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KRISHIMITHRA

Dhanush A Nayaka[1], Vithun V[2], Nevil Sebastian[3], Prof. Geetha.V[4]

[1,2,3]UG Scholars, Dept. of ECE, *Sambhram Institute of Technology, Bengaluru-97*

[4]Asst. Professor, Dept. of ECE, *Sambhram Institute of Technology, Bengaluru-97*

nayakadhanush07@gmail.com

ABSTRACT

The Remote monitoring of soil parameters is an emerging trend which has the potential to transform agricultural practices and increase productivity. pH value, temperature and moisture content of soil are the basic parameters which help in characterizing the soil and therefore in taking proper decisions regarding fertilizer application and choice of crops sown. In this work, antimony electrode is used for pH measurement. For soil moisture content estimation, the inverse relation between soil resistance and soil moisture has been utilized and corresponding circuitry has been developed. The determination of soil temperature is done using the DS18B20 sensor working on the Dallas one wire protocol. The system is integrated with Bluetooth for the transfer of data to a nearby cell phone. The entire system is developed on STM32 Nucleo platform.

Keyword: 1. *Remote monitoring, Soil parameters, Antimony electrode, Internet of Things, Smart agriculture.*

I INTRODUCTION

The Internet of Things (IoT) has revolutionized the way we interact with the world around us. It enables communication and interaction between objects that were previously isolated and disconnected. Today, the IoT has permeated many domains, opening up new opportunities for innovation and growth. One such domain that has attracted a lot of attention is precision agriculture. Farmers are constantly looking for ways to maximize yields, reduce spoilage, and minimize operating costs. By leveraging IoT-based infrastructure, farmers can collect and analyse real-time data to make data-driven decisions and optimize their agricultural practices. This approach can help farmers achieve high profits while minimizing input costs and reducing environmental impact.

Soil moisture, temperature, and pH are key parameters that affect plant growth and, in turn, agricultural production. However, conventional methods of measuring these parameters are often time-consuming and inefficient. Real-time monitoring of these parameters using IoT-based sensors can provide farmers with crucial information that can help them optimize irrigation management and fertilizer application, resulting in higher crop yields. Advances in sensor technology have made it possible to measure soil moisture, temperature, and pH accurately and in real-time. With the help of IoT-based infrastructure, farmers can leverage this data to make informed decisions and improve their overall agricultural practices.

II LITERATURE SURVEY

In "P. Reddel, G. D. Bowen, and A. D. Robson" The effects of soil temperatures between 15 and 30°C on plant growth, nodulation and nitrogen fixation in seedlings of Casuarina cunninghamiana Miq. inoculated with Frankia from two different sources were examined. The optimum soil temperature for the growth of plants dependent on symbiotic nitrogen fixation was 25°C. Decreasing the soil temperature below 25°C markedly decreased plant growth that was reliant on symbiotically fixed nitrogen; effects on the growth of plants supplied with mineral nitrogen were much smaller. At 15°C there was no response in plant growth to inoculation after 148 d, whereas plants supplied with nitrogenous fertilizer were 10 times the weight of uninoculated plants.Nodulation was delayed at 15 and 20°C with nodules formed at 15°C fixing no nitrogen in these studies. The production of fewer nodules at 20°C than at 25°C was partly compensated by the production of larger nodules. Nodule growth at 20 to 30°C was a prime determinant of nitrogen fixed, with the exception of one Frankia at 20°C. The absence of nitrogen fixation at 15°C would be expected to limit the natural distribution of Casuarina species reliant on symbiotically fixed nitrogen to areas where soil temperatures exceed 15°C for a major part of the potential growing season [1].

In "Gerald O. Barney" The Summary Report focuses on the Global 2000 Study, particularly noting the issues on the environment, population, and natural resources.

The book first offers information on the findings and conclusions of the study and environment projections. Topics include water, energy, and forestry projections and the environment; climate changes and the environment; and gross national product (GNP) projections and the environment. The manuscript then examines the "Government's Global Model," including the analysis of the foundation, interpretation of projections, and strengthening the foundation.

The text examines the elements of the ""Government's Global Model."" These include population, GNP, climate, technology, food, fisheries, forestry, water, energy, and fuel minerals. The book also surveys some of the studies and task forces whose findings might be helpful to those trying to provide methods and instructions in support of decision-making for international efforts in population, resources, and the environment. The manuscript will surely serve readers interested in the study of international efforts on population, resources, and the environment.

In "G. Vellidis, M. Tucker, C. Perry, C. Kvien, and C. Bednarz " A prototype real-time, smart sensor array for measuring soil moisture and soil temperature that uses off-the-shelf components was developed and evaluated for scheduling irrigation in cotton. The array consists of a centrally located receiver connected to a laptop computer and multiple sensor nodes installed in the field. The sensor nodes consist of sensors (up to three Watermark® soil moisture sensors and up to four thermocouples), a specially designed circuit board, and a Radio Frequency IDentification (RFID) tag which transmits data to the receiver. The smart sensor array described here offers real potential for reliably monitoring spatially variable soil water status in crop fields. The relatively low cost of the system (~USD 2400 for a 20-sensor node system) allows for installation of a dense population of soil moisture sensors that can adequately represent the inherent soil variability present in fields. This paper describes the smart sensor array and testing in a cotton crop. Integration of the sensors with precision irrigation technologies will provide a closed loop irrigation system where inputs from the smart sensor array will determine timing and amounts for real-time site-specific irrigation applications.

In "S. J. Birrell and J. W. Hummel" The use of microsensors for in-field monitoring of environmental parameters is gaining interest due to their advantages over conventional sensors. Among them microsensors based on semiconductor technology offer additional advantages such as small size, robustness, low output impedance and rapid response. Besides, the technology used allows integration of circuitry and multiple sensors in the same substrate and accordingly they can be implemented in compact probes for particular applications e.g., *in situ* monitoring and/or on-line measurements. In the field of microsensors for environmental applications, Ion

Selective Field Effect Transistors (ISFETs) have a special interest. They are particularly helpful for measuring pH and other ions in small volumes and they can be integrated in compact flow cells for continuous measurements.

In "Adamchuk, V.I" Morgan, M.T.; Ess, D.R.: Within the scope of precision farming there is a need for improved methods of assessing and managing soil variability. The site-specific management of soil pH is one application that has potential benefits for crop production. However, current grid sampling and mapping techniques to estimate lime requirement may not be adequate. For this reason, an automated soil sampling system for measuring soil pH on-the-go has been created. The system includes a computer-operated soil sampling mechanism mounted in a shank, a global positioning unit, and a pH meter with a flat surface electrode. The system measures soil pH directly on a sample. The automated soil sampling system can determine pH while taking soil samples at a selected depth (0-20 cm) every 8 s. A simple linear regression was used to calibrate the electrode mV output against soil pH obtained via a standard laboratory method. Field testing yielded an r(2) of 0.83 and a standard error of prediction of 0.45 pH.

In "Z. W. Sim, R. Shuttleworth, M. J. Alexander, B. D. Grieve"In this paper, two compact patch antenna designs for a new application | outdoor RF energy harvesting in powering a wireless soil sensor network | are presented. The first design is a low-profile folded shorted patch antenna (FSPA), with a small ground plane and wide impedance bandwidth. The second design is a novel FSPA structure with four pairs of slot embedded into its ground plane. Performance of both antennas was first simulated using CST Microwave Studio. Antenna prototypes were then fabricated and tested in the anechoic chamber and in their actual operating environment | an outdoor field. It was found that the FSPA with slotted ground plane achieved a comparable impedance bandwidth to the flrst design, with an overall size reduction of 29%.

In "J. M. Gilbert, F. Balouchi" Wireless sensor networks (WSNs) offer an attractive solution to many environmental, security, and process monitoring problems. However, one barrier to their fuller adoption is the need to supply electrical power over extended periods of time without the need for dedicated wiring. Energy harvesting provides a potential solution to this problem in many applications. This paper reviews the characteristics and energy requirements of typical sensor network nodes, assesses a range of potential ambient energy sources, and outlines the characteristics of a wide range of energy conversion devices. It then proposes a method to compare these diverse sources and conversion mechanisms in terms of their normalized power density

III METHODOLOGY

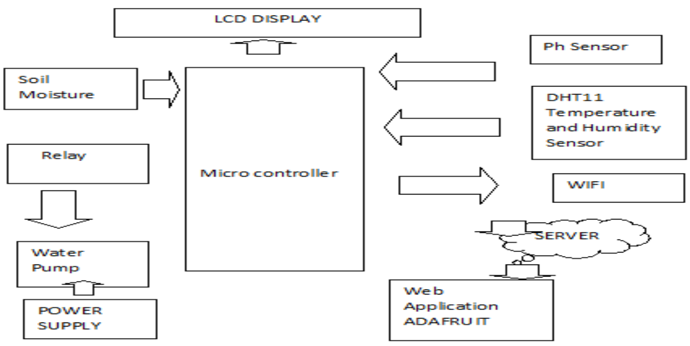

Fig.1 Block diagram of proposed system

B . System Components

- pH sensor: A pH sensor is an electronic device that measures the acidity or alkalinity of a solution. In agriculture, pH sensors are commonly used to measure the pH of soil, which is an important factor in determining the availability of nutrients to plants. The pH sensor typically consists of a glass electrode that is sensitive to changes in hydrogen ion concentration, and a reference electrode that provides a stable reference voltage.
- Soil moisture sensor: Soil moisture sensors are used to measure the amount of moisture in soil. This information is important for irrigation management, as different crops require different amounts of water at different stages of growth. Soil moisture sensors typically use either electrical or electromagnetic principles to measure soil moisture. Some sensors measure the resistance of the soil to electrical current, while others measure the dielectric constant of the soil.
- DHT11 sensor: The DHT11 is a digital temperature and humidity sensor that is commonly used in IoT applications. It consists of a capacitive humidity sensor and a thermistor for temperature measurement. The sensor is relatively inexpensive and easy to use, and can provide accurate measurements of temperature and humidity over a range of -40°C to 80°C and 20% to 90% relative humidity.
- Temperature and humidity sensor: A temperature and humidity sensor is a device that measures both temperature and humidity in the surrounding environment. These sensors are commonly used in applications where environmental conditions need to be monitored and controlled, such as in greenhouses or HVAC systems. They typically use either capacitive or resistive sensing elements to measure temperature and humidity, and can provide accurate measurements over a range of temperatures and humidity levels.
- LCD Display: An LCD (liquid crystal display) is a display module commonly used to show information such as sensor readings or system status. It is a low-power device that displays text and/or graphical information on a screen using liquid crystal technology.

- Relay: A relay is an electrically operated switch that can be used to control high-power devices with a low-power signal. It uses an electromagnet to mechanically switch a circuit on or off.
- Water Pump: A water pump is a device used to move water from one place to another. It can be used to provide water to crops or other plants, as well as for other applications such as irrigation or cooling systems.
- Power Supply: A power supply is a device that converts AC (alternating current) power to DC (direct current) power. It is used to provide a stable and reliable source of power for electronic devices
- ESP WiFi Module: An ESP WiFi module is a small, low-power device that provides wireless connectivity to a microcontroller or other device. It uses the WiFi protocol to connect to a wireless network and can be used to transmit data or control other devices.
- Arduino Uno: The Arduino Uno is a microcontroller board that is commonly used in DIY electronics projects. It is based on the ATmega328P microcontroller and provides a set of digital and analog input/output pins that can be used to control other devices or read sensor data.

- Web Application (Adafruit IO): Adafruit IO is a web-based platform that provides a set of tools and services for creating Internet of Things (IoT) applications. It includes features such as data logging, dashboard creation, and integration with other services, and can be used to create web-based applications that interact with sensors and other devices.

IV CONCLUSION

In conclusion, the ML-based formalin ascertain model for fruits is a promising tool for detecting formalin contamination in fruits. The model uses machine learning algorithms to analyze spectral data and predict the presence of formalin in fruits. This approach is faster, more accurate, and less expensive than traditional methods, which typically involve laboratory testing. By providing a rapid and reliable means of detecting formalin contamination, the model can help prevent the consumption of contaminated fruits and protect public health. However, further research is needed to optimize the model's accuracy and applicability to different types of fruits and environmental conditions. With continued development and refinement, the ML-based formalin ascertain model has the potential to become a valuable tool for ensuring food safety and quality in the fruit industry.

V. ADVANTAGES AND DISADVANTAGES

Advantages

- Real-time monitoring: IoT-based soil monitoring provides real-time data on soil characteristics, allowing farmers to make informed decisions about crop management practices.
- Improved efficiency: By leveraging technology, farmers can optimize their irrigation, fertilization, and other crop management practices, leading to improved efficiency and reduced costs.
- Environmental benefits: By using IoT-based monitoring, farmers can reduce their environmental impact by minimizing water usage, fertilizer use, and other inputs.
- Scalability: IoT-based monitoring can be easily scaled up or down depending on the size of the farm, making it suitable for both small and large operations.
- Accessibility: IoT-based monitoring can be accessed remotely, allowing farmers to monitor their fields from anywhere, at any time.

Disadvantages

- Cost: The initial cost of setting up an IoT-based monitoring system can be high, which may be a barrier for small-scale farmers.
- Technical expertise: Setting up and maintaining an IoT-based monitoring system requires technical expertise, which may not be available to all farmers.
- Data security: The use of cloud-based storage for sensor data raises concerns about data security and privacy.
- Connectivity: IoT-based monitoring relies on stable connectivity, which may not be available in all locations.
- Reliability: IoT-based monitoring systems are susceptible to technical failures, which may result in loss of data or inaccurate readings

VI. APPLICATIONS

- The applications of IoT-based soil characteristic monitoring are numerous and diverse. Some of the most important ones include:
- Precision agriculture: IoT-based soil monitoring enables precision agriculture, where farmers can tailor crop management practices to the specific needs of their fields. By collecting real-time data on soil characteristics, farmers can optimize irrigation, fertilization, and other inputs, leading to increased yields and reduced environmental impact.
- Environmental monitoring: IoT-based soil monitoring can also be used to monitor environmental conditions in agricultural areas, including soil quality, water quality, and air quality. This data can be used to identify potential environmental issues and develop strategies to mitigate them.
- Smart irrigation: IoT-based soil monitoring can be used to optimize irrigation, reducing water usage and minimizing the environmental impact of agriculture. By collecting real-time data on soil moisture levels, farmers can determine when to irrigate and how much water to apply, leading to more efficient water use.
- Crop quality monitoring: IoT-based soil monitoring can be used to monitor the quality of crops, including nutrient levels, pH levels, and other factors that affect crop health. This information can be used to improve crop quality and yield.
- Disease detection: IoT-based soil monitoring can be used to detect diseases in crops, allowing farmers to take timely action to prevent the spread of disease.
- Research: IoT-based soil monitoring can also be used in research applications, including the study of soil and plant biology, as well as the development of new agricultural technologies and practices.

VII. FUTURE SCOPE

In this project, the focus is on developing an IoT-based system for soil pH, temperature, and moisture measurement. The system is designed to provide accurate and real-time data on these soil characteristics, which can be used by farmers to make informed decisions about irrigation, fertilization, and other crop management practices.

To achieve this goal, the project team has developed sensor designs for pH, temperature, and moisture, which have been successfully implemented and tested with minimal error. These sensors are integrated into an STM32 board, which serves as the microcontroller for the system. The STM32 board is connected to a Bluetooth module, which enables communication with the farmer's smartphone.

The use of Bluetooth for communication provides a convenient and cost-effective solution for data transfer, as it eliminates the need for additional networking hardware. However, the project team recognizes that there may be scenarios where Bluetooth may not be the most suitable communication protocol. As a result, further work is underway to integrate 6LoWPAN for networking.

In addition to the hardware components, the project team has also developed a website for uploading sensor data to the cloud. This website provides a user-friendly interface for farmers to access and analyze the data collected by the system. By leveraging the power of the cloud, farmers can gain deeper insights into their soil characteristics and make more informed decisions about crop management.

Overall, this project represents an important step towards the development of IoT-based solutions for agriculture. By providing real-time data on soil characteristics, farmers can optimize their crop management practices, leading to increased yields and reduced environmental impact.

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