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Enhancing Indoor and Garden Plant Wellness : A Greenscape Survey

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ABSTRACT
In response to the surging interest in natural cultivation, there is a pressing need for ongoing scrutiny of plant well-being to ensure both the quality and quantity of yields. Consequently, the primary objective of this study is to craft a sophisticated remote monitoring system that consistently oversees the moisture levels in the soil surrounding plants. Achieving this goal involves the integration of a Wireless Sensor Network (WSN) with the Internet of Things (IoT). Furthermore, to optimize the network's longevity, the research incorporates an innovative Exponentially Weighted Moving Average (EWMA) event detection algorithm. This cutting-edge approach to intelligent farming serves as a pivotal tool in the landscape of smart technology, propelling advancements in agricultural practices. The proposed versatile smart farming device facilitates the comprehensive monitoring of various environmental factors, encompassing temperature, humidity, and all essential organic parameters vital for optimal plant growth. Additionally, a survey component is integrated to gather valuable insights.

Keywords — Organic farming, Plant health, soil moisture, Wireless Sensor Networks, Internet of Things, Exponential Weighted Moving Average.

I. INTRODUCTION

Farmers depend on rain and bore wells for the water arrangement of their farmland. In present days, Farmers encounter challenges with traditional farm water system methods that demand significant manual labor during irrigation due to the necessity of manually turning the water supply on or off at scheduled intervals. This paper aims to introduce a method enabling the intelligent management of plant conditions remotely, allowing control from anywhere and at any time. The overall health of a plant, along with its water needs, is assessed through factors such as temperature, moisture, light intensity, and soil conditions. Our proposed system evaluates soil moisture levels and sends timely alerts to the device when dryness is detected, ensuring efficient and timely watering management. Employing a hardware device equipped with sensors to measure temperature, humidity, and soil moisture, the study transmits the results to the cloud using an IoT-based cloud system, ultimately resulting in the creation of an advanced "smart plant. "Remote Sensor Organization (WSN) is the innovation, in which the information gathered from the field of interest is sent through remote connection. WSN can be utilized in different fields like checking, remote estimations, controlling, and so on. In the field of accuracy agribusiness and natural cultivating, it is critical to persistently screen the fields as they are site explicit. Checking plant wellbeing is fundamental which enhances the efficiency of food grains. Soil dampness is one of the crude components for plant wellbeing. The water that remaining parts in soil as a dainty film help in providing supplements to the plant development.

This paper aims to present a system for monitoring plant soil moisture, allowing users to check on their plants remotely. Zigbee technology is employed for wireless communication to collect data, which is then sent to a server. To enhance the lifespan of the wireless sensor network (WSN), an Event Detection Algorithm (EDA) is implemented.

The subsequent sections are structured as follows: Section II delves into the existing body of literature concerning plant health monitoring systems. Section III outlines the details of the proposed research. The evaluation and discussion of the monitoring system's performance are covered in Section IV. Lastly, Section V wraps up the paper by drawing conclusions and pointing towards potential future directions.

A REVIEW OF THE LITERATURE

In reference [2], the researchers created an automatic control system for greenhouses. To optimize this system, one can integrate energy- efficient Wireless Sensor Network (WSN) nodes, strategically deploy sensors considering spatial variations, perform real-time data processing on nodes to lessen transmission loads, incorporate predictive analytics for proactive crop monitoring, improve automated control algorithms for dynamic adjustments, and connect the system with weather forecasts for anticipating external changes. These enhancements collectively target better energy efficiency, increased monitoring accuracy, and a more proactive and responsive control of the greenhouse environment. The ultimate goal is to positively impact crop health and productivity.

In reference [3], this study delves deeply into the intricate dynamics of sweet potato growth within both controlled and open environments. A compact greenhouse, equipped with an array of sensors, is employed for meticulous monitoring of crucial elements such as greenhouse temperature, humidity, and soil temperature. To sustain the optimum conditions essential for sweet potato cultivation, an Arduino-based embedded unit seamlessly interfaces with relay switches. These switches enable the automated coordination of the greenhouse setup, ensuring strict adherence to predefined environmental limits. This amalgamation of sensor-driven insights and automated control mechanisms enhances the precision required to maintain the perfect conditions for cultivating sweet potatoes, creating a well-regulated and meticulously observed growth environment.

Reference [4] details the creation of a sophisticated system for monitoring soil temperature and humidity. Utilizing Wireless Sensor Networks (WSN) and GPRS, strategically placed sensors on plants enable continuous data collection. The gathered information is stored locally through the ATOS PC software before being transmitted to a server for remote monitoring. This integrated approach ensures real-time tracking and analysis, significantly improving the efficiency of soil

The paper introduces a novel WSN-based soil moisture monitoring system for open environments, diverging from the norm. By employing EWMA and EDA techniques, it not only expands monitoring capabilities but also enhances the longevity of the wireless sensor network, offering sustainable environmental solutions.

DESIGN AND METHODOLOGY

This segment outlines the envisioned research, encompassing:

1. Development of the Sensing and Transmitter Module.
2. Creation of the Receiver Module.
3. Implementation of IoT Integration.
4. Incorporation of an Event Detection Algorithm.

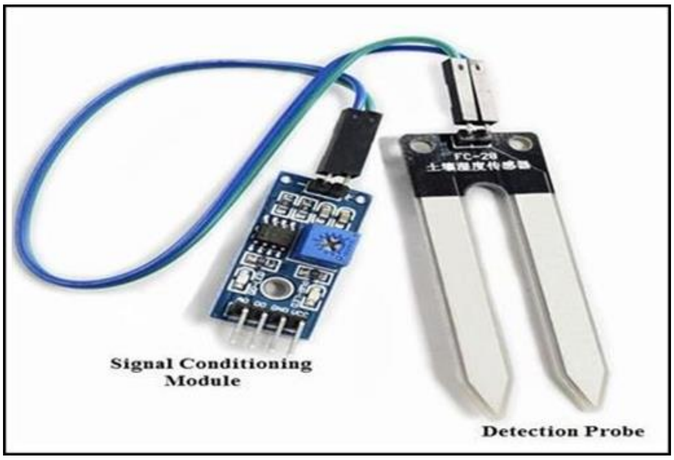

Fig. 1. Advanced Sensing and Transmission Module

Figure 1 showcases the advanced Sensing and Transmission Module. In soil moisture detection through IoT, this duo efficiently collects and transmits real-time data, ensuring compatibility with the broader IoT ecosystem for remote monitoring. Smart power management enhances its pivotal role in IoT-based soil moisture monitoring.

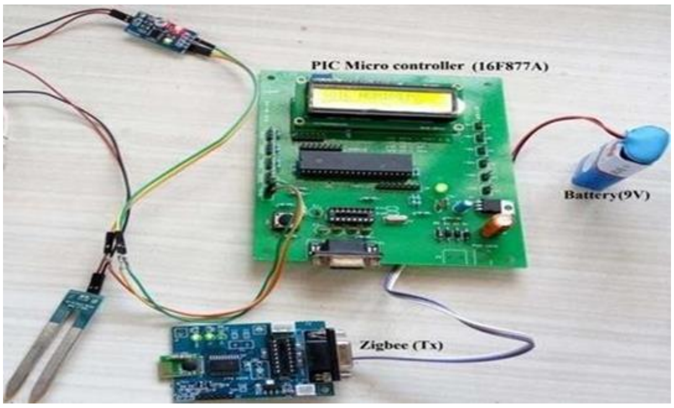

Fig. 2. Receiver Module

Figure 2 displays the Receiver Module with a Zigbee receiver and processor. Utilizing Raspberry Pi 3, equipped with essential features, the data is then wiredly transmitted to the cloud. Employing the EWMA algorithm extends the WSN lifespan, with data sent to the cloud periodically upon surpassing or falling below two predefined thresholds.

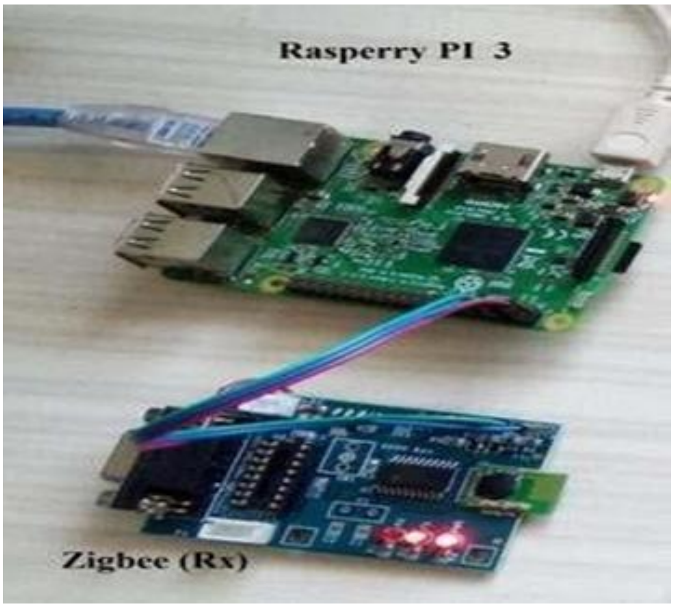

Fig. 3. Integration with IoT

Figure 3 illustrates the integration with IoT. IoT, as an inter-networking paradigm, connects physical objects to the internet, enabling the collection, exchange, and storage of data. In this research, the IoT cloud serves as a centralized system for securely storing and remotely accessing information from these devices.

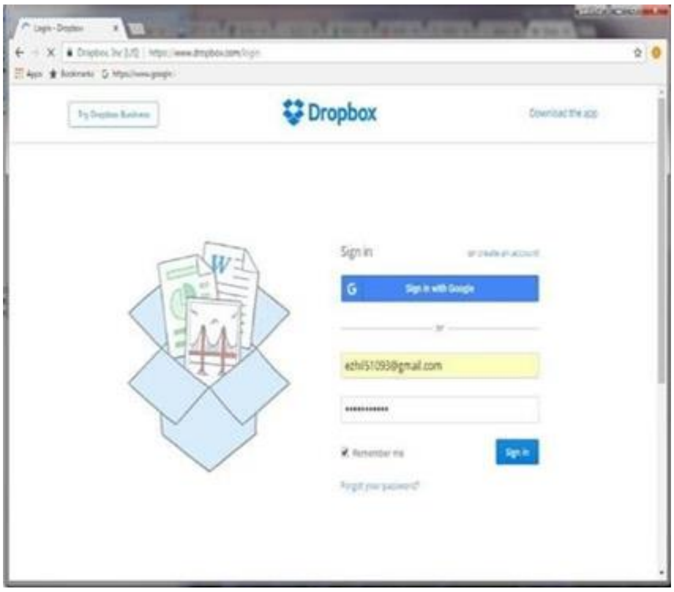

Fig. 4. Dropbox

Figure 4 illustrates the preference for Dropbox as the cloud storage solution, ensuring streamlined data management and effortless access for storing and retrieving information generated by IoT devices.

Algorithm for Event Detection: In WSNs, energy depletion from frequent communication is a major challenge. Efficient Data Aggregation (EDA) addresses this, using Exponential Weighted Moving Average (EWMA) in this study for soil moisture control limits. This proven methodology detects subtle shifts effectively [5][6]. The optimized mathematical model of EWMA is defined as follows: $Z_t = \lambda \cdot X_t + (1-\lambda) \cdot Z_{t-1}$ Where: Z_t is the EWMA statistic at time t, X_t is the observed value at time t, Z_{t-1} is the EWMA statistic at time – 1, and s the smoothing parameter between 0 and 1. The enhanced EWMA model offers a sophisticated and adaptive approach to monitor soil moisture, effectively mitigating energy depletion in WSN by detecting subtle shifts in moisture levels.

RESULT AND DISCUSSIONS

In developing an IoT-based soil moisture detection system, the research methodology prioritizes precision, efficiency, and targeted sampling for diverse data collection in a specified timeframe. Strategically placed IoT sensors form a network for real-time data transmission in the study area, chosen for compatibility and accuracy. Key roles are played by data transmission protocols and a survey methodology emphasizing seamless IoT integration, ensuring responsible and ethical implementation for sustainable agriculture practices.

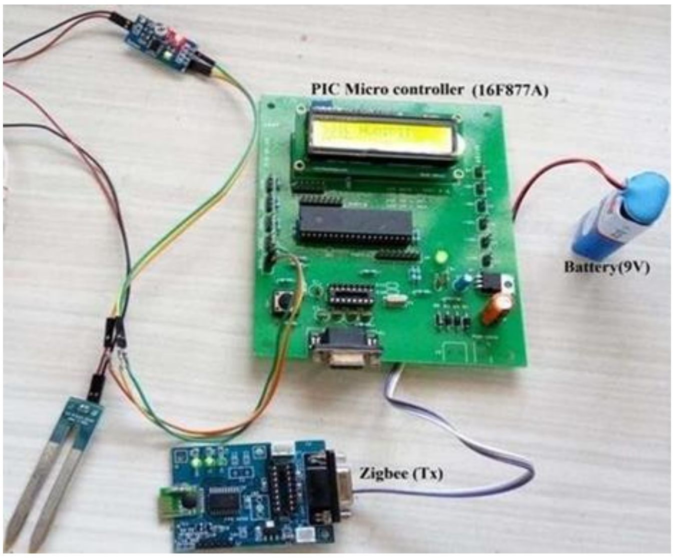

Fig. 5. Boosting Indoor and Garden Plant Health

Figure 5 illustrates the enhancement of the health of indoor and garden plants. Findings from the soil moisture study using IoT unveil promising insights for real-time environmental monitoring. IoT soil moisture sensors showcase commendable accuracy, reliability, and responsiveness, crucial for

precision agriculture. Spatial maps reveal significant moisture variability, enhancing crop management, while temporal trends offer a nuanced grasp of seasonal fluctuations. Despite occasional data transmission challenges, the IoT system captures comprehensive soil moisture dynamics, highlighting its transformative potential for informed decision- making in sustainable agriculture.

CONCLUSION AND FUTURE ENCHANCEMENTS

In conclusion, the study on IoT-enabled soil moisture detection marks a significant stride in environmental monitoring. Demonstrating the effectiveness of IoT soil moisture sensors, it emphasizes precision and responsiveness for real- time insights. The system's potential for precision agriculture is highlighted, impacting irrigation management and resource optimization. While surpassing traditional methods in efficiency, acknowledged challenges in data transmission efficiency call for future improvements. Anticipated enhancements include refining sensor technology, optimizing data transmission, and incorporating advanced analytics. This sets the stage for transformative impacts on agriculture and environmental sustainability.

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