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Crop and Fertilizer Prediction based on Soil Nutrients using IOT

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Abstract— The project is motivated from general observation on the following facts in Indian agriculture system. Traditionally, in order to know the fertility of the soil, farmers collect soil samples from their field and send it to nearby soil testing laboratories. These laboratories use primitive methods which take a long time to obtain results. In addition to that, soil nutrients also change over time. The proposed method efficiently estimates soil nutrients based on a sensor network that helps in predicting suitable crops for that soil under test. The sensors of the hardware kit collect nutrient level from the soil sample and data is stored through Raspberry-Pi. Based on the values obtained from the sensor the system makes predictions using the classification algorithms. Subsequently a text message is sent to the registered farmer with the best crop predicted. Based upon the suggested/desired crop the fertilizer is suggested. The same is also displayed on a web page.

Keywords— Crop Prediction, Soil Nutrients, Fertilizer Prediction, Decision Tree Classifier, Random Forest Classifier, Naive Bayes Classifier, Support Vector Machine, Raspberry pi, NPK sensor

I. INTRODUCTION

Estimating the nutrients(NPK) value present in the soil is an important factor for better crop management. Currently estimating these nutrients poses great difficulties. We propose to develop a semi-automated system to accurately estimate the soil nutrients(NPK) value for crop prediction and to suggest suitable fertilizers.

The project is aiming to achieve following objectives:

- Soil fertility can be known in a short duration that helps the farmer to choose a better crop and fertilizer to be used.
- Measuring the soil macro nutrients like Nitrogen, Phosphorus and Potassium (NPK) values to generate the analysis report of crop management (crop prediction, fertilizer suggestion) , to help farmers decide the best crop for a given piece of land inorder to increase the crop yield. Various classification algorithms are used to compare the accuracy and the best algorithm is determined.

II. LITERATURE REVIEW

Title of the work: Soil test based smart agricultural management system.

Authors: Ganesh babu rajendran, Chellaswamy chellaiah, T.S Geetha and T.Daniel Raj

Publication Details : IEEE International Conference on Smart Structures and Systems,November 2020,Chennai, India

Description: In this paper, ganesh babu rajendran, chellaswamy chellaiah, T.S Geetha, T.Daniel Raj have proposed a soil-based crop selection and fertilizer management system to obtain a developed and a normalized approach to characterize the composition of bare soil, metalloids, and mesological parameters. From the statistical analysis, we collect the data for various soils and which crop is suitable for cultivation to produce maximum yield for a particular field. Various sensors, such as humidity sensor, temperature, and camera, are used to control and monitor the agriculture field. Irrigation is controlled by water level sensors, GSM, and a controller. An APP has been developed to identify a suitable crop for the agriculture area, and it can easily be installed in the farmer's mobile phone itself. Simulation has been done using Matlab for four different crops. The results indicate that the proper utilization of fertilizers protects the agricultural field and increases productivity. An experimental setup is developed and tested under different test conditions.

Title of the work: Automated soil nutrient content analysis and fertilizer suggestion for farmers

Authors: M.K.Dharani and K.R.Prasanna Kumar

Publication Details : International Journal of Recent Technology and Engineering(IJRTE),ISSN: 2277-3878,Volume-8 Issue-4,November 2019

Description: M.K.Dharani and K.R.Prasanna Kumar proposed a system wherein the soil sample is sent to laboratories to test the pH value and to find the macro nutrient contents of the soil. This result obtained from the laboratory is then given as input to the Nutrient Analysis Algorithm Which compares the value to the nutrients in the database and calculates the required level of nutrient contents for the soil. An app is developed to store the details of farmers, so that each farmer is identified uniquely. The

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drawback of this system is that the soil needs to be sent to the laboratory for testing and the obtained data must be manually entered to get the fertilizer prediction.

III. METHODOLOGY

In the proposed system we use sensors to collect data regarding the soil. The NPK sensor is connected to Raspberry pi and the data obtained is thus stored. We then use classification algorithms to predict the best crop to be grown in that particular soil and based on the crop predicted desired fertilizer is suggested. The classification algorithms are first trained and tested using datasets collected from previous yields. We use different classification algorithms and find out which gives the best accuracy. The algorithms used to predict the crop are Decision Tree Classifier, Random Forest Classifier and Support Vector Machines(SVM). The fertilizer is predicted using Naive Bayes Classifier. All the algorithms are trained and tested using appropriate datasets. The predicted data is finally displayed on a web page and also sent to the farmer via a text message.

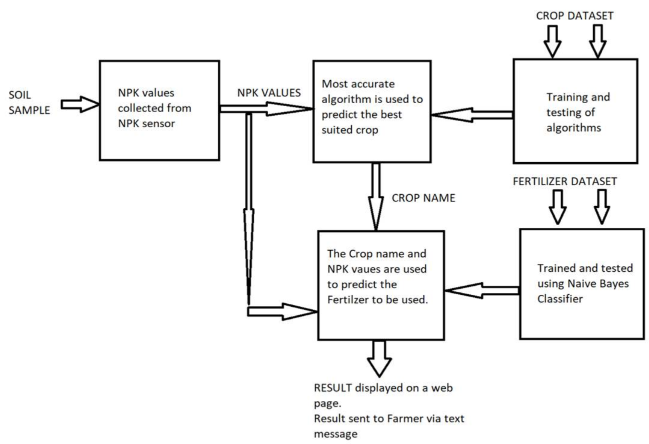

Fig. 1 Proposed system design

IV. IMPLEMENTATION

A. Hardware Implementation

The hardware implementation is as shown in Fig. 2. The NPK sensor consists of 4 pins of which two are connected to the power supply positive and negative respectively. The other two are used to wire the 485 signal line namely Rs485-A and RS485-B. The 485 signal lines are connected to the USB to RS485 converter which is then connected to the USB port of Raspberry PI. The sensor is powered using a 12V power adapter. A common ground is maintained for the sensor and raspberry pi.

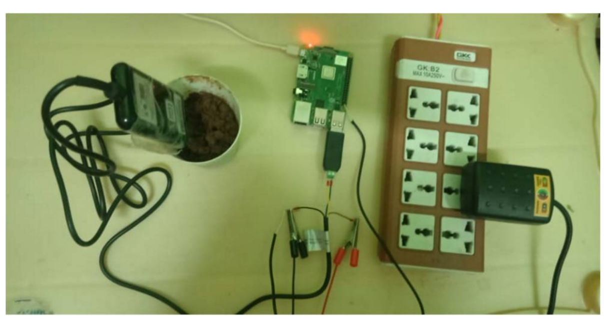

Fig. 2 Hardware Setup

B. Sensor Communication

The sensor communicates by sending inquiry frames and receiving answer frames. The frame packets are as shown in Fig. 3.

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Inquiry frame

Address Code	Function Code	Register start address	Register length	CRC_L	CRC_H
1bit	1bit	2bit	2bit	1bit	1bit

Answer Frames

Address Code	Function Code	Effective number of bytes	Data area	Second data area	Nth data area	Check code
1bit	1bit	2bit	2bit	1bit	2bit	2bit

Fig. 3 Sensor Communication

C. Dataset and Machine Learning Algorithms

A total of three datasets are used in our project, all of which are custom made. The three datasets are Crop dataset, Average crop value dataset and fertilizer dataset. The dataset consists of 4 fields namely- N values, P values, K values and Crop Name/ Fertilizer Name. The crop dataset is trained and tested to predict suitable crops and the algorithms used are Decision Tree Classifier, Random Forest Classifier and Support Vector Machine. The average crop dataset is used to calculate the N P K values needed to meet the crops required nutrient composition. This obtained value is thus used to predict the fertilizer using the Naive Bayes algorithm which is trained and tested using the fertilizer dataset.

The crop dataset has a total of 13 different crops with their N P K values with around 120 records. The average crop dataset consists of the average N P K values of each of the 13 crops. The fertilizer dataset consists of 11 different fertilizers and their corresponding N P K values.

V. TESTING AND RESULT ANALYSIS

The result obtained after executing the algorithms and the main file is a text message that is sent to the registered number and it is shown in Fig. 4.

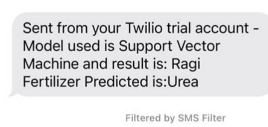

Fig. 4 Result Sent as a Message to the User

The first page that the user views as soon as the url is opened is shown in Fig. 5. The user is instructed to place the sensor in the soil and click NEXT. The onclick action of the button fires the main program.

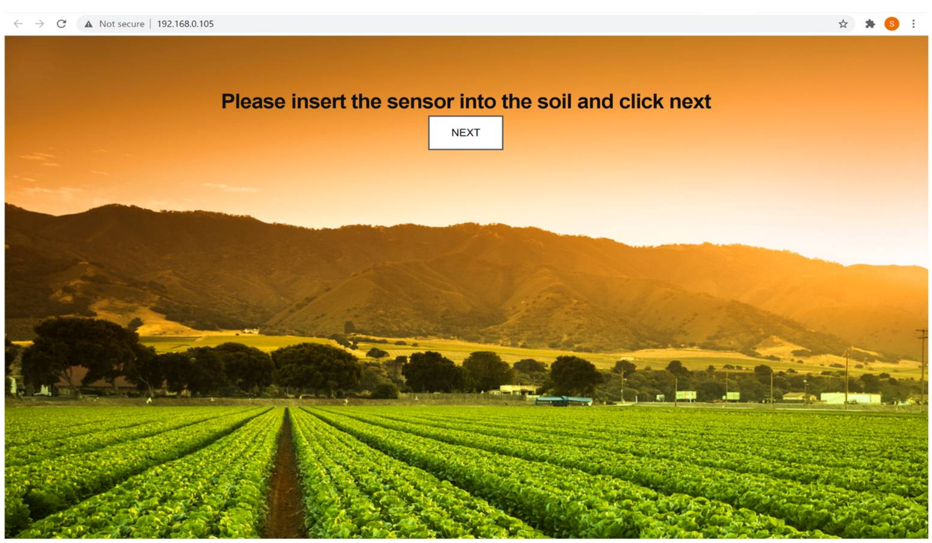

Fig. 5 Frontend webpage

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Once the button is clicked and the main program gets executed, the user is directed to the next page. Here the user can click on the 'SEE RESULTS' button to see the data read by the sensor as well as the predicted crop and fertilizer(Fig. 6).

Fig. 6 Data Collected webpage

Finally the real time N P K values collected from the soil sample are displayed(Fig. 7). The accuracy of all three algorithms used are displayed. Here we can see that:
Accuracy of Random Forest Classifier is 97.91%
Accuracy of Decision Tree Classifier is 97.22%
Accuracy of Support Vector Machine is 100%
The result is obtained by comparing the accuracy of all three algorithms. Here the algorithm with highest accuracy is Support Vector Machine, hence it is used to predict the crop. The crop predicted using SVM is Ragi. The NPK value along with the crop predicted is further used to calculate the NPK needed and thereby predicting the fertilizer for the needed NPK value. All of this is displayed on the web page and the same will be sent to the user via a text message.
The user can test another soil sample by clicking on the TEST ANOTHER SAMPLE button on the webpage. This will take the user to the first page.

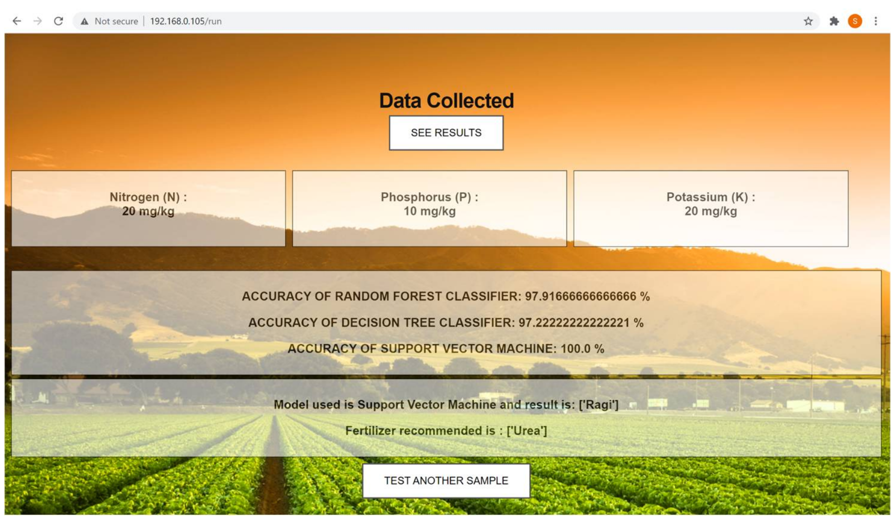

Fig. 7 Results displayed

VI. CONCLUSIONS AND FUTURE WORK

A semi-automated system is designed and built for implementation of soil testing for crop prediction and fertilizer suggestion for the agricultural farm, using this system, a farmer can accurately understand the soil health, fertility, best suited crop and suggested fertilizer. Thus the proposed system described integrates new technologies offering ease of maintenance, time saving, approximate results for understanding various nutrients like Nitrogen, Phosphorus and Potassium (NPK) present in the soil on spot and provides the correct guidance to the farmers regarding the crop to sowed and fertilizers to be used. This project helped us to understand the few problems of the farmers and how it can be solved using current technologies. In this process of solving the problems we explored various tools and technologies like Raspberry Pi, NPK sensor, Python, Flask, Twilio and libraries such as Scikit learn.

The future scope for this product is creating an application for user interface. This app can be used to retrieve previous information as well the current results. All the data processed can be stored in a database and can be retrieved by the farmer whenever in need. Security can be provided by using login credentials where each user has to login using username and password. Moreover, the webpage can be modified further to sell crop yields as well as to buy fertilizers. It can be developed into an E-commerce platform for the farmers to buy fertilizers and sell crop yields directly to consumers, without the involvement of a middleman.

The proposed system can be enhanced by adding these features:

- The crop prediction can be improved by adding parameters like Ph, moisture, temperature, humidity.
- Since many users are farmers Language localization on the webpage would help.
- Crop price prediction feature can be implemented.

ACKNOWLEDGMENT

Presentation inspiration and motivation have always played a key role in success of any venture. It gives us immense pleasure to write an acknowledgement to this project, a contribution of all the people who helped to realize it. We express our sincere gratitude to our college JSS Science Technology University, Mysore for providing us an opportunity to undertake and complete such an interesting project report. We extend our deep regards to Dr. S B Kivade, Honorable Principal of JSS Science Technology University, for providing an excellent environment for our education. We would like to convey our heartfelt thanks to our HOD, Dr. M. P. Pushpalatha, for giving us the opportunity to embark upon this topic. We would like to thank our project guide, Dr. M. A. ANUSUYA for their invaluable guidance and enthusiastic assistance and for providing us support and constructive suggestions for the betterment of the project, without which this project would not have been possible. It would be really very unfair without the mention of our friends and families. The immense love and moral support they have given is truly unmeasurable. Finally, We also convey our sincere thanks to all those who have contributed to this learning opportunity at every step of this project.

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