Precision Farming using Machine Learning and IoT

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Abstract— Agriculture has suffered significant losses as a result of climate change, which is a critical issue. Real-time weather data is crucial for agriculture, as farmers cannot control the weather and its impact on their crops can significantly affect profitability. In the past, poor weather conditions have caused severe setbacks to profitability in agriculture. However, farmers can mitigate losses by implementing extra farm management techniques. Therefore, having access to real-time weather data is becoming increasingly important for farmers to optimize crop yields and ensure a successful harvest. Use of machine learning algorithms on weather data to suggest crops best suited for that climate has led to both increase in production and reduction in use of fertilizers. This issue is clarified in this paper by suggesting a system that will gather real-time weather data and use machine learning algorithms on that data to recommend the best crops for that climatic condition and recommend a satisfactory amount of composts. Our system will assist farmers in increasing crop production and reducing fertilizer use, leading to greater profits.

Keywords— Wireless sensors, real-time, fertilizers, machine learning, embedded systems, precision agriculture, crop recommendation

I. INTRODUCTION

Due to its significance in our culture, agriculture is instilled in people from a young age, and both men and women are expected to grow crops on their property. Over time, conventional agricultural practices deteriorate and lose their effectiveness; this is compounded by the fact that natural disasters and abrupt weather changes are direct consequences of climate change [1-2].

The agriculture sector has suffered significant losses due to sudden changes in weather patterns, as even a brief period of adverse weather conditions can devastate crops in a particular region. Consequently, many farmers have had to abandon traditional agricultural practices. Unfortunately, the adoption of unsustainable farming methods in response to these challenges has led to unhealthy crops and associated health issues. Peasants are frequently coerced into injecting harmful drugs to increase farm output. Due to such cultivating approaches, along with climate change, the elemental resources like soil, water, and air are being exploited, which results in a loss of understanding about crop cultivation in the current generation at the proper time and place [3].

Algorithms for machine learning can be used to solve a variety of issues, including those in agriculture. Many learning algorithms, including supervised, unsupervised, and reinforcement learning, each have their own benefits and drawbacks. A mathematical model is created using supervised learning using a set of data that comprises both the intended input and the desired output. On the other hand, unsupervised learning algorithms create mathematical models from scant information that have only inputs and no desired output. It is a recognized and effective strategy to use embedded system and machine learning technologies separately in agriculture.

The purpose of this paper is to suggest real-time field data collection using the Internet of Things (IOT) and machine learning algorithms like K-nearest neighbour (KNN) on that data to suggest to farmers the best crops that can grow under the climate conditions and also recommend fertilisers to be used for the purpose of accurate farming. Both cutting-edge technologies, including machine learning and embedded systems, are combined. In order to boost agricultural yield and cut back on resource use, which will enhance revenues. In order to achieve more precision, our system will employ real-time data gathered from the precise place rather than data from the internet.

II. RELATED WORK

The purpose of the paper is to recommend crops to farmers in order to maximize their output. In order to anticipate crops, an ensemble technique is used. Ensemble is a strategy that also goes by the name "model combiners" because it combines the predictive power of two or more models [4]. Ensemble approach, often known as the majority voting procedure, is used to ensure accuracy. Their main recommendation was to help farmers increase harvest profitability. The purpose of the paper is to investigate horticulture soils with the aid of information preparation techniques. Several information preparation nuances were discussed in the paper, including information connections, bunches, affiliation, consecutive instances, choice trees, hereditary calculations, information representation, as well as various information collection techniques [5]. It likewise had covered different kinds of soils for the investigation reason and consequently the primary common elements which are affecting soil Stalinization and hardening [6]. The extents of AI and information preparation tools were also discussed in detail. The basic temperature, humidity, and a few other boundaries are obtained by the examination suggested in the text [6]. Their framework was created utilizing Node MCU. The exploration had utilized a temperature moistness sensor and soil dampness sensor for checking climate as boundaries regarding farming. This is generally done primarily to zero in on immature and non-industrial countries and to encourage accuracy in horticulture and help workers. In research paper [7] for the purpose of sensor board implanted with the NXP FRDM-K64F, author has created an effective continuous acknowledgment of a Gaussian combination model (GMM). This allows for continuous information analysis, consistent preparation, and re-preparation of the AI calculation thanks to their coordinated equipment and programming [8] A few uses with lower sensor information traffic can be obliged by ongoing ML stage.

III. PROPOSED SYSTEM

A. Dataset Collection

Government websites have a data set with explicit properties of the soil. Considered characteristics include depth, surface, pH, soil, colour, drainage, water retention, and erosion [9]. The soil's expressed borders play a crucial role in how well crops can drain water and useless nutrients from the soil [10]. The soil needs to have a favorable environment in order for crop growth to be possible.

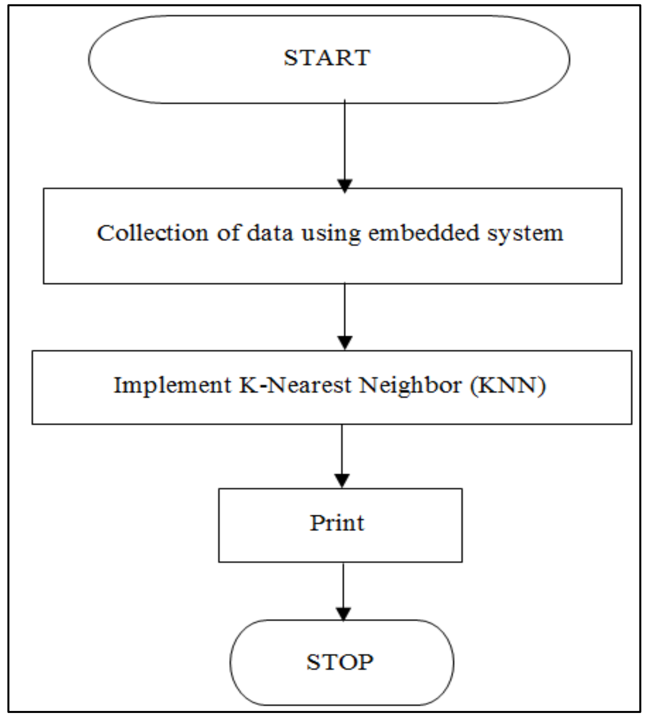

Fig. 1. Working of proposed system

Soil serves as the foundation for plants, anchoring their roots and providing stability. Additionally, the soil's porosity directly influences the availability of air and water, crucial for preventing water logging and facilitating nutrient absorption by plants [11-12]. The pH level of soil [13], influenced by microbial activity and replaceable aluminum, plays a significant role in determining the availability and distribution of soil nutrients. The extent of root spread is influenced by the amount of water and waste present. Considering these factors, the mentioned boundaries are now considered when selecting crops for optimal harvest outcomes [14-15].

B. KNN Algorithm

KNN, also referred to as K-nearest Neighbor, is a supervised and pattern classification learning technique that helps us identify which class the new input (test esteem) belongs to by selecting k nearest neighbours and calculating the distance between them. K-closest neighbours (KNN) calculations are a type of administered machine learning (ML) calculations that can be used for both order-specific and relapse-predictive problems [16]. Yet, it is mostly used in industry for problems with characterization of the future. The following two characteristics would describe KNN

Lazy learning algorithm − KNN is a lazy learning method since it uses all the data for preparation while characterization and doesn't have a specific pre-processing stage.

Non-parametric learning algorithm − Because it makes no assumptions on the underlying data, KNN is also a non-parametric learning algorithm.

The K-nearest neighbours (KNN) technique uses "include closeness" to predict the estimates of new information points. This further means that the new information point will be given a value based on how closely it coordinates the points in the preparation set [17]. With the help of the subsequent advancements, we can understand how it functions.

Step 1 − We require a data set in order to do any calculation. So, in the first step of KNN, we should stack the preparation data with the test data.

Step 2 − The next step is to select K, or the closest data points. Every integer can be K.

Step 3- For each point in the test data following calculations are performed:

Calculate the distance between each column of prepared information and the test data using one of the methods namely Euclidean, Manhattan, or Hamming distance. Euclidean geometry is the method of measuring distance that is most frequently used.

Now, in view of the distance esteem, sort them in climbing request.

Next, it will pick the top K lines from the arranged cluster.

Now, it will allocate a class to the test point dependent on most continuous class of these lines.

C. *Weather monitoring using embedded systems*

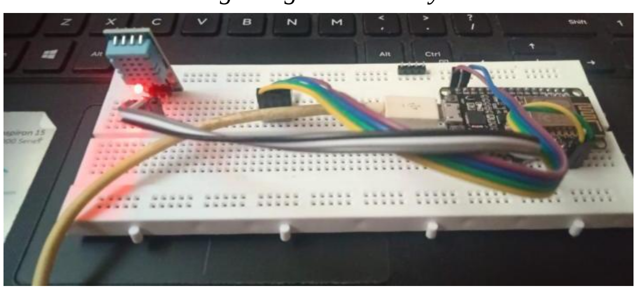

Fig. 2. Embedded system used for data collection

Various hardware components have been utilized in this study:

(i) ESP 8266 - The ESP 8266[Fig. 3] is a reasonably priced WIFI computer chip that has a complete TCP/IP stack with a small regulator capacity. This little module enables micro-controllers to join a Wi-Fi network and establish fundamental TCP/IP connections using Hayes-style commands [18].

(ii) BMP 180 pressure sensor – Absolute measurements of the air pressure surrounding them are made by barometric pressure sensors (Fig. 4). Its pressure fluctuates according to the altitude and the weather [19]. Depending on how you interpret the data, you might use it to perform additional tasks that need an accurate pressure reading, such as measuring altitude or keeping track of weather changes.

Fig. 3. ESP 8266 - Image source zerynth docs documentation

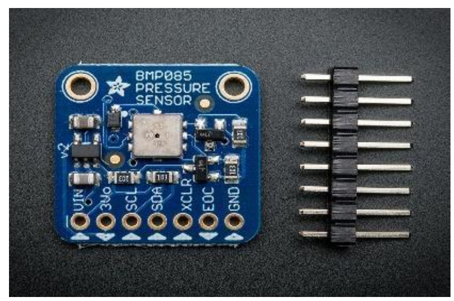

Fig. 4. • BMP 180 pressure sensor - Image source addafruit

(iii) Connecting wires - To enable an electrical current to move from one place in a circuit to another, connecting wires [Fig. 5] provide a medium. In the case of computers, cables are included into circuit boards to store electrical pulses. Since copper is affordable and electrically conductive, it is typically used for wiring in computers and other components.

Fig. 5. Connecting wires - Image source India-mart

(iv) DHT-11 - Due to its low cost and high efficiency, the DHT11[Fig. 6] is a common sensor used in conjunction with the Arduino for the BMP 180 pressure sensor, temperature, and humidity. [20] It collects data using a capacitive stickiness sensor and an NTC thermistor and outputs a digital signal on the data pin (no simple information pins required). Although it is quite simple to use, gathering information from it necessitates careful planning. It transmits new data at a frequency of recording 1 Hz [21].

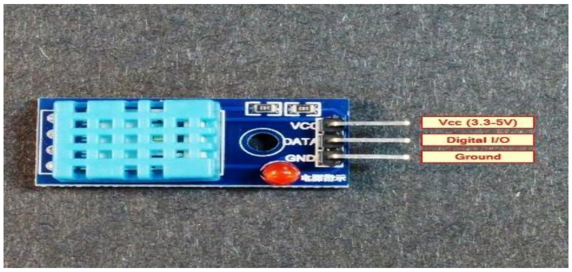

Fig. 6. DHT11- image source protosupplies

3.4 Chabot for local farmers

A chatbot in Messenger can go about as a menial helper for business. They engage with customers in a friendly, relatable manner, enabling farming enterprises to enhance customer service, profitability, and operational competence. Bots are incredibly helpful in data-intensive industries like agriculture because they can assist streamline and automate tasks that were previously only possible through meticulous counting and archaic human analysis. Many of our farmers may have to cope with issues like how much production can be grown on a single hectare. Responses to these queries are frequently provided by means of predetermined inquiries that farmers may make. Anytime a farmer asks a question, the chatbot will respond.

IV. Implementation

The NodeMCU system, depicted in figure 7, will collect data from various sensors, including temperature, stickiness, and pressure. The DHT11 sensor will be responsible for recording ambient temperature and humidity, while the BMP180 sensor will gather atmospheric pressure data. The collected data will then be processed by the NodeMCU system and converted into JSON format. This JSON data will be transmitted to the backend for utilization by machine learning algorithms.

For the backend framework, we have chosen Django, and Firebase will serve as our database. The information obtained from the NodeMCU system will be stored in Firebase. The data will be analyzed by Firebase to generate forecasts. To forecast the best crops suitable for the local climate and recommend the appropriate fertilizers based on the soil report, the K-nearest neighbors (KNN) algorithm will be applied to the gathered data.

V. Results

The research findings are presented in Table 1, which displays the output data. The table includes the date when the data was collected, the weather conditions recorded using our integrated technology, the recommended crop for farmers, the corresponding fertilizer required for cultivation, and the accuracy of the predictions.

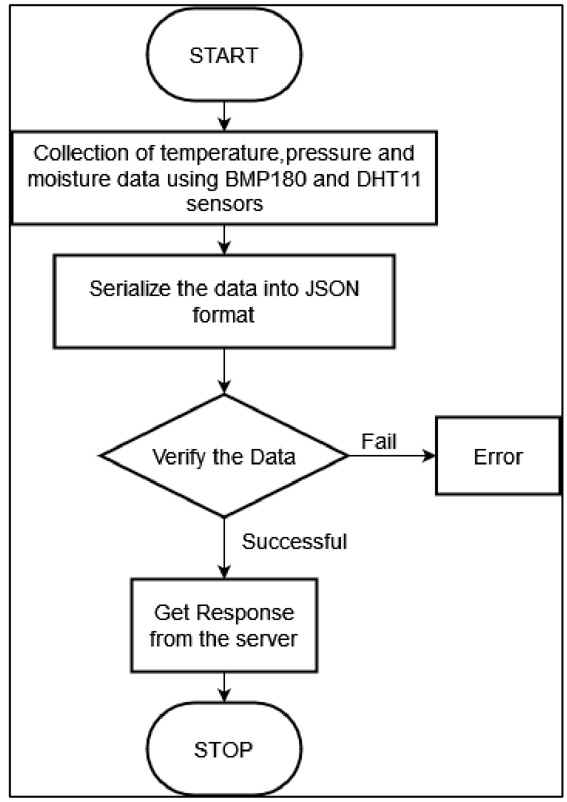

Fig. 7. Working of the system

TABLE I. Output of the System

S. No.	Date	Weather	Crop	Fertilizer	Accuracy
1.	23-08-20	Cloudy	Adzuki Beans	Muriate of Potash	90%
2	26-2-21	Sunny	Black gram	Nitrogen	87%
3	11-6-21	Rainy	Coconut	Muriate of Potash	95%

The results were taken at Vasai in Palghar district from Maharashtra State of India. First the system was tested in the month of August and based on the cloudy weather system suggested Adzuki beans with Muriate of Potash as the fertilizer. Adzuki beans were never tried before in the surrounding areas but the climate was suitable for them and gave expected yield in 120 days time which is the average harvesting time for it. Next reading was taken in month of February and the suggested crop was Black gram with Nitrogen as fertilizer. Black gram was traditionally grown in the region but the plantation time was in the month of March. When it was grown in February it gave better yield and took 60 days instead of 70 days. The last result was taken in month of June and weather was rainy the system suggested Coconut with Muriate of potash as fertilizer. Coconut saplings were planted with suggested fertilizer being used and grew at better than average rate due to rainy weather. Our framework would assist the workers with raising their efficiency of agribusiness.

It will confine the utilization of synthetic substances in the development of yields.

VI. Conclusion

In this paper we analyzed how climate change can affect crop growth and how this challenge needs to be tackled. We then built an embedded system that can capture the weather conditions of an area and store it in a web server. We studied how computer algorithms can be useful in solving this problem as the climate may not be suitable for crops grown earlier but can be suitable for some other crops. The best crops that can be grown in the area will be suggested when the KNN algorithms are applied to the data that the system has acquired. This system is quite accurate since it uses an embedded system to get real-time data from the field. It may be made even better by adding more sensors that can gather more information and enhancing the suggestions. By using this approach, less chemical fertilisers will be used. This technology would assist farmers in raising production and earnings using conventional farming techniques. In future new methods of agriculture like aquaponics and aeroponics will heavily rely on the use of embedded systems that provide real time data and use algorithms to monitor and grow crops

VII. FUTURE SCOPE

When examining the weather, additional factors can be taken into account. A potential future development of this interface involves creating a platform where ranchers can seek advice from industry experts. By utilizing soil sensors, it is possible to automate irrigation control, enabling farmers to receive information about the moisture levels in their crops and activate or deactivate the water supply accordingly. In terms of security, intrusion detection can be performed through the use of a reconnaissance system incorporating weight and infrared sensors. Furthermore, the implementation of drone technology can greatly enhance the precision of horticulture. Robots can be programmed to water the crops periodically, ensuring they receive the necessary hydration naturally.

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