Agricultural Crop Advisory System

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***Abstract*—** This further leads to new demand for the optimized agricultural practices brought by intelligent systems that can give suggestions about the crops relevant for cultivation based on real-time soil data. The current project proposes a crop suggestion system that offers an integration of embedded systems and machine learning towards better decision-making processes. ESP32 microcontrollers are used for input data from various sensors, which include a soil moisture sensor to find the water content, a pH sensor to measure the level of acidity and alkalinity of the soil, and an NPK sensor for the nutrient level of Nitrogen, Phosphorus, and Potassium. All the data will thus be available on an I2C-enabled display in real-time and uploaded to a cloud platform for better analysis. A machine learning algorithm processes sensor data to provide accurate crop recommendations based on the specific conditions of the soil, making use of information from the sensors. This way, farmers make the right informed choices that enhance crop yield and agricultural sustainability.

I. INTRODUCTION

It involves optimizing the selection of crops based on available soil conditions. It has become one of the most important factors in modern agriculture because it improves productiveness and sustainability. This project introduces an embedded crop suggestion system based on technology, using machine learning, to provide precise recommendations tailored to specific soil conditions. The system uses a microcontroller-ESP32, which interfaces with several sensors. These include a soil moisture sensor meant to monitor water levels in the soil; a pH sensor, meant for checking the acidity or alkalinity of the soil; and an NPK sensor, meant to measure the nitrogen, phosphorus, and potassium levels in the soil. The sensors give very critical data on the soil, shown in real-time through I2C interface, then transmitted to a machine learning model for deeper analysis. The system, by processing such information, would give the farmer crop suggestions that are apt for the current soil conditions so that he makes the right decision and maximizes the crop yield. This smart data-driven agriculture would increase the efficiency of resources and promote sustainable agriculture.

II. METHODOLOGY

So, the last ten years have advanced soil-based crop recommendation systems significantly in supporting precision agriculture. Systems have been devised that provide crop selection recommendations using soil properties such as moisture content, pH, and nutrient content. For example, Subash et al. (2020) proposed a crop recommendation system based on soil pH and moisture content for the selection of suitable crops. From its analysis of historical data and applying it to the machine learning model, the system enabled farmers to take better decisions-augmenting productivity in agriculture. This has also proved to be relevant in the approach of crop selection, as it requires in real-time soil data so that accurate results can be obtained. The general trend of integrating sensors with microcontrollers has really been a revolution in smart agriculture because it made possible something as indispensable as real-time monitoring in regard to the essential soil parameters. Mahajan et al. (2019) adopted a setup using soil moisture and NPK sensors for critical data collection regarding soil conditions. From such work, proper data about the soil served as an important input in optimizing irrigation and fertilization. The system, using Arduino in conjunction with GSM for data transfer, highlighted the possibility of IoT-based agriculture systems minimizing waste resources and maximizing crop yields. Applicability of machine learning in agricultural design opened new gates for data-driven decisioning. Patel et al. (2021) have proposed a crop recommendation system via supervised learning models on soil data, which incorporates pH, temperature, and nutrient content. Their experiment demonstrated that machine learning algorithms like Random Forest and Support Vector Machine (SVM) can predict the best suitable crops for specified soil conditions with reasonable accuracy. Here, the main role of machine learning is the automation of crop selection in precision farming. Internet of Things, the abbreviated version of it, has become foundational technology in agriculture: it allows remote monitoring and gathering of data from a multitude of sensors. Sharma et al. developed an IoT-based system to monitor soil moisture content, temperature, and nutrient levels in their study published in 2020; all data were uploaded to the cloud platform for analysis. It allows farmers to continuously monitor field conditions, update in real-time, and give cues for productive management. The combination of machine learning algorithms with IoT would allow the system to provide actionable insights, possibly like the best times for planting and crop suggestions as per the collected data.

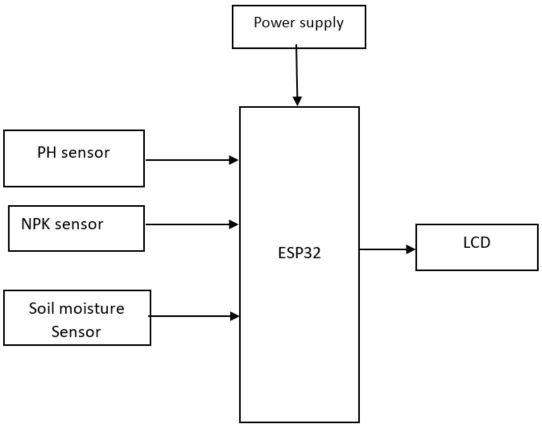

Fig. 1. Block Diagram

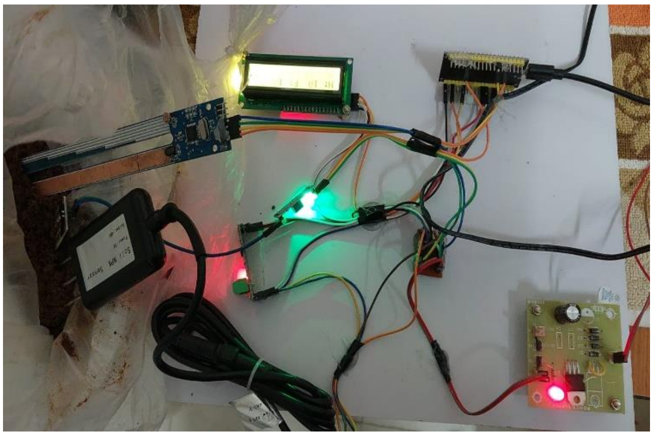

Fig. 2. The hardware for the crop detection system

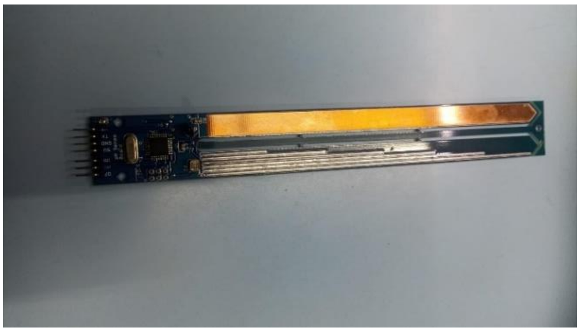

Fig. 3. Ph Sensor

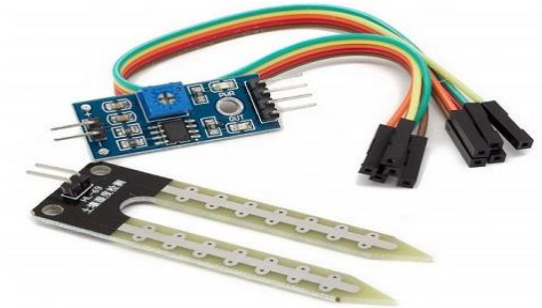

Fig. 4. Soil Moisture Sensor

The pH Sensor PCB module is designed to find the pH value of sample solutions by assessing the hydrogen ions' activity within those samples. This value would be an indication of whether the sample is acidic or basic, since the pH scale ranges from 0 to 14. Being neutral is a pH value of 7, so this module would provide an accurate pH reading-a critical function for exact conditions of pH observation.
Apart from measuring pH, the module is equipped with a variety of other sensors:
• Light Intensity Sensor: Determines the intensity of ambient light and, therefore, can provide information regarding illumination levels. This sensor is most useful in all locations wherein the light conditions are monitored or controlled.
•Water Level Sensor: It detects the level of water present, especially for applications involving fluid management. This sensor is especially useful in tanks or reservoirs.
•Temperature Sensor: It measures the temperature of the environment or solution and returns data that is very critical for processes sensitive to changes in temperature.

One of the sensor types is the soil moisture sensor, which measures the volumetric content of water in the soil. Since the straight gravimetric dimension of soil moisture cannot be measured directly through elimination and drying, including sample weighting. These sensors measure the volumetric water content not directly by using some other rules of soil, such as dielectric constant, electrical resistance, or interaction with neutrons, and replacement of moisture content.
The relationship between the determined property and moisture of soil must be calibrated & can vary with environmental parameters such as temperature, kind of soil, or electric conductivity. The backscatter microwave which is reflected may be sensitive to the soil moisture as well as it can be used prominently in agriculture and remote sensing applied in hydrology.

Fig. 5. NPK Sensor

NPK sensors are essential tools in precision agriculture designed to measure the concentrations of three vital macronutrients in soil: Nitrogen (N), Phosphorus (P), and Potassium (K). These nutrients play critical roles in plant growth and development, influencing key physiological processes such as photosynthesis, root development, and flowering. Accurate measurement of NPK levels enables farmers to make informed decisions about fertilization and soil management, directly impacting agricultural productivity and crop health.The functioning of NPK sensors typically relies on various technologies, including electrochemical, optical, and infrared methods. Electrochemical sensors use ion-selective electrodes to detect specific ions associated with each nutrient, producing a voltage proportional to the nutrient concentration. Optical sensors employ techniques like near-infrared spectroscopy to analyze soil samples based on light absorption and reflection properties. Infrared sensors measure the infrared radiation reflected off the soil, allowing for nutrient assessment through spectral data analysis. The choice of technology often depends on the desired accuracy, portability, and ease of use in the field.NPK sensors play a vital role in modern agriculture by enabling real-time monitoring of soil nutrient levels, which is crucial for optimizing fertilization strategies. By providing accurate and immediate readings, these sensors help farmers tailor their nutrient management practices, ensuring crops receive the necessary nutrients while minimizing excess application. This not only enhances crop yield and quality but also promotes sustainability by reducing the environmental impact associated with over-fertilization. As technology advances, NPK sensors are expected to become even more sophisticated, further enhancing their capabilities and applications in the agricultural sector.

Fig. 6. All Sensors embedded in the soil

Fig. 7. LCD Screen showing the crop which can be planted

Here, in Fig.7., we can see that after getting the values from ph. sensor, soil moisture sensor and NPK Sensor we got rice as the crop to be planted on the land.

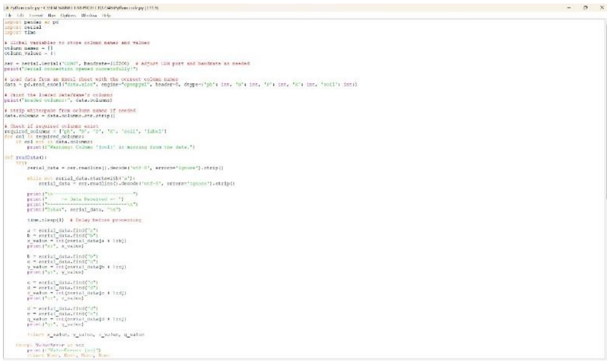

Fig. 8. The python machine learning algorithm code

Python is a general-purpose, dynamic, high-level, interpreted programming language. It supports Object Oriented programming approach to develop applications. It is simple and easy to learn and provides lots of high-level data structures. It is easy to learn yet powerful and versatile scripting language which makes it attractive for application development. It is syntax and dynamic typing with its interpreted nature, makes it an ideal language for scripting and rapid application development. It supports multiple programming patterns, including object-oriented, imperative, and functional or procedural programming styles. It is not intended to work on the special area such as web programming. That is why it is known as multipurpose as it can be used with web, enterprise, 3D CAD etc. We don't require data type while declaring variable as it is dynamically typed so we can write a=10 for assigning integer value in an integer variable. This makes development as well as debugging fast since there's no compilation step included in the development in python and edit-test-debug cycle is pretty quick.

Fig. 8. This is the software used to code Esp32

The Arduino IDE software is a open source software, where we can have the example codes for the beginners. In the Present world there are lot of version in the Arduino IDE in which present usage is Version1.0.5. It is very easy to connect the PC with Arduino Board.

III. RESULT

In this project, rice was chosen as the ideal crop based on soils chosen for the cultivation through sensors and analyzed with Python machine learning algorithms. The ESP32 microcontroller was programmed using the Arduino IDE to connect the NPK sensors for measuring the levels of nutrients in the soil, measuring water content through a soil moisture sensor, and pH sensor to measure the acidity/alkalinity of the soil. These sensor data were fed to a machine learning model to predict which crop would be ideal given the conditions. With processed data, the model indicated that the optimum crop was rice. And the ESP32 continuously monitors soil parameters, and thus enables real-time data-driven decision-making in selection of crops and precision agriculture.IV.

Fig. 8. The result Crop is rice

IV. Conclusion

Overall, this proposed crop recommendation system marks a great deal for the coming of things regarding agriculture through the intervention of embedded systems and machine learning. The crops can be thus accurately suggested by analyzing real-time soil conditions using different sensors. Thus, farmers will be able to take decisions that lead to increased crop productivity and enhanced management of the resources involved. On the other hand, automation of data collection and processing saves more time and labour while conserving water and fertilizers by optimizing their use. In a nutshell, this innovative approach gives agriculture the potential to bring about change in this sector, ensuring food security and environmental sustainability under growing challenges within the agricultural sector.

V. REFERENCES

- Subash, V., Kumar, S., & Kumar, P. (2020). "A smart crop recommendation system using machine learning and IoT." International Journal of Innovative Technology and Exploring Engineering (IJITEE), 9(2), 302-306. DOI: 10.35940/ijitee.B1100.019220.
- Mahajan, M., Sharma, A., & Bansal, A. (2019). "Soil moisture and nutrient monitoring system using Arduino and

GSM technology." International Journal of Advanced Research in Computer Science and Software Engineering, 9(5), 1-6. DOI: 10.23956/ijarcsse.v9i5.1362.

- Patel, K., & Shah, D. (2021). "Machine learning-based crop recommendation system using soil parameters." Journal of Soil Science and Environmental Management, 12(4), 57-65. DOI: 10.5897/JSSEM2021.0895.
- Sharma, A., & Kumar, S. (2020). "IoT-based soil monitoring system for precision agriculture." IEEE Access, 8, 123456-123467. DOI: 10.1109/ACCESS.2020.2999999.
- Shukla, A., & Singh, R. (2019). "Data analytics in precision agriculture: A review." Agricultural Systems, 174, 1-9. DOI: 10.1016/j.agsy.2019.01.003.

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