A Survey on Analysis and Prediction of Soil Nutrients Quality Using Machine Learning

Apoorva G S [1], Apoorva M [1], Chithra B [1], Harishwini D C [1], Dr. Kavitha C [2]
[1] *Student, Department of CSE, Dayananda Sagar Academy of Technology and Management, Bangalore, India*
[2] *Professor, Department of CSE, Dayananda Sagar Academy of Technology and Management, Bangalore, India*

Abstract – India is a country which is majorly dependent on agriculture and hence it is more affective in growth of nation and even economic development. Therefore in order to have effective quality of soil and to have maximum growth there were adaptions of many practices. In this paper, one such method is proposed. The developed method uses internet of thing based approach and with the use of machine learning algorithm, makes decision on soil nutrient balancing, crop prediction and crop yield estimation with the data storage in Firebase cloud platform. The data from IoT is computed using Raspberry Pi and using ML algorithm the crop prediction is done based on the soil quality calculated from the data obtained from sensor. The proposed approach helps farmers in deciding the right amount nutrients to be added and the crop prediction and yield estimation.

Keywords – Internet of Things (IoT), Raspberry Pi, Machine Learning, Firebase cloud platform.

1.INTRODUCTION

Analysis and prediction of soil nutrients with IoT technology empowers the farmers and producers to maximize the crop yield and reduce the losses. The sensors are used to measure the soil parameters like temperature, NPK values, moisture, humidity and pH level. The obtained data will be transmitted and stored in cloud. Machine Learning algorithms will be used to predict the nutrients which will give the reliable and accurate results. The requirement of the crop nutrients are compared with the sensor values obtained and any deficiency in the soil can be identified through this, so that the Farmer will be able to add required amount of nutrients according to the specific crop, which makes the soil testing procedure easier. The smart agriculture system determines the essentials of crop and help with process in most efficient manner. By using sensors soil temperature, moisture content, NPK values can be monitored. Data obtained from the sensors are stored in cloud for further analysis. The result of this analysis can then be used to optimize farming culture, identify drawbacks and make suitable arrangements to maximize crop yield and quality. IoT and ML algorithms combination can be used for prediction and analysis of crop growth.

2.LITERATURE SURVEY

[1]IoT based real time soil nutrients detection was developed by Varsha Kiran Patil, Aniket Jadhav, Someshwar Gavhane and Venkatesh Kapare. In this project they proposed real time, cloud-based soil nutrient detection with parameters like temperature, humidity and pH values, to fetch the values of these parameters, they have used DHT11 for detecting temperature and humidity which as been connected to microcontroller ESP8266 Wi-Fi module. Soil analysis which has been done by using RGB color sensor and that will capture output based on RGB values. They collected the real time data from different cities like Pune and others. This process of analysis of soil is based on cloud can be used for identifying deficiency in soil nutrient quality and increasing yield of the crops, so in this case the farmers need not to wait for days to get the results from the labs and in addition to that farmers can monitor soil parameters from their mobile phones with required credentials.

[2] Soil Classification using machine learning methods and crop suggestion based on soil series was developed by S M Mohidul Islam, Kaushik Chandra Mitra, Sk Al Zaminur Rahman. There are different soil types each land area has their own features and various crops can

be grown depending on the nutrients that are present. In this proposed system, two datasets are present i.e., datasets of crop and soil which contains features of soil, they have used ML algorithms like weighted kNN algorithm and support vector machines are provided for classification of soil. This model has an ability to predict different crops that can be grown in suitable soil. The research involved different soil datasets of different regions. This present model can be improvised by providing fertilizer recommendation and additional data can be added in future to this model to get more reliable and accurate output.

[3] Implementation of soil nutrient measurement using Raspberry Pi was implemented by K Deepika, A Dharani, S Diviya Shree, P Madhavan. The technology used in this system is significantly helpful in cultivation to avoid the monetary losses faced by the farmers. The system includes different mineral soil sensors to measure soil and atmospheric temperature, wet and lightweight, humidness and pH are used. The data from sensors to the Raspberry Pi device and that data will be saved to cloud storage then the farmers can see the soil parameter information in cell phone and desktop, laptop using browser in the form of graph. The result obtained from this system quite reliable and accurate.

[4] Soil nutrient analysis using machine learning techniques was proposed by Madhumathi R, Arumuganathan T, Sneha Iyer R, Shruthi R, Shruthi K. This soil analysis prediction determines the composition of NPK content present in the soil. Machine learning algorithms are mostly used algorithms in prediction. The soil parameters like N,P,K are used in trained datasets. In addition to that, it includes parameters like conductivity of electricity , pH value , water content and soil temperature. The dataset is being imported in RStudio platform, well defined models like classification regression and clustering collects the specific data and apply algorithms to get a expected output. Multiple linear regression algorithm is used in this proposed system. The graph shows the result where each of the parameters are denoted by specific color. The accuracy of the model is about 78%, thus it will help farmers to predict right crop and fertilizers to get a better yield of crops.

[5] Machine Learning Algorithms for Soil Analysis and Classification of Micronutrients in IoT-Enabled Automated Farms was implemented by T. Blesslin Sheeba, L.D. vijay Anand, Gunaselvi Manohar, Saravana Selvan, C. Bazil Wilfred, K. Muthukumar, S. Padmavathy , P. Ramesh Kumar and Belete Tessema Asfaw. This system is used to check the nutrient states of mulberry gardens and the parameters involved are micronutrients like Iron, Manganese, Copper and Zinc are observed using certain device which works based on electromagnetic spectroscopy and other nutrients like sulphur, potassium, nitrogen, carbon. By using this system the deficiency in the soil and excess nutrients content can be monitored. The samples used in this system are tested using sensors and passed to farmers with in a matter of seconds, 75% of samples are used while 25% remaining is used for testing. The extreme learning method (ELM) which work fastly and efficiently is used. This model is trained using obtained information to evaluate the nutrients in the soil. After this process the model went through ten trails to obtain the final outcome and the classification of micronutrients are done. The method used in this model will be helpful in maintaining soil fertility graphs and in monitoring the quality and quantity of nutrients.

[6] A Multiple Linear Regression Model for Crop Prediction with Adam Optimizer and Neural Network was developed by M Lavanya, Dr. R Parameswari. This model is framed using the real time data with parameters of soil that are collected from Chennai soil laboratory. This model uses both micro and macronutrients which includes 16 parameters in addition to that EC, pH, OM values and gives the crop recommendation. Multiple Linear Regression model is used to analyse and nutrient prediction. A regression model is built using artificial neural network and this model gives approximation in output than the other regression algorithms such as Random forest and Naïve Bayes. This model perform effectively with less number of iterations and epochs, the result is shown in the form of graphs which gives the clear picture of the model performance. The system as its own limitations and it can be improved by adding some more parameters like atmospheric conditions like climate, weather and speed of wind.

[7] Soil Analysis and Crop Recommendation using Machine Learning was developed by Aditya Motwani, Param Patil, Vatsa Nagaria, Shobhit Verma, Sunil Ghane. This system gives the specific crop that can be grown in tested soil by using random forest model and CNN to identify the suitable crop for the tested soil by considering parameters like region, type of soil, crop yield, market price. This model gives accuracy around 95%. This system involves two steps which is machine learning based technique helps by capturing the image

of soil, mention the location then upload the data to the model and the outcome will crop recommendation list based on obtained values and revenue. The goal of this project is to help farmers with minimal land areas by reducing the loss and maximizing productivity of crop and the system can be improved further by adding more parameters and large dataset to obtain valid results.

[8] Crop Yield Prediction using Machine Learning Algorithm was implemented by D Jayanarayana Reddy and Dr M.Rudra Kumar. This project deals with the process of parameters reviewing and other soil characteristics considered in the determining crop growth and the various methods were proposed with the help of Artificial Intelligence techniques in prediction of crop yield. This system provide efficient and accurate system for classification of crop by considering the weather conditions, crop nutrients, dieseases, humidity, soil information, solar information, wind speed, pressure and images of growing phase, then use ML techniques for estimation of crop yield and gives detailed information of soil and crop. The CNN technique is used to decrease the relative error and reduction in of crop yield. In addition the time series model of BPNNs is used along with the small datasets. The system is efficient but the increased parameter count might not be able to give proper accurate results and improvement was still required.

[9] IoT based Agri Soil Maintenance Through Micro-Nutrients and Protection of Crops from Excess Water was developed by Manikandan B Dr. Ayyasamy S, Mithun Solomon S P, Eswaran S, Nirmal Kumar S. In this IoT based smart agriculture the soil water content is monitored and at some specific point the water content will reach the maximum level that might cause harm to the crops. The suction motor is used to deal with such conditions, it removes the excess moisture from the soil. DHT sensors are used to take the weather readings at the particular land areas that will be analyzed and prediction will take an average time of 10 days with the help of prediction and regression algorithms. This model uses sensors and transmit the obtained data through bluetooth and wifi network and analyze in cloud and performs the functions using robots which work based on GPS system. This development is useful in measuring the quantity of micronutrients required in the soil and the amount of fertilizers to be supplied. The Cloud storing the data behaves as an intermediate between model application and the sensors. It shows the sensor outcomes in graph format.

[10] Monitoring of Soil Parameters and Controlling of Soil Moisture through IoT based Smart Agriculture was proposed by Abhishek Srivastava, Ravi Kumar, Dushmanta Kumar Das. This model uses both software and hardware setup which helps in monitoring required parameters of soil from local and remote areas. It automatically controls the moisture content of soil and also helps in conservation of water. An IoT based model uses real time data collected from soil laboratories monitored continuously to increase the protectivity of crops. The automated irrigation system presented is controlling and can access of data with the help of Arduino microcontroller and all the obtained data from the sensors are reached out to the farmers through mobile application. The presented system uses radio communication with Bluetooth to access sensor values. They have used soil moisture sensor and rainfall sensor which also consist of probe and DTH-22 sensor is used in this model to measure temperature and humidity level of crop field and surrounding environment. In future the system can be further developed using better suited algorithms to measure and control the excess soil parameters. Provides ready solutions of ML for computer vision task. It is mainly used for Image analysis, processing, recognition, detection and for various other purpose. The Media Pipe structure is well designed to face the AI challenges that are commonly found in video and sound web based.

3. METHODOLOGY

The Soil parameters obtained from the sensors are collected and the data obtained is pre-processed which removes the noisy data. The data collected is communicated with Raspberry Pi using RS485. The data is utilized for the soil nutrient detection and produce yield prediction. The use of machine learning algorithms to predict soil nutrient levels and crop yields can be a useful tool for farmers and agricultural professionals. By analyzing data on soil nutrients and crop yields, these models can help to identify patterns and relationships that can be used to make more accurate predictions about future crop performance. There are a wide range of machine learning algorithms that can be used for these tasks, including decision trees, random forests, support vector machines, and neural networks. Each algorithm has its own strengths and weaknesses, and the choice of which algorithm to use will depend on the specific characteristics of the data being analyzed. To

get the best results from these models, it is important to carefully preprocess the data and choose an appropriate evaluation metric to measure the performance of the model. It is also important to fine-tune the model's hyperparameters to achieve the best possible performance.

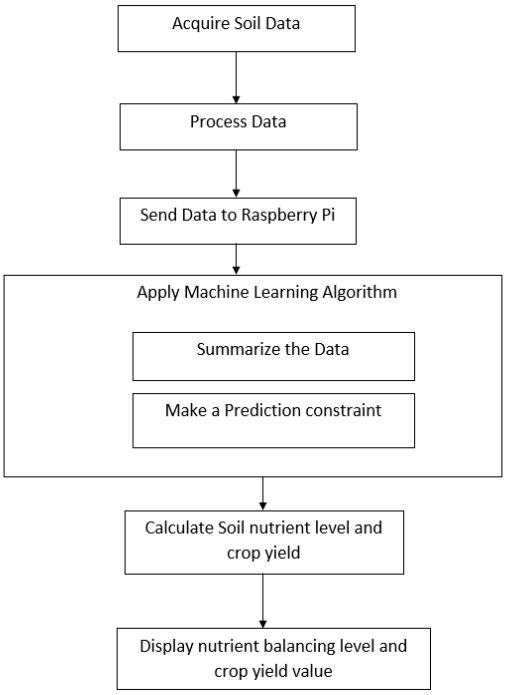

Fig 1: Flow chart of Soil Monitoring System

A.Sensor's interfacing and its working

Sensors play a vital role in collecting data from soil. When it comes to the health of the crop directly or indirectly many vital parameters present in the soil and the surrounding environment of the farm plays a major role. The major soil nutrients that effect the crop growth are N, P, K etc. The other parameters include temperature, soil NPK sensors are used to measure the levels of nitrogen (N), phosphorus (P), and potassium (K) in soil. These nutrients are essential for plant growth and development, and their levels can have a significant impact on crop yields. By measuring the levels of NPK in soil, farmers and agricultural professionals can determine which nutrients are present in the soil and in what quantities, which can help them to make informed decisions about how to best care for their crops. It is used in determining the fertility of soil by based on the result obtained and the required nutrients. Soil moisture sensor that determines the amount of moisture in soil. Adequate amount of water must be supplied to the plant for it grow in a healthy manner. Temperature and humidity sensor that reads the respective values that maintains the soil temperature to be maintained between certain value. These sensors are then interfaced with the Raspberry Pi microprocessor that calculates and maintains the adequate nutrients and other parameters.

B.Transmission of sensor data

RS-485 is a connector that behaves as electrical interface and layers for The sending of data from sensors to Raspberry Pi is done many ways but the proposed system uses RS485. It is an electrical interface for end to end communication of electrical devices and sensors. The main advantage of using this is that it has duplex communication system where it can communicate with more than one device on the same bus in both directions. It is also used in long distance cabling with noisy environments.

C.Application of ML algorithm

The data received from the sensors are pre-processed and used in a trained model to check the deficiency or excess amount of nutrients in soil. The ML techniques is used to predict crop yield. The major issue in crop yield prediction can be solved by using ml algorithm. The model developed evaluates the values from sensors which is pre-processed. It makes a prediction based on the sensor data obtained and results the yield of the crop. Based on the data of soil nutrients and other parameters the yield of the particular crop can be predicted. Based on the ML algorithm used nutrient level balancing and amount of fertilizers to be used can also be predicted.

D.Remote Monitoring

The soil data is used to observe the soil behaviour and the updated value is displayed to the user through an app. At regular intervals the data is updated. The updated value is displayed in the app through which the user gets the latest information about the level of nutrients in soil. It also gives information on yield of crop based on soil parameters and surrounding condition, which helps user in understanding about the fertility and type of crops to grow.

4. CONCLUSION

Soil with more nutrients is essential for the production of crops used for human food and livestock. In addition to providing a strong quality to support plant roots,

storage of water in roots and nutrients required for plant growth. Soil Monitoring by using IoT technology to help farmers and producers to maximise growth of crops, decrease the loss and increase the growth and optimise resources. The soil nutrients are monitored using sensors and predict which crop can be grown in that soil using ML algorithm. To identify the nutrient content in the soil and give the information about the nutrient level in the soil. It will give farmers an idea of the nutrients that their soil is lacking. It gives information about which crops they should invest in and also help in choosing which nutrients they need. So, ultimately the crop yield will increase. The temperature, pH, moisture and humidity level of the soil will be determined along the nutrients. Make an easy and best way to test the soil which is less time consuming.

REFERENCE

[1] IoT Based Real Time Soil Nutrients Detection 2021 International Conference on Emerging Smart Computing and Informatics (ESCI) AISSMS Institute of Information Technology, Pune, India. Mar 5-7, 2021

[2] Soil Classification using Machine Learning Methods and Crop Suggestion Based on Soil Series 2018 21st International Conference of Computer and Information Technology (ICCIT), 21-23 December, 2018

[3] Implementation of soil nutrient measurement using raspberry pi International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 07 | July 2020 p-ISSN: 2395-0072

[4] Soil Nutrient Analysis Using Machine Learning Techniques National E-Conference on "Communication, Computation, Control and Automation" (CCCA-2020)

[5] Machine Learning Algorithm for Soil Analysis and Classification of Micronutrients in IoT-Enabled Automated Farms Hindawi Journal of Nanomaterials Volume 2022, Article ID 5343965

[6] A Multiple Linear Regressions Model for Crop Prediction with Adam Optimizer and Neural Network Mlraonn (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 11, No. 4, 2020

[7] Crop Yield Prediction using Machine Learning Algorithm Proceedings of the Fifth International Conference on Intelligent Computing and Control Systems (ICICCS 2021) IEEE Xplore Part Number: CFP21K74-ART; ISBN: 978-0-7381-1327-2

[8] IoT based Agri Soil Maintenance Through Micro-Nutrients and Protection of Crops from Excess Water Proceedings of the Fourth International Conference on Computing Methodologies and Communication (ICCMC 2020) IEEE Xplore Part Number: CFP20K25-ART; ISBN: 978-1-7281-4889-2

[9] Monitoring of Soil Parameters and Controlling of Soil Moisture through IoT based Smart Agriculture 2020 IEEE Students Conference on Engineering and Systems (SCES) July 10-12, 2020 Prayagraj, India

[10] Prediction of Soil Quality Using Machine Learning Techniques International journal of scientific and technology research volume 8, issue 11, November 2019.