IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

QUALITY ANALYSIS OF SOIL USING SENSORS

N Hariharan, J Ranjani, M Mohamed Javeed

Student, Assistant Professor, Student
Information Technology
Sri Sairam Engineering College, Chennai, India

Abstract: Analysis of soil quality is critical in agriculture, environmental science, and land management. Traditional soil testing procedures sometimes include time-consuming and labor-intensive laboratory processes, which are costly and can result in analysis time delays. The study covers numerous types of sensors used in soil analysis, such as temperature, humidity, and pH sensors. Each sensor type has its own set of capabilities and is sensitive to various soil characteristics such as moisture content, pH, nutrient levels, salt, and organic matter content. The benefits of sensor-based soil quality analysis are numerous. Sensors give quick readings, allowing for instant feedback and changes in agricultural methods. This paper is about monitoring the quality of the soil using sensors (IOT) and displaying which crop type is suitable for particular sensor value using already existing dataset along with the characteristics and attributes of the soil.

Index Terms - Internet of Things (IOT), Quality analysis, Dataset, Sensors.

INTRODUCTION

Soil is a valuable and finite resource that is necessary for life on Earth to survive. It is the foundation of agriculture, provides habitat for different ecosystems, and is required for a wide range of human activities. The soil's physical, chemical, and biological properties are essential for ensuring sustainable agriculture, environmental protection, and human well-being. Historically, soil quality analysis was a labor-intensive and time-consuming process, but technology improvements have enabled new and efficient methods. One of the most promising advances in this field is the use of sensors. This research analyzes the significance and potential of soil quality analysis using sensors. Traditional approaches usually need the collecting of soil, which has the potential to damage the natural environment.

There are several reasons for testing the quality of the soil like,

1. Soil quality has a direct impact on crop output and food security in sustainable agriculture. Farmers may make educated judgments regarding fertilizer management, irrigation, and crop selection by examining soil parameters. As a result, agricultural operations become more efficient and sustainable.
2. Environmental Conservation: Understanding soil quality is critical for preserving ecological equilibrium. Soil is a natural filter that removes contaminants from water while also promoting plant development. Soil health monitoring aids in the protection of ecosystems and water resources.
3. Soil quality analysis influences land use planning and urban development decisions. It assists in determining the appropriateness of land for various reasons, such as residential, commercial, or industrial usage, thereby reducing deterioration and pollution.
4. Mitigation of Climate Change: Healthy soils contribute to carbon sequestration, which helps to moderate the consequences of climate change. Soil sensors can offer data on soil carbon content, which can be used to build methods to improve soil carbon storage.

Soil sensors give real-time data on various soil parameters, including moisture content, temperature, pH, electrical conductivity, and nutrient levels. This real-time data enables fast decision-making. Sensors are normally non-destructive, which means they may be used repeatedly without causing harm to the soil. Traditional methods frequently require the collection of soil samples, which might disrupt the natural ecology.

1. Cost-Efficiency: While the initial investment in sensor technology can be high, the long-term cost reductions are significant since they remove the need for recurrent laboratory testing and lower the cost of inputs like water and fertilizers.
2. Precision agriculture: By integrating soil sensors into precision agricultural systems, farmers can apply resources precisely where required, eliminating waste and optimizing yields.
3. Some soil sensors may be connected to remote monitoring systems, allowing farmers and researchers to receive data from their computers or mobile devices, enhancing efficiency and information availability.

Although sensor technology has various advantages in soil quality measurement, there are certain obstacles that might impede the analysis process.

1. Calibration and Maintenance: To obtain reliable findings, soil sensors must be calibrated and maintained on a regular basis. Neglecting these elements might result in inaccurate data.
2. Data Interpretation: The data acquired by sensors may need professional interpretation. To make meaningful judgments, users must grasp the context and constraints of the metrics.
3. Accessibility: The initial cost of sensor technology might be too expensive for certain users, particularly in low-resource environments. To guarantee wider acceptance, this technology's accessibility must be increased.

The use of sensors to analyze soil quality is a promising development in agriculture, environmental conservation, and land management. Sensor technology's real-time data, cost-efficiency, and accuracy make it a great tool for assuring soil health and sustainability. However, it is critical to recognize the need for proper calibration, maintenance, and data interpretation, in addition to addressing accessibility difficulties. As technology advances, the incorporation of soil sensors into agricultural and environmental operations is expected to become increasingly vital for our planet's long-term well-being. After all, soil is the foundation upon which life depends, and protecting its quality is critical for future generations.
Soil analysis is critical in modern agriculture and environmental research because it provides critical insights into soil quality and condition. This procedure has traditionally been labor-intensive, including physical soil collection and subsequent laboratory tests. Recent technological breakthroughs, however, have brought novel alternatives to speed up and improve this process.

Obtaining data from a dataset for soil quality analysis offers various benefits that contribute to more informed decision-making and effective land management practices.

1. Data-Driven Insights: Dataset analysis allows for a comprehensive, data-driven understanding of soil quality. Patterns, trends, and correlations in the data can reveal valuable insights into soil characteristics and behavior.
2. Precision Agriculture: Data from a dataset enables precision agriculture by providing detailed information about specific areas within a field. This allows farmers to tailor their practices to the unique needs of different soil types, optimizing resource use and improving crop yield.
3. Timely Decision-Making: Real-time or historical data from a dataset allows for timely decision-making. Farmers can respond quickly to changes in soil conditions, implement appropriate measures, and avoid potential issues such as nutrient deficiencies or overwatering.
4. Crop Selection and Rotation: Dataset analysis allows for the identification of soil conditions suitable for different crops. Farmers can make informed decisions on crop selection and rotation based on historical data, maximizing yield and preventing soil degradation.
5. Early Detection of Issues: Monitoring soil quality through datasets facilitates the early detection of potential issues. Changes in soil composition, nutrient levels, or moisture content can be identified early, allowing for proactive measures to address problems before they significantly impact crop health.
6. Research and Innovation: Soil quality datasets contribute to ongoing research and innovation in agriculture. Researchers can use the data to develop new technologies, methodologies, and best practices for soil management, benefiting the entire agricultural community.
7. Long-Term Planning**:** Historical data from datasets supports long-term planning. Farmers and land managers can assess trends over time, make informed decisions for future seasons, and implement sustainable practices for the ongoing health of the soil.

The leveraging soil quality data from datasets enhances agricultural practices, promotes sustainability, and enables farmers to make informed decisions that lead to improved productivity and environmental stewardship.

LITERATURE SURVEY

The literature review aimed to investigate the application of Internet of Things (IoT) technology in soil quality assessment for precision agriculture. The examined research papers presented systems that utilized sensors and IoT to collect essential soil data, including moisture levels, pH, electrical conductivity, and nutrient content. The collected data was subsequently processed and presented to farmers, enabling them to access and engage with the information in a more intuitive and dynamic manner. These technological advancements offer the potential to assist farmers in making well-informed decisions regarding soil management strategies by providing real-time data and interactive visualization tools, ultimately leading to increased crop yields and the promotion of sustainable agricultural practices.

In the first paper, IoT technology was highlighted for improving agriculture by measuring specific soil properties such as moisture, temperature, humidity, pH, and nutrient content. The data was processed locally, optimizing agricultural tactics and providing trend analysis for accurate resource allocation and operational direction. The suggested IoT system included pH sensors, humidity and temperature sensors, soil moisture sensors, soil nutrient sensors probes, and a Wi-Fi-enabled microcontroller or microprocessor.

In the second paper, the focus shifted to an effective IoT-based soil nutrient monitoring and machine learning-based crop recommendation system. Various sensors assessed soil nutrients, continuously gathering data from the farm field and transferring it to a local database via a wireless sensor network (WSN). This system provided farmers with crop-related information and suggestions based on soil and meteorological parameters.

The third paper proposed an intelligent precision agriculture system using augmented reality and smart sensors. The hardware included an ESP32 microcontroller, DHT11 sensor, and load, while the software incorporated augmented reality technology through Unity Hub and the Blynk application. A deep learning algorithm was employed for sensor interface, wireless transmission, data processing, and monitoring and control, all performed locally.

In the fourth paper, the concept of computing was removed. Instead, the emphasis was on local data processing and storage. The IoT applications interfacing with devices such as sensors now rely on local resources for tasks such as data storage, processing, and transmission. This modification underscores a more self-contained and localized approach to data handling in precision agriculture using IoT technology, eliminating the reliance on external services.

EXISTING SOLUTION

The Internet of Things (IoT) is a transformative technology that connects physical devices, enabling them to collect and exchange data for improved decision-making and operational efficiency. In agriculture, the integration of IoT presents a powerful approach to soil quality analysis, revolutionizing traditional farming practices.

Farmers and agricultural experts can now harness the capabilities of IoT sensors embedded in the soil to gather real-time data on crucial parameters such as moisture levels, temperature, nutrient content, and more. This information is seamlessly transmitted to a cloud-based platform to gain insights into soil health.

One notable example is the "Precision Farming" concept leverages IoT to optimize resource usage. Sensors integrated into agricultural equipment and machinery collect data on soil conditions as the equipment traverses the field. This real-time information, empowers farmers to make informed decisions regarding irrigation, fertilization, and crop selection.

By integrating IoT into traditional farming practices, agriculture is undergoing a transformative shift. Farmers are equipped with a wealth of real-time information and historical data. This not only maximizes crop yields but also contributes to sustainable farming practices by optimizing resource utilization and minimizing environmental impact.

The convergence of IoT and in-built datasets in agriculture is revolutionizing soil quality analysis. This technology-driven approach empowers farmers with the tools they need to make informed decisions, resulting in increased productivity, cost savings, and a more sustainable future for agriculture

PROPOSED SOLUTION

The following processes might be included in a suggested solution for soil quality analysis utilizing IoT and integrating it with existing dataset.

1. Sensor Deployment: To collect real-time data on soil quality, a network of sensors such as temperature, humidity, pH, and nutrient level sensors would be put in the soil.
2. Data Collection and Transmission: Using IoT technology, the data gathered by the sensors would be communicated to a backend database, where it would be processed and integrated with the existing dataset.
3. Soil Management Recommendations: Based on the data collected and processed, the platform may propose soil requirements such as crop recommendation, irrigation, fertilization, and crop rotation to farmers.
4. Integration and Testing: Once installed, the system should be connected with current farm management systems and fully tested to verify accuracy and dependability.
5. Using visualizing technology to construct a soil quality analysis system may considerably increase the efficiency and accuracy of soil management procedures. This technology can assist in maximizing crop yields and promote sustainable agriculture by providing farmers with real-time data and interactive visualization capabilities.

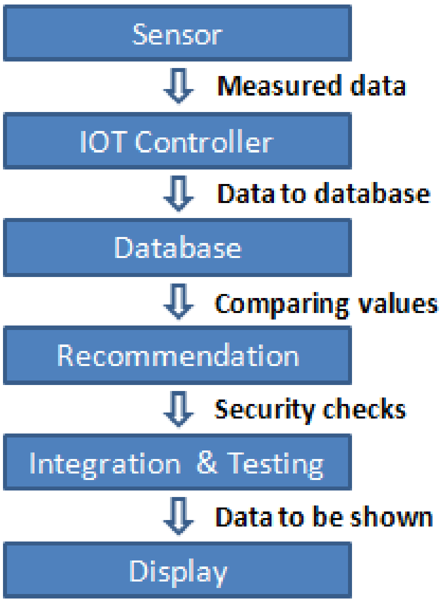

Fig 4.1 Flow of data.

This suggested approach will enable farmers to make more educated decisions regarding soil management procedures, resulting in higher crop yields and more sustainable agriculture. This system would provide farmers with real-time data and interactive visualization tools by merging IoT and Visualizing technologies, boosting the accuracy and efficiency of soil quality assessments. Analyzing soil through visualization involves a systematic process that combines real-time data collection with already existing data. This innovative method empowers farmers, environmental researchers, and land administrators to efficiently and accurately assess soil quality. Here's a simplified breakdown of how visualization can be used for soil analysis:

1. Soil data is collected using a range of sensors that specialize in detecting certain soil qualities such as moisture, pH, electrical conductivity, and nutrient concentrations.
2. The data collected by these sensors is often wiredly transferred to systems.
3. Recommendation systems compares real-time data from soil sensors with existing data into a database and provide crop recommendations to the users. Users can have an visual of the data range from the sensors along with the recommendation of the suitable crop to grow.
4. Users may make educated decisions regarding soil management procedures when they have access to easily available information via visualization. Decisions about when and where to irrigate, crop selection or the use of fertilizers or soil upgrades are examples of this.
5. Data Sharing and Management, Using a cloud-based platform, users can also share data with colleagues, experts, or other stakeholders.
6. Soil data is often securely saved in a cloud-based repository for future reference and study.
7. Long-term Evaluation, users may examine historical data over time to identify patterns and make better-educated judgments regarding soil management practices, eventually contributing to higher crop yields and more sustainable agriculture.

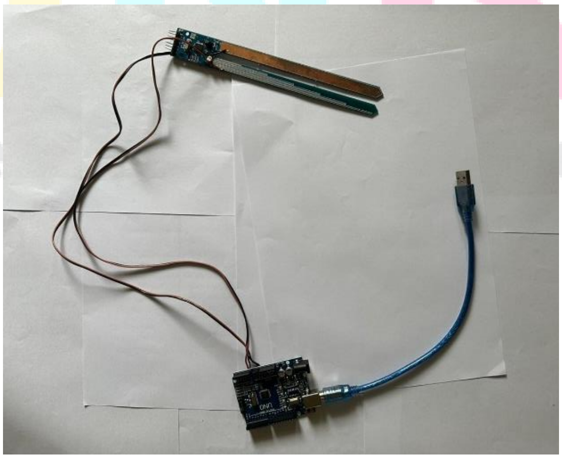

Fig 4.2 Sensor & Iot Controller.

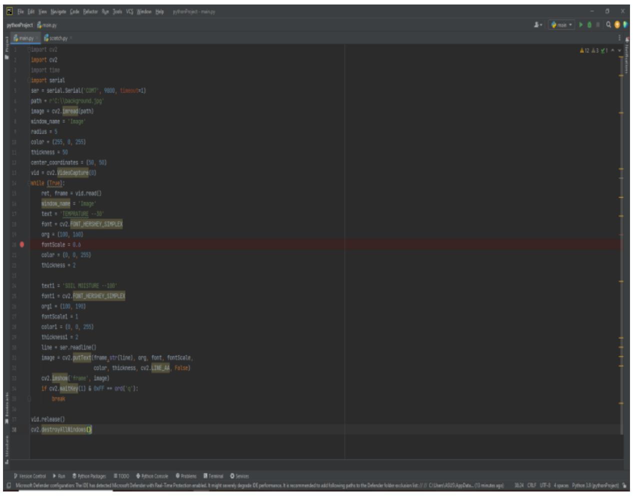

Fig 4.3 Python Implementation of sensors.

This innovative method of soil analysis promotes precision agriculture and environmental management by combining real-time sensor data with visualization capabilities, making soil quality evaluation more accessible and interactive. IoT effortlessly integrates soil parameters such as moisture levels, pH values, and nutrient concentrations into a user-friendly interface, delivering instant insights and enabling data-driven decision-making. The ability to engage with this data, along with historical analysis, enables users to make educated decisions regarding soil management methods, resulting in higher crop yields and the promotion of sustainable agriculture.

As technology advances, the use of augmented reality in soil analysis can hold enormous potential for tackling the complex difficulties confronting agriculture and environmental protection. It improves our capacity to optimize resource allocation, safeguard ecosystems, and maintain the long-term viability of this critical natural resource for future generations.

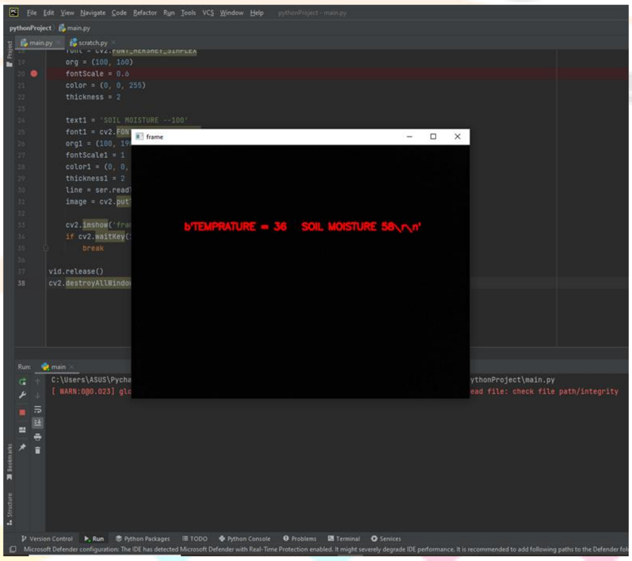

Fig 4.3 Output of the implementation

RESULT AND CONCLUSION

Finally, an IoT and visualization soil quality measurement system may considerably increase the efficiency and accuracy of soil management activities. This system may provide farmers with real-time data and interactive tools to maximize crop yields and promote sustainable agriculture by merging IoT sensors, inbuilt data processing, and visualization. The sensor module, data collection and transmission module, cloud-based platform module, visualization module, soil management recommendation module, and monitoring and optimization module all work together to create a comprehensive and user-friendly solution for soil quality analysis. Overall, this approach has the potential to transform agriculture by improving soil management methods and boosting crop yields while encouraging sustainability.

REFERENCES

1. Pandya, N., & Patel, K. (2019). IoT based smart agriculture using soil analysis and crop prediction. 2019 International Conference on Communication and Signal Processing (ICCSP). IEEE.
2. Raza, H., Shaukat, A., &Rehman, S. U. (2019). Smart farming with IoT-based soil monitoring system using machine learning. International Journal of Advanced Computer Science and Applications, 10(3), 134-141.
3. Sahu, A. K., Chakraborty, T., & Pal, S. (2019). An IoT-based smart agriculture system for soil health monitoring and crop yield prediction. International Journal of Computer Applications, 179(47), 1-6.
4. Bhatia, M., & Bhargava, S. (2020). IoT-based smart agriculture using augmented reality. International Journal of Engineering Research and Technology, 13(6), 2179-2183.
5. Mohapatra, S., &Sahoo, S. (2021). A review of IoT and machine learning-based smart agriculture systems. Computer Science Review, 39, 100335.
6. Gao, Z., Wang, X., Liu, Y., & Gao, L. (2021). A smart agriculture system based on IoT and augmented reality. 2021 IEEE International Conference on Artificial Intelligence and Computer Applications (ICAICA). IEEE.
7. B. B. P. Rao, P. Saluia, N. Sharma, A. Mittal and S. V. Sharma, "Cloud computing for Internet of Things & sensing based applications," 2012 Sixth International Conference on Sensing Technology (ICST), Kolkata, India, 2012, pp. 374-380, doi: 10.1109/ICSensT.2012.6461705.
8. M. Ulagammai and R. N. Moorthy, "An Augmented Reality based Intelligent Precision Agriculture using Cascade Advancement Technique," 2023 7th International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India, 2023, pp. 303-307, doi: 10.1109/ICOEI56765.2023.10125750.