Smart Onion Monitoring System: A Comprehensive Approach for Crop Care

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***Abstract* - Onion cultivation demands meticulous attention to environmental factors such as humidity, temperature, and gas levels for optimal growth and yield. Traditional monitoring methods are often labor-intensive and prone to errors, leading to suboptimal outcomes. To address these challenges, we present the "Smart Onion Monitoring System," an innovative solution integrating IoT technology and sensor capabilities. This system comprises a network of sensors, including humidity, temperature, and gas sensors, connected to an Arduino Uno microcontroller. These sensors continuously collect real-time data on environmental parameters, providing growers with insights into the conditions within the onion cultivation area. The collected data is displayed locally on an LCD screen and can be accessed remotely through an IoT application, enabling growers to monitor and manage their crops from anywhere. One of the key features of the system is its ability to autonomously adjust environmental conditions based on sensor data. For example, if the temperature rises above a set threshold, the system can activate a fan to cool down the environment. Similarly, if humidity levels become too high, the system can trigger a lamp to reduce moisture. This proactive approach to environmental management ensures that the onion plants are always provided with the optimal conditions for growth. By streamlining monitoring processes and enabling precise environmental control, the Smart Onion Monitoring System offers growers a reliable and efficient tool to improve crop health and maximize yields. This system represents a significant advancement in onion cultivation practices, promising to enhance productivity and sustainability in the industry.**

Keywords—Onion, Cultivation, Monitoring Process, IoT Application

I. INTRODUCTION

The cultivation of onions is a complex process that requires careful attention to various environmental factors to ensure optimal growth and yield. Among these factors, humidity, temperature, and gas levels play crucial roles in influencing plant health and productivity. However, traditional methods of monitoring these parameters have often been laborintensive and prone to errors, resulting in suboptimal outcomes for growers. In response to these challenges, we introduce the "Smart Onion Monitoring System," an innovative solution designed to revolutionize onion cultivation practices through the integration of IoT technology and advanced sensor capabilities.

At the heart of the Smart Onion Monitoring System lies a network of sensors, including humidity, temperature, and gas sensors, strategically deployed throughout the onion cultivation area. These sensors are connected to an Arduino Uno microcontroller, serving as the central hub for data collection, processing, and control. By continuously monitoring environmental conditions in real-time, the system provides growers with valuable insights into the health and status of their onion crops.

One of the key features of the Smart Onion Monitoring System is its ability to autonomously adjust environmental conditions based on sensor data. For example, if the temperature exceeds a predefined threshold, the system can activate a fan to cool down the environment and prevent heat stress on the onion plants. Similarly, if humidity levels rise beyond optimal levels, the system can trigger the activation of a lamp to reduce moisture and minimize the risk of fungal diseases.

The Smart Onion Monitoring System offers growers the convenience of remote monitoring and control through an integrated IoT application. This application allows growers to access real-time data on humidity, temperature, and gas levels from anywhere with an internet connection, providing them with greater flexibility and convenience in managing their crops. Additionally, the system enables growers to receive alerts and notifications for critical environmental conditions, empowering them to take timely action to mitigate risks and ensure the health and productivity of their onion crops.

In addition to real-time monitoring and control capabilities, the Smart Onion Monitoring System also facilitates data logging and analysis, enabling growers to track environmental trends over time and make informed decisions to optimize cultivation practices. By analyzing historical data, growers can identify patterns and trends in environmental conditions, allowing them to fine-tune their cultivation strategies and maximize yields.

The Smart Onion Monitoring System represents a significant advancement in onion cultivation practices, offering growers a reliable, efficient, and user-friendly tool to monitor and manage environmental conditions. By leveraging IoT technology and advanced sensor capabilities, the system empowers growers to optimize crop health, minimize risks, and maximize yields, ultimately contributing to the sustainability and profitability of onion cultivation operations. With its ability to provide real-time insights, remote monitoring and control capabilities, and data logging and analysis functionalities, the Smart Onion Monitoring System is poised to transform the way onions are cultivated, ushering in a new era of innovation and efficiency in the agriculture industry.

II. LITERATURE REVIEW

P. Vasanthi Kumari, M. Mythili[2021], Said to recognize the various advances that have been made in many areas through the use of new technologies, this research work presents a remote internet of things (IoT) based onion growth monitoring method using Wireless Sensor Networks and Think Speak Cloud. The proposed research work enhances the traditional approach to onion farming in rural areas with the help of internet of things and wireless sensor networks. Said to propose the development and implementation of a
thermal-based Internet of Things system within the onion farms for the purpose of controlling devices such as fan and heater according to the optimal range of onion production and good onion growth. The proposed model is implemented and validated using the simulator. The results show that the proposed method is faster and that this proposed model provides a shorter simulation time with greater efficiency.

N.K. Soundarya, Mohit Kangotra, S. Mayukha, J. Hemchander, D. Abishek, M. Saravana Mohan [2021], Said to consider traditional farming methods outdated and timeconsuming, scientists are diligently exploring new techniques to enhance plant growth and increase yields. Among these, hydroponics has emerged as a promising alternative, known for its ability to produce higher yields compared to traditional farming. Given the rising global population, there is a pressing need for increased productivity without compromising nutritional value. In India, where onions hold significant importance as a staple crop, growing them hydroponically can lead to higher yields with enhanced nutrient content. Monitoring the growth of onions in hydroponics can be facilitated through the implementation of an IoT system. By automating the system with sensors and microcontrollers, machine-to-machine communication can be established to regulate the hydroponic environment automatically. The intelligent system can adjust control actions based on various parameters, ensuring optimal conditions for onion growth. Furthermore, leveraging solar power to control water flow can reduce electricity costs and promote eco-friendliness. With the capability to discharge nutrient solutions as needed, the IoT-based hydroponic system offers users the convenience of periodic monitoring while maximizing efficiency and sustainability.

Pavan V, Riya K, Rohan R, Rathnakar Achary[2022], Said to be impacted by rapid changes in climatic conditions, onion cultivation in various regions of India, including Karnataka State, faces challenges. The objective of this research paper is to analyse the influence of volatile atmospheric factors, such as temperature and relative humidity (RH), on onion cultivation in both open and greenhouse farming environments. It aims to provide early alerts to maintain favourable conditions for optimal onion yields through the implementation of a smart farming system. This system, developed using IoT technology, monitors onion crops using various sensors. Data collected by these sensors are analysed to assess the impact of climatic parameters on onion crops and to make informed decisions regarding cultivation practices or maintaining favourable environmental conditions in greenhouses to mitigate crop losses. Additionally, the system offers early warnings to farmers regarding fluctuations in environmental factors and their effects on crops at different growth stages. Variations in these parameters can lead to undesirable conditions such as bolting, which adversely affects onion quality. The proposed smart farming system is designed to monitor environmental changes and analyse their effects in both greenhouse and open environments. Experimental results indicate that the percentage of bolting is higher in open environments compared to greenhouses, with the latter demonstrating better yields due to controlled parameters.

WSNs have evolved into one of the most dynamic technologies, serving as the bridge between the physical and virtual realms by facilitating the measurement, collection, and monitoring of environmental or physical conditions. However, with the widespread deployment of WSNs on the Internet, security and privacy risks have become paramount concerns. The objective of this paper is to address these concerns by devising a technique for anonymous communication and implementing a robust security system for WSNs. This is achieved through the integration of "Onion Routing" functionality onto sensing devices, leveraging cryptography techniques, and employing key distribution algorithms.

Juanhong Zhao, Junbin Yu, Hui Wu, Shuai Xian, Huicheng He, Jinsha Song, Yang Xiang, Jian He, JiliangMu[2023], Said to attract significant attention, the self-driven sensor based on contact-separation type triboelectric nanogenerator (CS-TENG) has been lauded for its compatibility with human gait characteristics, particularly at low frequencies. Unlike conventional CS-TENGs that rely on passive separation between two friction materials, this article introduces a novel design featuring an elastomeric driven structure to serve as a carrier for the CS-TENG. The aim is to mitigate hysteresis and enhance sensor sensitivity by promoting active separation through resilience forces. Additionally, the surface of the Eco flex film is roughened to increase its specific surface area, while the inclusion of conductive nano onion carbon (NOC) particles in the Eco flex film facilitates charge accumulation on the surface through the nano capacitance effect, further enhancing sensor sensitivity. Through material and structural optimization, the CS-TENG with the elastic driven structure (TGES) demonstrates remarkable performance characteristics, including high sensitivity (0.26 V/kPa in the range of 40–80 kPa and 0.17 V/kPa in the range of 80–530 kPa), excellent linearity (voltage $R2 = 0.993$ and 0.989, respectively), fast response time (10 MS), and durability (more than 5000 cycles). When combined with back-end circuit design and software programming, this sensor enables diverse plantar pressure monitoring applications, holding substantial practical value in medical and health-related fields.

III. METHODOLOGY

System Design and Sensor Deployment: Initiate the development process by delineating the system architecture and strategically deploying state-of-the-art sensors across the onion cultivation area to ensure comprehensive coverage of crucial environmental parameters, such as humidity, temperature, and gas levels.

Microcontroller Integration: Interface the deployed sensors with an Arduino Uno microcontroller, establishing a centralized data collection and processing unit. Implement appropriate communication protocols to facilitate seamless interaction between the sensors and the microcontroller.

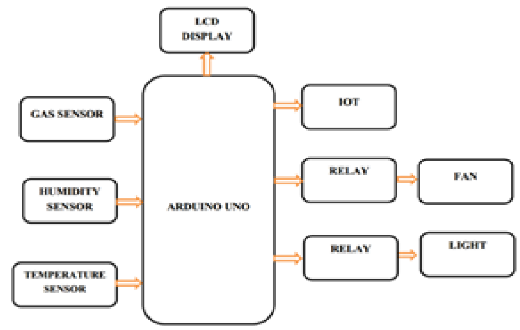

Fig 3.1 Block Diagram of Proposed System

Local Monitoring and Control: Develop software logic on the Arduino Uno to collect real-time data from the sensors and display it on an LCD display, enabling local monitoring. Implement control mechanisms to respond autonomously to abnormal conditions by activating corresponding devices, such as fans or lamps.

IoT Integration: Establish connectivity between the Arduino Uno microcontroller and an IoT application platform, utilizing cloud-based solutions such as Thing Speak. Develop an intuitive IoT application interface to enable remote monitoring and control of the onion cultivation environment, providing users with real-time updates and control capabilities.

Validation and Testing: Validate the functionality and efficacy of the Smart Onion Monitoring System through rigorous testing, including simulated tests and real-world experiments. Verify the system's ability to monitor and control environmental parameters effectively under varying conditions.

Optimization and Fine-Tuning: Continuously optimize and fine-tune the system parameters based on feedback and performance evaluations. Ensure that the Smart Onion Monitoring System operates efficiently and reliably to provide optimal conditions for healthy crop growth and yield.

IV. RESULT AND DISCUSSION

Field deployment: The Smart Onion Monitoring System was successfully implemented in onion fields, showcasing its usefulness in practical agricultural environments. Farmers gained from both local and remote monitoring options, receiving immediate notifications on environmental factors vital for onion farming. The system's automated control mechanisms reacted to unusual situations, guaranteeing optimal growth circumstances and minimizing crop damage. The IoT application's integration with the system allowed for effortless remote monitoring and control, boosting growers' ability to manage their onion cultivation environment effectively. Ultimately, the field deployment confirmed the system's extensive solution for crop care, promoting healthy onion growth and maximizing yield.

The "Smart Onion Monitoring System" introduces a significant advancement in agricultural technology, particularly for onion cultivation, by providing a comprehensive approach to environmental monitoring and control. This discussion explores the essential features and benefits of this innovative system, as well as its implications for onion growers.

Firstly, the system's incorporation of state-of-the-art sensors, including humidity, temperature, and gas sensors, enables growers to gain unparalleled insights into their cultivation environment. By continuously monitoring these critical parameters, the system empowers growers to maintain optimal conditions necessary for healthy onion growth. This level of precision allows for proactive intervention, significantly reducing the risk of crop damage due to adverse environmental conditions.

Moreover, the utilization of an Arduino Uno microcontroller as the central processing unit ensures efficient data collection and analysis. The real-time data gathered by the sensors is swiftly processed, enabling prompt decision-making and timely responses to any deviations from the desired environmental parameters. This not only enhances the overall efficiency of onion cultivation but also decreases the likelihood of yield loss due to environmental stressors.

The addition of an LCD display facilitates local monitoring and control, providing growers with immediate access to crucial information right at the cultivation site. This empowers them to make informed adjustments and optimizations as needed, thereby optimizing resource utilization and maximizing crop yield.

The "Smart Onion Monitoring System" presents a revolutionary approach to onion cultivation by addressing major challenges faced by farmers and researchers. By employing cutting-edge sensor technology, IoT connectivity, and automated control mechanisms, this system allows for real-time monitoring and management of critical environmental factors such as humidity, temperature, and gas levels.

One of the primary advantages of this system is its ability to optimize growing conditions for onions, resulting in increased crop yields and enhanced quality. The system's automation function eliminates the need for manual labor, saving farmers time and resources. Furthermore, the remote accessibility of the system provides farmers with the convenience of monitoring and controlling their onion crops from any location.

The "Smart Onion Monitoring System" also promotes costeffectiveness by optimizing the use of resources such as water and energy, thereby decreasing operational expenses. The integration of IoT technology not only enhances the efficiency of onion cultivation but also opens up opportunities for further advancements in smart farming practices.

The "Smart Onion Monitoring System" represents a significant leap forward in agricultural technology, offering a sustainable and efficient solution for onion cultivation. Its potential applications extend beyond onion farming to other crops and environmental monitoring systems, showcasing its versatility and scalability. As agriculture continues to progress, innovative solutions such as the "Smart Onion Monitoring System" will play an essential role in ensuring food security and sustainability for future generations.

Fig 3.2 Working Model of Smart Onion Monitoring System

V. COLCLUSION

The "Smart Onion Monitoring System" represents a significant leap forward in onion cultivation practices, offering growers a comprehensive and effective solution to monitor and manage environmental conditions. By integrating IoT technology and advanced sensor capabilities, the system provides real-time insights, remote monitoring and control functionalities, and data logging and analysis capabilities, empowering growers to optimize crop health, minimize risks, and maximize yields. With its ability to autonomously adjust environmental conditions based on sensor data, the system ensures that onion plants receive the optimal growing conditions required for healthy growth and development. Moreover, by facilitating remote access to critical data and control functionalities, the system offers growers greater flexibility and convenience in managing their crops, regardless of their location. Overall, the Smart Onion Monitoring System promises to revolutionize onion cultivation practices, driving innovation, efficiency, and sustainability in the agriculture industry. As growers increasingly adopt precision farming techniques, the Smart Onion Monitoring System emerges as a pivotal tool in enhancing productivity, profitability, and environmental stewardship in onion cultivation operations.

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