# Smart Agriculture System Using IOT and Machine Learning

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**Abstract— Smart agriculture is an emerging concept, because IOT sensors are capable of providing information about agriculture fields and then act upon based on the user input. The development of Smart Agriculture System using IOT & ML helps not only increasing the quality of farming but also saves the lots of time of farmers. In Our system this will be accomplish with the use of Soil moisture, NPK and Flame detection sensors. The motive of this project to prevent accidents and overcome the traditional way of farming, also helps the farmer to avoid infections from fertilizer. In Our system soil moisture sensor checks the moisture of soil if water level of soil is less motor will get on automatically and when water level reaches to required level motor will get off automatically. NPK sensor collects the Nitrogen, Phosphorus and Potassium from soil and machine learning model and model will suggest the crops, fertilizers required to soil according to soil NPK values. Flame detection sensor, if detects fire in farm and water pump will get on automatically. Roof structure pipeline will be created in farm through which water will get sprinkled to extinguish the fire also this pipeline is used to sprayer the pesticides and fertilizers.**

**Keywords - Random Forest, Android Studio, Anaconda Navigator, Jupyter Notebook, Arduino IDE.**

## I. INTRODUCTION

Agriculture plays a very important role where economic growthof a country like India is considered. The development of smartagriculture system using IOT & ml helps not only increasing the quality of farming but also saves the lots of time of farmers.All of this is accomplished with the use of soil moisture, NPK and flame detection sensors. It also helps farmer to fertilize the farm using roof structure created by pipes in farm and this pipesstructure is also used for extinguish the fire. A significant amount of work has been done regarding IoT technology in the agricultural industry to develop smart farming solutions. IoT has brought a great revolution in the agriculture environment by examining multiple complications and challenges in farming [1]. The need for food both number and quality have grown, necessitating to modernization of agriculture and detailed manufacturing techniques. Internet of Things (IoT) industry is flourishing or carrying a slew of contemporary agricultural ideas to the fore [2]. The usage of fertilizers, which give crops vital nutrients and increase yields, is one of the major components in managing intensive farming operations. Farmers' poor fertilizer application is one of the main causes of low yield [4]. While forest fires spontaneously occur in a variety of ecosystems, they could be extremely destructive to people, properties, and natural resources [5]. Overall, IoT technology in agriculture has tremendous potential for increasing crop yields, reducing environmental impact, and improving sustainability. By leveraging the power of IoT-enabled smart sensors and machine learning algorithms, farmers can optimize their farming operations, reduce costs, and maximize their profits while contributing to a more sustainable future [1]. In Our system this will be accomplish with the use of soil moisture, NPK and Flame detection sensors. The motive of this project to prevent accidents and overcome the traditional way of farming, also helps the farmer to avoid infections from fertilizer. In our system soil moisture sensor checks the moisture of soil if water level of soil is less than required level signal is send to the arduino and arduino will send signal to the relay module so that water pump will get on automatically and when water level reaches to required level motor will get off automatically.

## II. LITERATURE SURVEY

1. Paper name: Smart Agriculture System Using IoT and ML.

Author: Arthi.R , Nishutham S , Deepak Vignesh L
[1] A comprehensive IoT-based smart agricultural system that monitors and manages crops using machine learning and sensor networks is presented in this paper. The system is made up of Internet of Things (IoT) sensors that track a range of environmental factors and a mobile app that lets customers manage and keep an eye on their sensors in real time. The system also has machine learning models that forecast which fertilizers and crops would grow best given the soil and other environmental parameters.
This system can assist farmers in making data-driven decisions, increasing agricultural yields, and reducing resource use and environmental impact by combining IoT with machine learning.

2. Paper name : IoT – Enabled Technologies for Sustainable Smart Agriculture and their Comprehensive Survey .

Author: Prof. Santosh S, Raghavendra R
[2] There must be several open architectural options for low cost, flexible IT design. Interoperable, and scalable packages. To understand how to use IoT devices, all farmers must complete a basic education. In order for the Agro-Tech subculture to spread globally, it is crucial to advance knowledge about it. This article offers a thorough analysis of the literature along with a discussion of innovative concepts.
Very excellent research papers regarding IoT-based farming. The analysis comprised a total of sixty-seven carefully selected papers. After then, some IoT farm applications, sensors and devices, and networking protocols were covered. The number of governments supporting this field's research and the number of nations with IoT farm rules is the most encouraging aspect. Furthermore, the contextualization of the essential components of fully IoT-based agriculture. Lastly, possible research avenues for scientists studying IoT-based agriculture were examined.

3. Paper name: An IoT Based Smart Irrigation System.

Author : Dhruvi Gosai, Chintal Raval, Rikin Nayak.
[3] The aim of this work was to design a smart irrigation system. A mobile program Providing an intuitive user experience aids in reducing the system's complexity. Furthermore, the website that has been established and offers rich content for farmers also significantly contributes to the user's education. Although there is still sufficient space for development in this prototype, the sustainability period is expected to last between three and five years. Due to the unavailability of certain important apparatus, the pricing of the components was a little excessive. Still, there's always space for development. The projects can be developed further by including the application of image processing to recognize the health of the crops.

4. Paper name : intelligent fertilizer recommendations to improve crop yield using wireless sensor network .

Author : Sumit Kumar , Jay Prakash , Jyoti Srivastava , Rahul Chakravorty .
[4] Data on numerous parameters, including soil moisture, temperature, humidity, nitrogen, phosphorus, potassium, etc., can be gathered in the field by setting up a network of sensors. Processing and analysis with a machine learning algorithm with a 95% accuracy rate, the Stacking Classifier is utilized to find patterns and trends in the data and produce fertilizer recommendations. Stacking provides superior performance as compared to other machine learning algorithms. All in all, this strategy might improve the sustainability and effectiveness of intensive farming.

5. Paper name: using IOT and ml for forest fire detection, monitoring, and prediction: a literature review.

author: mounir grari 1 , mimoun yandouzi 2, idriss idrissi 1 , mohammed boukabous 1 , omar moussaoui 1 , mostafa azizi 1 , and mimoun moussaoui 1 .
[5] In this paper, we conducted a systematic review of the scientific literature that addressed the challenge of detecting and predicting forest fires using IoT and machine/deep learning. Temperature, humidity, CO, and light are the characteristics that are most frequently employed to identify and detect forest fires, according to the data analysis that was done. We also discovered that the majority of the communication channels used in this situation are built on one of these protocols: GSM, WiFi, or ZigBee. Furthermore, the majority of the datasets utilized for this purpose are synthetic. The methods for object detection,

regression, and classification were by far the most widely used. Our systematic literature review's results lead us to the conclusion that scientific works that combined machine learning and IoT with deep learning produced the best results and served as a viable example of the efficacy and promise of their approach to wildfire detection and forecasting.

## III. METHODOLOY

A. Arduino Module :

As a microcontroller board, the Arduino UNO R3 is responsible for supervising and controlling system functions. This ATmega328-based board has several functionalities, including: There are six PWM outputs and 14 digital I/O pins on this device. It also has a crystal oscillator that runs at 16 MHz, a reset button, a power jack, an ICSP header, a USB port, and six analogue inputs. It is pre-assembled with every part required to support the microcontroller. It is simple to use an AC-to-DC adapter to power it, connect it to a computer via USB, or even start it up with a battery. The ATmega328 has a 32 KB memory capacity, with 2 KB of SRAM and 1 KB of EEPROM available. The Arduino can be powered by an external power supply or a USB connection, with the device automatically determining which power source is best. Batteries or an adapter, usually an AC-to-DC converter, can serve as the external power source. A variety of communication devices, such as PCs, other Arduino boards, or extra microcontrollers, can be connected to the Arduino. The ATmega328 uses digital pins 0 (RX) and 1 to enable UART TTL (5V) serial communication (TX). Additionally, a built-in ATmega16U2 on the board manages serial connectivity via USB and appears to PC applications as a virtual COM port.

A. Soil Moisture Sensor :

Soil moisture sensors (SMSs) measure soil moisture at the rootzone and regulate the existing conventional irrigation timer, resulting in considerable water savings when installed and used properly. A customized soil water content threshold is set, allowing for dryer or wetter soil condition.

B. Flame Detection Sensor :

A flame detector is a type of sensor that can detect and respondto the presence of a flame. These detectors have the ability to identify smokeless liquid and smoke that can create open fire For example, in boiler furnaces flame detectors are widely used,as a flame detector can detect heat, smoke, and fire.

C. NPK Sensor :

The soil NPK sensor is suitable for detecting the conten of nitrogen, phosphorus and potassium in the soil, and judges thefertility of the soil by detecting the conductivity transformation caused by different nitrogen, phosphorus and potassium concentrations in the soil.

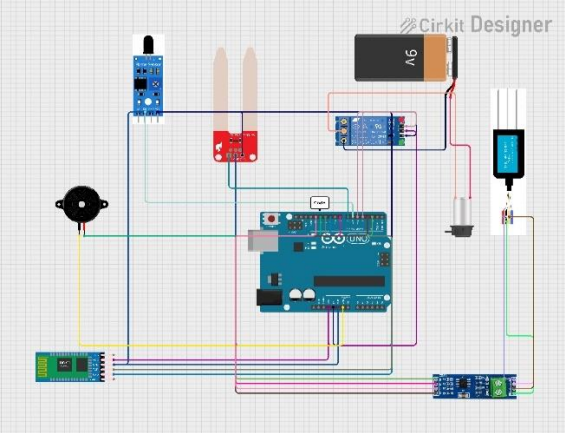
D. Random Forest :

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. It is based on the concept of ensemble learning, which is a process of combining multiple classifiers to solve a complex problem and to improve the performance of the model

## IV. OUR SYSTEM

Smart agriculture is an emerging concept, because IOT sensors are capable of providing information about agriculturefields and then act upon based on the user input. The development of Smart Agriculture System using IOT & ML helps not only increasing the quality of farming but also savesthe lots of time of farmers. In proposed system this will be accomplish with the use of soil moisture, NPK and Flame detection sensors. The motive of this project to prevent accidents and overcome the traditional way of farming, also helps the farmer to avoid infections from fertilizer. In proposed system soil moisture sensor checks the moisture of soil if water level of soil is less motor will get on automatically and when water level reaches to required level motor will get off automatically. NPK sensor collects the nitrogen, Phosphorus andpotassium values from soil and make the dataset, use this dataset to build the machine learning model and model will suggest the crops, fertilizers required to soil according to soil NPK values. Flame detection sensor, if detects fire in farm motor will get on automatically. Roof structure pipeline will be created in farm through which water will get sprinkled to extinguish the fire also this pipeline is used to sprayer the pesticides and fertilizers.

1. IOT ARCHITECTURE SETUP :

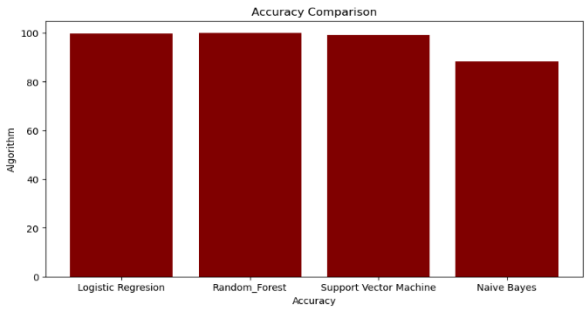



2. ML MODEL :

To evaluate which algorithm gave the most accurate prediction, we trained the ML model using SVM (Support Vector Machine), Naive Bayes, Logistic Regression, and Random Forest algorithms. The results were then compared. We used the Random Forest technique to build our machine learning model since it provides crop recommendations with 100% accuracy and fertiliser recommendations with 93.90% accuracy.

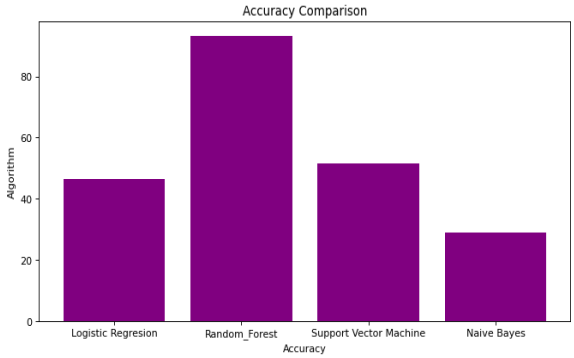
A. Crop Recommendation :

There are 4,512 samples in the dataset used by the crop recommendation algorithm. The following are the attributes of the dataset: soil colour, season, PH, rainfall, temperature, and nitrogen, phosphorus, and potassium. There are sixteen distinct crop kinds listed in the label column. When the dataset was first visualised, it was shown as a graph. The data is pre-processed by looking for missing values and, if any are found, using missing value treatment to remove them.




B. Fertilizer Recommendation :

Total samples 4,512 are included in the dataset for the fertiliser recommendation system. The attributes in the dataset include crop, temperature, rainfall, PH, crop colour, phosphorus, and potassium. There are eighteen different fertilisers in the label column. When the dataset was first visualised, it was shown as a graph. The data is pre-processed by looking for missing values and, if any are found, using missing value treatment to remove them.



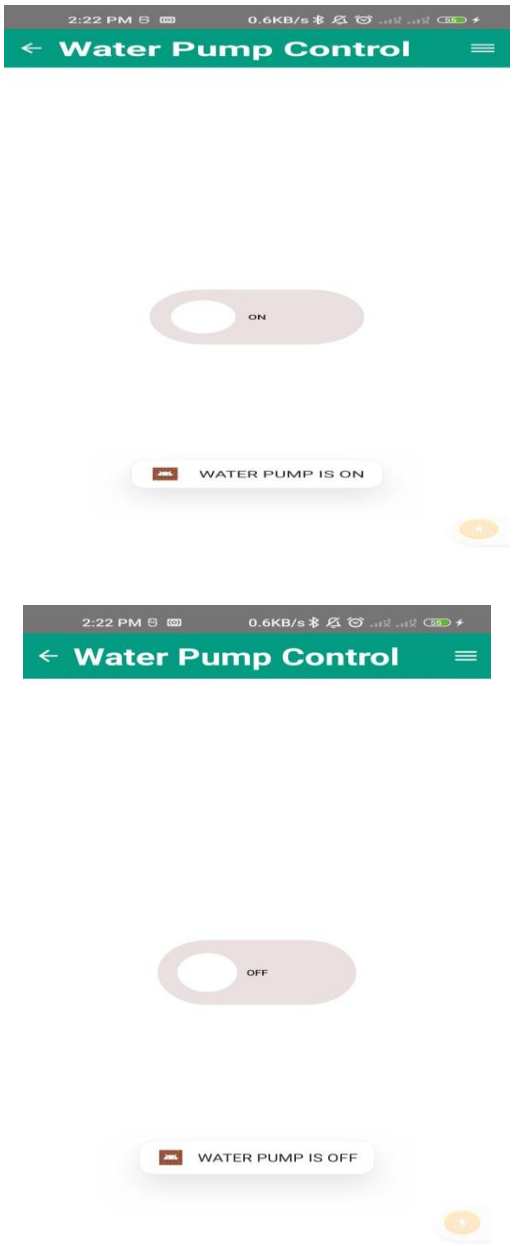

3. MOBILE APPLICATION

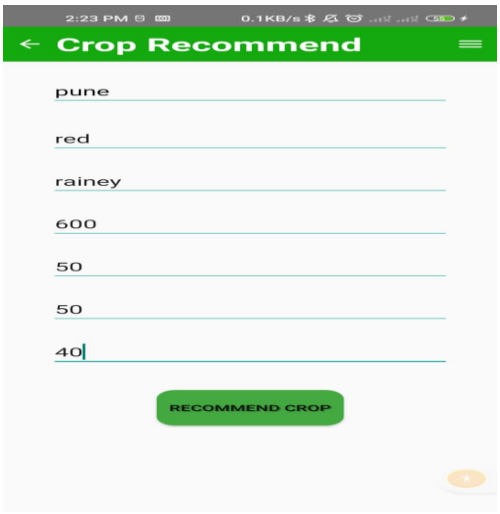
A mobile application using Android Studio IDE has been developed. Android Studio is an Integrated Development Environment (IDE) for developing Android apps, which supports Flutter. With the help of Android Studio SDK, developers can build and test their apps on Android emulators or physical devices. Android Studio also provides features like debugging, layout editors, code completion, and version control to make the development process easier. Overall Android Studio provide a powerful and efficient environment for developing high-quality cross platform mobile applications.

The mobile application has a very simple user interface which includes the following options :

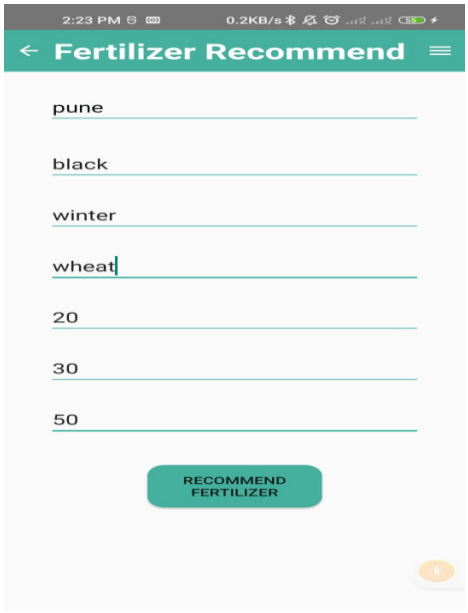
1. Home Page : The home screen is where the list of all the available Water pump control Section ,Crop Recommendation Section and Fertilizer Recommendation Section is displayed as shown in Fig.

2. Water pump control Section: In water pump section use get access to control the water pump. When farmer click on, ON button water pump will be ON. When farmer click on, OFF button water pump will be OFF.




4. Fertilizer Recommendation Section: In Fertilizer recommendation section farmer can know which Fertilizer he should spray on farm. By entering following values like District, Season, Soil Color, crop name and NPK Values, he will get suitable Fertilizer recommendation to spray on farm.




3. Crop Recommendation Section :

In crop recommendation section farmer can know which crop he should grow in farm. By entering following values like District , Season , Soil Colour , NPK Values , Rain Fall in that area and Temperature of particular area and he will get suitable crop recommendation and he have three options by these options he can grow any crop.

## VI. CONCLUSION

High-tech equipment was employed in this system to give the farmer the facilities. The farmer saves money and time using this approach. It also gives farmers access to all information, including NPK values, and makes fertilizing farms as simple as possible. Additionally, it shields farmers from hazardous fertilizers.

## VII. REFERENCES

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