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"Soil Analysis and Crop Prediction in IoT enabled farms using ML Algorithm"

SoilMaster: an ecosystem for soil testing

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Abstract: *The advent of IoT-enabled farming systems is a result of both the quick development of technology and the rising desire for effective and sustainable agricultural practices. In this study, a machine learning (ML) algorithm is used to provide a novel method for scheduling and testing soil in IoT-enabled farms. This study's goal is to maximize the use of fertilizers and irrigation by analyzing real-time soil data obtained from IoT sensors and using ML to forecast soil moisture content and nutrient levels. Farmers may make data-driven decisions for fertilization and irrigation by utilizing the power of IoT and ML, which will increase crop output, conserve resources, and have a smaller environmental impact. In order to monitor soil factors including pH, temperature, moisture, and nutrient levels, the process entails placing IoT sensors in the field. These sensors provide the data to a central system, which analyses it and uses an ML algorithm to produce precise predictions. To improve its predictive power, the ML model integrates a number of variables, including crop kind, growth stage, and meteorological conditions, which are trained using historical soil data.*

Index Terms **- pH, soil moisture, micronutrient, crop growth.**

I. INTRODUCTION

The objective of this research paper is to propose a soil analysis and crop prediction framework for IoT-enabled farms using ML algorithms. By combining IoT technology, real-time soil data, and predictive analytics, this framework aims to provide farmers with actionable insights for effective soil management and crop planning. The proposed system not only enhances the efficiency of resource utilization but also contributes to sustainable farming practices by minimizing the use of chemical inputs and water resources.

In this paper, we will discuss the methodology employed for soil analysis and crop prediction in IoT-enabled farms. We will delve into the deployment of IoT sensors, the collection of real-time soil data, and the utilization of ML algorithms for predictive modeling. Furthermore, we will present the results of implementing this framework and highlight its benefits in terms of improved crop yield, resource conservation, and cost-effectiveness.

Agriculture has experienced a change thanks to the Internet of Things (IoT) revolutionizing a number of industries. The potential of IoT-enabled farming systems to increase crop output, optimize resource use, and promote sustainable agricultural practices is enormous. Soil analysis is a crucial component of precision agriculture because it offers useful information on the fertility, nutrient levels, and moisture content of the soil. Farmers may choose crops wisely and maximize productivity while reducing costs by studying the features of the soil and applying them to their decisions about fertilization, irrigation, and crop selection.

In the past, soil analysis required laborious manual sampling and laboratory testing that frequently resulted in delayed results. Predictive analytics and real-time soil monitoring have become possible, though, because of the combination of IoT sensors and machine learning (ML) algorithms.

II. Literature Survey

A survey done by the team Visited Place: K. K. Wagh College of Agriculture, Nashik Department: BTech /BSC Staff: 1. Prof. Dr H.V. Deshmukh (Principal of BTech Agriculture) 2. Prof. Dr S. M. Hadole (Principal of BSC Agriculture), Observation: 1. Testing Process • PH- PH Meter • EC- EC Meter • N- Nitrogen (Kjeldahl Flask Method) • P- Phosphorus (Spectrophotometer) • K- Potassium (Flame Photometer128) 2. Soil Profile Records: Dataset of Makhmalabad Farm Soil Testing Report Methods Used: 1. Flame Photometer128: • Name of the Equipment: Flame Photometer 128 • Make: Pelican Equipment • Model: Elite Ex • Specification: Digital display with indicators • Function: It does the estimation of Sodium (Na), Potassium(K), Lithium(Li), And Calcium (Ca) in single aspiration of a sample. Used in inorganic chemical analysis to determine the concentration of certain metal ions. 2. UV-Visible Spectrophotometer: • Name of the Equipment: UV-Visible Spectrophotometer • Model: V-730 UV-Visible Spectrophotometer • Specification: Rowland off-circle arrangement, Single monochromator, Double Beam Type • Function: UV-Visible Spectroscopy (or Spectrophotometry) is a quantitative technique used to measure how much a chemical substance absorbs light. It uses wavelengths in the range of 100-750nm and can be used to determine organic molecules that are present in various agricultural products. 3. Centrifuge Machine: • Name of the Equipment: Centrifuge Machine • Model: R-8C Laboratory Centrifuge REMI • Specification: Digital Speed Indicator, Stepless Speed Regulator. • Function: Laboratory Centrifuges model R-8C is suitable for routine sample analysis in Medical, Hospital, Pathology, and Institutional laboratories. A centrifuge is used to separate particles suspended in a liquid according to particle size and density, the viscosity of the medium, and rotor speed. 4. Digital PH-Meter: • Name of the Equipment: Centrifuge Machine • Model: pH meter model EQ-610 • Function: This meter is used to measure the alkalinity of a liquid ad is connected to an electronic meter to display pH reading.

III. Project Methodology

1. **Study Area Selection:** Soil quality has drastically decreased recently as a result of ineffective crop and soil management techniques. This is mostly because of the number of artificial fertilizers used, which have altered the balance of nutrients in the soil. These factors have a big effect on how productive soils are. Due to the characteristics of the soil, either the presence or absence of elements will result in soil erosion, soil imbalance, and other soil issues. This will decrease the production of agricultural land. In systematic models, soil management and conservation are heavily emphasized. The deficiencies in earlier methodologies are discovered to be filled by integrating information technology with auxiliary inputs and services.

2. **IoT Sensor Deployment:** It starts with gathering information from the field. The field area is used to gather data on variables like N, P, K, pH, soil moisture, temperature, and humidity. The gathered information is subsequently saved and provided to the GUI as input. A soil moisture sensor is used to determine the amount of water in the soil.

3. **Data Collection**: For the purpose of collecting and storing the sensor data, create a data collection system. Set up the IoT sensors so they can wirelessly send information to a central database or cloud-based platform. Ascertain that the data-gathering technology is reliable, secure, and able to manage huge volumes of real-time data.

4. **Data Preprocessing**: Collected data from the sensor is preprocessed, trained, and tested by ML algorithms.

Model Training using ELM: Apply the ELM algorithm to train the crop prediction model using the preprocessed soil data and corresponding crop performance data. ELM is a feedforward neural network that efficiently learns the underlying patterns in the data. Configure the ELM model by specifying the number of hidden nodes, activation functions, and regularization parameters.

Model Validation and Evaluation: Split the dataset into training and testing sets. Use the training set to train the ELM model and assess its performance on the testing set. Evaluate the model's accuracy, precision, recall, or other relevant metrics to measure its predictive capability. Fine-tune the model by adjusting hyperparameters if necessary.

Crop Prediction: Apply the trained ELM model to predict crop performance based on real-time soil data collected from the IoT sensors. Continuously update the model as new data becomes available. Monitor and analyze the predictions in comparison with actual crop performance to assess the accuracy and reliability of the ELM model.

IV. MODELING

Fig.1. System Modeling

A. Soil Analysis:

IoT Sensor Deployment: Deploy IoT sensors in the farm to measure various soil parameters. These sensors can include devices for measuring pH, temperature, moisture, electrical conductivity, nutrient levels, and other relevant soil characteristics. The number and placement of sensors depend on the size of the farm and the level of soil variability.

Real-Time Data Collection: IoT sensors collect data from the soil at regular intervals and transmit it wirelessly to a centralized data management system. This system can be cloud-based or located on-premises, and it stores and processes the collected data.

Data Monitoring and Visualization: Farmers and agronomists can access the collected soil data through user-friendly interfaces or dashboards. These interfaces provide real-time monitoring of soil conditions, allowing users to visualize the data in a comprehensible format. Graphs, charts, and maps can help identify trends, patterns, and anomalies in soil parameters.

Data Analysis and Interpretation: Analytical tools and algorithms are used to process and analyze the collected soil data. Statistical methods, machine learning techniques, or domain-specific algorithms can be employed to gain insights into soil fertility, nutrient imbalances, moisture stress, and other relevant information. This analysis helps identify areas of improvement and potential interventions for optimizing soil conditions.

Decision Support Systems: Based on the analyzed data, decision support systems can provide farmers with recommendations and actionable insights. These systems leverage the collected soil data and historical knowledge to suggest appropriate measures for fertilization, irrigation, crop rotation, and other soil management practices. These recommendations are aimed at improving crop yield, resource utilization, and sustainability.

Integration with Farm Management Systems: Soil analysis data integrated with farm management systems, enabling seamless integration with other operational processes. This integration allows farmers to streamline their activities, align soil management practices with crop planning, and make informed decisions related to planting, harvesting, and other farm operations.

B. **Crop Prediction:** Apply the trained model to predict crop growth, based on real-time environmental data collected from the IoT sensors. Continuously update the model with new data as it becomes available to improve the accuracy of predictions. Monitor and analyze the predictions to make informed decisions regarding irrigation, fertilization, and other agronomic practices.

C. **Water Management**: Real-time soil moisture data collected and stored in a database helps the system to analyze the water requirements for various crops.

D. **Crop Scheduling**: A schedule for crop cultivation to harvesting provided by our system.

V. EXPERIMENTAL SETUP

As shown in Figure 2 the actual prototype of the proposed system is designed, it includes cloud storage, sensors used, and all the necessary parts.

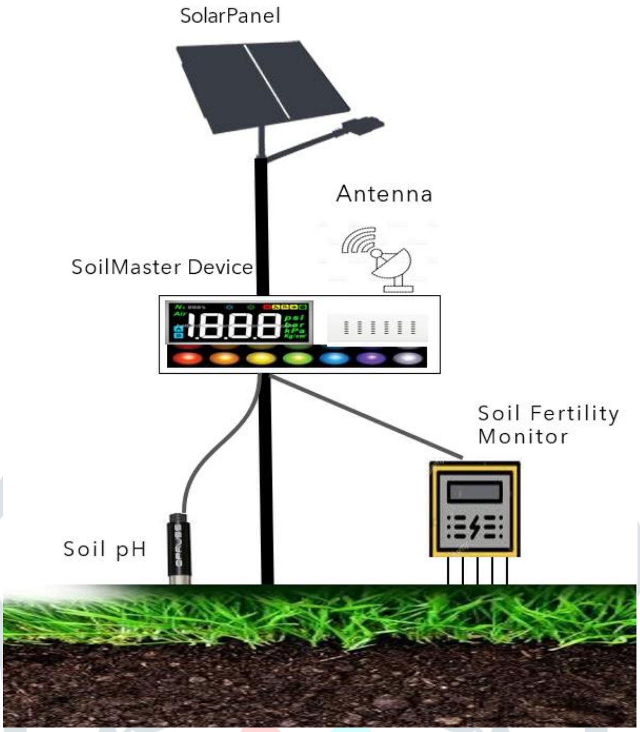

Fig.2. System Setup

VI. RESULTS

A. UI of Website

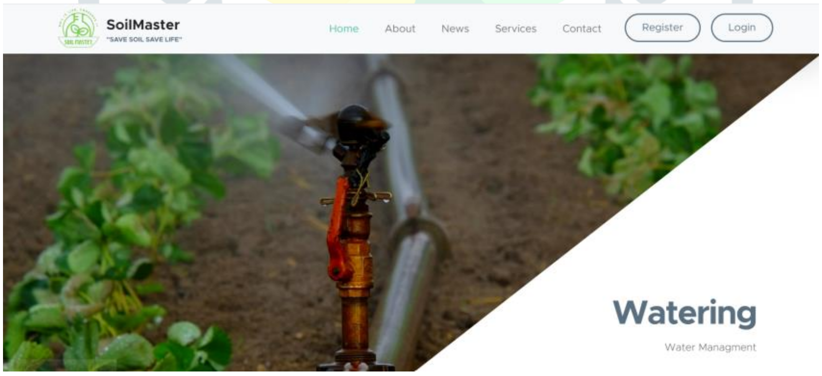

Fig. 3. Website UI for System

B. Adding Farm Details

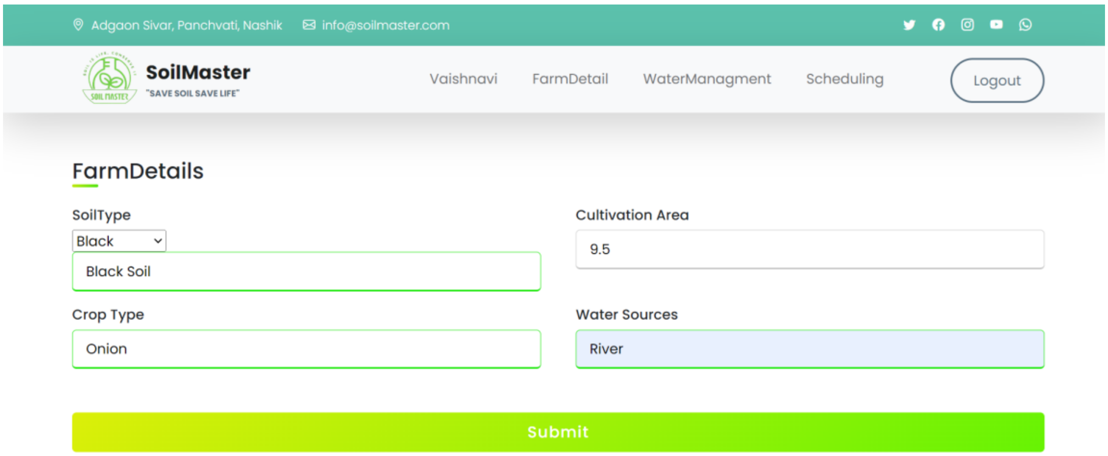

Fig.4. Farm details Page

C. Nutrition Data Collected by sensors

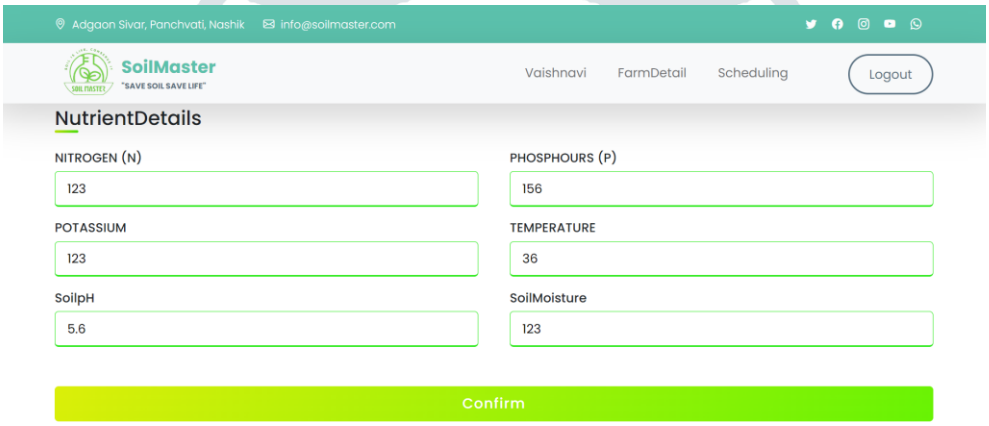

Fig.5 Nutrient data page

VII. Conclusion

IoT integration can revolutionize agricultural practices and result in more sustainable and effective farming systems, as shown by the study project on IoT-enabled farms. Farmers may optimize resource use, lessen environmental impact, and increase agricultural yields by utilizing real-time data, advanced analytics, and decision support tools. The results of this study pave the way for the use of Internet of Things (IoT)-enabled technologies in agriculture, advancing smart farming techniques and enhancing the overall sustainability of the agricultural sector.

REFERENCE

[1] IoT-Driven Model for Weather and Soil Conditions Based on Precision Irrigation Using Machine Learning. Dushyant Kumar Singh, Rajeev Sobti , Praveen Kumar Malik , Sachin Shrestha , Pradeep Kumar Singh , and Kayhan Zrar Ghafoor, Research Article, Hindawi Security and Communication Networks Volume 2022, Article ID 7283975, 10 pages https://doi.org/10.1155/2022/7283975.

[2] Machine Learning Algorithm for Soil Analysis and Classification of Micronutrients in IoT-Enabled Automated Farms, 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, Research Article, Hindawi Journal of Nanomaterials Volume 2022, Article ID 5343965, 7 pages https://doi.org/10.1155/2022/5343965

[3] Precision agriculture using IoT data analytics and machine learning Ravesa Akhter, Shabir Ahmad Sofi, Journal of King Saud University – Computer and Information Sciences 34 (2022) 5602–5618.

[4] Soil Temperature Prediction Using Convolutional Neural Network Based on Ensemble Empirical Mode Decomposition, HUIBOWEN HAO, FANHUA YU, AND QINGLIANG LI, Received December 13, 2020, accepted December 24, 2020, date of publication December 30, 2020, date of current version January 8, 2021. Digital Object Identifier 10.1109/ACCESS.2020.3048028.

[5] Machine Learning Strategy for Soil Nutrients Prediction Using Spectroscopic Method, Janez Trontelj ml. and Olga Chambers, Sensors 2021, 21, 4208. https://doi.org/10.3390/s21124208

[6] Improving the prediction accuracy of soil nutrient classification by optimizing extreme learning machine parameters, M.S. Suchithra, Maya L. Pai, Available at www.sciencedirect.com INFORMATION PROCESSING IN AGRICULTURE 7 (2020) 72– 82.

[7] Machine Learning and Soil Humidity Sensing: Signal Strength Approach LEA DUJIĆ RODIĆ, TOMISLAV ŽUPANOVIĆ, TONI PERKOVIĆ, and PETAR ŠOLIĆ (CORRESPONDING AUTHOR), University of Split, Croatia JOEL J. P. C. RODRIGUES, Federal University of Piauí (UFPI), Teresina - PI, Brazil and Instituto de Telecom union cações, Portugal. Evaluation of California weather-based “smart” irrigation controller programs https://p2infohouse.org/ref/53/52030.pdf, Accessed: 24 February 2020.

[8] Analysis and Prediction of Soil Nutrients pHNPK for Crop using Machine Learning Classifier: A Review. Mrs. Disha S. Wankhede, Ph.D. Research Scholar Alliance University. Research Gate 2020

[9] Prediction Of Soil Quality Using Machine Learning Techniques, T. Venkat Narayana Rao, INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 8, ISSUE 11, NOVEMBER 2019 ISSN 2277-8616.

[10] Random Forest Algorithm for Soil Fertility Prediction and Grading Using Machine Learning, Keerthan Kumar T G, Shubha C, Sushma S A, International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075 (Online), Volume-9 Issue-1, November 2019.

[11] Soil Classification using Machine Learning Methods and Crop Suggestion Based on Soil Series, Sk Al Zaminur Rahman Kaushik Chandra Mitra S.M. Mohidul Islam, 2018 21st International Conference of Computer and Information Technology (ICCIT), 21-23 December 2018.