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Internet of Things(IoT) Application for Crop Prediction and Fertilizer Suggestion Using Machine Learning Techniques

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Abstract: ***Agriculture serves as the primary source of income globally, particularly in regions like the Indian subcontinent. However, modern challenges such as unpredictable weather patterns, water scarcity, and market fluctuations necessitate the adoption of advanced farming techniques. Soil fertility depletion, caused by various factors, further exacerbates these challenges, leading to decreased crop yields. To solve these problems, our project utilizes modern technology, specifically leveraging machine learning techniques. By integrating an NPK sensor with a web application, our goal is to give farmers practical insights into their soil's nutrient composition. Upon collecting nitrogen, phosphorus, potassium, and pH levels from the soil, these values are entered into the application. Compared to traditional farming methods, our project offers several advantages. Firstly, it empowers farmers with accurate and timely information about their soil's nutrient levels, giving them the ability to make wise decisions. Secondly, by the use of machine learning methods, our system provides personalized recommendations that address the particular needs of each farmer's soil. Overall, our project aims to enhance agricultural productivity and sustainability by bridging the gap between traditional farming practices and modern technology.***
Keywords: Machine learning Techniques, Internet of things, web application, Logistic Regression, Crop Recommendation.

I. INTRODUCTION

In the landscape of modern agriculture, Technology integration is becoming more and more common., offering innovative solutions to solve the challenges faced by farmers worldwide. Our project centres around leveraging technology, specifically the Internet of Things (IoT) and web applications, to streamline and optimize crop and fertilizer recommendations based on soil nutrient analysis. The process begins with the deployment of NPK sensors, which are able to measure nitrogen, phosphorus, potassium, and pH levels in the soil. These sensors serve as the foundational element in our project, providing real-time data on the nutrient composition of the soil. Upon collecting the soil nutrient data, the information is then fed into a user-friendly web application, designed to provide farmers with actionable insights and recommendations tailored to their specific agricultural needs. The application offers two primary functionalities: crop recommendation and fertilizer recommendation. These options empower farmers to make knowledgeable choices about soil management techniques and crop selection, ultimately enhancing agricultural productivity and sustainability. A major development in the world of agriculture is the incorporation of technology into farming operations, offering farmers access to valuable data and insights that can inform decision-making processes. Making use of web applications and Internet of Things sensors, our project aims to empower farmers with the tools and information they need to maximize crop yields, optimize resource utilization, and promote long-term sustainability in agriculture.

II. LITERATURE REVIEW

Paper [1]: The paper titled “Internet of Things (IoT) assisted Context-Aware Fertilizer Recommendation". It considers variables including crop kind, soil type, and soil fertility to satisfy the requirement for real-time context-awareness in fertilizer recommendation. The study suggests an Internet of Things-based approach to real-time mapping of soil fertility that gets beyond the difficulties and expensive nature of conventional techniques. When compared to conventional soil chemical analysis, the system's accuracy is validated through practical implementation in crop fields. The most precise machine learning model for context-aware fertilizer recommendation is the Gaussian Naïve Bayes (GNB) model. To improve sustainability and profitability in agriculture, this research provides a framework for the integration of IoT and machine learning.

Paper [2]: The paper titled " Artificial Intelligence-Based Crop Suggestion System" tackles the urgent problem of India's farmers choosing the wrong crops, which results in low incomes and a desire to leave the agricultural industry. It offers a method based on machine learning algorithms to make crop recommendations based on a variety of environmental and financial factors, including temperature, rainfall, soil properties, and more.

This method forecasts yields, examines profitability, and recommends appropriate crops. Crop selection is done using a different types of machine learning methods, such as Decision Tree Learning and Artificial Neural Networks. The study highlights the importance of data mining and machine learning in assisting farmers in making knowledgeable crop decisions., which improves agricultural sustainability and financial viability.

Paper [3]: The paper titled "Crop, Fertilizer, & Irrigation Recommendation using the Machine Learning Techniques" emphasizes the use of agriculture to the economy as well as the difficulties farmers encounter because of weather fluctuations, a lack of water, and problems with soil fertility. It underlines the necessity of utilizing contemporary technology to offer practical solutions to these issues. Crop yield prediction is advised to use machine learning, which offers different methods such as regression, clustering, classification, and prediction.

To predict agricultural productivity, a variety of methods can be used, such as Naïve Bayes, support vector machines, decision trees, and artificial neural networks. The research aims to examine how different machine learning algorithms may be used to forecast crop yield and recommend fertilizers, thereby supporting efficient crop management. We'll focus on supervised learning techniques and big data computing.

Paper [4]: The paper "Crop prediction using machine learning" addresses the pressing issue of declining agricultural productivity in India due to unpredictable climatic changes. This decline threatens the livelihoods of farmers and national food security. The study proposes a solution leveraging machine learning, specifically Naive Bayes, to predict suitable crops for cultivation. By collecting seed data and considering crucial parameters like temperature, humidity, and moisture content, the model assists farmers, especially beginners, in making informed decisions about crop selection. Additionally, the development of a user-friendly mobile application for Android facilitates easy access to the prediction process, encouraging user engagement and adoption of the technology in agricultural practices.

III. MOTIVATION

Our project revolves around harnessing technology to empower farmers with real-time soil insights. Using a specialized sensor, we delve into the soil, uncovering its nutrient secrets - nitrogen, phosphorus, potassium, and pH levels. This data is then fed into a user-friendly web application, offering farmers two invaluable tools: crop recommendations and fertilizer suggestions. With crop recommendations, Farmers receive customized guidance on which plants are ideal for the particular composition of their soil, optimizing yields and sustainability.

Meanwhile, fertilizer suggestions provide guidance on how to enhance soil fertility, promoting healthier crops and reducing environmental impact.

IV. OBJECTIVE

1) *Enhance Crop Selection:* The primary objective is to employ Machine Learning and IoT to provide data-driven recommendations for optimal crop selection, considering soil conditions, climate, and previous historical data. This will increase agricultural productivity and assist farmers in making wise selections.
2) *Optimize Fertilizer Application:* The project aims to recommend precise fertilizer application strategies, reducing waste and its negative effects on the environment while making sure crop nutrient requirements are efficiently supplied.
3) *Improve Resource Efficiency:* By integrating technology, the project strives to enhance resource utilization, reducing water, energy, and fertilizer wastage, thereby increasing agricultural sustainability.
4) *Increase Productivity:* The system will work towards maximizing crop yield and, in turn, the economic well-being of farmers through better decision-making.
5) *Sustainable Agriculture:* In order to balance output with environmental responsibility, sustainable farming practices must be promoted, contributing to global food security and ecological well-being.

V. METHODOLOGY

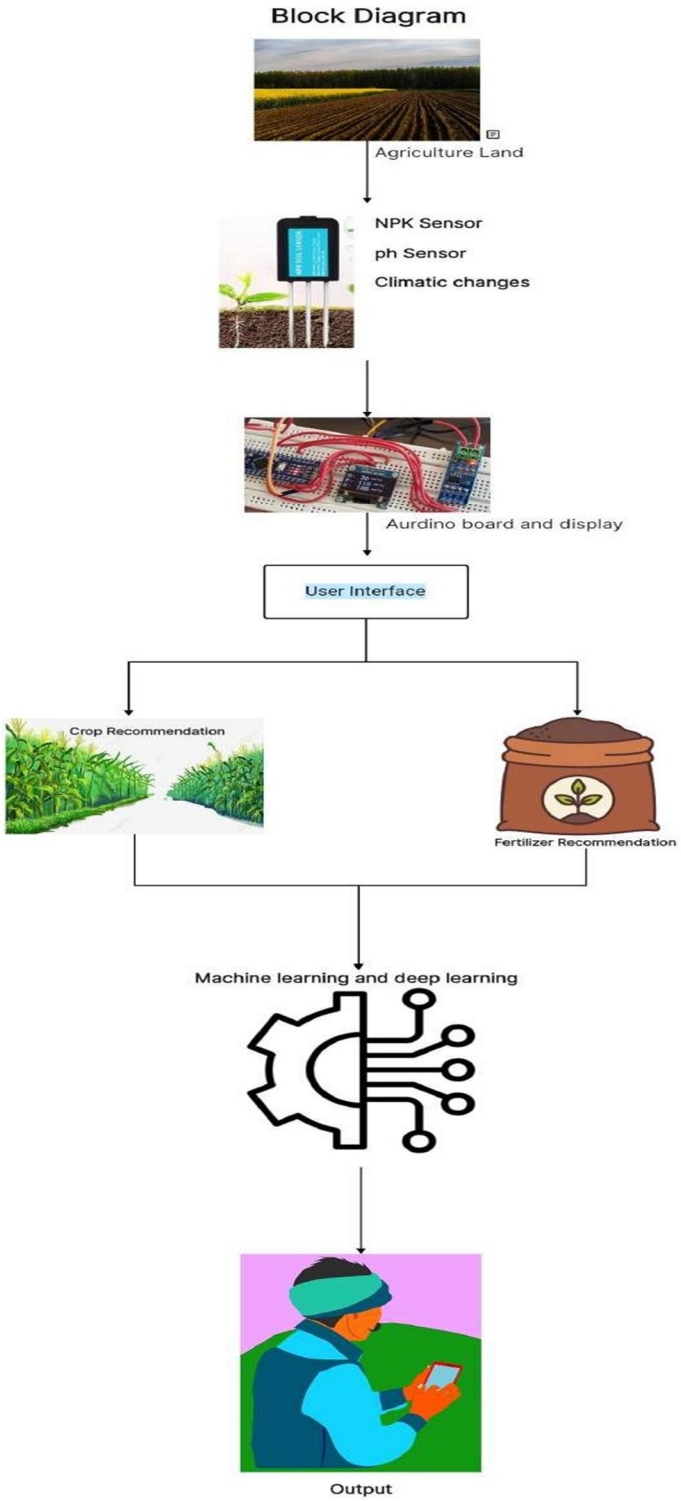

Fig 5.1 Block Diagram

Fig 5.1 Represents by considering agricultural land, and we're using sensors like NPK (Nitrogen, Phosphorus, Potassium) and pH sensors to measure the levels of these elements in the soil. The results are then shown on an OLED display. After obtaining these values, users can enter these into our web application. The application provides crop and fertilizer recommendations based on the soil's nutrient levels. This aids farmers in selecting the best crops to plant and fertilizers to utilize for maximum production.

VI. RESULTS

A. Home Page of The User Interface

The user interface of the home page is displayed in Fig. 6.1.

Fig 6.1 Project Home page

B. Services Page

The user interface displays the services that are available to the user in Fig. 6.2.

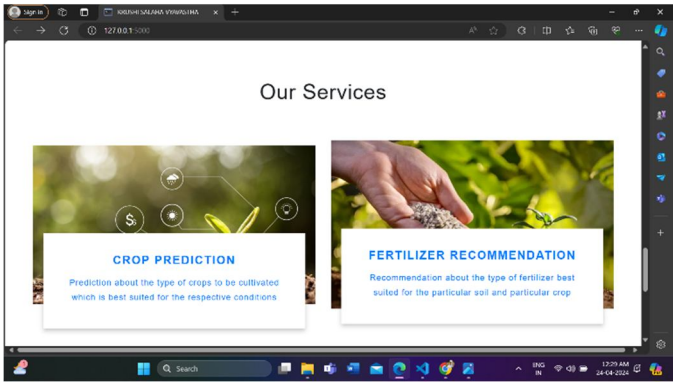

Fig 6.2 Services page

C. Crop Prediction

The user interface for entering values to obtain crop recommendations is depicted in Fig. 6.3.

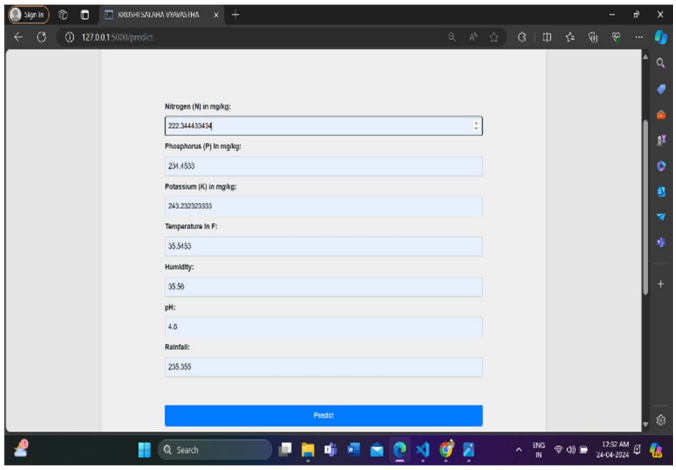

Fig 6.3 Crop Prediction

D. Predicted Crop

The crop recommendation result is shown in the user interface in Fig. 6.4.

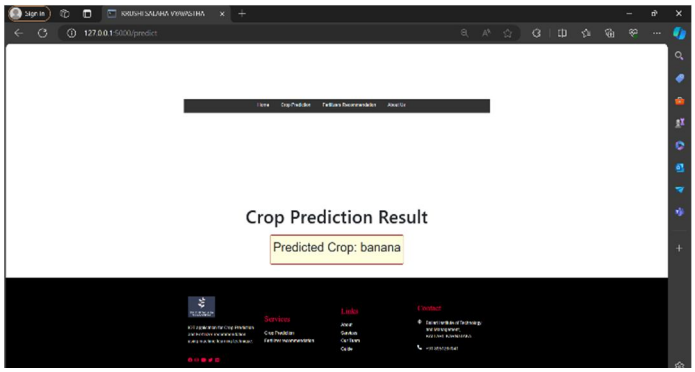

Fig 6.4 Predicted Crop

E. Fertilizer Recommendation

The user interface for entering values to obtain Fertilizer recommendations is depicted in Fig. 6.5.

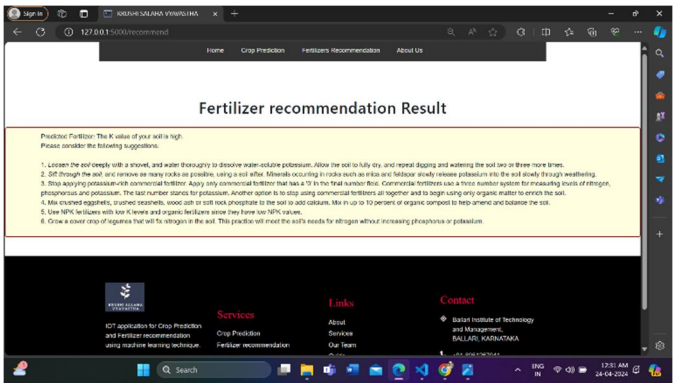

Fig 6.5 Fertilizer Recommendation

F. Recommended Fertilizer

The Fertilizer recommendation result is shown in the user interface in Fig. 6.6.

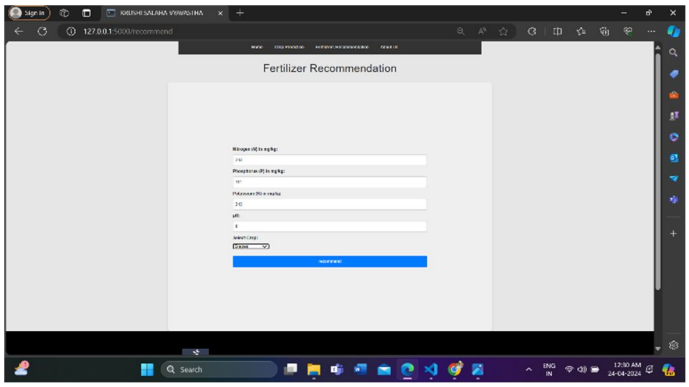

Fig 6.6 Recommended Fertilizer

VII. FUTURE SCOPE

1) The project will combine models of machine learning with IoT data streams to provide dynamic fertilizer and crop recommendations that optimize nutrient application and minimize environmental impact.
2) The project will focus on recommending crops suitable for cultivation in the specific geographical region where the IoT sensor network is deployed.

3) The crop recommendation system will be limited to recommending a select number of major crops commonly grown in the target region.

4) The accuracy of crop and fertilizer recommendations may be affected by the quality and completeness of input data, including soil samples, weather data, and historical crop yields.

5) The fertilizer recommendation system will give suggestions for the type and quantity of fertilizers based on the specific crop selection and real-time data from the IoT sensor network.

VIII. CONCLUSION

In conclusion, our project leverages advanced sensor technology and web-based analytics to offer tailored agricultural solutions, enhancing soil management and crop production. By incorporating an NPK sensor to assess soil fertility levels, our system provides critical data points on nitrogen, phosphorous, and potassium and soil pH values. This data-driven approach enables precise crop and fertilizer recommendations through an intuitive web application. Users can choose between optimizing crop selection or improving soil nutrient profiles via customized fertilizer suggestions. Our system not only promotes optimal resource use but also supports sustainable agricultural practices by allowing farmers to adjust inputs based on real-time soil conditions, thus minimizing environmental impact. The combination of machine learning and technology tools in our project aims to revolutionize traditional farming techniques, improve yields, and offer a scalable solution adaptable across various agricultural settings. Overall, this project represents a significant step forward in the pursuit of sustainable agriculture powered by smart technologies.

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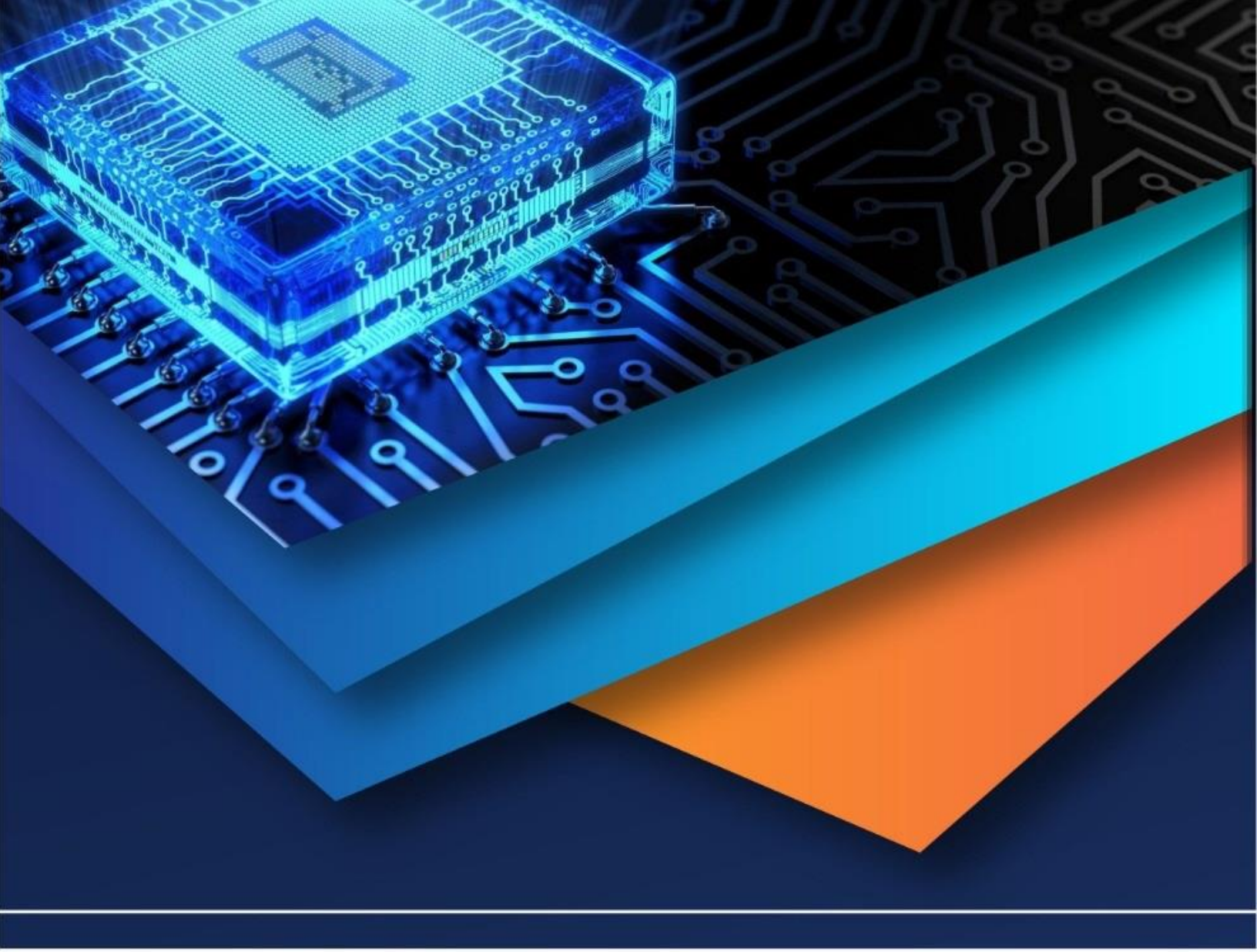

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