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Crop Recommender System Using Machine Learning Approach and IoT

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***Abstract* – Food, shelter and clothing are essential for human survival. With advancements in science and technology, we've seen incredible improvements in the way we design and build modern homes and clothing. From smart homes that use various technologies to make our lives more comfortable and convenient, to high fabrics that provide better insulation and protection, we're living in the era of incredible innovation and progress. With increased awareness and support, we can create a more inclusive and diverse community in agriculture. However, there are initiatives and programs in place to provide education and training for farmers to improve their knowledge and skills. These programs can cover topics such as crop management, soil health, pest control, and sustainable farming practices, which can help farmers, increase their yields, reduce their environmental impact, and improve their livelihoods. Additionally, there are also scientific advancements in agriculture technology that aim to simplify and automate farming processes, making it easier for farmers to manage their crops and minimize errors. By leveraging technology and data-driven models, we can help farmers make more informed decisions and reduce the need for trial and error. This can save time and resources for farmers, leading to more efficient and sustainable farming practices. By providing farmers with the right tools and information, we can help improve their livelihoods and contribute to the overall growth and prosperity of the agricultural sector.**

Keywords: Machine Learning, ESP32 microcontroller, DHT 11 sensor, K-Nearest Neighbours (KNN)

I. INTRODUCTION

Agriculture has been a vital part of India's economy and culture for thousands of years. The agricultural industry in India has been impacted by several factors, including globalisation, climate change, urbanization, land use changes, and government policies.From precision agriculture techniques to using data analytics and machine learning to optimise crop production, there are various ways to enhance yields and improve sustainability. Precision agriculture is a promising approach to improving the efficiency and sustainability of modern farming practices. In India, precision agriculture is gaining popularity, particularly in states like Punjab, Maharashtra and Karnataka.

Precision agriculture helps farmers make informed decisions that lead to higher yields, better quality crops, and increased profitability.

There are many factors that need to be considered while recommending crops. Some of the important factors include:

1. Soil type and Quality: Different crops have different soil requirements, so it is essential to assess the soil type and quality before recommending a crop.
2. Climate and weather: The climate and weather conditions of a particular region can greatly impact the success of a crop. Therefore, it is important to consider temperature, rainfall, humidity and other

weather-related factors when recommending the crop type.

Precision agriculture allows for site-specific analysis of various factors that can affect crop selection. These factors include soil type, pH levels, nutrient levels, moisture content, elevation, climate, and weather patterns. By analysing these factors, farmers can identify the best crops to plant in a particular area, as well as the optimal timing for planting and harvesting. This can help to maximize crop yield, reduce input costs and minimize environmental impact.

The article discusses the use of software and algorithms that can help to process and analyse this data, providing farmers with valuable insights that can inform their decision-making. Open farms can help to build trust and transparency between farmers and consumers. Ensemble learning techniques like voting can be used to improve the accuracy and robustness of machine learning models. Voting involves combining the predictions of multiple models, often with different algorithms to produce a final prediction.

II. RELATED WORK

The Paper [1] discusses about the use of Agro Consultant, which helps the Indian farmers in performing decision about which crop to grow depending on the sowing season, geographical location of his farms, soil parameters as well as environmental conditions such as temperature and rainfall.

The Paper [4] work presents a system, which uses data mining techniques for predicting the category of the analysed soil datasets. This prediction will indicate the yielding of crops. The problem of predicting the crop yield is formulised as classification rules such as Naive Bayes and K-Nearest Neighbor methods are used for predicting the problem of crop yield.

The Paper [7] discusses about Machine Learning where it can be used as one of the major tool which supports crop yield prediction which may include to decide on what crop to be grown during a particular season of the crops. We can predict the yield of the crop using machine learning concept Classifiers such as KNN (Kernel-Nearest Neighbor), Naive Bayes Theorem, SVM (Support Vector Machine), Logistic Regression, and Random Forest Classifier. This paper predicts the crop yield using KNN Algorithm. According to the analysis, the most considered factors in our prediction are- Production of the crop, Area of the crop yield produced.

III. METHODOLOGY

3.1 System Requirement Specification

System requirement specifications provides a complete knowledge of the proposed system to achieve this goal.

1. Soil Grids

Soil Grids is a global digital soil mapping system that models the geographical distribution of soil attributes across the globe using global soil profile information and covariate data. Soil Grids is a set of global soil property maps created with machine learning at a resolution of 250 meters.

2. REST API

A REST API (also known as a RESTful API) is a web API that allows for interaction with RESTful web services. In computer science, REST is an abbreviation for representational state transfer, which was invented by Roy Fielding.

3. Hardware Requirements

Processor - i3 or any compatible
Hard Disk - 500GB
Random Access Memory - 4GB
ESP32 microcontroller
DHT11 sensor
LCD display
Push Button
Jumper wires

4. Software Requirements

Front end - Boot Strap Frame work
Back end - Python
Web frame work - Flask
Operating System - Windows 7
IDE - Vscode, Jupyter notebook, Aurdino IDE

3.2 SYSTEM ARCHITECTURE

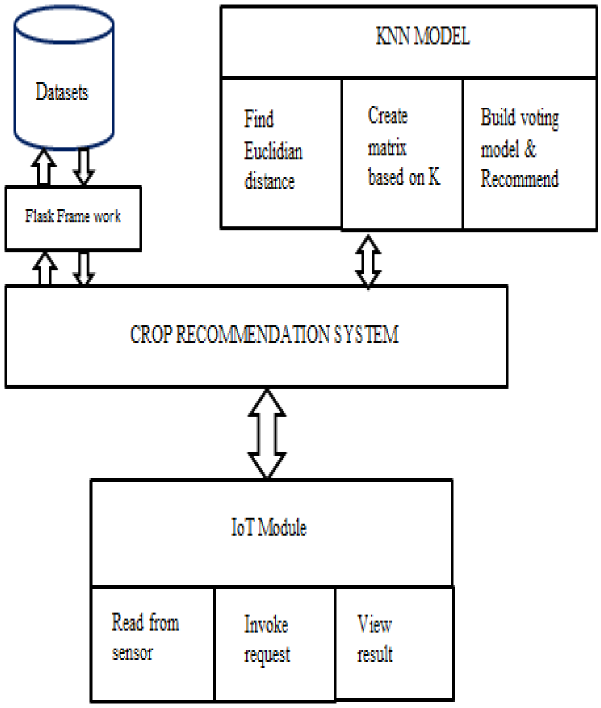

Fig 3.2 System Architecture

The above figure shows the system architecture. It includes various functional units mentioned in the figure, here we have used Mysql as the database and apache as the web server.

3.3 CONTEXT DIAGRAM

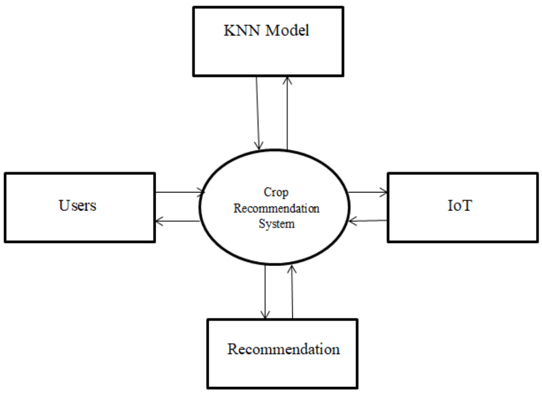

Fig 3.3 Context Diagram

The proposed system has the following steps for recommendation of crop.

1. Dataset Collection
2. Training Data
3. Testing Data
4. Feature Extraction
5. Ensemble Model
6. Recommendation System

3.4 Ensemble Module

Name of the Module: K Nearest Neighbor
Actor: System
Use Cases: Fetch test data, Find Euclidian, Sort records based on K, Create voting

Functionality: The primary purpose of this module is to provide recommendations on which crop to plant.

Description:
Figure 3.4 shows the use case diagram of classification using KNN module. In this use case diagram, there are four use cases and one actor. In the first use case, the system fetches test data. In second use case the Euclidian distance is obtained. In the third use case the records are sorted based on k. In the fourth use case the voting is done and the favorable or the recommended crop which is best suited is suggested here.

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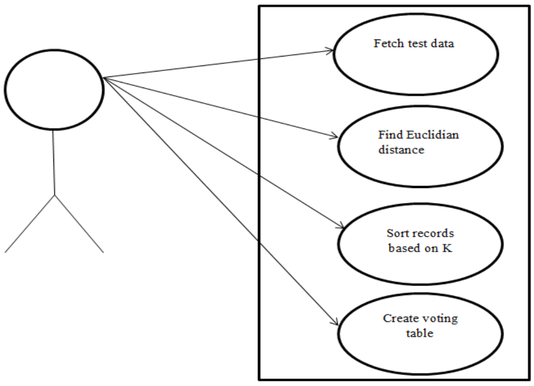
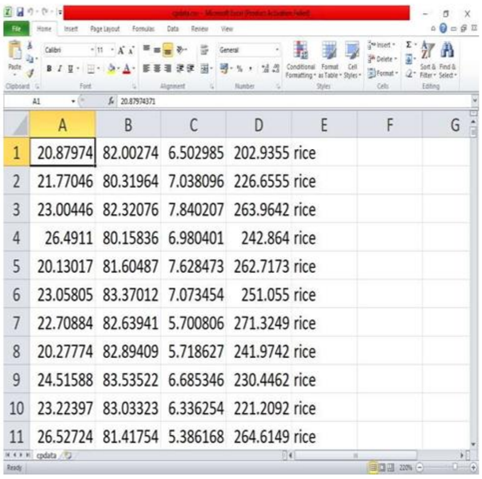


Figure 3.4: Use Case Diagram of Ensemble using KNN module

3.5 Recommendation System

This is the system where the manipulated are resulted. Here based on the result of KNN algorithm progress the crop is recommended. According to the value of k different crops are recommended and then over the voting system best crop is recommended. Recommendation system can recommend more than one crop

3.6 Dataset



	A	B	C	D	E	F	G
1	20.87974	82.00274	6.502985	202.9355	rice		
2	21.77046	80.31964	7.038096	226.6555	rice		
3	23.00446	82.32076	7.840207	263.9642	rice		
4	26.4911	80.15836	6.980401	242.864	rice		
5	20.13017	81.60487	7.628473	262.7173	rice		
6	23.05805	83.37012	7.073454	251.055	rice		
7	22.70884	82.63941	5.700806	271.3249	rice		
8	20.27774	82.89409	5.718627	241.9742	rice		
9	24.51588	83.53522	6.685346	230.4462	rice		
10	23.22397	83.03323	6.336254	221.2092	rice		
11	26.52724	81.41754	5.386168	264.6149	rice		

Figure 3.6 Dataset being used for building the model.

3.7 System Implementation

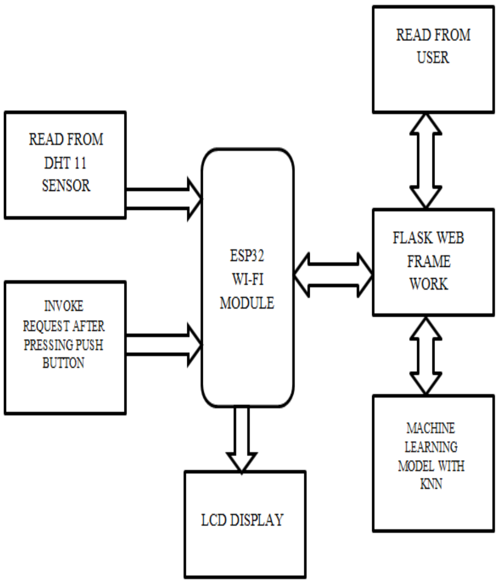


Fig 3.7 Design Methodology of Proposed System

3.8 Flowchart for Recommendation and Prediction module

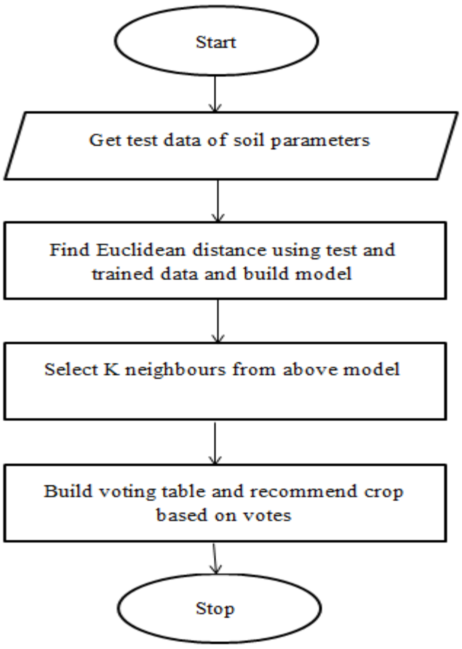


Fig 3.8 Recommendation and Prediction Module

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IV. RESULTS AND DISCUSSIONS

4.1 Board Work

- By using android application, location of a place is taken using GPS.
- Co-ordinate values are sent to rest soil grid website. Here soil parameters values are observed.

Table 4.1 : Testing data, data fetched from Soil Grid.

PH	Carbon	Sand	Slit	Clay
6.4	0.7	51	24	26

- Trained data set collected from agricultural office is stored in apache web server in theform of database.
- This data is used along with the testing data for manipulations and calculations of KNNAlgorithm.

Table 4.2: Training Dataset

	A	B	C	D	E	F	G	H	I
1	pH	Carbon	Sand	Slit	Clay	Crops	Temp	Rainfall	Result
2	6.23	2.1	53	22	25	wheat	21-26	75-100	yes
3	6.41	1.58	40	28	32	rice	22-23	150-300	no
4	5.82	0.88	65	17	18	corn	13-30	500-600	no
5	5.82	0.88	65	17	18	cotton	27-33	700-1500	yes
6	5.27	1.34	49	15	36	sunflower	27-33	800-1000	yes
7	5.82	0.88	65	17	18	groundnut	25-30	750-1500	yes
8	6.23	2.1	53	22	25	pulses	21-27	450-500	no
9	6.41	1.58	40	28	32	barley	20-25	500-1250	no
10	6.23	2.1	53	22	25	wheat	24-27	50-75	yes
11	6.41	1.58	40	28	32	rice	20-30	390-430	no
12	5.82	0.88	65	17	18	corn	17-27	75-100	yes
13	5.82	0.88	65	17	18	cotton	17-27	150-300	no
14	5.27	1.34	49	15	36	sunflower	27-33	500-600	yes
15	5.82	0.88	65	17	18	groundnut	17-27	75-100	no
16	6.23	2.1	53	22	25	pulses	17-27	150-300	no
17	6.41	1.58	40	28	32	barley	27-33	500-600	yes
18	6.23	2.1	53	22	25	wheat	25-30	700-1500	yes
19	6.41	1.58	40	28	32	rice	21-27	800-1000	yes
20	5.82	0.88	65	17	18	corn	20-25	750-1500	no
21	5.82	0.88	65	17	18	cotton	24-27	450-500	no
22	5.82	0.88	65	17	18	cotton	[illegible]	500-1250	[illegible]

naive dataset

- Euclidean distance of KNN Algorithm is calculated using the below formula

$$D(p,q) = d(p,q)=\sqrt{(q1-p1)^2}+ \sqrt{(q2-p2)^2}+ \ldots + \sqrt{(qn-pn)^2}$$

Equation 1: KNN Algorithm Equation

Where,

q values are testing data,
p values are training data,
q1 & p1 are pH, q2 & p2 are carbon,
q3 & p3 are sand, q4 & p4 are silt,
q5 & p5 are clay values.

Applying the respective values to the formula we get,

$$=\sqrt{(6.4-5.82)^2 + (0 .7- 0.88)^2 + (51-53)^2 + (24-25)^2 + (26-23)^2}$$

$$= 3.061$$

- Here p values are constant since they are training data where as q values changes forevery calculations.
- Calculation of Euclidean distances is performed for a certain number of training datasets (n number of trained data sets).
- We take K value as 3 which is a standard value. 4 and 5 can also be taken.
- Hence, we obtain the table with three rows which are the three minimum Euclideandistance values.

Table 4.3: Resulting Data

PH	Carbon	Sand	Slit	Clay	Distance	Crops
5.82	0.88	53	25	23	3.061	Corn
5.82	0.88	53	25	23	3.061	Corn
6.41	1.58	53	25	23	3.126	Rice

- Again, we use the COUNT query to calculate the repeated crops and which gives therecommended crop result.

Table 4.4: Voting Count

Crops	Count
Corn	2
Rice	1

Here corn scored 2 votes and rice scored 1 vote. So corn will be the recommended crop as per the

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highest voting.

4.2 Code snippet

```
@app.route('/getdata',methods=['GET','POST'])
def getdata():

    if request.method=='POST':

        try:

            lang = request.form['lang']
            lat = request.form['lat']
            p1 = {"lat": lat, "lon": lang}
            # lat=15.9268
            # lang=76.6413
            p1={"lat":lat,"lon":lang }
            rest_url = "https://rest.isric.org"
            prop_query_url =
f"{rest_url}/soilgrids/v2.0/properties/query"

            props = {"property": "silt", "depth": "0-5cm",
"value": "mean"}
            res1 = requests.get(prop_query_url, params={**p1,
**props})

            res = res1.json()['properties']["layers"][0]
["depths"][0]["values"]
            silt = res["mean"] / 10

            props = {"property": "sand", "depth": "0-5cm",
"value": "mean"}
```

Fig 4.2: Code snippet of Arduino IDE

4.3 Snapshots of Project

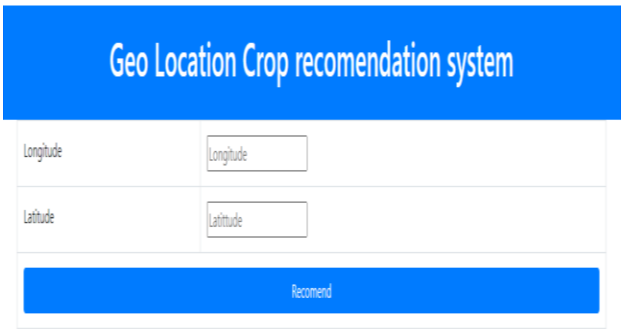

Fig 4.3 Snapshot of Location Based Crop Recommendation System

4.4 Result of Crop Recommendation System

Place	Dharwad
Crop (KNN algorithm)	jute
Crop (Deicisionn Tree algorithm)	grapes
Crop (SVM algorithm)	jute
Ph	7.0
Silt	32.6
Sand	34.7
Clay	32.7
Nitrogen	75.5
Temparature	24.74000000000001
Humidity	88
Langitude	75.060242
Latitude	15.444743

Fig 4.4 Result of Crop Recommendation System

V. CONCLUSION

The suggested project is an effort to apply the machine learning idea to crop recommendation via the implementation of KNN, as well as other techniques. It is necessary to gather and utilise real- time soil test reports from the district agricultural department as training data. Testing data is obtained from the soil grids via the REST API (Representational State Transfer). After normalising the raw data, the KNN algorithm for crop selection, it is hoped that itwould be helpful in precision agriculture, which is becoming more popular in India.

The project may be further enhanced by increasing the number of observations, such as soil test data, and it could also be implemented by including more machine learning algorithms.

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