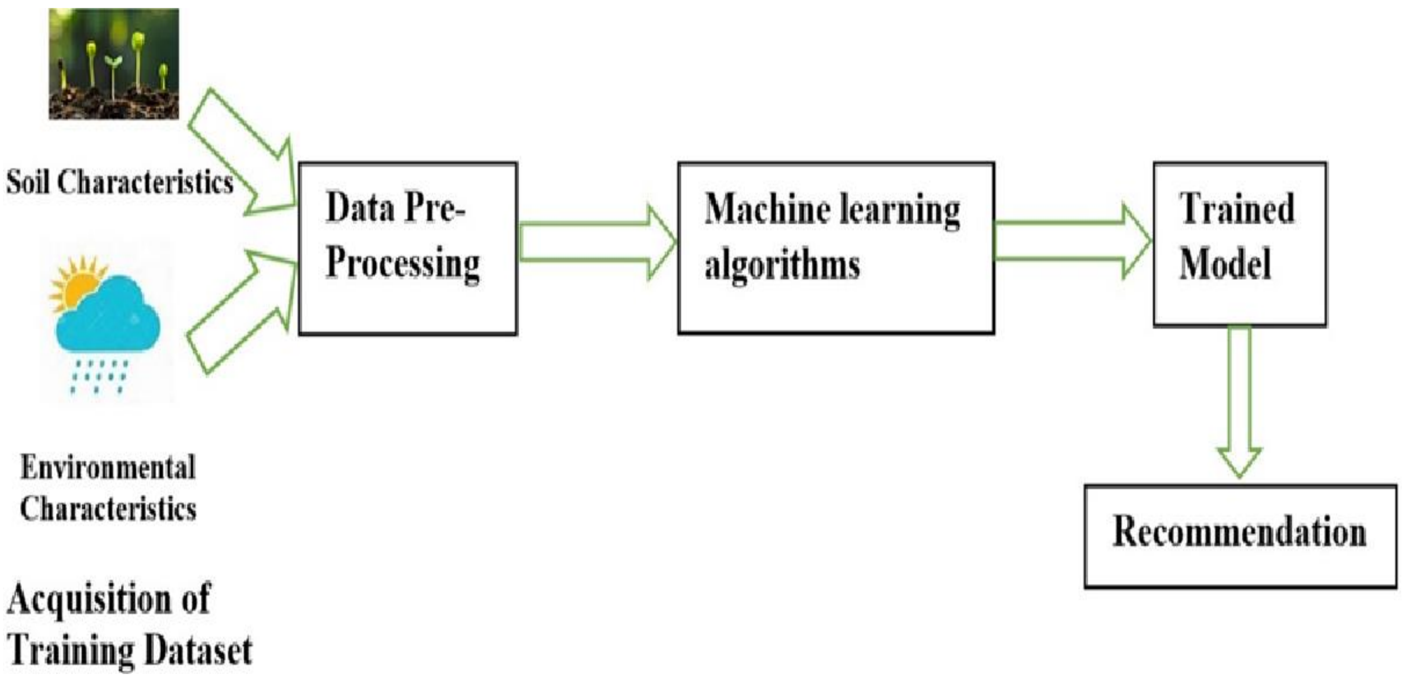

Figure 1.3: System architecture

The urgent requirement is to create a system that might offer Indian farmers predictive information to choose which crop to produce with knowledge. So, we proposed a Crop recommendation system, an intelligent system that would consider soil characteristics (pH, nitrogen, phosphorous, potassium values) and environmental parameters (temperature, rainfall, humidity) before recommending the most suitable crop to the user. Figure 1.4 shows the sample data set with visualization of parameters.

	N	P	K	TEMPERATURE	HUMIDITY	pH	RAINFALL	CROP
2	90	42	43	21	82	6.5	203	rice
3	85	58	41	22	80	7.0	227	rice
4	60	55	44	23	82	7.8	264	rice
5	74	35	40	26	80	7.0	243	rice
6	78	42	42	20	82	7.6	263	rice
7	69	37	42	23	83	7.1	251	rice
8	69	55	38	23	83	5.7	271	rice
9	94	53	40	20	83	5.7	242	rice
10	89	54	38	25	84	6.7	230	rice
11	68	58	38	23	83	6.3	221	rice
12	91	53	40	27	81	5.4	265	rice
13	90	46	42	24	81	7.5	250	rice
14	78	58	44	27	81	5.1	284	rice
15	93	56	36	24	82	7.0	185	rice
16	94	50	37	26	81	6.9	210	rice
17	60	48	39	24	80	7.0	231	rice
18	85	38	41	22	83	6.2	277	rice
19	91	35	39	24	80	7.0	206	rice
20	77	38	36	22	80	6.0	225	rice
21	88	35	40	24	84	5.9	291	rice
22	89	45	36	21	80	6.4	185	rice
23	76	40	43	25	83	5.1	231	rice
24	67	59	41	22	81	6.0	213	rice
25	83	41	43	21	83	6.3	233	rice
26	98	47	37	23	81	7.4	224	rice
27	66	53	41	25	81	7.8	257	rice

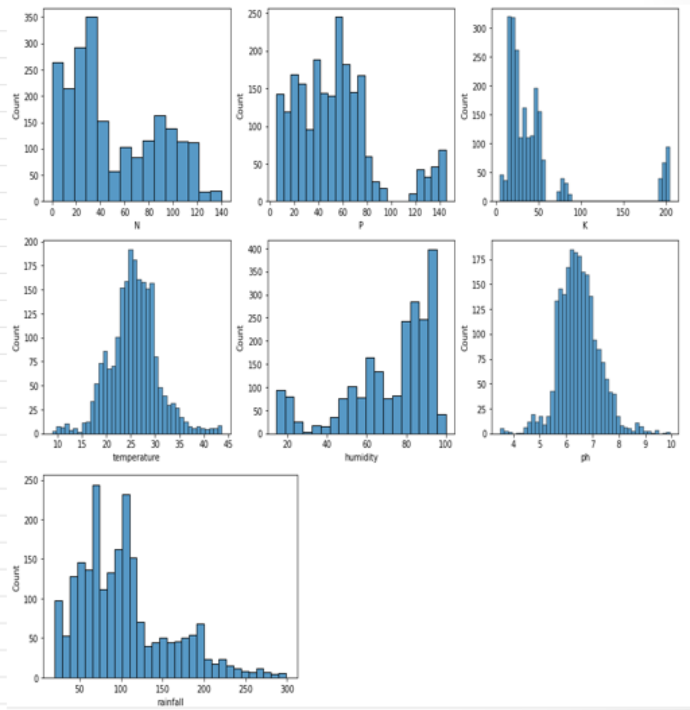

Figure 1.4: Dataset and visualization of parameters

Our goal in this project is to assist farmers with crop yields by employing efficient methods for assisting them during the drought season due to insufficient rainfall, preventing over-flooding of the field due to excess rainfall, and reducing the farmers' workload daily, periodically updating the status of soil parameters so that any malfunctioning of mechanical systems such as pumps/motors can be noticed, and finally assisting farmers in determining the best crop cultivate.

2. LITERATURE SURVEY

This section briefs about various related work in the domain of the proposed system here. There are discussions on the various systems that have put to use the idea of machine learning and IoT both together and individually as well.

For instance, maintaining constant control over several physical factors, such as soil moisture content, pH level, and soil nutrient content, results in a sophisticated but effective system [1]. The system can unquestionably produce a superior result if it can control the power distribution [2]. Completely changing the dynamics has also been a critical area of experimentation in the search for an effective farming system [3].

Using the most recent technologies, such as real-time data creation, also significantly helps to maximize output [4]. A less well-liked method in our part of the world that has produced some hypnotic results is greenhouse farming. Due to the considerably higher richness of the soil in this area, this endeavor has not been as successful as it could have been [5]. A remote controlling system also offers a practical means of ensuring the highest success in agricultural operations [6].

A solar energy system will protect the fuel, a natural resource in danger. Such systems' real-time monitoring ensures natural resource preservation and precise utilization [7]. Monitoring indicators, like water, soil moisture, temperature, and humidity, is an efficient technique to sustain an agricultural system. Even yet, using a GSM module is an option that is somewhat more expensive and requires a proportionally more significant amount of power [8]. Other areas of interest in this broad subject include reducing the cost of human labor and making optimal use of water for irrigation [9].

The use of automated greenhouse systems has the potential to improve many areas, although their implementation may be complex, given the region's current level of soil fertility [10]. It may prove that the Internet of Things (IoT) is a valuable and effective tool for building a feasible system after compiling all the reliable and affordable ways.

The research [11] focuses on constructing a crop prediction system built on sensor networks that utilize the internet of things. The results of the submitted soil samples take a long time to arrive from the testing lab for soil. As a result, the method asserts that it enables farmers to receive a better harvest estimate without waiting longer. The author's primary focus in this research has been assessing the nitrogen, phosphorus, and potassium levels of the soil sample taken for the survey. Based on the data collected by the sensor network, the proposed method in the study accurately calculates the nutrients in the soil. So, it is possible to forecast the ideal crop to grow on the tested soil.

The study [12] clearly illustrates a method to address the crop selection problem and improve net harvest yield. The authors have suggested an approach that suggests a range of crops to be picked during a season while considering important factors such as the climate, soil composition, water density, and crop type. The precision of the crop selection method is determined by the estimated values of the highly influential factors. The method of crop sequencing is the technique considered in the paper.

The authors have developed a method for predicting crop usage using an information mining approach employing a thorough examination of the soil properties and behavior presented in the paper [13]. The report emphasizes the importance of enhancing crop productivity rather than crop selection methodology. The inputs used in the analysis are the soil datasets. Using

Naive-Bayes and the k-Nearest algorithm, the crop yield has been forecasted due to this categorization.

A model that uses historical records of meteorological data as a training set has been proposed by the authors of [14]. A model is trained to recognize environmental factors that hinder the growth of apples. The output of apples is then accurately predicted based on monthly weather patterns. The impact of temperature on apple sugar concentration is also considered to determine the potential quantity of damaged product. As shown in [15], various algorithms, including Artificial Neural Networks, K-Nearest Neighbors, and Regularized Greedy Forests, are used to choose a crop based on the predicted yield rate, which is, in turn, affected by several characteristics.

3. REQUIREMENTS FOR AUTOMATIC IRRIGATION SYSTEM

This section explains about the required items for developing the protype of automatic irrigation system.

3.1 NodeMcu Es8266

NodeMCU is an open-source platform built on the ESP8266 that allows things to be connected and data to be transferred over Wi-Fi. Additionally, it may address many of the project's requirements by offering some of the most crucial microcontroller functionalities, like GPIO, PWM, ADC, and others. Figure 3.1 represents the NodeMcu Esp8266 device.

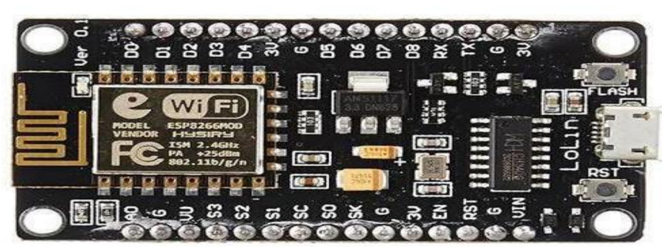

Figure 3.1: NodeMcu ESP8266

3.2 Sensors

- **Soil moisture Sensor**

The amount of water in the soil is measured or estimated by soil moisture sensors. These sensors can either be fixed or mobile, like handheld probes. Portable soil moisture probes may monitor soil moisture at many sites, in contrast to stationary sensors installed in the field at specified depths and locations.

In order to determine how much water is in the soil horizon, soil moisture sensors monitor the water content of the soil. Soil moisture sensors do not immediately measure water in the soil. Instead, they track changes in another soil characteristic which is predictably connected to water content. Figure 3.2.1 represents the Soil moisture sensor.

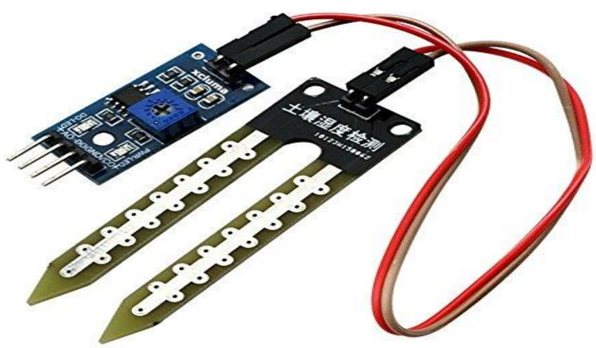

Figure 3.2.1: Soil moisture sensor

- **DHT11 Sensor**

A primary, extremely affordable digital temperature and humidity sensor is the DHT11. It can measure temperature and relative humidity, the difference between the amount of water vapor in the air and its saturation point.

A sensor and a module are available for the DHT11. The pull-up resistor and a power-on LED distinguish this sensor from the module. This sensor employs a sensitive humidity sensor and a thermistor to measure atmospheric air. Figure 3.2.2 represents the DHT11 sensor.

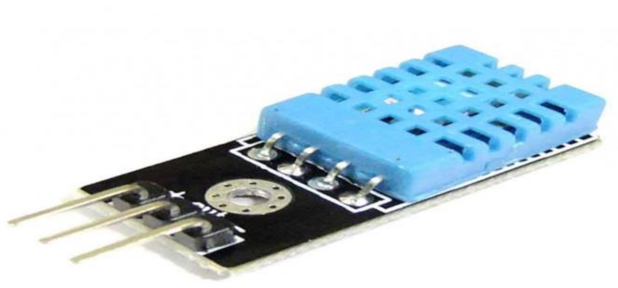

Figure 3.2.2: DHT11 Sensor

3.3 Relay module

An electrical switch controlled by an electromagnet is known as a power relay module. A separate low-power signal from a microcontroller activates the electromagnet. When turned on, an electrical circuit can be opened or closed by the electromagnet.

A primary relay comprises a wire coil wrapped around a soft iron core. This iron yoke provides a low resistance channel for magnetic flux, a moveable iron armature, and one or more sets of contacts. Figure 3.3 represents the Relay module.

Figure 3.3: Relay module

3.4 DC motor

An electrical device known as a DC motor, or direct current motor, uses direct current to generate a magnetic field that converts electrical energy into mechanical energy. A magnetic field is generated in a DC motor's stator when it is energized. Magnets on the rotor are drawn to and drawn away by the field, which rotates the rotor. The commutator, connected to brushes and the power source, supplies current to the motor's wire windings to keep the rotor turning continuously. Figure 3.4 represents the Dc motor.

Figure 3.4: DC motor

3.5 Jumper wires

Electrical wires having connector pins at each end are known as jumper wires. They are employed to connect two circuit points without the usage of solder. Jumper wires can be used to change a circuit or find issues in a circuit. Additionally, they work best when bypassing a suspected-faulty area of the circuit that lacks a resistor. Figure 3.5 represents the Jumper wire.

Figure 3.5: Jumper wires

4. ALGORITHM FOR CROP RECOMMENDATION SYSTEM

This section explains about the algorithms that were tried upon the data set obtained from the GitHub and discusses about which works well for the system.

4.1 Decision Tree

It is a supervised learning approach in which class labels and attribute representations are done via a tree. Here, the record's attribute is compared to the root attribute, and based on the result; a new node is reached. This comparison is continued until a leaf node with a projected class value is reached. A modeled decision tree is quite effective for making predictions. Figure 4.1 depicts the example for Decision Tree algorithm.

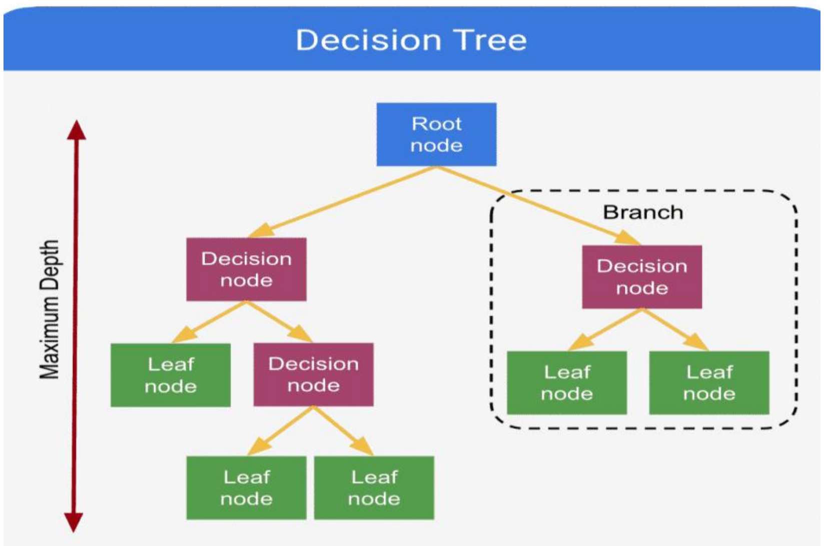

Figure 4.1: Decision Tree

4.2 Random Forest

It is an ensemble learning technique frequently applied to regression and classification problems. Using this approach, the test features must be passed through each randomly generated tree's rules to train the model to make predictions. As a result, each random forest will forecast a different target for the same test feature. Votes are then computed based on each expected target. The target with the most forecasted votes is the algorithm's final prediction. Figure 4.2 depicts the example for Random Forest algorithm.

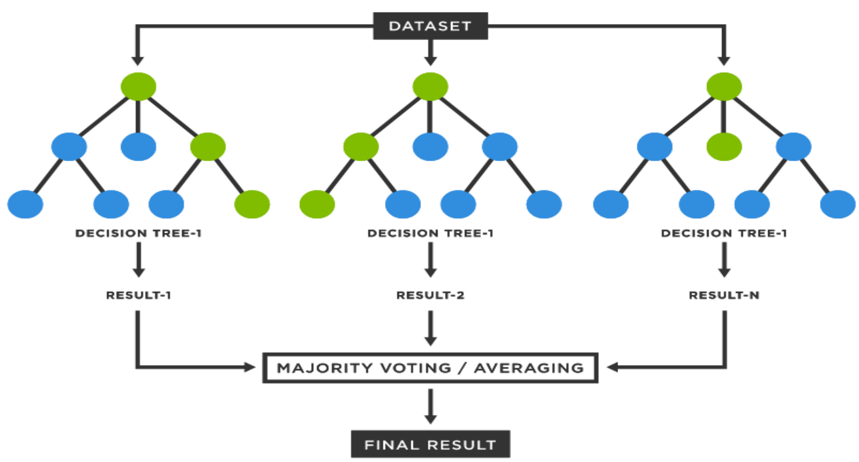

Figure 4.2: Random Forest

4.3 Naive Bayes

Naive Bayes is a classification technique for situations involving binary and many classes. A Naive Bayes classifier believes that the existence of one feature in a class has absolutely nothing to do with the presence of any other feature. The Naive Bayes classifier, based on the Bayes hypothesis, is a valuable tool when the sources of information are highly dimensional.

Naive Bayes offers a wide range of uses, including real-time prediction, predicting the likelihood of various target attribute classes, spam filtering, and support for recommendation systems when combined with collaborative filtering. Figure 4.3 depicts the example for Naive Bayes algorithm.

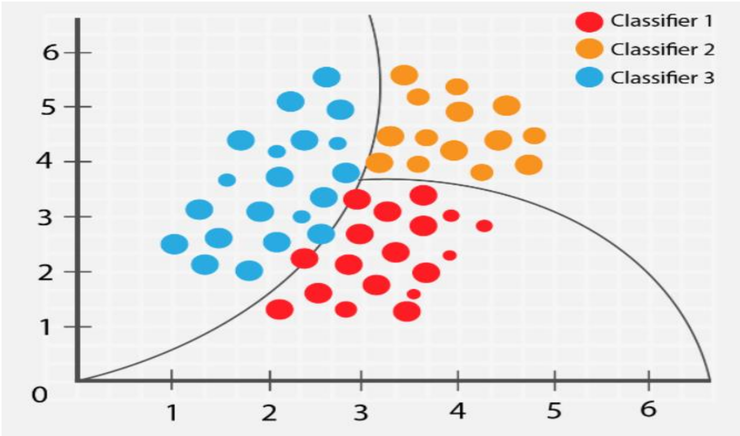

Figure 4.3: Naive Bayes

4.4 K-NN

It is a non-parametric technique for forecasting. The expected value, in this case, is class membership. For each incoming new instance, the initial stage of the K-NN method is to determine the k nearest neighbors. These neighbors' majority vote categorizes the occurrence. In the second stage, a label is projected for the new instance based on the label sets of the k neighbors. Figure 4.4 depicts the example for KNN algorithm.

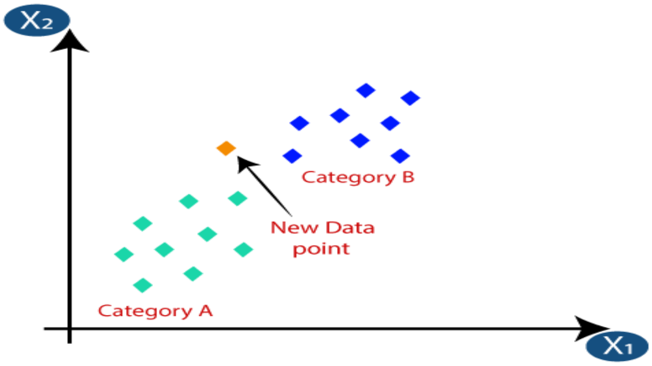

Figure 4.4: K-NN

5. IMPLEMENATATION AND RESULTS

This section discusses about the implementation and outcomes in automatic irrigation system and crop recommendation system.

The Nodemcu Esp866 is used to communicate the values from the DHT11 and soil moisture sensor to the Blynk console. The pin connected in the Nodemcu Esp8266 determines the classification of the incoming value. The relay module manages the DC motor, which is attached to a pipe. The Blynk console shows the temperature, humidity, and soil moisture content. Users can turn the engine on or off depending on the soil moisture. Figure 5.1 represents Over all setup of the prototype.

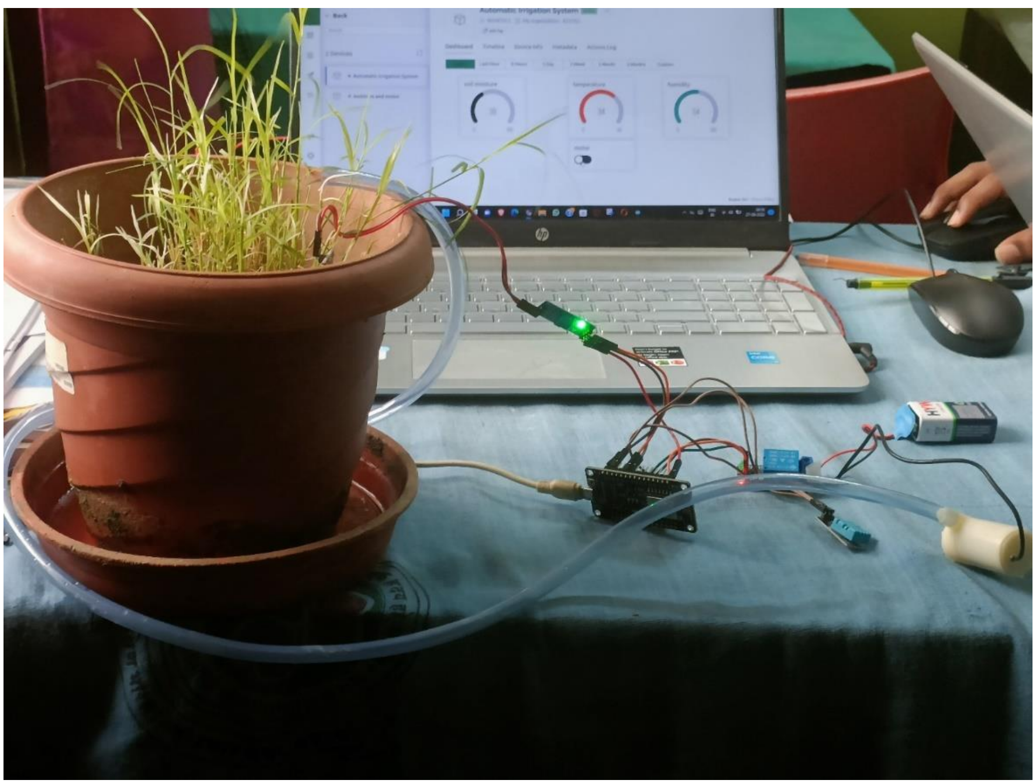

Figure 5.1: Overall setup

Figure 5.2 represents the Sensor setup of the prototype.

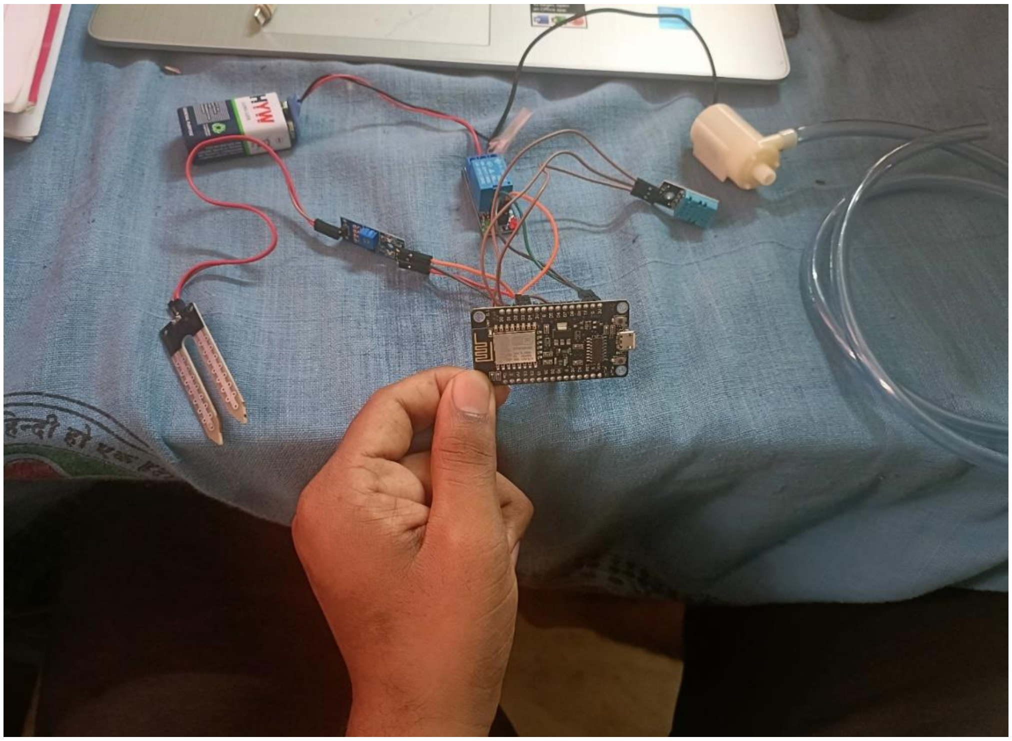

Figure 5.2: Sensor node setup

Connection between NodeMcu ESP8266 with other components is shown below.

Pin A0	->	Soil moisture sensor
Pin D3	->	Relay module
Pin D4	->	DHT11 sensor
GND	->	GND (Soil moisture, DHT11, Relay module)
3.3V	->	VCC (Soil moisture, Relay module)

Figure 5.3 shows the Blynk console interface.

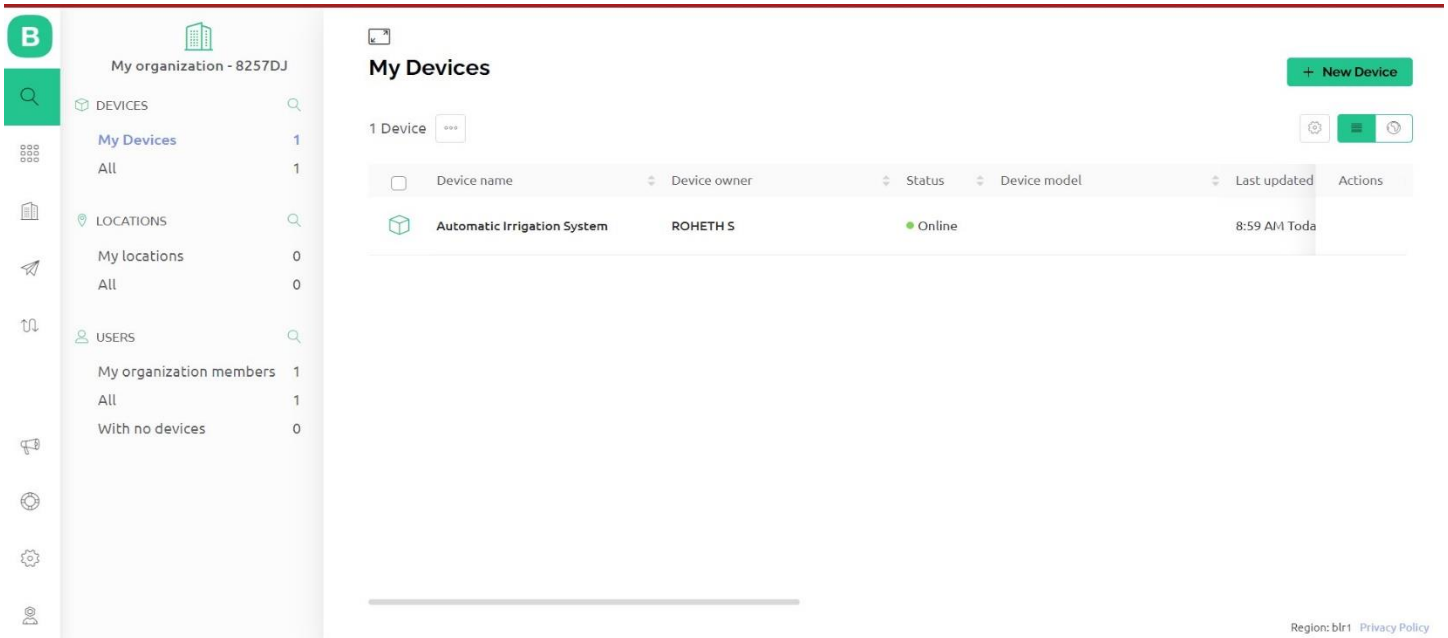

Figure 5.3: Blynk console

Figure 5.4 shows the sensors initialization in Blynk console interface.

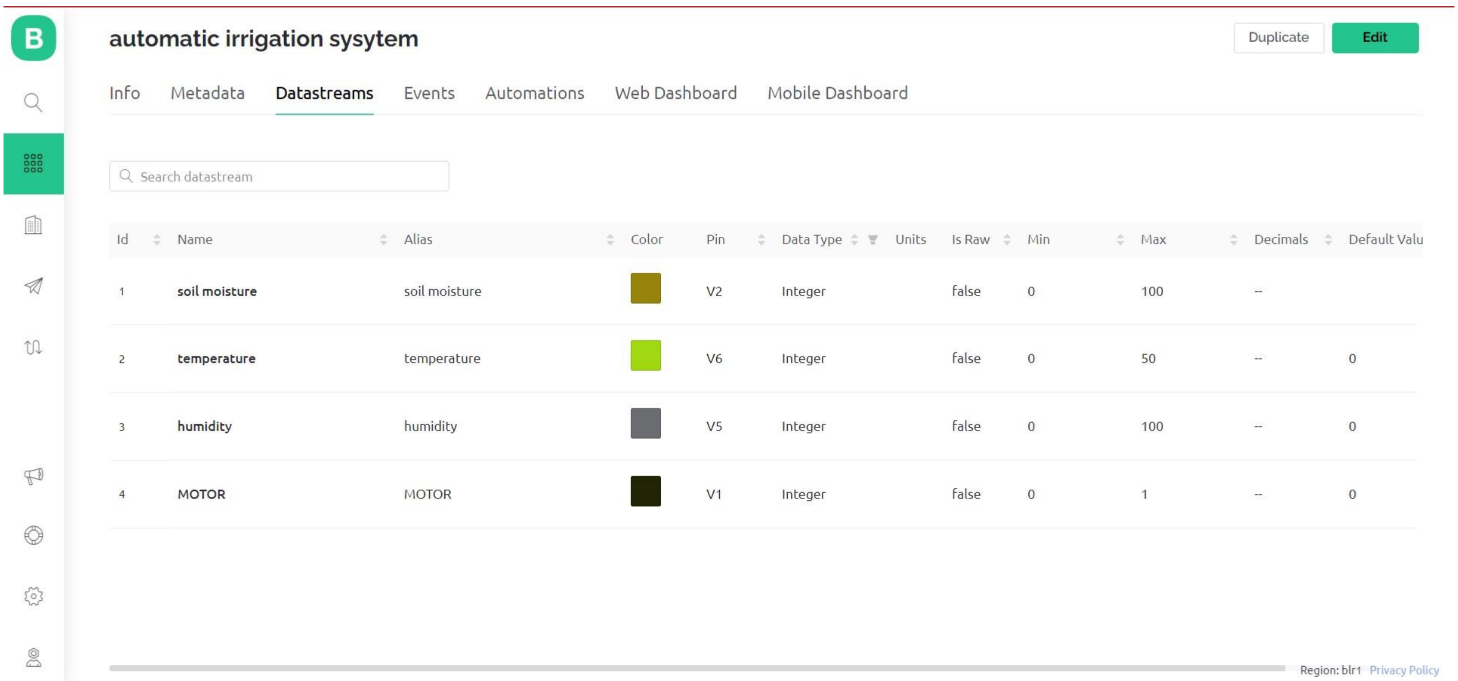

Figure 5.4: Initializing sensors

Figure 5.5 shows the sensor values and control option for motor in Blynk console interface.

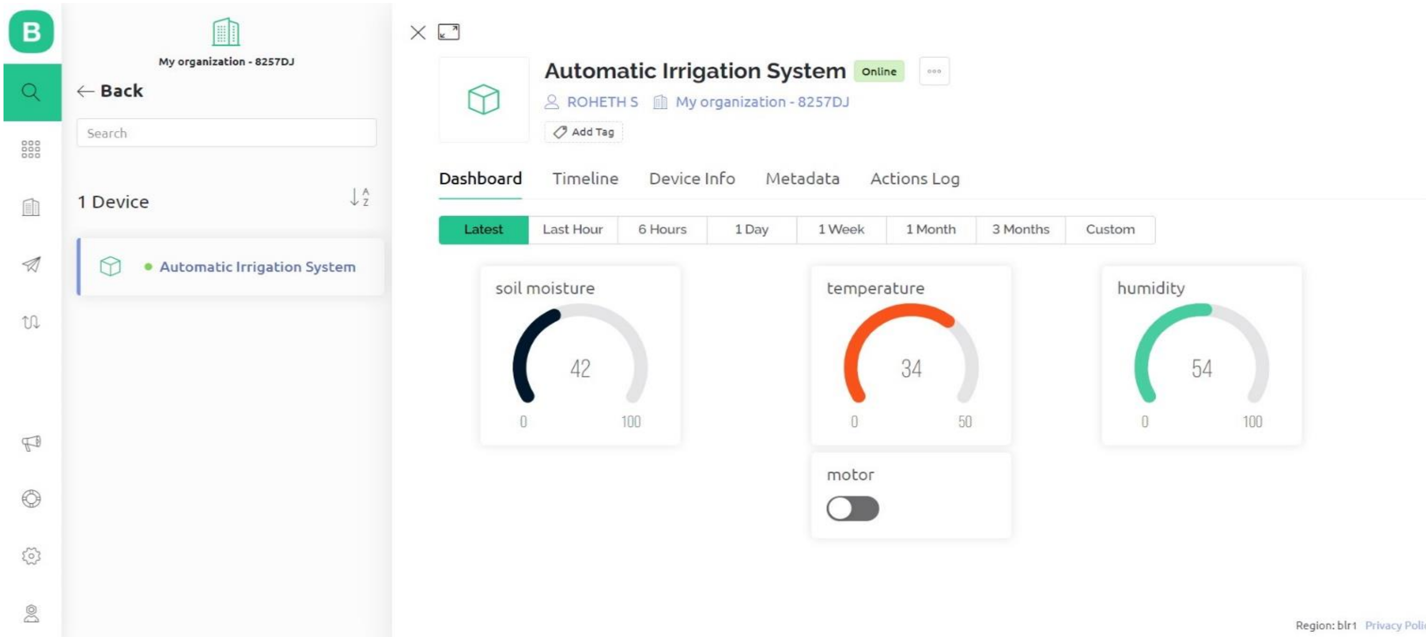

Figure 5.5: Data visualization and motor control – web

Figure 5.6 shows the sensor values and control option for motor in Blynk app.

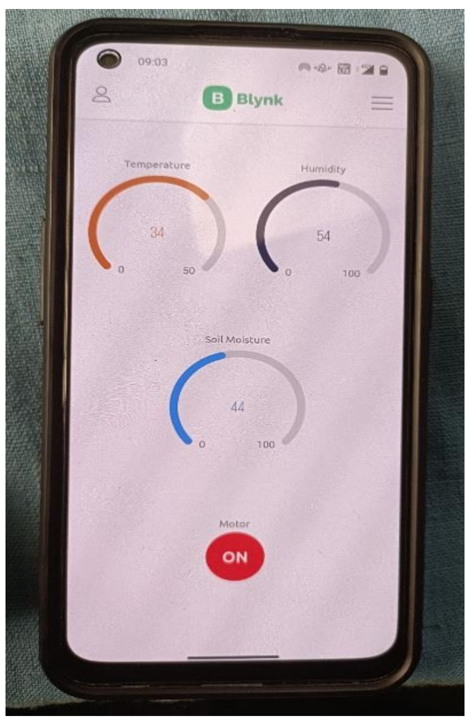

Figure 5.6: Data visualization and motor control - app

Figure 5.7 shows the alert notification send to the user whenever the soil moisture value is less than the threshold value.

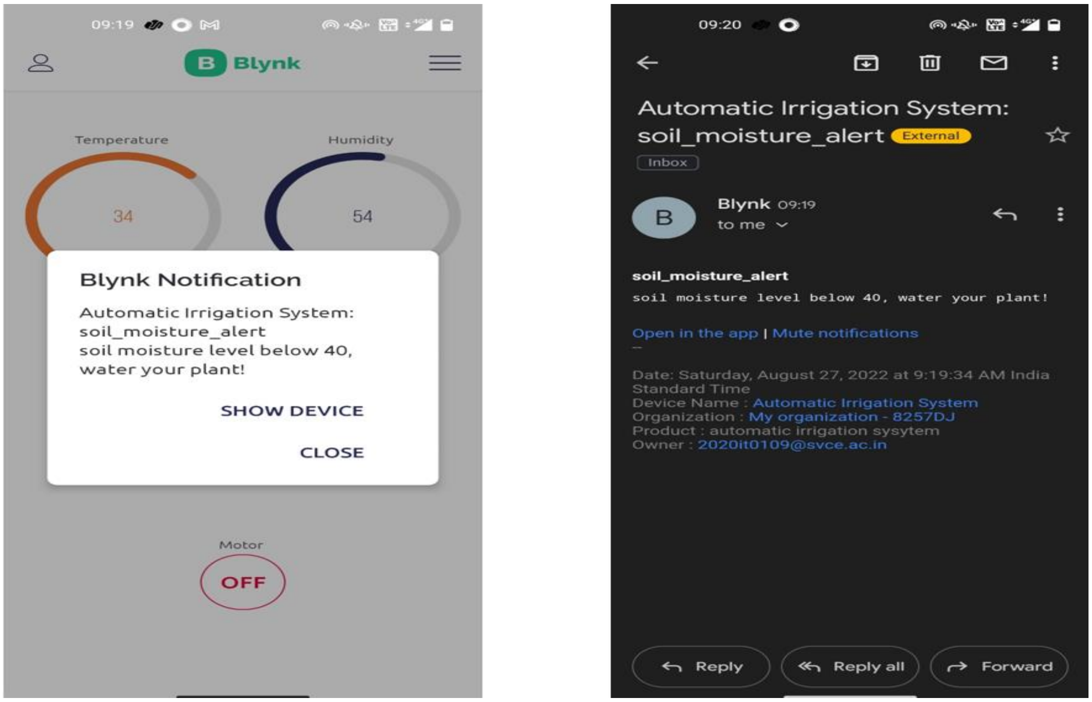

Figure 5.7: Soil moisture alert

Temperature and humidity readings were measured using the DHT11 sensor. While nitrogen, phosphorus, and potassium readings were measured using the NPK sensor, pH readings were measured using the pH sensor, and rainfall readings were measured using the Rainfall sensor. These values allow us to forecast the recommended crop. Figure 5.8 shows the GUI of the crop recommendation system.

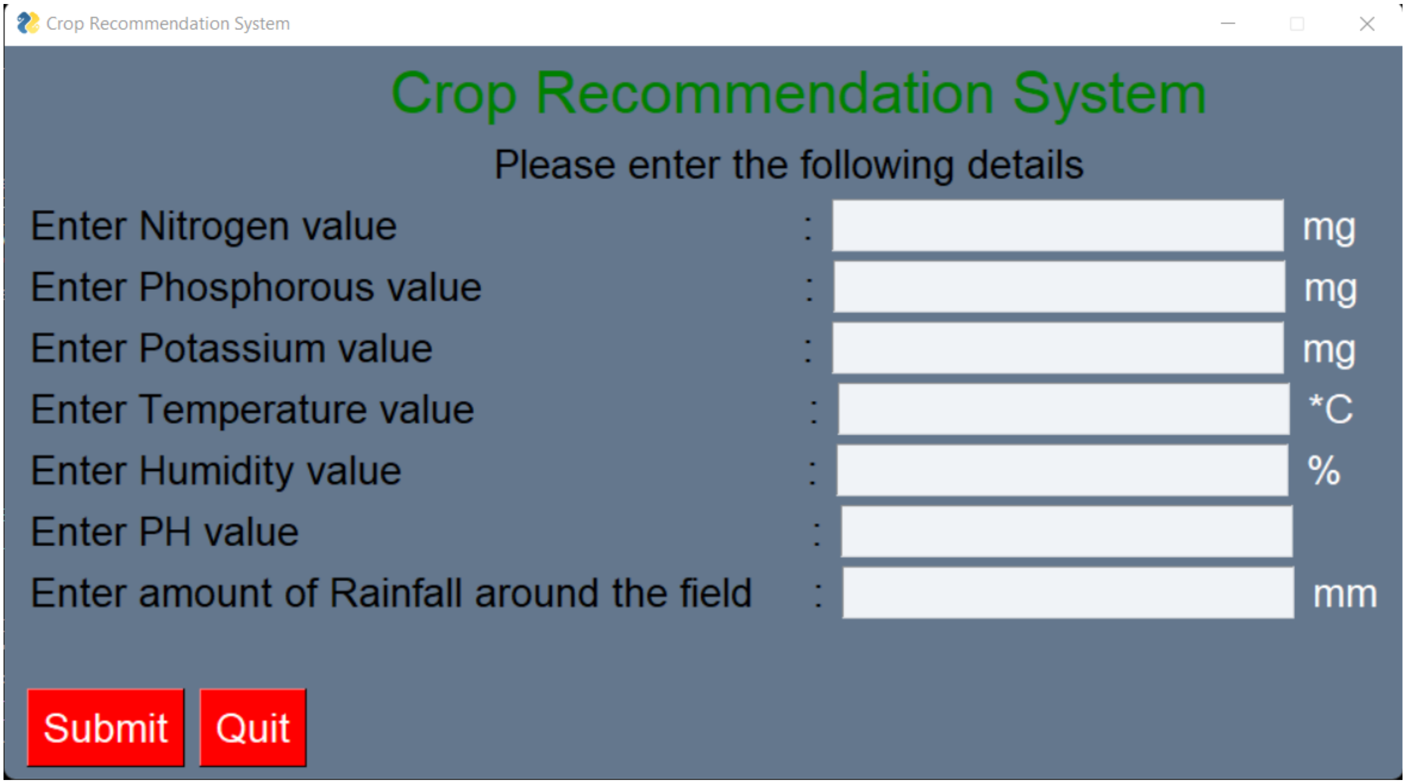

Figure 5.8: Crop recommendation GUI

Figure 5.9 shows the sample test values of the crop recommendation system for rice.

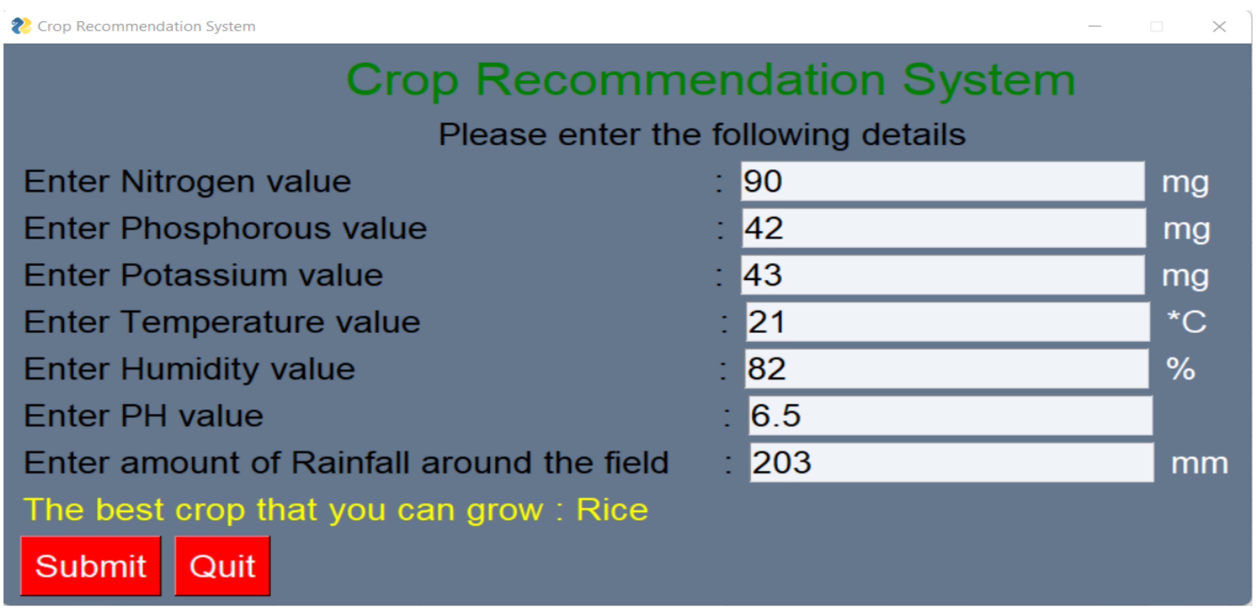

Figure 5.9: Sample test values of the crop recommendation system for rice

Figure 5.10 shows the sample test values of the crop recommendation system for mango.

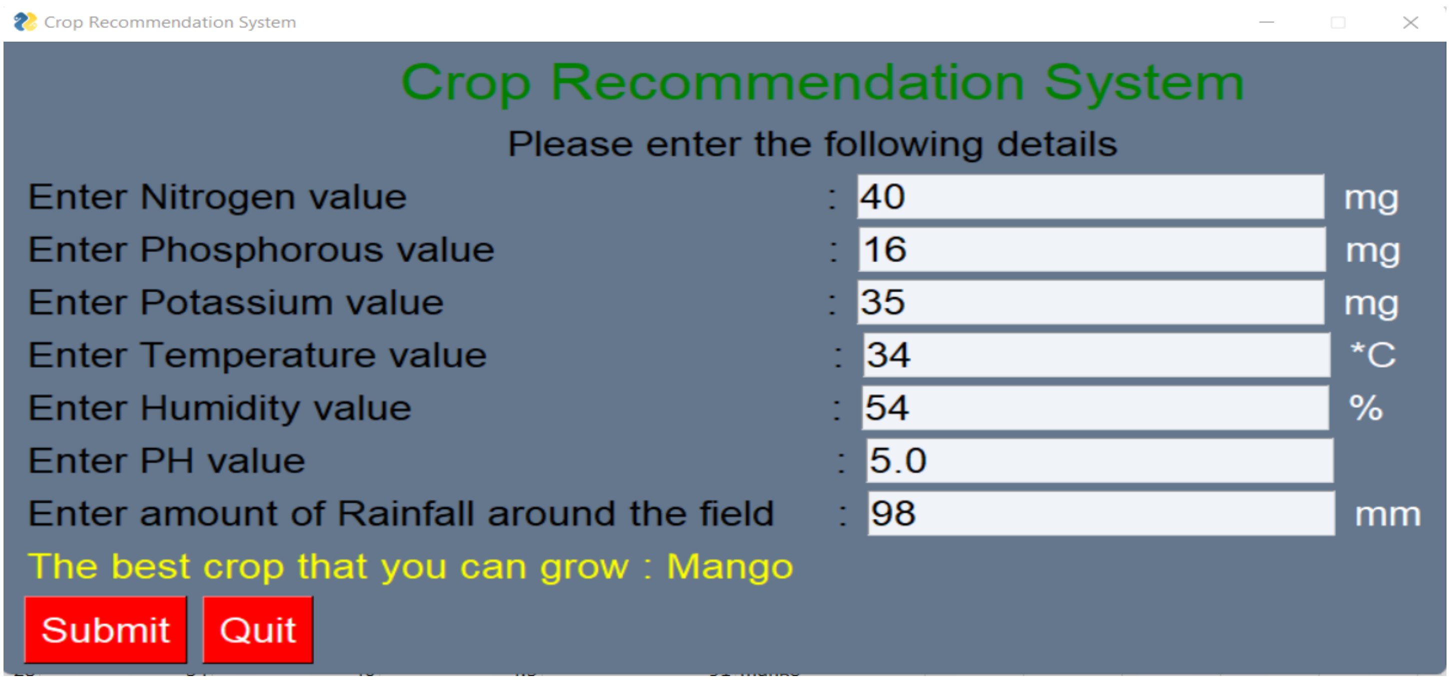

Figure 5.10: Sample test values of the crop recommendation system for mango

Table 5.1: Comparison on accuracy obtained through various algorithms

Algorithm	Accuracy
Decision Tree	85%
Random Forest	87%
Naïve Bayes	91%
K-NN	94%

6. CONCLUSION AND FUTURE SCOPE

Today's society cannot afford to waste fresh water, making precision agriculture and intelligent irrigation systems necessary. A futuristic agricultural development is made possible by the use of modern agricultural technologies. Precision agriculture is needed for a rising population, declining agricultural land, and finite water supplies. This report outlines an automated, efficient, intelligent irrigation system. The sensor, which measures the soil moisture level and distributes water to the entire field as needed, is buried in the ground to assist the farmers.

Using IoT sensors, irrigation is carried out based on crop circumstances, climatic and weather conditions, and soil properties. This system is inexpensive and easy to maintain. By employing this technology, crop yield will significantly rise. The best crop for the soil is predicted by a "crop recommendation system" using the sensor data that is now available. Future developments of this system could include detecting animal intruders in the field, the time it is appropriate to harvest the crops, and the nutrition level of the plants. With machine learning, the system can be autonomous of human intervention and produce significant output.

7. REFERENCES

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