IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 6, April 2023

Machine Learning and IoT Applications in Agriculture

S. D. Padiya[1], Atharva Raut[2], Bhavy Mittal[3], Mayur Patel[4], Vedant Polshettiwar[5]
Assistant Professor, Department of Information Technology[1]
Student, Department of Information Technology[2,3,4,5]
Shri Sant Gajanan Maharaj College of Engineering, Shegaon, Maharashtra, India

Abstract: *Agriculture is an industry that has historically relied on traditional methods for crop production, but with the advent of new technologies, it is now possible to integrate machine learning and Internet of Things (IoT) applications to improve agricultural practices. Machine learning algorithms and IoT devices can be used to analyze data collected from agricultural fields to optimize crop yield, reduce resource consumption, and improve farm management. In this review paper, we explore the various applications of machine learning and IoT in agriculture, specifically focusing on their use in crop monitoring, disease detection, and water management. We examine the challenges associated with implementing these technologies in agriculture, including issues related to data collection, privacy, and security. Finally, we discuss the potential benefits of integrating machine learning and IoT in agriculture and identify future research directions that can help advance this field. Overall, this review highlights the potential of machine learning and IoT technologies to revolutionize agriculture and improve food security in the years to come.*
The Internet of Things (IoT) network must be integrated with sensors in order for "smart agriculture" to be a reality. At many layers of the IoT system architecture, machine learning (ML) techniques are incorporated to increase usefulness and capabilities. For agricultural systems to properly integrate with information technology, intelligent agricultural systems must be established, and all types of information created by agricultural systems must be integrated and analysed.The agriculture sector might undergo a transformation thanks to the fusion of machine learning (ML) and internet of things (IoT) technology. Precision agriculture and more economical resource usage are made possible by using IoT sensors to collect data on a variety of factors, including soil moisture, temperature, and nutrient levels. Then, using these data, ML algorithms may be used to forecast outcomes and improve decision-making. For example, they can forecast agricultural yields, spot disease or insect infestations, and suggest the best dates for planting and harvesting.

Keywords: Soil NPK Sensor, Soil Moisture Sensor, Random Forest

I. INTRODUCTION

Machine learning and Iot technologies have been used in agriculture to conduct innovative researches1. Using iot-based data-driven farm management strategies, agricultural yields may be improved. The key benefits of machine learning and iotin agriculture are the reduction of issues, crop and yield predictions, management of livestock, and identification of databases of agricultural output in India. By using these technologies to accurately automate agricultural cultivation practices, management, and production, researchers are assisting farmers. Agriculture is a crucial sector that plays a vital role in global food security. In recent years, there has been an increasing demand for sustainable and efficient agricultural practices that can meet the growing food demands of the world's population. Machine learning (ML) and Internet of Things (iot) are two technologies that have gained significant attention in the field of agriculture. These technologies have the potential to transform traditional farming practices by enabling farmers to make data-driven decisions, optimize crop yield, and reduce resource consumption.

In this review paper, we explore the applications of ML and IoT in agriculture, with a specific focus on their role in crop monitoring, disease detection, and water management. We discuss the challenges associated with implementing these technologies in agriculture, such as the need for large amounts of data, privacy and security concerns, and the cost of deploying and maintaining IoT devices.[1]

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 6, April 2023

The integration of ML and IoT in agriculture has the potential to revolutionize the way we approach farming. By leveraging the power of ML algorithms and IoT devices, farmers can gain insights into the health and growth of their crops, detect diseases early on, and optimize resource usage. This can lead to higher crop yields, reduced environmental impact, and improved food security. Random forest models have emerged as a popular and effective machine learning technique for agriculture applications.[2]Random forest algorithms are a type of collaborative learning technique that amalgamates numerous decision trees to generate a resilient and precise prognostic model. These models are particularly useful for studying large and complex datasets, such as those collected from IoT sensors..

In agriculture, IoT sensors can be used to collect data on various environmental factors such as temperature, humidity, soil moisture, and light intensity. This data can be fed into a random forest model to predict crop yield, detect diseases, and optimize resource usage. For instance, a random forest model trained on data from IoT sensors can accurately predict the amount of water required for a specific crop in a particular field. This can help farmers optimize their irrigation practices and reduce water consumption, ultimately leading to more sustainable and efficient farming practices.[2]

One example of an IoT sensor-based system that uses random forest models in agriculture is the smart farming system developed by the University of California, Davis. The system uses IoT sensors to collect data on soil moisture, temperature, and humidity, which is then fed into a random forest model to predict the optimal time for irrigation. This system has been shown to reduce water consumption by up to 25%, while maintaining crop yield and quality.

However, the use of IoT sensors in agriculture also presents some challenges. For instance, the sensors may be prone to malfunctions, and the data collected may be noisy or incomplete. Furthermore, there are privacy and security concerns associated with collecting and storing large amounts of data from IoT sensors. These issues need to be addressed to ensure the wide spread adoption of IoT and machine learning.

In summary, the integration of random forest models and IoT sensors in agriculture has the potential to revolutionize traditional farming practices. By leveraging the power of machine learning and IoT, farmers can make data-driven decisions and optimize resource usage, ultimately leading to more sustainable and efficient agricultural practices.

The paper makes three key contributions:

- We develop an IoT-based smart agriculture system.
- We introduce various exemplary machine learning models.
- We analyze the potential challenges and use cases of machine learning in the context of smart agriculture.

II. METHODOLOGY

2.1 Smart Agriculture IoT System

Since agriculture is the most dominant activity across all cultures and civilizations throughout history. It's not only a significant aspect of the growing economy but is also crucial for the survival and the future of humankind. It is a major contributor to employment and has seen an exponential increase in production requirements over time. However, people are misusing They can also be used in landscaping and gardening to conserve water and avoid over-watering. Moreover, soil moisture sensors are extensively used in research to monitor variations in soil moisture over time and analyze the correlation between soil moisture and plant growth. Soil moisture sensors operate within a voltage range of 3.3 to 5 volts.

Machine learning is a method of teaching machines without the need for explicit programming, it improves machine execution by portraying the consistency and pattern of information. In this work various machine learning methods such as Decision Tree, Naïve bayes, Logistic Regression, and Random Forest were employed to predict crops for different states.

New hybrid varieties produced through mass production techniques lack essential nutrients found in naturally grown crops and can cause harm to the environment. To minimize losses in agriculture, machine learning is becoming increasingly popular as it aids in making informed decisions and improving sector throughput. The prediction accuracy of machine learning models, such as logistic regression and random forest, depends on the knowledge provided during the training period. The primary focus is on precision agriculture, which prioritizes quality over environmental factors. Random forest is the most precise algorithm for predicting crop yield, particularly in the face of fluctuating temperature and rainfall trends. By using historical data on weather and temperature, the system predicts the best crops to grow and provides a list of reasonable harvests and expected yields.

A smart agriculture IoT system leverages machine learning techniques to analyze collected data. By using historical data on environmental factors like temperature and rainfall, various machine learning classifiers such as logistic regression and random forest can be employed to identify patterns and make accurate predictions, thereby improving crop yield. The system takes necessary measures to modify the environment to suit crop growth based on the predictions made by these machine learning models.

The system relies on sensors to sense the soil parameters in real time and use an external dataset. The data obtained in real-time is stored on a local machine, and machine learning algorithms are employed for subsequent analysis.

2.2 Soil Moisture Sensor

A device designed to measure the moisture content of soil is known as a Soil Moisture Sensor. It is an electronic device that calculates the amount of moisture present in the soil.

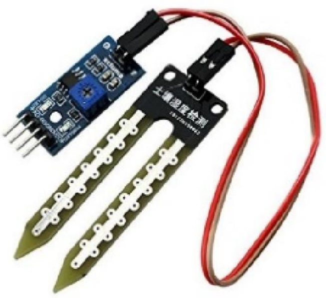

Figure 1: Soil Moisture Sensor

It typically comprises a probe that is placed in the soil to gauge its moisture content based on its electrical conductivity. Soil moisture sensors are widely employed in agriculture to optimize irrigation practices and ensure appropriate water supply for crops.

They can also be used in landscaping and gardening to conserve water and avoid over-watering. Moreover, soil moisture sensors are extensively used in research to monitor variations in soil moisture over time and analyze the correlation between soil moisture and plant growth. Soil moisture sensors operate within a voltage range of 3.3 to 5 volts.

2.3 Soil NPK Sensor

A Soil NPK Sensor is a device that detects the levels of nitrogen, phosphorus, and potassium (NPK) in the soil. These are the primary nutrients necessary for plants' healthy growth and development. Soil NPK sensors use different methods, such as electrochemical or spectroscopic techniques, to measure NPK concentration in the soil. The usage of soil NPK sensors is crucial in agriculture because it helps farmers optimize fertilization practices, reduce fertilizer waste, and enhance crop yields. By determining the NPK levels in the soil, farmers can apply the right amount of fertilizer at the right time, preventing under or over-fertilization that can lead to plant stress or environmental pollution. Besides agriculture, soil NPK sensors can also be employed in research and environmental monitoring to comprehend nutrient cycles in soil and assess soil health. With this information, land managers and researchers can develop strategies to maintain soil fertility, prevent nutrient depletion, and restore degraded soils. Overall, soil NPK sensors are a critical tool for sustainable agriculture and environmental management, providing valuable data for precision farming and resource conservation. Soil NPK (Nitrogen, Phosphorus, and Potassium) sensors measure the levels of these essential nutrients present in the soil. The specific values and range of soil NPK sensor will depend on the its operating requirements.

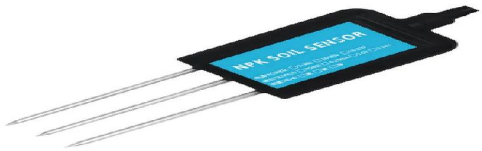

Figure 2: Soil NPK Sensor

Typically, the measurement range of soil NPK sensors varies based on the nutrient being measured. The following are the general measurement ranges for soil NPK sensors:

- Nitrogen (N): 0-2000 mg/kg
- Phosphorus (P): 0-1000 mg/kg
- Potassium (K): 0-2000 mg/kg

The values measured by a soil NPK sensor may also be affected by soil type, pH, and other environmental factors. Calibration of the sensor based on local conditions may be required to obtain accurate measurements.

It's important to note that soil NPK sensors provide an estimate of nutrient levels in the soil, and laboratory analysis may be necessary to confirm the measurements. Additionally, the interpretation of the sensor readings requires knowledge of the crop being grown and its specific nutrient requirements.

2.4 Arduino Uno

Based on the ATmega328P microcontroller, Arduino Uno is an open-source microcontroller board. chip. It has a relatively small form factor and is designed for use in a wide range of electronic projects, including robotics, home automation, data logging, and IoT (Internet of Things) applications.

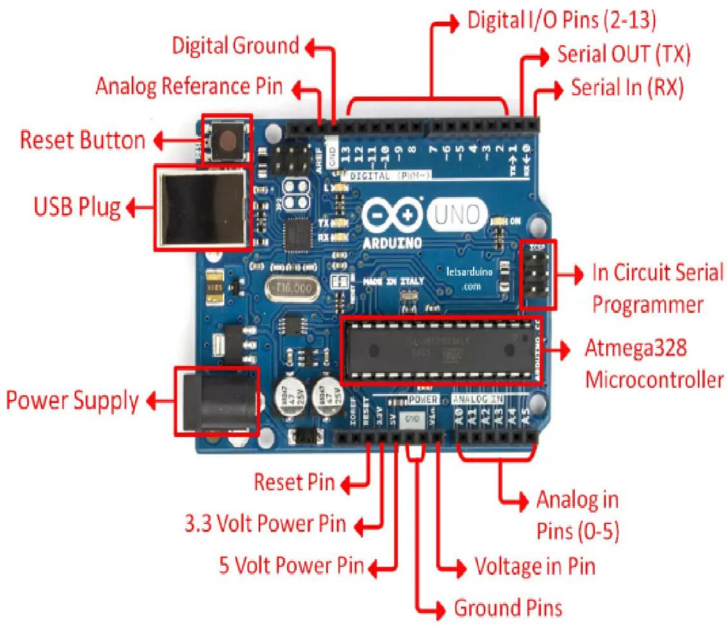

Figure 3: Pin diagram of Arduino Uno

The Arduino Uno board has a number of key features, including:

- 14 Digital Input/Output Pins: These pins can be used to interface with a variety of digital devices, such as sensors, LEDs, and switches.
- 6 Analog Input Pins: These pins can be used to measure analog signals, such as light or temperature.
- 16 MHz Clock Speed: This clock speed allows the microcontroller to run code quickly and efficiently.
- USB Connection: This connection allows the board to be programmed and powered through a computer.
- Power Jack: This jack allows the board to be powered by an external power supply.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 6, April 2023

- Reset Button: This button resets the board.

After connecting hardware components and getting data in Arduino ide next step is to build an ML model.

Figure 4: Hardware Setup

2.5 Flowchart

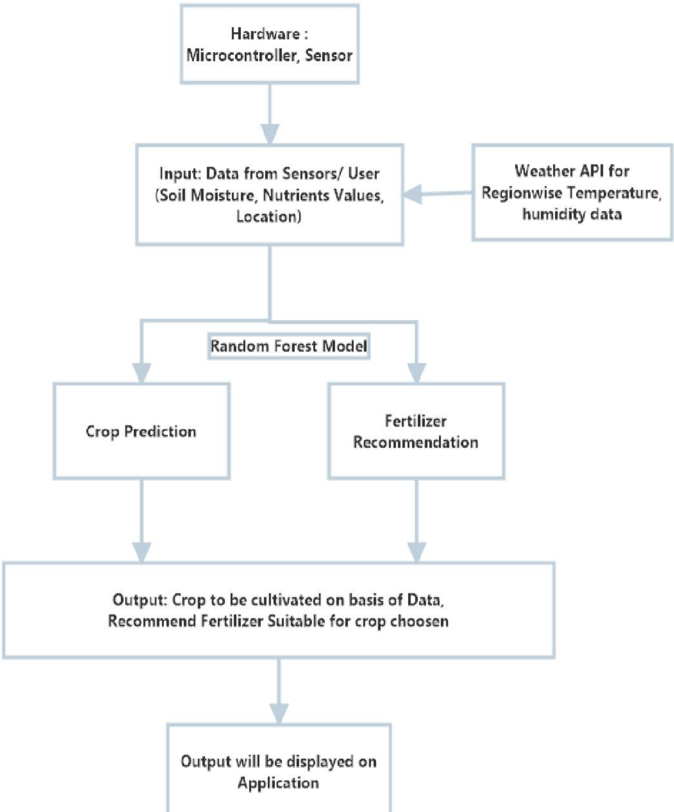

Figure 5 : Flowchart Diagram of System

III. MACHINE LEARNING MODELS APPLICATION

3.1 Importing Libraries

- NumPy: It's a library from Python used to deal with arrays, and in addition, it provides features of matrices, linear algebra, etc.
- Pandas: It's a Python library used to deal with datasets.
- Matplotlib: This library is used for creating animated, static, and interactive visualizations in Python.
- Sklearn: Python library with various effective methods for statistical modeling and machine learning.
- Seaborn: It is a Python data visualization library built on top of the popular matplotlib library. Seaborn is used to creating more visually appealing and informative statistical graphics than Matplotlib

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 6, April 2023

3.2 Data Cleaning

At first, we imported the dataset from data.gov.in for crops requirement in different regions of India with the help of the pandas' library. We have a dataset with six columns, one is the Nitrogen column containing Nitrogen nutrient requirement and the others are Phosphorus, Potassium, Temperature, Humidity, and Rainfall column.

3.3 Selection and comparison of ML Algorithms

Before selecting an algorithm, we need to first assess and compare different options, and then choose the one that best fits our specific dataset. Machine Learning is the best approach for providing a practical solution to the crop selection problem.

There are various ML algorithms that can be used for predicting crop. This study will consider the following algorithms for selection and accuracy comparison:

- Naïve Bayes Classifier: A popular machine learning algorithm for classification tasks is Naive Bayes. It depends on Bayes' hypothesis and accepts that the elements used to characterize the information are autonomous of one another. Given the input features, the probability of each class is calculated by the algorithm, and the class with the highest probability is chosen as the predicted class. It gives an accuracy of 98.01%.
- Logistic Regression: A classification algorithm called logistic regression is used to predict the probability of a target variable. There are only two classes that can be found in the target binary variable. At the point when strategic relapse is applied to our dataset it has given an accuracy of 95.22%.
- Decision Tree: The Decision Tree is a method of machine learning that can be used for classification and regression. The model appears as a tree, with every hub addressing a property or component, each branch addressing a choice rule, and each leaf hub meaning a class mark or anticipated esteem. The calculation separates the information into subsets in view of the information highlight values, determined to deliver subsets that are essentially as homogeneous as conceivable with respect to the objective variable. The procedure is recursive and goes on until a stopping point is reached. When applied to the dataset, it has produced an accuracy of 90%.
- Random Forest: Based on various data subsets, the algorithm creates decision trees and then makes predictions for each subset. The algorithm improves the system's solution by combining the results from a voting process. The output of Random Forest is more accurate because it trains the data using the bagging technique. RF has provided an accuracy of 99.09 percent for these data.

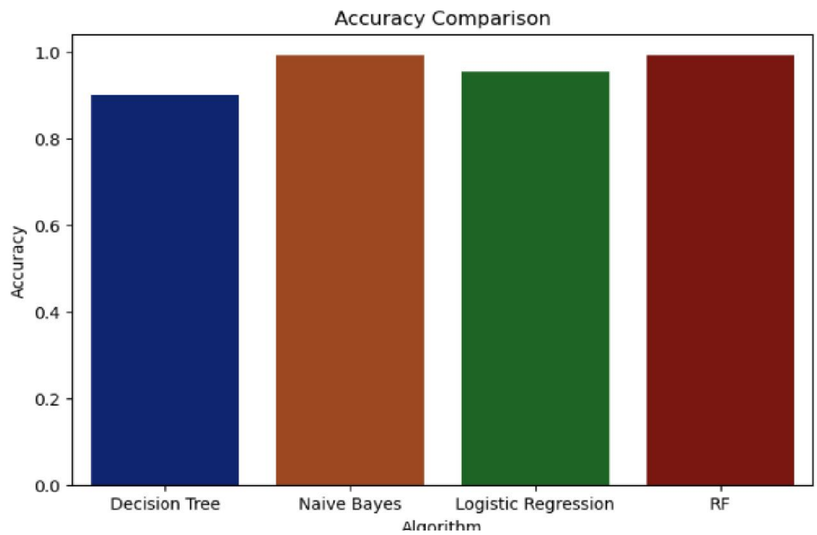

Figure 6: Accuracy comparison of ML models

3.4. Model Building

In this step, we will build a Random Forest model which is based on RF(Random Forest *Classifier*) as we got maximum accuracy and precision with RF. We selected dependent and independent features which will be required for crop prediction and classification and also to recommend fertilizers application using pre-existing values of required nutrients.

3.5. Evaluation

We assessed the model on "accuracy" and "precision". We ended up with a precision of 96.36 percent and an accuracy of 99.09 percent.

IV. CONCLUSION

This system focuses on the prediction of crop and fertilizers recommendations with the help of machine learning techniques and IoT sensors. Various machine-learning techniques were employed for the computation of precision. The Random Forest classifier was implemented to predict the harvest for a specific soil contains. A mechanism was established to anticipate crop yield based on prior data. The given System assists farmers in making choices regarding which crop to grow on their agricultural land. This system improves the overall efficiency of farmland. By maximizing crop yield rates, this undertaking enhances the Indian economy

REFERENCES

[1]. Amna Ikram, Waqar Aslam, RozaHikmat Hama Aziz, Fazal Noor, Ghulam Ali Mallah , Sunnia Ikram, Muhammad Saeed Ahmad, Ako Muhammad Abdullah, and Insaf Ullah(2022). “Crop Yield Maximization Using an IoT-Based Smart Decision. In 2022 Journal of Sensor” Volume 2022, Article ID 2022923.

[2]. Anakha Venugopal, Aparna S, Jinsu Mani, Rima Mathew, Prof. Vinu Williams. (2021). "Crop Yield Prediction using Machine Learning Algorithms".International Journal of Engineering Research & Technology (IJERT), NCREIS-2021 Conference Proceedings.

[3]. Payal Gulati, Suman Kumar Jha. (2020). “Efficient Crop Yield Prediction in India using Machine Learning Techniques”. In Proceedings of 2020 International Journal of Engineering Research & Technology (IJERT).

[4]. Deepti Dighe, Harshada Joshi, Aishwarya Katkar, Sneha Patil, Prof. Shrikant Kokate. (2021).“Survey of Crop Recommendation Systems”. In 2018International Research Journal of Engineering and Technology (IRJET).

[5]. Bhanu K N, Jasmine H J, Mahadevaswamy H S. (2020). “Machine learning Implementation in IoT based Intelligent System for Agriculture”. International Conference for Emerging Technology (INCET), 2020, Belgaum, India.

[6]. Jaimahaprabhu A, Praveen Kumar V, Gangadharan P S, Dr.B. Latha. (2019). “Cloud Analytics based Farming with Predictive Analytics using Artificial Intelligence”. Fifth International Conference on Science Technology Engineering and Mathematics (ICONSTEM).

[7]. Aruvansh Nigam, Saksham Garg, Archit Agrawal "Crop Yield Prediction using ML Algorithms ",2019.

[8]. Priya, P., Muthaiah, U., Balamurugan, M."Predicting Yield of the Crop Using Machine Learning Algorithm",2015.

[9]. Tushar Hanwater, Madhav Vaidya, Ankush Sawarkar,” Survey on Integrated platform for Development Rural Agriculture in India using ICT platform”, International Journal of Computer Science and Information Technologies, Vol. 5 (2), 2014.

[10]. Gouravmoy Bannerjee, Uditendu Sarkar, Swarup Das,& Indrajit Ghosh, “Artificial Intelligence in Agriculture: A Literature Survey,” International Journal of Scientific Research in Computer Science Applications and Management Studies, Volume 7, Issue 3 (May 2018).

DOI: 10.48175/IJARSCT-9416