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IOT-BASED SOIL EROSION MONITORING AND SOIL NUTRITION SUPPLY SYSTEM

Vedanti Deshmukh[*1], Aarchi Bamore[*2], Chanchal Rathi[*3], Mayuri Popat[*4], Ms. Sneha N Kherde[*5]

[*1,2,3,4]Research Scholars, Department of Electronics And Telecommunication Engineering Sipna College Of Engineering And Technology Amravati, India

[*5]Associate Professor, Department of Electronics And Telecommunication Engineering Sipna College Of Engineering And Technology Amravati, India

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ABSTRACT

Soil erosion is one the most serious environmental issues that has direct effects on agricultural productivity and soil quality. Conventional methods of soil management are not adequate to cater to the dynamic condition of soil degradation, and thus, unsustainable farming and economic losses occur. This study suggests a sophisticated IoT-based Soil Erosion Monitoring and Soil Nutrition Supply System that combines cutting-edge sensor technology with automated control. The system utilizes pH sensors, controlled by a NodeMCU microcontroller. Data is gathered in real- time, processed, and utilized to maximize irrigation and provision of nutrients through automated pumps and relays.

In addition, the system sends information to a cloud platform, providing remote monitoring and management features. This enables farmers to make decisions, minimize water loss, and maintain adequate soil nutrition levels.The scalability of the system ensures that it can be used in small and large agricultural fields. Through the prevention of soil erosion and soil fertility, the system promotes sustainable agriculture, which in turn leads to enhanced food security and environmental protection.

Keywords: Soil Erosion Prevention, Agriculture Phytoremediation, Iot-Based Soil Monitoring, Automated Fertilization, Sensor-Based Soil Analysis, Remote Farming Technology, Renewable Energy In Agriculture.

I. INTRODUCTION

Soil erosion is perhaps the most serious environmental problem confronting contemporary agriculture. If causes the loss of fertile topsoil, lowering soil fertility and leading to decreased crop yield. Water runoff, wind and poor agricultural methods are primarily responsible for soil erosion .Furthermore, incorrect irrigation, soil exposure and overuse of fertilizers intensity the problem. Stopping soil erosion needs an intensive system of monitoring and management in order to have sustainable land use. Technological advancements, especially the Internet of Things (IoT), have made it possible to create new solution for agricultural problems. IoT-based systems provide real-time data acquisition, analysis and decision-making. Through sensors and automated controls, farmers can track soil conditions and implement precise interventions to avoid soil erosion and ensure soil health .This research presents a Soil Erosion Monitoring and Soil Nutrition Supply System based on IoT for round-the-clock soil health monitoring .The system supports automated irrigation and nutrients delivery with sensor input to minimize water losses and achieve soil optimality .Real-time data is available on a cloud-based platform, and farmers are supplied with actionable data for successful soil management. Based on this solution, the study seeks to eliminate soil degradation, increase agricultural production, and improve sustainable farming techniques.

II. LITERATURE SURVEY

Several researches have investigated the implementation of IoT in precision agriculture to find solutions to soil health, water management, and nutrient supply problems .IoT systems furnished with soil moisture sensors, pH sensors, and temperature sensors have shown considerable improvements in agricultural productivity through resource maximization Smith(2020) conducted a study highlighting the advantages of smart irrigation systems, which save water by monitoring soil moisture levels in real time [1] . In the same manner ,Kumar and Sharma(2019) proposed nutrient management systems based on IoT sensors to regulate soil nutrition levels

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for balanced inputs, leading to improved crop yield. Lee (2021) proposed a soil erosion monitoring system using sensor networks, highlighting the importance of continuous soil quality assessment. While this approach effectively detected erosion patterns, it lacked integration with automated nutrient supply systems [3]. Patel and Gupta (2023) extended this research by integrating sensor data with automated pumps and relay systems for efficient water and nutrient management [4].

This study builds upon previous research by developing an integrated system that combines soil erosion monitoring with automated soil nutrition management. By providing real-time data, remote monitoring, and automated interventions, the proposed system offers a more holistic and sustainable solution for soil conservation and agricultural productivity.

III. METHODOLOGY

The proposed system consists of hardware and software components that work together to monitor soil conditions and manage irrigation and nutrient supply. The main components include:

- **NodeMCU Microcontroller:** Serves as the central control unit for data processing and decision-making.

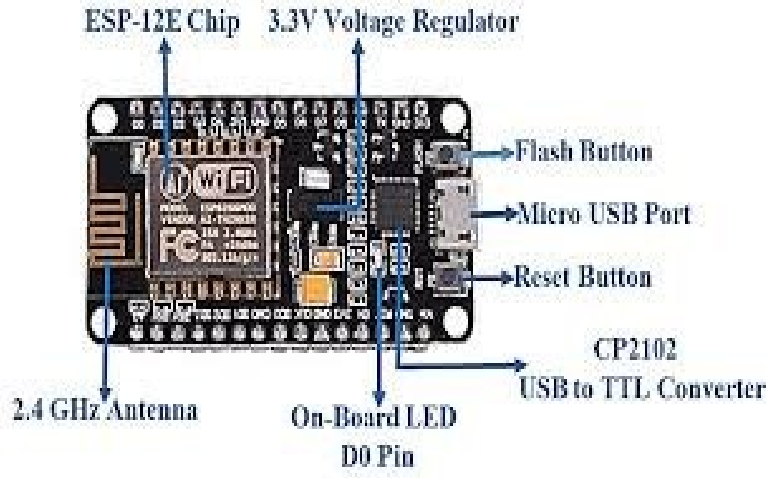

Fig 1: NodeMCU Microcontroller

- **Soil Moisture Sensors:** Measure the water content in the soil to determine irrigation needs.

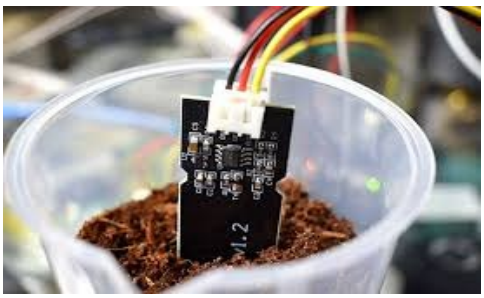

Fig 2: Soil Moisture Sensor

- **pH Sensors:** Monitor soil acidity levels to ensure balanced nutrient supply.

Fig 3: pH Sensors

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- **DHT11 Sensors:** Collect temperature and humidity data for environmental analysis.

Fig 4: DHT11 Sensors

- **Soil Erosion Sensors:** Detect soil displacement and erosion patterns.

Fig 5: Soil Erosion Sensor

- **Pump and Relay System:** Automates water and nutrient delivery based on sensor data.

Fig 6: Pump

Fig 7: Relay

IV. WORKING PROCESS

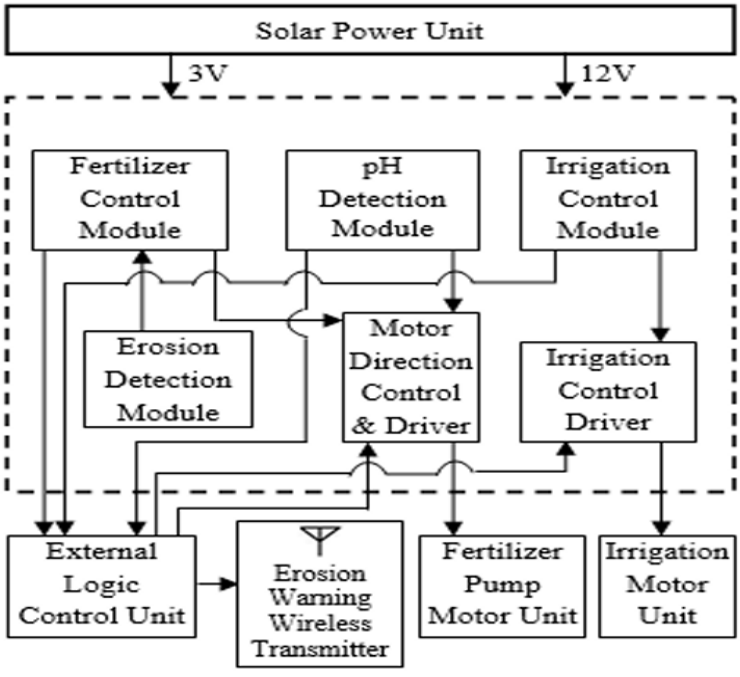

Fig 6.3 Block diagram of the system with the designed IC

1. Data Collection :

Sensors collect real-time data of soil moisture, pH, temperature , humidity, and erosion levels.

2. Data Transmission :

The information is sent to the NodeMCU microcontroller for processing.

3. Analysis and Decision-Making :

The system compares sensor readings with pre-defined threshold values. If soil moisture is low, the pump is turned on to irrigate the soil. If pH levels are unbalanced , nutrients are added.

4. Cloud Integration :

Information is uploaded onto a cloud platform for remote viewing and monitoring.

5. User Interface:

Planters are able to see live soil data and receive notifications via a mobile or web

Application.

This method provides effective utilization of resources, avoids erosion of soil, and preserves soil health for maximum agricultural productivity.

Advantages:

1. Water and Nutrient Conservation: Automated irrigation and fertilization reduce water loss and over-fertilization.
2. Real-Time Monitoring : Round-the-clock soil data collection allows rapid decision-making.
3. Low Soil Erosion : Effective management of soil moisture minimizes the risk of erosion.
4. Enhanced Productivity : Healthy soil increases crops yields.
5. Remote Accessibility: Farmers are able to access soil health from any location via a mobile app.

Disadvantages:

1. Initial Cost: Installation of IoT-based systems entails a higher initial cost.
2. Internet Dependence: Permanent connectivity to the internet is vital for remote monitoring.
3. Sensor Maintenance: Ongoing calibration and maintenance are needed to ensure precise data.
4. Power Consumption: Sensor and pump activity is powered by electricity, which could be a factor in remote locations.

V. CONCLUSION

Soil Erosion Monitoring and Soil Nutrition Supply System utilizing IoT provides end-to-end solution against soil erosion. Sensors, automation and cloud-based data storage facilitate the system to maximize irrigation and nutrient supply. Monitoring in real-time enables farmers to take necessary decisions, minimizing wastage of resources and ensuring sustainable agriculture. Scalability and flexibility make the system highly promising for revolutionizing soil management in various agricultural environments.

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