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Crop Selection using IoT and Machine Learning

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Abstract: ***Food production is an important factor in our day to day life. Farming is the method of food production. There are many problems that affect food production .One of the main solutions for the problems of the farmers is good crop selection. We developed a model of 'CROP SELECTION USING IOT AND MACHINE LEARNING' which helps farmers to select the best crop for their farmland. In this study, we use the KNN algorithm to select appropriate crops for the farmland according to the farmer land's climatic conditions. The used dataset consists of parameters like crop name, temperature, humidity and soil ph. In this paper we would like to help farmers to find crops which are more suitable for his land and to increase the yield. The KNN algorithm will output possible 5 crops and the farmer can select his favourable crop from that.***
Keywords: K Nearest Neighbour Algorithm.

I. INTRODUCTION

Agriculture plays a vital role in India's economy as well as in our lives. We can't imagine a world without farming. Farmers are the producers of food, they are the largest livelihood providers to our country. However they don't get recognition for their work that much. The continuous loss in farming led to the stories of farmers suicides. It is crucial to take adequate measures to preserve the agricultural sector. There are several problems that affect agriculture such as climatic changes, floods, low profit, high cost of production, low quality crops and so on. Many new technologies are evolving in the agricultural sector as they ease the physical work of the farmers. But they are not enough to increase the profit of the farmers. Selection of crops is an important factor in agriculture. We need to select a crop which is suitable for the soil and climatic conditions of the agricultural land. As the atmospheric conditions keep changing rapidly, farmers fall prey to the lack of knowledge that is required to estimate what kind of farm conditions, techniques and soil type is essential for growing a type of crop [6]. Moreover, every so often it happens that farmers over utilize a particular piece of land to such an extent that it leaves the land devoid of all minerals[6]. Hence, it is important to be able to predict and forecast the performance of the crop for all kinds of environmental conditions. This proposed system consisting of hardware and software components will help the farmers to select the best crop which is suitable for their land and soil type[6]. Machine learning and IoT can contribute a lot in the agricultural sector. Use of sensors like DHT11, soil ph sensor will retrieve the temperature, humidity and ph values from the land. using a wi-fi module we can send out fetched data to a machine learning model. Using the values, the machine learning model will retrieve some crops which are suitable to the agricultural land and provided to the farmers using a web application.

II. EXISTING SYSTEM

The existing agricultural processes are composed of reducing the manpower using machines and so that the profit may increase. Machines like tractors(for ploughing the land),harvesters(to harvest the crops. Different harvesters are available for different crops) ,threshers(to separate seeds from the crops)etc are used. Each of these machines are heavy and high cost.

There are so many updates happening in the field of agriculture. [1]Applying Big Data for Intelligent Agriculture-Based Crop Selection Analysis. But most of them are used for minimizing the manpower. machineries like tractors, harvesters ,and threshers are commonly used by the ordinary farmers. but those machines are heavy and costly. Also some notable innovations are taking part in this field. [2]Smart Management of Crop Cultivation using IOT and Machine Learning, The Precision Agriculture model is a result of the rapid developments in the Internet of Things and cloud computing paradigms,which feature context-awareness and real-time events[10];Wolfertetal.[11] and Biradar et al. [12] present surveys about smart-farm industries.Some of them are:

A. Barrix Agro Sciences [8]

It is a bangalore based startup which offers eco-friendly crop production methods that support organic farming to increase crop production and quality of the products.their products are:

1) Barrix Catch Fruit and Fly Lure + trap : Barrix's pheromone-based pest control traps have artificially synthesised smelling agents that attract and trap pests. Instead of eating the crops, the pests are attracted to the pheromones in the trap.
2) Fly pest sticky sheet: Barrix uses bright yellow and blue coloured recyclable sheets that effectively attract and trap at least 19 high-risk pests from a long distance.

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B. Anulekh Agrotech [8]

Set up by Mumbai-based entrepreneurs, It focuses on increasing soil fertility to achieve higher agricultural productivity and crop yield with lower resource use.Their product name is called BIOSAT.It is made of biochar mixed with different organic nutrients which helps farmers to prevent the use of chemical fertilizers.

C. Digital Green [8]

Digital Green is an international development organisation that focuses on training farmers to make and show short videos where they can record their problems, share solutions and highlight success stories as community engagement to improve lives of rural communities across South Asia and Sub-Saharan Africa.It uses technology-enabled behaviour change communication that is cost-effective, scalable and brings together researchers, development practitioners, and rural communities to produce and share locally relevant information through videos.

D. CropIn Technology Solutions [8]

This startup was founded by a Bangalore software engineer. It provides the technology and expertise to create a smarter and safer food supply for the worldwide consumers. CropIn offers information on a cloud-based platform, integrated with a mobile application for Android, called Smart Farms. It allows large food companies to track the growth of crops on farms around the country with details about what the crop is and the conditions it is grown in, to help companies remotely monitor farms, interact with farmers and make every crop transparents and trAceable. It also aids farmers in adopting global agricultural practices and improves productivity by offering productivity insights and harvest forecasts.

III. PROPOSED SYSTEM

Our proposed scheme requires establishing required sensors in agricultural land. We established IoT sensors in farms to monitor the farm environment; the sensor equipment can help detect temperature, humidity, pH value of the soil. The data of our IoT sensors are transmitted to the server. Data from all sensors can be exported from the database to undergo data analysis. Our system does analyze the environmental factors of the farm and selects the suitable crops. Before analyzing any data,our system performs feature extraction like suitable months, soil types to ensure that both the analyzed data and the analysis result of predetermined targets are accurate. Our proposed approach and goals can effectively increase crop production and help analyze cultivation techniques of farmers.

A. The main features provided by the application are:
B. The proposed system can be used by farmers individually.
C. It can also be used in soil investigating centres.
D. Since the yield of a farm highly depends on the crop selected for cultivation and environmental parameters therefore proper selection of crop before cultivation is important in farming.
E. This system can be a great help in deciding the proper crop as per the given climatic conditions which will help to maximize yield rate.
F. This work introduces practical, cheap, and easy-to-develop tasks that are useful to increase the productivity of the agricultural sector.

IV. METHODOLOGY

A. Dataset Collection

Dataset consists of different varieties of crops and their suitable climate conditions such as temperature, soil type and pH. Different types of crops like fruits, vegetables, cereals, pulses, medicinal plants, tubers, etc. are taken. Across 114 varieties of crops are available in the dataset. The data is collected from different agricultural websites like kissankerala.net , kau.in etc.

B. Hardware Setup

The proposed system consists of Arduino uno ,the microcontroller board and sensors like DHT11 and soil pH sensors. DHT11 sensor is a temperature and humidity sensor, which is placed in the land to take the temperature and humidity value , DHT11 is connected to an arduino board. The values in the analog format are converted to digital in the arduino board. Likewise, the ph sensor, which is connected to its own board, gives the current ph of the land and the board is connected to the arduino board. The wi-fi module,ESP8266-01 will send the sensor data to the server. The sensor data will be continuously sent to the server for monitoring.

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C. KNN Classification Algorithm

KNN is a supervised machine learning algorithm used to solve classification as well as regression problems[9]. It is a supervised learning algorithm that relies on labeled input data to learn a function and produce output according to the new unlabelled data.KNN mens K Nearest Neighbor algorithm which assumes that similar things that are near to each other[9].

D. Loading The Data

First of all we need to load the dataset that is in CSV format. we can load it using the read_csv function pd.read_csv("data.csv").

E. Calculation Of Euclidean Distance

For using the KNN algorithm, we need to calculate the distance between two rows in a dataset [9]. Rows of data are mostly made up of numbers. An easy way to calculate the distance between two rows or vectors of numbers is to draw a straight line. This makes sense in 2D or 3D and scales nicely to higher dimensions[9] .We can calculate the straight line distance between two vectors using the Euclidean distance measure. It is calculated as the square root of the sum of the squared differences between the two vectors[9].

Euclidean distance=$\sqrt{\sum_{k=1}^{n} (x_{1i} - x_{2i})^2}$

Where *x1* is the first row of data, *x2* is the second row of data and *i* is the index to a specific column as we sum across all columns.

Neighbors for a new piece of data in the dataset are the *K* closest instances, as defined by our distance measured[9].To locate the neighbors for a new piece of data within a dataset we must first calculate the distance between each record in the dataset to the new piece of data. We can do this using the euclidean equation .Once distances are calculated, we must sort all of the records in the training dataset by their distance to the new data. We can then select the top K to return as the most similar neighbors[9].

The most similar neighbors collected from the dataset can be used to make predictions. here ,the nearest neighbor algorithm used is ball_tree[9]. we can use ball_tree class directly to find the nearest neighbor.ball trees partition data in a series of nesting hyper-spheres. This makes tree construction more costly, but results in a data structure which can be very efficient on highly structured data, even in very high dimensions[9].

A ball tree recursively divides the data into nodes defined by a centroid C and radius r , such that each point in the node lies within the hyper-sphere defined by C and r. The number of candidate points for a neighbor search is reduced through use of the triangle inequality:$|x + y| \leq |x|+|y|$[9].

With this setup, a single distance calculation between a test point and the centroid is sufficient to determine a lower and upper bound on the distance to all points within the node.In scikit-learn,we can use algorithm="ball_tree" to select the nearest neighbor algorithm and perform the classification[9].

F. Web Application

Django is the web framework we used to deploy the web application. The database is postgresql. There are different modules are there in the web application. They are:

1) *Login:* Users can log in to their existing account by giving the correct username and password.
2) *Register:* New users can register into the web app by giving necessary information.
3) Crop selection: after login to their account, the user can view his dashboard. There, the temperature, humidity and pH values will be shown automatically if he has set up hardwares. He can enter the type of the soil and month in which he is going to plant the crop on the required field. In the backend, the machine learning model will analyse the values and return the best 5 crops that are suitable to plant in user's land.
4) *Monitoring:* after the plantation, the user can monitor the crop using the web app. He may be able to view the sensor values and he can take necessary actions when any rapid change happens to his crop.

V. SYSTEM IMPLEMENTATION

Implementation is an activity that is contained throughout the development phase. A successful system should be delivered and users should have confidence that the system would work efficiently and effectively. The more complex the system being implemented the more involved will be the system analysis and design effort required for implementation.

The implementation plan involves the following:

A. Completion of arduino board and the sensors
B. Modelling of the machine learning algorithm that is knn.
C. Development Web App which is the interface for the users.

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D. Integration of above modules together into a single Web App.
E. Debugging and correction the errors noticed.
F. Running and checking the application with the output.

VI. RESULTS

We were able to design the system according to the planning. The effectiveness of our system was measured by choosing two types of soil at two different locations with variable climatic conditions. The first soil was loamy with a pH of 6.5 and the average temperature was around 24 degree celsius in the month of February, 2020. The system has given us these five recommendations. From the recommendation we choose to grow tomatoes in that soil. For the second soil we choose clayey soil at a different location with pH 7.6 and an average temperature of 27 degree celsius. For the second soil we decided to plant one which was not given in the crop recommendation i.e. tomato. We planted tomatoes for both soil and given necessary water and growed them simultaneously at that different location.

After three months we could see the result of those two tomatoes at different soil and location. The first tomato planted according to the recommendation has tomato grown.Whereas the second one which was not recommended has not grown upto the mark where the first one has grown and also there are no fruits grown on it.

Since the plant that was recommended grew incredibly and the other one that was not recommended was not grown successfully we could formulate to the conclusion that our system was successful in suggesting the right crop for the right climatic conditions. Therefore our system could be used for a larger farm which could yield very good crops and the farmers could earn more profit from his/her farmland.

VII. CONCLUSION

Agriculture is gradually being replaced and enhanced by more sophisticated and accurate digital and electronic devices. A high percentage of agriculture revenue is lost to power loss,incorrect methods of practicing. This is reduced by the use of smart sensors. The proposal is to perform agriculture in a smart and more efficient way.Sensors for distinctive sorts are used to gather information the majority of the data of crop states and Ecological transforms and this data will be transmitted through organizing the farmer/devices that initiate restorative activities.Farmers are associated and mindful of the states of the agriculture field at any time and anyplace in the world.

The future works may focus on adding fertilizer recommendations for each crop. We can make the web app into a hybrid app so that the system could also access the mobile device features like location, gps etc. Adding more features to the dataset like location, rainfall etc.The rates of crop could also be added along with crops so that farmers could select the crop based on price also.

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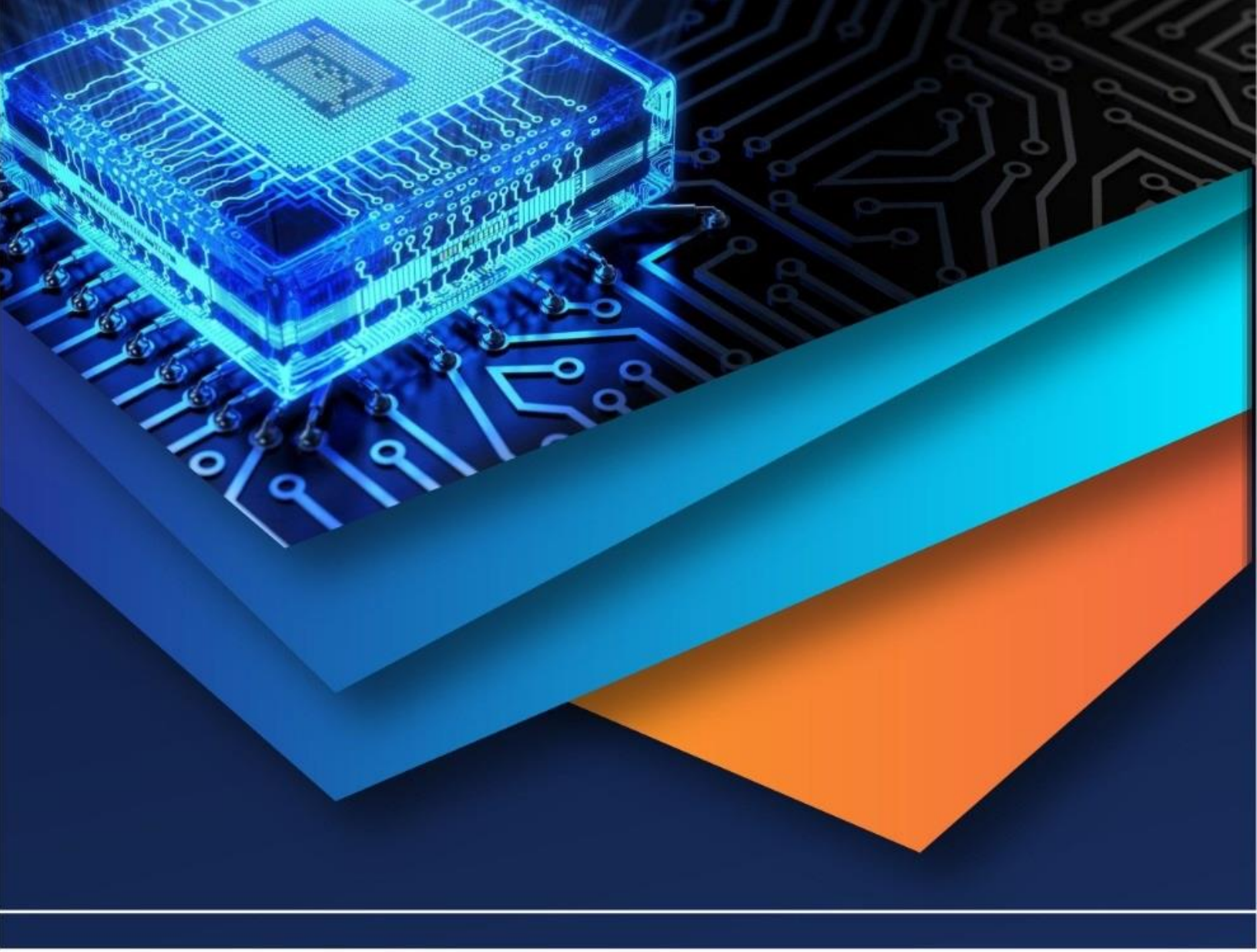

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