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Soil Nutrients Detection Using Raspberry PI

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ABSTRACT:

Crops are always in demand in the country, not only for the lives of the people but also for economic growth, so growing crops is of utmost importance. Using standard technology also increases efficiency and lessens the workload of the farmers. Therefore, in order to increase productivity, it is important to know about soil moisture and types of crops. Each variety of crop and the associated soil requires a particular amount of water, so the project need to make the most of what is available. In order to achieve this, it must utilize modern technology and tools. The detection and monitoring of soil nutrients are crucial for agriculture and plant growth. This project aims to develop a system for measuring soil nutrients using a Raspberry Pi and displaying the results on a mobile application. The system consists of a Raspberry Pi equipped with sensors for measuring soil pH, moisture, and temperature. The data collected by the sensors is processed by the Raspberry Pi and transmitted to a mobile application using Bluetooth or Wi-Fi. The mobile application provides real-time data visualization and analysis, allowing farmers and gardeners to monitor their soil health and adjust their nutrient management practices accordingly. The system is low-cost, easy to use, and can help improve crop yield and quality.

I. INTRODUCTION

In modern agriculture, understanding soil nutrient levels is essential for optimizing crop growth and ensuring efficient fertilizer application. Traditionally, soil nutrient analysis involved sending samples to laboratories, which can be time-consuming and costly. However, with the advancements in technology, it is now possible to perform on-the-spot soil nutrient detection using a Raspberry Pi and receive the results directly on a mobile phone in real-time.The Raspberry Pi is a compact and affordable single-board computer that offers extensive capabilities for various projects. By harnessing the power of Raspberry Pi along with appropriate sensors and software, we can develop a portable system for soil nutrient detection.The primary objective of this project is to create a user-friendly and efficient solution that allows farmers and gardeners to analyze soil nutrient levels in a convenient and cost-effective manner. By integrating the Raspberry Pi with mobile phone output, the system enables users to receive instant updates about their soil's nutrient composition.

II. LITERATURE SURVEY

1. Using relative vegetation indices from unmanned aerial systems.

The livelihood of the people is intimately tied to the timely and accurate projection of rice yield information, which has been given significant weight by all levels of government. Large-scale agricultural production estimation is possible with satellite remote sensing, although these methods are typically restricted by spectral and spatial resolution. Hyper spectral sensors on Unmanned Aerial Vehicles (UAV) allow for remote sensing with great spatial and temporal resolution. Time-series Vegetation Indices (VIs) are typically employed to calculate grain yield. The variations in vegetation indices may include impacts brought on by external conditions, which will offer a problem because multi-day vegetation indices may be altered by different background and illumination conditions.

2. Soybean Yield Prediction Using Deep Neural Networks: A Case Study from Lauderdale County, Alabama, USA

Due to the ongoing rise in global population, enough crop production is required. Estimating crop yields and tracking crop growth are crucial for a country's economic success. The management and security of food are directly impacted by crop production predictions, which also have a significant impact on regional, national, and global economy. With the most recent developments in image classification utilising deep convolutional neural networks, deep learning becomes increasingly important for applications such as crop monitoring, crop type classification, and agricultural yield estimation. Traditional remote sensing-based crop yield prediction techniques use traditional machine learning techniques like Support Vector Machines and Decision Trees.

3. Prediction of crop yield and effective fertilizer use.

India's economy, which is mostly dependent on agricultural products and yield growth, is an agricultural nation. An increasing area of study in crop production analysis is data mining. The ability to anticipate yield is a critical issue in agriculture. Any farmer is curious to know how much of a crop he can anticipate. Analyse the many factors that are associated, such as the location and the pH level used to calculate the soil's alkalinity. Additionally, the proportion of nutrients like potassium (K), phosphorus (P), and nitrogen (N) Location is used in conjunction with the use of third-party apps, such as APIs, to obtain information on the weather and temperature, the kind of soil, the region's soil nutrients, the region's rainfall totals, the soil.

4. Using support vector machines, India's rice crop yield is predicted

India's food production is heavily reliant on cereal grains including rice, wheat, and different pulses. A good climate is necessary for the sustainability and production of rice-growing regions. Seasonal climate variability can have a negative impact, with instances of drought lowering production. Better methods for predicting agricultural productivity under various climatic circumstances might help farmers and other stakeholders make better agronomic and crop selection decisions. Using machine learning approaches, crop yield predictions under various climatic conditions can be improved. This essay reviews the application of such machine learning methods to rice-growing regions in India. This paper explores the experimental findings made using.

III. METHODOLOGY

The Analysis Phase's main draw is gathering requirements. Typically, gathering requirements entails more than merely asking people what they require and noting their responses. The process for gathering requirements has a clearly defined approach of its own and depends on how sophisticated the application is. This process is made up of a number of repeating steps that use particular methods to gather, record, communicate, and manage needs. The process of defining a system's architecture, parts, modules, interfaces, and data in order to meet predetermined requirements is known as systems design. One way to think of systems design is as the product development application of systems theory. The fields of systems analysis, systems architecture, and systems engineering have certain areas of overlap.

The design phase is followed by two sub phases

- High Level Design.
- Low Level Design.

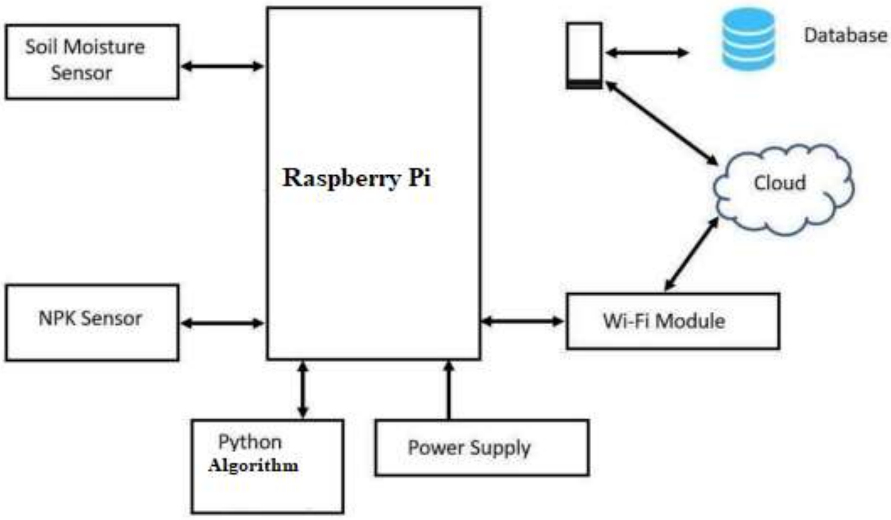

Fig 3.1: System Architecture

HIGH-LEVEL DESIGN

In the high level design, the proposed functional and non-functional requirements of the software are depicted. Overall solution of the architecture is developed which can hand let those needs. This Chapter involves the following considerations.

- Design Considerations
- Data Flow diagrams

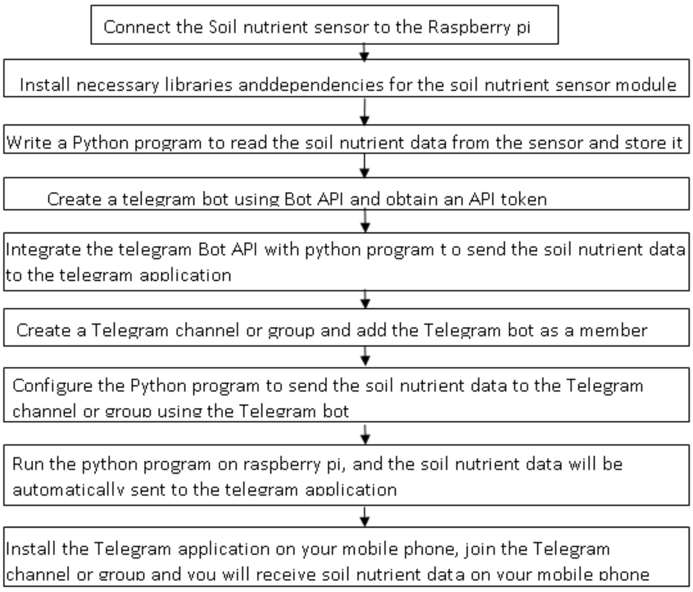

Fig 3.2: Data Flow Diagram

IV. IMPLEMENTATION

Implementation is the carrying out, execution, or practice of a plan, a method, or any design, idea, model, specification, standard or policy for doing something. As such, implementation is the action that must follow any preliminary thinking in the order for something to actually happen. Implementations allow the users to take over its operation for use and evaluation. It involves training the users to handles the system and plan for a smooth conversion. Implementation is a process of ensuring that the information system is

- Constructing a new system from scratch.
- Constructing a new system from the existing system.

Hardware Requirements:

1. Raspberry Pi: You'll need a Raspberry Pi board (such as Raspberry Pi 3 or Raspberry Pi 4) as the main controller for your project.

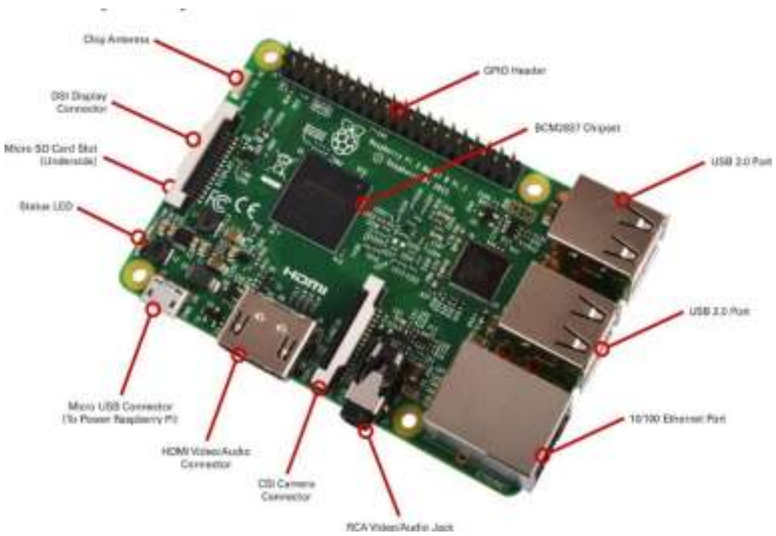

Fig 4.1: Raspberry Pi 3

2. Soil Nutrient Sensors: Choose sensors that can measure the desired soil nutrients. Common sensors include pH sensors, EC sensors, and moisture sensors. Make sure the sensors are compatible with the Raspberry Pi.

Fig 4.2 : Ph and moisture sensor

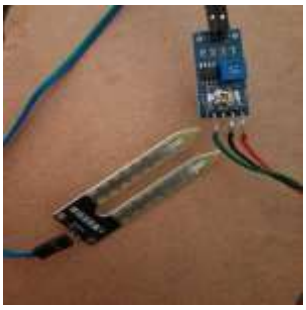

Fig 4.3: Soil NPK sensor

3. Wiring Components: You'll need jumper wires, breadboard, and/or a custom PCB to connect the sensors to the Raspberry Pi.

Fig 4.4: Jumper wires

4. Power Supply: Provide an appropriate power supply for your Raspberry Pi and other components.

5. Mobile Device: You'll need a mobile device (e.g., smartphone or tablet) to display the nutrient data through the mobile application.

Software Requirements:

1. Operating System: Install and set up an operating system on your Raspberry Pi. Raspbian (based on Debian) is a popular choice for Raspberry Pi. Ensure that you have the latest version of the operating system.

2. Python Libraries: Install the necessary Python libraries to interface with the sensors and communicate with the mobile application. For example, you may need libraries like RPi.GPIO for GPIO access and sensor-specific libraries for data acquisition.

3. Sensor-specific Libraries: Depending on the soil nutrient sensors you're using, you may need to install specific Python libraries or use existing libraries for sensor communication. Refer to the sensor datasheets and documentation for instructions on installing and using these libraries.

4. Mobile Application Framework: You'll need a framework or development environment to build the mobile application. Some popular options include React Native, Flutter, or native app development for iOS or Android.

5. Mobile Application Libraries: Depending on the mobile application framework you choose, you'll need to install the required libraries to communicate with the Raspberry Pi and display the nutrient data. These libraries will vary based on the chosen framework.

V. RESULTS

Expected Outcomes :

Fig 5.1: Final Telegram Result

VI. APPLICATIONS

1. Precision Agriculture: The system can be used to optimize fertilizer usage by providing real-time information about soil nutrient levels. Farmers can make data-driven decisions on the type and quantity of fertilizers to apply, leading to efficient nutrient management and improved crop yields.

2. Soil Health Assessment: By regularly monitoring soil nutrient levels, farmers and researchers can assess the overall health and fertility of the soil. This information can help identify nutrient deficiencies or imbalances, enabling targeted soil amendments and better land management practices.

3. Crop Monitoring and Growth Analysis: Continuous monitoring of soil nutrients can provide insights into crop health and growth patterns. By correlating nutrient data with plant growth stages, farmers can identify potential nutrient-related issues early on and take appropriate actions to maintain optimal crop development.

4. Precision Irrigation: Soil nutrient data combined with moisture sensor readings can facilitate precise irrigation management. By understanding the nutrient and moisture levels in the soil, farmers can implement irrigation strategies that optimize water usage and nutrient uptake by plants.

5. Research and Education: The system can be used in educational institutions and research settings to study the effects of various factors on soil nutrients and plant growth. Students and researchers can gain hands-on experience with soil analysis and explore the relationships between soil parameters and plant health.

6. Urban Gardening and Home Farming: The system can be adapted for smaller-scale applications, such as urban gardening or home farming. It allows hobbyists and enthusiasts to monitor soil nutrient levels in their gardens or small-scale crop setups, ensuring proper nutrient management for healthy plant growth.

7. Environmental Monitoring: Soil nutrient detection using Raspberry Pi can also be employed for environmental monitoring purposes. Researchers can analyze soil nutrient levels in different locations to assess the impact of land use, pollution, or natural processes on soil health. This data can contribute to understanding ecosystem dynamics and informing conservation efforts.

VII. CONCLUSION

Agriculture is the backbone of counties like India. However, the usage of technology towards agriculture is to be given paramount importance towards preclusion agriculture. This paper proposes as system that will help farmers to have an idea of yield estimates based on weather parameters and the are a under cultivation using this farmers can make decisions on whether to grow that particular crop or go for the alternate crop in case yield predictions are unfavorable. This research work can be enhanced to the next level. We can build a recommender system of agriculture production and distribution for farmers. Farmers can make decisions in which season crops should sow so that they can get more benefits. This system is work for structured datasets. In the future, we can implement data independent system also. It means the format of data whatever, our system should work with the same efficiency.

In the future development of a web application based on this ideology and make the user use this easily and help the user to understand the yield of the crop, he is going to crop in that season.

Soil nutrient detection using Raspberry Pi is a practical and efficient way to monitor the quality of soil and improve crop yields. By integrating the system with Telegram, farmers can receive real-time updates on the soil nutrient levels on their mobile phones, enabling them to take immediate action. This system can be further improved by adding machine learning algorithms to predict soil nutrient levels and recommend appropriate fertilizers.

VIII. FUTURE SCOPE

Integration with IoT platforms: The project can be further developed to integrate with various IoT platforms to enable data collection, analysis, and visualization. This can allow for better tracking of soil nutrients, as well as more accurate predictions and recommendations for soil management.

Python algorithms: The project can be expanded to include Pyhton algorithms to analyze the soil nutrient data and predict soil fertility. This can help farmers to make better decisions on crop selection, planting times, and fertilizer applications.

Mobile application development: The mobile application used in this project can be further developed to include more features, such as real-time notifications, customized recommendations, and more detailed soil analysis reports.

Integration with precision agriculture technologies: The project can be further developed to integrate with precision agriculture technologies, such as drones and GPS systems, to enable more precise and efficient soil nutrient detection and management.

Cloud-based storage and analysis: The data collected by the project can be stored in the cloud and analyzed using various tools and algorithms. This can allow for more comprehensive and scalable soil nutrient analysis and management.

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