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IoT and Machine Learning Based Crop Suggestion System

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Abstract

The practise of analysing and extracting meaningful information from enormous amounts of data is referred to as data mining. Data mining is used in a wide range of industries, including banking, retail, medicine, agriculture, and so on. In agriculture, data mining is utilised to investigate the various biotic and abiotic factors that influence crops. Agriculture is India's most important industry, providing the majority of work possibilities. One of the most common issues that Indian farmers confront is choosing the right crop for their soil. As a result, they are experiencing a major drop in output. Precision agriculture has provided farmers with a solution to this problem. Agriculture with pinpoint accuracy Precision agriculture is a modern agricultural strategy that uses research data on soil features, soil types, and crop yield data to recommend the best crop to produce based on site-specific parameters to farmers. Precision agriculture is gaining popularity.

1. Introduction

Crop recommendation in agriculture is a new generation bubble that is enthralling the public. The majority of the time, farmers is unaware of the kind of crops that should be grown on their farms. This causes a lot of confusion and has an impact on productivity. This is why we are concentrating our efforts on determining the optimal crop to produce in order to achieve maximum production. We created a dataset by combining rainfall, climate, and fertiliser data from several sources throughout India.

This will offer us a better sense of crop patterns when diverse environmental and geographical factors are taken into account. This dataset can be used to build a machine learning model for predicting the best crop to produce in a specific location. Machine learning has the potential to transform the agriculture industry. We will assist farmers in determining the raw materials and other resources required considerably earlier than they would have worked out otherwise[1] by forecasting the proper crop to be cultivated.

This would eliminate the issue of nutrient inadequacy in fields caused by incorrect crop planting, which can reduce production efficiency in a compound way. India is still lagging behind in terms of developing technical solutions for agriculture, which accounts for nearly half of the country's income. Promoting more scientific solutions is critical if India's agriculture business is to achieve greater heights.

The model's major goal is to provide farmers with the best crop-growing advice possible, taking into account elements such as soil composition, environmental parameters such as temperature, humidity, and rainfall, and geographical influence.

The growth of digital agriculture and its associated technologies has created a plethora of new learning opportunities. Remote sensors, cameras, and other linked equipment will collect data 24 hours a day, seven days a week throughout an entire farm or area. These will keep track of plant health, soil conditions, temperature, and humidity, among other things. The amount of data generated by these sensors will be enormous. This allows farmers to have a better knowledge of the state of affairs on the ground by using innovative technology to provide them with more precise and timely information about their situation[2].

2. **Literature survey**

The team looked for and reviewed various patents, research papers, documents, newspapers and magazine articles from diverse scenes for this project's literature review.

The needs and strategy needed for designing a software model for precision farming are explored by Sardar Maran[1]. It delves into the fundamentals of precision farming. The authors begin with the fundamentals of precision farming before moving on to constructing a model to support it. This research offers a model that uses Precision Agriculture (PA) concepts to control variability on small, open farms at the individual farmer and crop level. The model's overall goal is to provide direct advising services to even the tiniest farmer at the level of his or her smallest crop plot, using the most accessible technologies available, such as SMS and email. This model was created for the situation in Kerala, where the average holding size is significantly lower than the rest of India. As a result, with some alterations, this model can be used in other parts of India.

Pradeepa Bandara [2] investigates assortment algorithms and how well they work in yield prediction in precision husbandry. These algorithms are used to forecast yield on a soya bean crop using data collected over multiple years. Support Vector Machine, Random Forest, Neural Network, REPTree, Bagging, and Bayes are the methods employed in this article for yield prediction. The conclusion reached at the end is that, among the above-mentioned algorithms, bagging is the best for yield prediction because its error deviation is the smallest, with a mean absolute error of 18985.

M. Heibloem [3] discusses the importance of crop selection as well as the elements that influence it, such as production rate, market price, and government policy. This work provides a Crop Selection Method (CSM), which addresses the crop selection problem while also increasing the crop's net yield rate. It recommends a series of crops to be planted throughout the course of a season, taking into account weather, soil type, water density, and crop type. The accuracy of CSM is determined by the expected value of influential parameters. As a result, a prediction approach with increased accuracy and performance is required.

Prof. Rakesh Shirsathand provided a framework in his research [4] that allows clients to make decisions about which crop to grow. The system used is a membership-based system with personalised information for each rancher enrolled. The framework includes a module that stores data from previous harvests gathered from various sources and displays a coordinating crop that can be planted. The entire process is carried out with the use of fictitious impartial mechanisms. Finally, a critique framework is provided so that the designer can make any necessary adjustments if the rancher encounters any issues when using the framework.

RSF is a proposal framework for farmers that includes an area location module, information investigation and capacity module, trim evolving database, and physiographic database, as described in article [5]. The comparative area discovery module identifies regions that are similar to the client's areas and compares the harvests planted in those areas. Similarly, the proposals for the client are created using the comparability framework. The Google API APIs are used by the area recognition module to obtain the client's current location in order to identify similar places. However, the framework does not encourage clients to provide feedback in order to improve the process.

Rishit Hemant Dabhade [6] discusses the necessities and why they are moving into precision agriculture [7] as a result of globalisation. Precision agriculture is farming that is done on a site-by-site basis. Despite the fact that precision agriculture has improved over time, there are still certain difficulties. As previously stated, site-specific approaches of such systems must be overseen in order to achieve a better result. Only a few of the outcomes are given a specific outcome. Nonetheless, farming is necessary because any failure or mistake could result in catastrophic damage to resources and plants.

This study proposes a method in which all of the important aspects are considered at the same time and a solution is found so that the system is not overly confusing for the user. As stated earlier in the sentence, unlike other models proposed by previous researchers, this system considers all of the major factors that are essential for plant growth and processes them all at the same time using various algorithms, whereas other models consider only parameters at a time while keeping the other factors constant.

Some experiments, for example, are conducted out to determine the rate of evaporation and how plant development is affected when there is insufficient water. As a result, a derived equation is presented[8].

ETo = K pan × E pan

ETo: reference crop evapotranspiration

Kpan: pan coefficient E pan: pan evaporation

Despite the existence of an equation, there are significant limits [9]. This might mostly be done for a land with a smaller area. This is not suited for commercialization since the profit will be minimal if the cultivation area is reduced. The second constraint is Sri Lanka's average rainfall, which is generally sufficient for various crop varieties to flourish without deficiency. As a result, while the water level is not a major concern, other issues are. It would be an issue if there was adequate water for plants but no temperature, because the key environmental elements have a mutual link in plant growth.

The purpose of past studies has likewise been to predict the best crop kind. The system's task is done after the farmer or user has cultivated the projected crop kind. However, the approach suggested in this study includes a feedback system. The system can track plant growth and provide feedback if the farm is malnourished even after recommending the optimal crop kind. In order for the user to take the required safeguards ahead of time.

3. Methodology

3.1 Dataset Collection

For a plant to grow healthy, it need a certain temperature, humidity, soil pH, sunshine, and soil moisture. These parameters must be met in order to have a satisfactory harvest. However, depending on the plant kind, such criteria may differ. The initial data set was compiled using sources such as the Department of Agriculture [2], various agriculture books, agricultural online sites [1], and other publications and research papers. This original data set was utilised to improve the accuracy of the crop recommendation model by training it using this data collection.

Crop	Temp	Hum	pH	Rain	Moist
Bean	26	63	7	8	63
Lettuce	23.8	60	6.5	8	60
Carrot	26	98	6.5	8	98
Cabbage	29.4	95	7.1	5	95
Onion	27	98	7.4	5	96
Beet	30	99	6.5	6.5	6.5

Table 1.Sample data set

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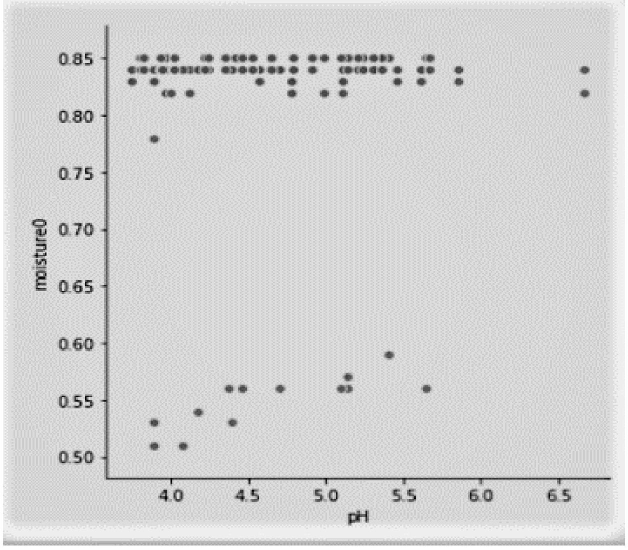

Fig 1: Data plot of soil moisture using Linear Algorithm

The graph depicts soil-specific features obtained from the Polytest Laboratories soil testing lab in Pune, Maharashtra, India. In addition, Marathwada University provided similar sources of general crop data. Groundnut, legumes, cotton, vegetables, banana, paddy, sorghum, sugarcane, and coriander are among the crops examined in our model. The training dataset's number of examples of each crop is displayed. Depth, Texture, Ph, Soil Color, Permeability, Drainage, Water Holding, and Erosion were all factors evaluated.

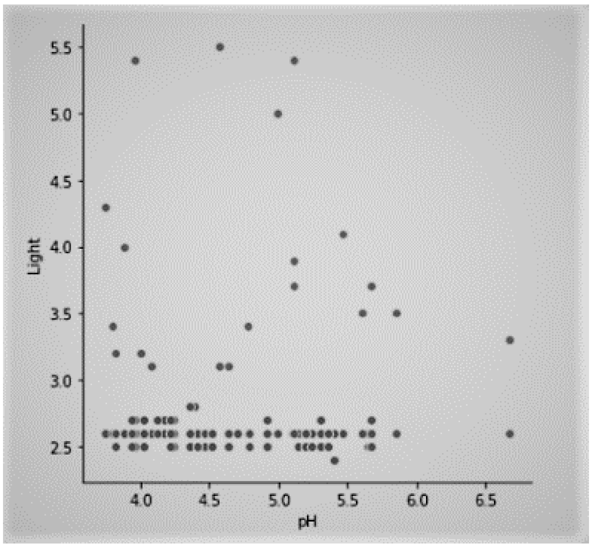

Fig 2: Data plot of Sunlight (lux) using Linear Algorithm

3.2 Crop Prediction

Because environmental circumstances vary by region, a machine learning model is employed to forecast the optimal crop variety for the chosen land. Machine learning algorithms [8] are used to train the crop suggesting model with the data obtained from the Arduino sensors in order to identify the best crop to cultivate with the highest probability of growing. The optimal crop type is chosen using the Nave Bayes and Support vector machine techniques.

It was chosen what type of crops the farmer should cultivate based on this model. This is accomplished through the examination of parameters like as humidity, temperature, soil moisture, pH level, and sunlight. Using two machine learning algorithms, the system primarily recommends four crop types based on the above-mentioned characteristics.

Naive Bayes [9] - Naive Bayes is a classifier model construction technique that assigns class labels to problem cases represented as vectors of feature values, with the class labels selected from a finite set.

The goal of the support vector machine method (SVM) [10] is to find a hyperplane in N-dimensional space (N — the number of characteristics) that distinctly classifies the input points.

3.3 Collecting Environment Factors

The environmental elements have to be obtained in order to compare and predict the initial data set. Arduino microcontrollers are used to collect environmental data. Because the temperature and humidity sensors are both made up of a single microcontroller, data is collected using four sensors. Sunlight intensity sensor, soil moisture sensor, soil pH sensor, and humidity and temperature sensor are the sensors. The sensors are linked to an Arduino Wi-Fi module, and the data collected is relayed to a database. The data is cleaned and processed using clustering and other techniques before being passed on to the next component of crop recommendation and stored in a database.

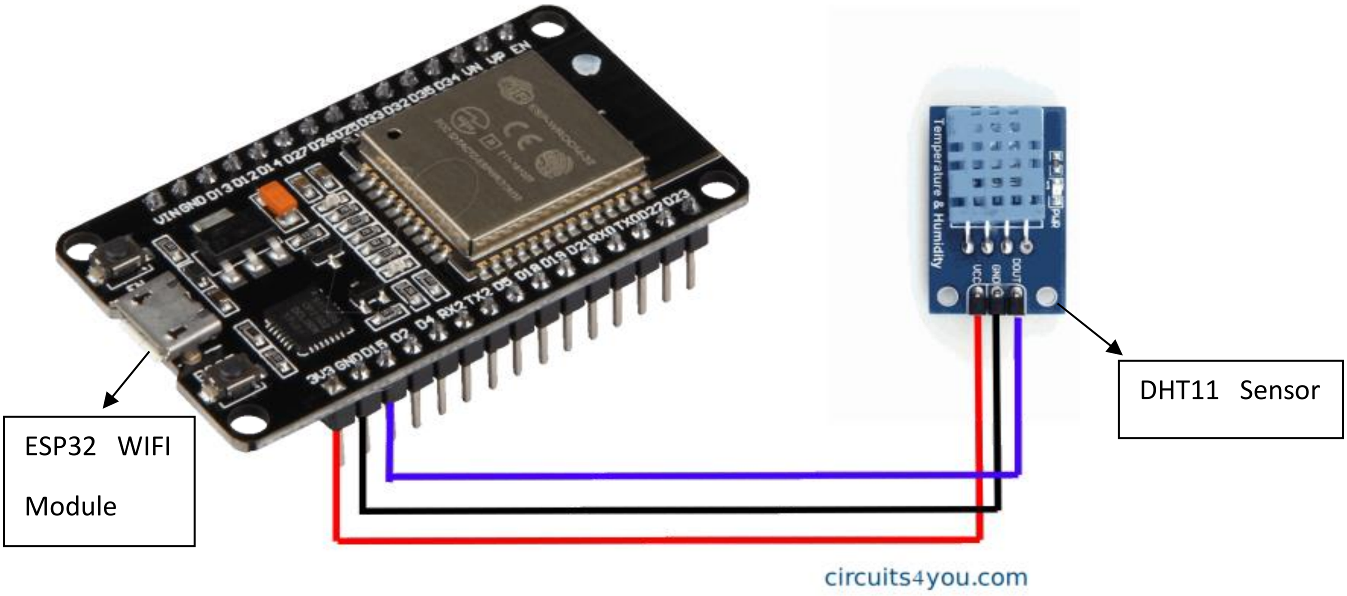

Fig4: ESP32 Block Diagram

A hall effect sensor is included into the ESP32. The hall effect sensor can detect changes in magnetic fields in its environment. Depending on which magnet pole faces the sensor, the sensor's values can turn positive or negative.

3.4.1 Soil Moisture Sensor

https://www.elprocus.com/soil-moisture-sensor-working-and-applications/

The volumetric water content in soil is measured by soil moisture sensors. Because direct gravimetric measurement of free soil moisture necessitates the removal, drying, and weighing of a sample, soil moisture sensors indirectly measure the volumetric water content by using another property of the soil as a proxy for the moisture content, such as electrical resistance, dielectric constant, or neutron interaction.

The relationship between the measured property and soil moisture must be calibrated, and it can differ depending on environmental conditions including soil type, temperature, and electrical conductivity. The soil moisture affects reflected microwave radiation, which is employed for distant sensing in hydrology and agriculture. Farmers and gardeners can use portable probing tools.

Sensors that assess volumetric water content are commonly referred to as soil moisture sensors. Another family of sensors, known as soil water potential sensors, measures another feature of moisture in soils called water potential. These sensors include tensiometers and gypsum blocks.

3.4.2 Temperature And Humidity Sensor

https://www.linquip.com/blog/temperature-and-humidity-sensors-an-ultimate/

The most often used environmental sensors are temperature and humidity sensors. Humidity sensors, commonly known as hygrometers, are a type of humidity sensor. These gadgets are used to determine the real humidity level in the air at any given time or location. These devices are frequently utilised in settings where air conditions are extreme or when air conditions must be controlled for a variety of reasons.

The presence of water in the air is referred to as humidity. The amount of water vapour in the air can have an impact on not just personal comfort, but also on many manufacturing processes in industrial settings. Moisture or humidity levels, for example, must be carefully managed and monitored in the semiconductor sector to ensure optimal wafer manufacturing. Incubators, respiratory devices, sterilisers, and biological products all benefit from humidity management. Furthermore, the presence of water vapour may have an impact on a variety of chemical, biological, and physical processes.

3.5 Monitoring and Feedback

According to the environmental variables of the chosen piece of land, this proposed system product would primarily identify four types of crops. However, the soil condition or any other modifications in the chosen land would be the reason for obtaining a chance of greater than 90% for the above-mentioned crops. However, the farmer's feedback mechanism is integrated in the system to avoid these influences affecting crop prediction.

Following the recommendation of a crop type, the farmer is asked for more information and input on a regular basis via the mobile application, which is used to guide the farmer with essential safeguards. The feedback system is employed in the mobile application by selecting the crop type to deliver the appropriate feedback. As a result, the product's overall accuracy and reliability improve with time.

4.Summary of existing approach

SNO	AUTHOR	TITLE	MDETHODOLOGY USED	RESULT
01	M.V.R. Vivek	Crop Recommendation System for Precision Agriculture	1. Random tree 2. CHAID 3. KNN 4. Naïve Bayes 5. WEKA tool	1. Pre-processing of data 2. Handling missing and out-of-range values 3. Feature extraction 4. Ensemble
02	Pradeepa Bandara	A Study on Various Data Mining Techniques for Crop Yield Prediction	1. Attribute selection 2. Multiple Linear Regression 3. Decision Tree using ID3	1. Selection of agricultural field 2. Selection of crop previously planted 3. Input from user

			4. SVM 5. Neural Networks 6. C4.5 8. K-means and KNN	4. Preprocess 5. Attribute Selection
03	Dhruv Piyush Parikh	RSF: A Recommendation System for Farmers	1.Location Detection 2.Data analysis and storage 3.Similar location detection 4. Recommendation generation module.	1. Physiographic, thermal, crop growing period, crop cropion rate 2. Seasonal crop database 3. Similar location detection 4. Generating the set of crops 5. Similarity between the crops planted in a region
04	Rohit Kumar Rajak	Agriculture decision support system using data mining	1.Subscription based system 2. ANN 3. Android application 4. Personalized	1. Android app with a login module 2. Previously planted crops known to system 3. User feedback mechanism 4. Maintenance of crop.
05	Kamatchi	Big Data Analysis Technology Application in Agricultural Intelligence Decision System	1.Inference engine 2.Domain expertise 3.Knowledge engineering 4.Knowledge acquisition module 5.Knowledge base for recommendation system	1. Large database of crops 2. Processed using Hadoop 3. Professional knowledge 4. Past experiences 5. Feature selection using HDFS 6. Future Scope: Using Hadoop with Artificial Neural Networks.
06	Dhruvi Gosai	Use of Data Mining in Crop Yield Prediction	1. J48 2. LAD tree 3. LWL 4. IBK algorithm	1. WEKA tool 2. LAD tree showed the lowest accuracy 3. Errors can be minimized by pruning the tree 4. IBK was observed to achieve higher accuracy

07	Vijay S. Rajpurohit	Crop Recommendation System for Precision Agriculture decision support system using data mining	1.Inference engine 2.Domain expertise 3.Knowledge engineering 4.Knowledge acquisition module 5.KNN 6.SVM	1. Classification algorithm on data 2. Crop is recommended 3. . Large database of crops 4. Similar location detection 5. . Pre-processing of data

Table 4: Summary of the recent existing approaches

5.Conclusion

Our research will aid farmers in increasing agricultural productivity, preventing soil deterioration on cultivated land, reducing chemical use in crop production, and making better use of water resources. Our future effort will focus on creating a better data set with a large number of features as well as incorporating yield prediction.

All elements are examined from the standpoint of the farmer and the plant in a modern setting with less space and less understanding of agriculture, and the farmer is appropriately directed till harvesting. It is critical to have information and comprehension of the factors that affect plant culture, as well as how to maintain or regulate them, before choosing a plant to grow. These criteria are automatically evaluated by this system, which then selects the crop type to be planted.

Following the cultivation of the plant, the farmer is asked for comments on a monthly basis. The system self-trained as a result of the feedback it received, and its accuracy improved over time as more data was collected. This technique eliminates the need for a specialist's advice and reduces the amount of maintenance required. As a result, the user will not incur any additional financial costs as a result of implementing this system.

The inquiry demonstrates the abilities of various computations in predicting a few climate wonders, such as temperature, rainstorms, and precipitation, and concludes that real systems are capable of doing so. In this study, we offer a method for analysing soil data using various calculations and forecasting strategies. Based on the findings of this work, we believe that more research is needed in the agricultural industry to improve precision. Using group approaches is a good way to ensure that the framework is more precise. Additionally, because of its fundamental computing requirements, we can employ SVM if we just need to consider a single calculation for the proposal framework.

6. Future Work

It can perform a variety of additional functions for the system. It currently uses relevant environmental elements as inputs and recommends a highly suited crop for cultivation. However, as a further step, the Automation component might be included as a feedback response system. This can be tweaked to adjust humidity, water level, and other factors based on the farmer's needs. It currently accepts all environmental elements as inputs, however an algorithm can be created to predict one factor using two other factors as an added feature. As a result, the initial cost of installing the sensors will be lower, and they will be easier to maintain.

In terms of future score, when farmers sow a specific crop, they may have problems or disease crops before harvesting. They can then upload the crop images as well as the soil report. The AI model can then detect the issues and suggest possible solutions.

We can also give IOT solutions through APIs or virtual agents that can connect farmers with raw material vendors who can supply them with the things they need, such as seeds and fertilisers, based on the crop indicated by the model.

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