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Crop Monitoring and Recommendation System using Machine Learning and IOT

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Abstract: ***Farming is an important sector of input for any country's economic growth. Country like India's majority population livelihood relies on agriculture. The usage of Internet of Things in agriculture promises unavailable productivity, resource and cost reduction, automation and data driven processes. This paper proposes the implementation of a smart agricultural system that uses advantages of cutting edge technologies such as IoT, Sensor network and data analysis to help farmers enhance the way farming and marketing are done. The work focuses on crop selection for planting, conservation of humidity and nutrient content during plant development, suitable usage of fertilizer and quality check of the crop. The selection of crops is done by checking the soil which includes various factors such as color, soil PH value and moisture content. Sensors such as humidity, moisture etc. are used to gather field information and help farmers make precise decisions about insights and recommendations for irrigation based on the data collected. The soil's nutrient level is sensed, and if there is a deficiency, a suitable fertilizer is suggested and a notification is generated to the farmer. An acceptable price for the plant based on its yield is calculated and a standard price is fixed. Ultimately, the farming and agriculture industries will benefit from these various technologies and platforms. Not only is the revolutionary farming system of today a smart agricultural solution, it is the main solution to the increasing concern for the food intake and environmental footprint of the global population.***

Keywords: IoT, pH value, crop, soil, fertilizer, sensors.

I. INTRODUCTION

India is one of the oldest countries that still practices farming. Yet the developments in agriculture have changed dramatically in recent times due to globalization. Different factors have impacted agriculture health in India. Several new technologies have been developed to regain the health. In India, farming systems are used strategically, depending on the locations where they are most appropriate. The farming systems that contribute significantly to India's agriculture are subsistence agriculture, organic farming, and industrial farming. Regions throughout India vary in the forms of agriculture they use; some are based on horticulture, farming rules, agro forestry, and many more. Terrain, atmosphere, soil properties, and soil water are environmental factors affecting the level of crop agriculture.

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It is the combination of these four factors that permits the growing of different crops in some regions. Soil is a vital part of productive cultivation, and is the original source of nutrients used for crop growth. The nutrients move from the soil to plants that are part of the food that animals consume as well. Therefore, crops benefit from healthy soil.

The healthiest soils provide the most available healthiest food sources. Because the most food is provided by the healthiest soils, they have also been at the core of the best communities in history. The adding of fertilizer is one essential means of assisting sustainable agricultural production systems. By fact, plants use nutrients from the soil, and then they die and are decomposed by microorganisms. It takes the nutrients back to soil. The crops pick up nutrients in an agricultural environment, but are then removed from the field so that humans and livestock can consume them and in turn get the nutrients. That takes nutrients off the ground. It is necessary to apply fertilizer to maintain nutrient levels in soil, whether from natural sources such as manure or from human-made sources such as ammonium.

Soil fertility depends on various factors, such as:

1. Depth
2. Texture (influences water retention)
3. Acidity or Alkalinity
    - The acidity of soils is measured by their pH.
    - The PH of pure water is 7 (neutral).
    - When a soil's pH value is lower than 7, it is acidic.
    - When its pH value is higher than 7, it is basic or alkaline.
    - Soils which are too acidic or alkaline are not very fertile.

Soil is a significant source of nutrients, needed for plant production. Nitrogen (N), Phosphorus (P), and Potassium (K) are the three primary nutrients. They form together the trio known as the NPK. Calcium, magnesium, and sulphur are also essential nutrients. Plants also need small amounts of iron, manganese, zinc, copper, boron, and molybdenum, known as trace elements because the plant only needs traces. Such nutrients play a very complex role in plant development. Every soil type benefits different crop types through its specific physical, chemical, and biological properties. Alluvial soil is a fertile, potassium rich soil. It is highly suitable for farming, especially crops such as paddy, sugarcane, and plantain. Red soil has a high content of iron, and is suitable for crops such as red gram, bengal gram, green gram, groundnut and castor seed. Black soil is rich in calcium, potassium and magnesium but the nitrogen content is low. The crops that grow well are cotton, tobacco, chilly, oil seeds, and maize.

Sandy soil is poor in nutrient content but is useful in areas with high rainfall for growing trees like coconut, cashew, and casuarinas. The main aim or objective of the paper is to ground a decision making support system for farm management through an Android application that implements the following:

i. To optimize production output.
ii. To preserve resources.
iii. To automate farming with collection of data from the soil.
iv. To analyze the soil data for making better.
v. To gain high quality output of the product.
vi. To minimize human work.

These objectives can be achieved by automating the process of crop selection for cultivation, maintenance of moisture and nutrient content during plant growth, correct utilization of fertilizers, and quality check of the crop and price estimation. It addresses the issues of population growth, and labour that has gained a lot of technological attention, from planting and watering of crops to health and harvesting. The remainder of the paper is organized as follows: Section II describes the Literature Survey and existing work. Section III explains about Methodology. Section IV describes the Experimental results. Section V is about Conclusion which concludes the overall results and also the scope for Future Enhancements.

II. LITERATURE SURVEY

This section discusses current recent research work and offers insight into the problems and seeks to recognize the differences in existing approaches. India faces the daunting task of food production with a growing population to meet the growing demand which is not an easy task. The farming systems that contribute significantly to India's agriculture are subsistence farming, organic farming, and commercial agriculture. Such conventional structures cannot meet contemporary requirements to the full. The following are the drawbacks with conventional cultivation:

• Conventional approaches only employ basic devices

When farmers burn the brush and clear the field, they cannot adequately prepare the land, since they only use a hoe. We can just smash the soil and mix the ashes into the ground. Farmers cannot get a successful yield like this.

• Do not use fertilizers

When a piece of land first bears a crop, all the mineral salts are taken up by the plants for their nourishment. Soon the soil gets very soft. The field must be left fallow, after two or three years. This takes a long time before the soil gets fertile again.

• Lack of Nutrients

The top soil gets washed because of excessive water runoff, taking away all the vital nutrients needed for plant growth. This results in nutrient deficiency. The above problems arise because of the lack of soil data, which could be analyzed using advanced technology. The IOT advancement aids in social affair information on conditions like -atmosphere, temperature and productivity of soil, harvest web watching engages area of weed, level of water, bug acknowledgment, animal interference into the field, alter improvement, cultivation. Further a thought of consolidating the most recent innovation into the agrarian field to turn the customary techniques for water system to current strategies was proposed. Make easy rentable and temperate trimming in this way. Some degree of mechanization is introduced encouraging the concept of monitoring the field and the conditions of the commodity were well explored in some long-separate extents using cloud administration [1]. A novel Agriculture Stick based on Smart IoT is proposed to assist farmers in obtaining live data (temperature, soil moisture) for efficient monitoring of the environment, enabling smart farming and increasing the overall yield and product quality. The Agriculture stick is equipped with Arduino Technology, Breadboard mixed with different sensors and live data feed is available online from Thingsspeak.com [2]. The aforementioned models present a technique for collecting soil data using sensors that track soil conditions efficiently and further help improve soil quality. Nonetheless, the model does not offer a technique for making informed agricultural decisions. With the introduction of precision farming and regular survey of fields, these problems can be overcome to provide sustainable food production.

III. METHODOLOGY

This section includes the methodology which describes the approach used to conduct the research for comparative analysis.

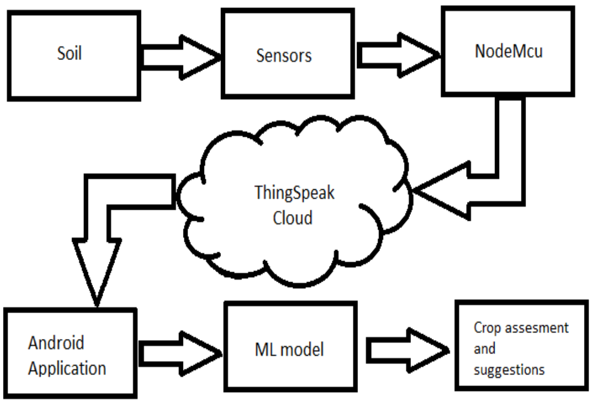

Fig 1. Architecture of Crop Monitoring System

The Fig 3.1 depicts the architecture of Crop Monitoring System which contains six components namely Sensors, NodeMcu, ThingSpeak Cloud, Android Application, ML Model, and Crop Assessment and Suggestions.

The soil attributes like colour, pH, moisture content, and nutrients are collected using sensors and uploaded into NodeMcu.

The NodeMcu has a built in WiFi module which is used to send these values to ThingSpeak cloud that is responsible for storing and generating responses to the android application. The android application has four modules that are elaborated in the following section 3.2.

These responses within the android app are sent to the machine learning module which triggers appropriate crop recommendations.

A. Implementation

- **Moisture Content**

Moisture from the soil is essentially the substance of soil water. This can be measured using a sensor of soil moisture consisting of two conductive probes which act as a probe. It can determine the soil moisture content based on the change in resistance between the two conducting plates.

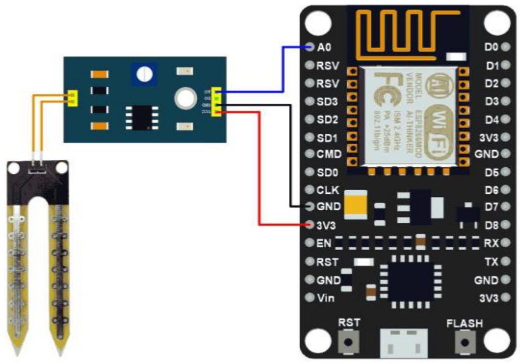

Fig 2. Moisture Sensor Connections to NodeMcu

The sensor is inserted into the soil after cabling connections as depicted in Fig.2.Moisture in the soil is expressed in percentage terms. Here soil moisture sensor analog output is processed with ADC. In percentage terms, the moisture content is displayed on the serial display. The soil moisture sensor performance varies within the ADC value range from 0 to 1023. This can be expressed in terms of percentage as a moisture value using the formula given below.

Analog performance = value of ADC / 1023

Percentage humidity = 100 – (Analog output * 100).

We get full value of 10-bit ADC for zero moisture, i.e. 1023.

This in turn gives moisture of ~0 %. 22.

The soil moisture value is sent to the ThingSpeak cloud by writing the code in the Arduino IDE. The code consists of client and server connection and credentials such as API key which is unique for every channel of the ThingSpeak cloud, Wi-Fi name and Wi-Fi password. Soil moisture value is retrieved into the android app from the cloud using the Fig.3.

Fig 3. MIT App Connections to Cloud

- **Nutrients Detection**

The Nutrient values are detected using the principle of Calorimetry. Colorimetry is a technique which is commonly used in biological systems. It requires calculating a compound or a compound group that is present in a complex mixture. Colorimetric analyzes have the property of determining the strength or concentration of compounds in a colored solution. It is achieved by passing through the solution, the light of the same wavelength of the visible spectrum in a photoelectric colorimeter device, and galvanometric reflection reading is obtained, sensitizing the amount of light absorbed. The colored solution is prepared using Agrinex Corporation Soil Testing Kit. Soil solution is prepared by mixing soil and water in the ratio of 1:2. To detect the N, P, K and pH values, respective capsules are added to the 20ml of prepared soil solution in a test tube as shown in Fig 3.4. The test tube is exposed to the colour sensor to detect the N, P, K and pH values.

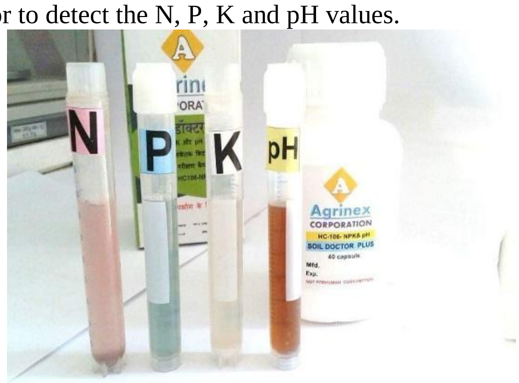

Fig 4. Agrinex Corporation Soil Testing Kit

Obtained values are sent to the ThingSpeak cloud by writing code in the Arduino IDE. The code consists of client and server connection and credentials such as API key which is unique for every channel of the ThingSpeak cloud, Wi-Fi name and Wi-Fi password. Soil moisture value is retrieved to the android app by copying the link and keeping that link in the code blocks code of MIT App Inventor.

- **Crop Selection**

Crop selection module uses moisture, N, P, K and pH attributes of the soil to identify the type of the soil and specifies suitable crops that can be grown in the recommended soil type. This process is done by retrieving the above attribute values from NodeMcu through ThingSpeak cloud into the application. Once the data is retrieved, suitable crops are recommended.

- **Price prediction**

The dataset chosen for price prediction is Rice Farm dataset. It contains 4 features and class attribute namely block, N, P, K, and yield respectively. The feature block indicates the field in which the crop was grown. N, P, K indicate the levels of nitrogen, phosphorous, and potassium in the soil. The class attribute yield indicates the amount of crop produced in kg/hectare. The estimated yield production is multiplied by current market price to get its price. The following steps indicate the procedure to generate linear regression model on the dataset.

Step 1: Import the libraries required to perform the regression.
Step 2: Defines Jupyter Notebook plot parameters
Step 3: Dataset upload.
Step 4: Find the predictant and predictor relationship.
Step 5: Find Null or Missing Values
Step 6: Define the Linear Regression Model and Fit on the dataset.
Step 7: Test the accuracy of the model and find Coefficients and Intercepts.

IV. RESULTS

A sample soil was taken to test its attributes using sensors. When the Arduino script is executed, the data of the soil is sent to ThingSpeak cloud through NodeMcu. The results obtained from NodeMcu were used to plot various graphs in ThingSpeak cloud. The data values stored in the cloud were further retrieved into the android application to perform various tests using the modules available in the application.
The various modules available in the app are moisture test, nutrients test, crop selection, and price prediction. The moisture test module in the app retrieves the latest moisture value of soil from the cloud and displays it.

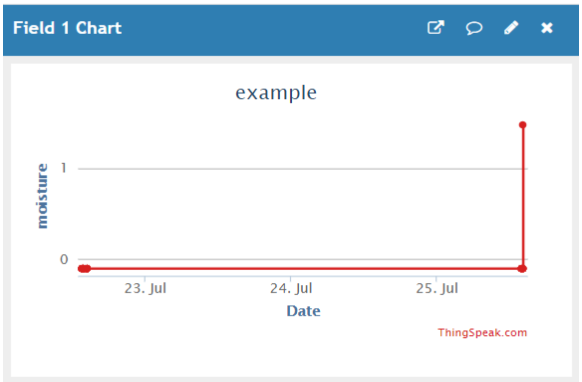

Fig 5. Moisture Readings in Cloud

When the type of soil is chosen, an appropriate recommendation is generated according to the Table: 5.1.

Soil Type	Low	Recommended
Sandy	<15%	15-25%
Loamy	<35%	35-45%
Clay	<45%	45-55%

Table: 1. Moisture Content in Different Soils

The nutrients test module in the app retrieves the latest pH value of soil from the cloud as shown in Fig.4.2 and displays it. An appropriate recommendation is generated accordingly,

- pH=7 neutral
- pH<7
- pH>7 basic or alkaline

Fig.6. pH Readings in Cloud

The crop selection module in the app retrieves the latest pH, moisture, and npk values of soil from the cloud and performs various operations to display the soil type and recommend a suitable crop. The price prediction module estimates the price of the yield by running a linear regression classifier on the data collected over a period. This data consists of N, P, K, and moisture values.

V. CONCLUSION AND SCOPE FOR FUTURE ENHANCEMENTS

Agriculture is a major input sector for economic development of our country. Traditional agricultural system suffers from many problems that are caused due to ill soil health. The proposed system provides a very useful Android based application that facilitates an interface for farmers to monitor soil conditions and generate recommendations to improve crop production. The model includes interfaces for crop selection, maintenance of soil moisture and nutrient contents during plant growth. The modules are implemented using main components such as sensors and the Arduino, and the algorithms that are used in this system. The developed system is user friendly and gives proper suggestions.

Automated crop recommendation system has tremendous demand and potential for the future too. It is time-saving, leading to the elimination of human error in adjusting the available levels of soil moisture and optimizing net profits in terms of factors such as market price, product quality and production. It involves the additional sensors and outputs implemented by the system at an enhanced degree of smart interventions.

REFERENCES

1. Muthunoori Naresh, P Munaswamy, "Smart Agriculture System using IoT Technology", International Journal of Recent Technology and Engineering (IJRTE)
2. AnandNayyar, Er. Vikram Puri , "Smart Farming: IoT Based Smart Sensors Agriculture Stick for Live Temperature and Moisture Monitoring using Arduino, Cloud Computing & Solar Technology, using Internet of Things".
3. S.Pudumalar*,E.Ramanujam*, R.HarineRajashreeń, C.Kavyań, T.Kiruthikań, J.Nishań, "Crop Recommendation System for Precision Agriculture", IEEE Eighth International Conference on Advanced Computing (ICoAC), 2016
4. EkataGhadage, VibhavariKharate, Parnika Mane, SamruddhiPimpale, SantwanaGudadhe, "Intelligent support system to recommend suitable Crops: using arduino microcontroller", International Journal of Advance Computational Engineering and Networking (IJACEN), Vol. 5, 2017
5. Abhishek L, Rishi Barath, "Automation in Agriculture Using IOT and Machine Learning", International Journal of Innovative Technology and Exploring Engineering (IJITEE), Vol. 8, 2019
6. T Raghav Kumar, BhagavatulaAiswarya, Aashish Suresh, Drishti Jain, NateshBalaji, VarshiniSankaran, "Smart Management of Crop Cultivation using IOT and Machine Learning", International Research Journal of Engineering and Technology (IRJET), Vol. 5, 2018
7. AnandNayyar Assistant Professor, Department of Computer Applications & IT KCL Institute of Management and Technology, Jalandhar, Punjab Er. VikramPuriM.Tech(ECE) Student, G.N.D.U Regional Center, Ladewali Campus, Jalandhar, "Smart Farming: IoT Based Smart Sensors Agriculture Stick for Live Temprature and Moisture Monitoring using Arduino, Cloud Computing & Solar Technology"
8. ArshdeepBahga and Vijay Madisetti, "Internet of Things - A Hands-on Approach", Universities Press.
9. B. Balaji Bhanu ; K. Raghava Rao ; J.V.N. Ramesh ; Mohammed Ali Hussain, " Agriculture field monitoring and analysis using wireless sensor networks for improving crop production", Eleventh International Conference on Wireless and Optical Communications Networks (WOCN),2014.

10. Imran Ali Lakhiar,[1] Gao Jianmin,[1] Tabinda Naz Syed,[1] Farman Ali Chandio,[1] Noman Ali Buttar,[1] and Waqar Ahmed Qureshi[2] ,"Monitoring and Control Systems in Agriculture Using Intelligent Sensor Techniques: A Review of the Aeroponic System", Hindawi Journal of Sensors Volume 2018.

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