International Journal of Research in Engineering and Applied Sciences(IJREAS)
Available online at http://euroasiapub.org/journals.php
Vol. 13 Issue 8, August -2023,
ISSN(O): 2249-3905, ISSN(P) : 2349-6525 | Impact Factor: 8.202| Thomson Reuters ID: L-5236-2015

ENHANCING AGRICULTURE WITH WIRELESS SENSOR NETWORKS AND IOT SOLUTIONS

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ABSTRACT

The use of Wireless Sensor Networks (WSNs) along with Internet of Things (IoT) solutions in contemporary agriculture is transforming the methods used for cultivating and managing crops. These technologies offer immediate and up-to-date information on the soil's moisture content, temperature, and the health of crops. This investigation's chief goal is to probe the utilisation of WSNs and IoT solutions to improve agricultural practices. This paper introduces the technologies of Active Radio Frequency Identification (RFID) and Wireless Mesh Sensor Network (WMSN) that will be employed in the field of agriculture. So, this study highlighted the significance of incorporating technology in agriculture, specifically for the purpose of enhancing production while simultaneously reducing labour expenses and water needs. This allows farmers to take well-informed decisions and maximize the use of resources. WSNs and IoT improve productivity and sustainability by automating irrigation systems and monitoring environmental conditions. This novel methodology not only enhances the quality and quantity of production but also diminishes operational expenses and environmental repercussions.

Keywords: *Agriculture; WSN; IoT; RFID; Productivity; Technology.*

INTRODUCTION

The integration of WSNs and IoT technologies inside agriculture has been motivated by the necessity to tackle diverse difficulties including climate change, limited resources, and the growing global food demand. The research in this domain has concentrated on creating and implementing sensor networks capable of monitoring essential variables like soil moisture, and temperature, humidity, and crop health in real-time (Jawad et al., 2017; Sanjeevi et al., 2020). The utilization of IoT platforms allows for the connection of these sensors, which in turn facilitates accurate and prompt interventions in farming activities. This ultimately results in improved crop management and enhanced efficiency in resource utilization (Dasig, 2020). Research has shown that the integration of WSNs and IoT can greatly improve irrigation efficiency, decrease water usage, and limit the need for fertilizers and pesticides. This, in turn, encourages the adoption of sustainable farming methods (Ojha et al., 2015). Furthermore, the progress in wireless communication technology and data analytics has enabled the incorporation of these systems into current agricultural frameworks, enhancing their accessibility and cost-efficiency for farmers (Kiani & Seyyedabbasi, 2018). The research background emphasizes the revolutionary capacity of WSNs and IoT in agriculture, enabling the development of more intelligent farming methods that can address the needs of a growing population while safeguarding environmental well-being. The subsequent section delivers an in-depth analysis of all previous literature pertaining to this specific study.

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LITERATURE REVIEW

The subsequent part delivers an in-depth analysis of all previous literature pertaining to the improvement of agriculture through the utilization of wireless sensor networks and IoT solutions.

Table 1: Related works

AUTHORS AND YEARS	METHODOLOGY	FINDINGS
Abdollahi et al., (2021)	The academic literature on agricultural WSN applications is examined in this study. Using bibliometric methods, 2444 Scopus articles were studied to determine the temporal distribution of WSN research, the most productive journals, the most cited authors, the most influential studies, and the most relevant keywords.	The keyword dynamics showed that agricultural uses WSN, IoT, Zigbee, RFID, UAV, and cloud computing. WSN collects, monitors, and analyses agricultural data, enabling precision agriculture.
Chehri et al., (2020)	Hierarchical-logic mapping and deployment techniques were presented to address random IoT deployment's low network connectivity and sensing coverage.	Improve farming practices by inspecting farm equipment and farmer experiences using IoT items to capture farm data via the Internet for smart digital agriculture. Traditional farming is limited by its inability to control all farming processes, especially in real time.
Rathinam et al., (2019)	This work used wireless sensor nodes to monitor crops. Temperature, humidity, and theft detection are possible using sensors. This boosts agricultural output.	Automatic processes reduce human effort and boost farm land development. Send farm land location using GPS. Smart agriculture uses sensors, Wi-Fi, cameras, and other equipment. All collected data is saved in memory or the cloud.

Research Gap: WSNs and IoT solutions for agriculture have made progress, yet research needs remain. No common protocols exist for combining different sensor types and IoT platforms, limiting interoperability and scalability. There is very little research on these devices' long-term endurance and maintenance in tough agricultural situations. More investigation is compulsory to conclude the economic viability and return on investment for small-scale farmers in developing regions to ensure widespread adoption of these technologies.

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METHODOLOGY

The IoT solution that is functioning on WSN embedded with RFID technology is being promoted by the remote monitoring systems. When it comes to sending data throughout the farm, the system automatically interfaces with both the hardware and the software. The solution is demonstrated to be effective, and as a result, it can be utilised as a tool for conducting proper irrigation strategies to enhance crop yields from planting to harvesting. Additionally, the nodes of the WSN are capable of collecting data in an efficient manner. A high-quality agricultural production can be ensured through the utilisation of WSNs and radio frequency identification for remote monitoring of irrigation and fertilization. The application efficiency of irrigation systems is increased by fifty percent, despite the fact that the environmental conditions are demanding. Delhi is the location of the farm where the herbaceous plants are grown, and the collaboration is created with a local farmer enterprise that manages the business. Within the context of this collaboration, research and progression of this project are made easier, and the company can boost its productivity while simultaneously lowering its operational costs.

Within the framework of this system, autonomous watering systems are established within the farm to receive data from moisture sensors that are positioned elsewhere in the field. The farm will be monitored by means of a WSN that is combined with the active RFID that is located in the field. WSN will be able to feel and monitor the environment, counting the temperature and moisture content of the soil. Active RFID's end device, which is seen in Figure below, is equipped with a sensor that is a representation of a wireless network sensor ID and operates on the Zigbee 2.4 GHz platform.

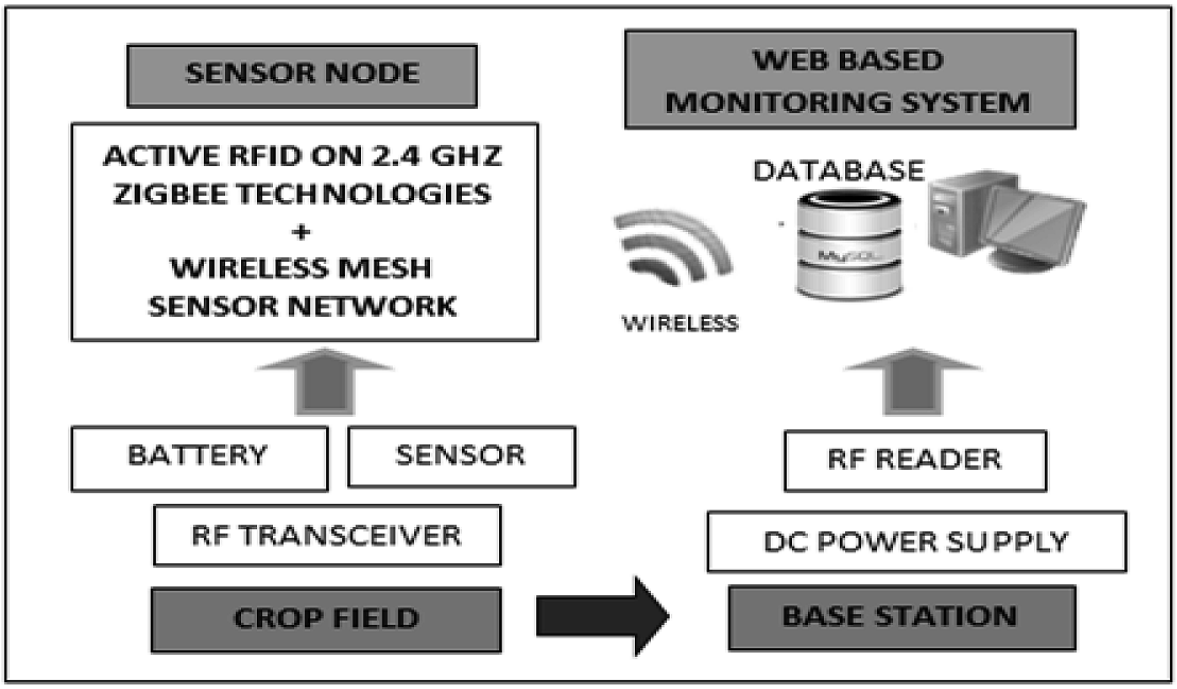

Figure 1: The reader at the base station gets ID from the sensor node

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RESULTS AND DISCUSSIONS

Within a span of five months, a comparison was carried out at two distinct locations, one of which utilised automatic irrigation while the other applied irrigation through manual means. It is possible to draw the conclusion, grounded in the data that was obtained, that implementing the proposed method on the farm has its advantages. When compared to the traditional approach, the utilisation of embedded technology has the potential to drop water consumption by about around fifty percent. When a signal is received from the moisture sensors indicating that the appropriate amount of water is present, the sprinkler will begin to deliver water. Owing to the fact that the soil is in a dry state, the sprinkler can deliver a noteworthy amount of water whenever the sensor is in the range of 0-30%. That being the case, it requires an exact quantity of water. While this is going on, the sprinkler will drop the quantity of water it takes in by fifty percent and deliver an average water amount to the soil when the sensor is in the range of thirty to seventy percent.

An enormous amount of water is conserved by this range. In the event that the moisture sensor transmits data of about 85 to 95%, the sprinkler will immediately cease the water flow. Owing to the fact that the soil is already damp, there is no requirement for the provision of water in this state. Therefore, farmers can decrease their water consumption. Because it is necessary to irrigate on a daily basis, the conventional method uses the same quantity of water each time. The over-irrigation of plants can result in their death, which in turn can have a negative impact on the production of the farm. In particular, this can have an impact on the revenue that farmers bring in because it results in the waste of water and excessive irrigation can lead to harm to the plants. In addition to this, the typical method of irrigation requires a large count of personnel because it is a laborious procedure.

CONCLUSION

In a nutshell, the approaches that are utilised in agricultural applications that are grounded in the IoT and smart sensors to boost productivity focus around accurate monitoring, real-time data analysis, and automated reactions. Farmers can obtain a thorough understanding of their operations through the utilisation of soil moisture monitors, environmental sensors, drones, and wearable animal sensors. Farming operations are further optimized through the incorporation of automated machinery and predictive analytics, which results in greater yields, decreased resource waste, and enhanced efficiency. These technologies, when combined, make it possible to move toward agriculture that is more ecologically friendly and productive, thereby meeting the ever-increasing demand for food around the world in a manner that is responsible to the environment.

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