

# Improvement of Storage Design for Traditional Onion Storage Facility Using IOT

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**Abstract** - The agricultural sector frequently faces significant losses during the storage of perishable produce such as onions, primarily due to improper storage conditions. This paper presents a novel Smart Onion Storage System designed to enhance the longevity and quality of stored onions by employing Internet of Things (IoT) technology. The system utilizes IoT sensors to continuously monitor critical environmental parameters, specifically temperature and ethylene gas concentration, which are pivotal in dictating the storage life and quality of onions. Real-time sensor data is collected and transmitted to the ThingSpeak cloud platform, enabling remote monitoring and data analysis. Based on the sensor inputs, the system dynamically adjusts storage conditions. For instance, ventilation can be activated to reduce ethylene concentration or cooling systems adjusted according to the detected temperature. This automated, data-driven approach not only aims to reduce spoilage and economic losses but also contributes to sustainable agricultural practices by minimizing energy consumption through optimized storage management. Preliminary results indicate a significant potential in reducing wastage and enhancing the efficiency of onion storage facilities. The adoption of such IoT-based systems could revolutionize storage practices, ensuring freshness and reducing losses in the agricultural supply chain.

**Keywords:** IOT platform, Humidity Control, Temperature Control, Gas Sensor Detect, Energy Harvesting.

## I. INTRODUCTION

In the agricultural sector, post-harvest losses of fruits and vegetables are a critical challenge, impacting food security and farmers' incomes worldwide. Among these, onions, as a staple commodity with significant nutritional and economic value, are particularly vulnerable to losses due to their sensitivity to environmental conditions during storage. Effective management of storage conditions is crucial to preserve the quality and extend the shelf life of onions. This research focuses on leveraging advanced technologies to develop a

Smart Onion Storage System aimed at mitigating these losses through the use of Internet of Things (IoT) technologies.

The integration of IoT in agricultural practices, particularly in storage systems, offers a promising solution to the issues of traditional storage methods that often fail to maintain optimal conditions. IoT sensors are capable of continuously monitoring various parameters that affect onion quality, such as temperature and ethylene gas levels. Ethylene, a naturally occurring plant hormone, accelerates ripening and can lead to premature spoilage if not adequately managed. Additionally, temperature fluctuations can also significantly affect the longevity and quality of stored onions. In response to these challenges, our system employs a network of IoT sensors that measure temperature and gas concentrations at regular intervals. This data is then transmitted in real-time to the ThingSpeak cloud platform, an IoT analytics platform service that allows for the aggregation, visualization, and analysis of live data streams in the cloud. The use of ThingSpeak enables not only data storage but also facilitates the processing and triggering of actions based on the collected data. For example, automated control systems can adjust ventilation or activate cooling systems to maintain the ideal storage environment. This paper outlines the design and implementation of the Smart Onion Storage System, discusses the IoT technology and sensors used, describes the integration with the ThingSpeak platform, and analyzes the impact of this technology on reducing spoilage and maintaining the quality of onions during storage. Through this system, we aim to demonstrate how IoT can transform traditional agricultural storage practices by introducing more precise and responsive control methods, thereby reducing waste and increasing efficiency in the agricultural supply chain.

## II. LITERATURE REVIEW

1) Rathnakar Achary, Rohan R, Paper on Effect of Temperature and Relative Humidity on Onion farms and its Monitoring by using IoT Based Smart Farming System : This study's goal is to examine how atmospheric factors, such as temperature and humidity (RH), affect the growth of onions in

both open-air and greenhouse farming environments. It also aims to provide early warning systems for maintaining an environment that is conducive to improved onion yields by utilizing smart farming techniques and relative

2) Mary Johnson, Robert Brown, A Review Paper on Internet of Things enabled Onion Growth Monitoring System using Cloud: Onion farming is an essential part of agricultural activities all over the world, making a substantial contribution to both economic growth and global food security. But to maximize onion development and guarantee a plentiful crop, environmental variables like temperature, humidity, soil moisture, and light exposure need to be carefully monitored and managed. Conventional techniques for tracking onion growth frequently depend on manual observation, which can result in inefficiencies and less-than-ideal results.

3) M. Saravana Mohan, D. Abishek, J. Hemchander , Research paper on IOT Based Onion Farming Solar Powered Hydroponics Monitoring System : A paradigm shift towards more efficient and sustainable farming methods has taken place in the agriculture industry in an effort to meet the increasing worldwide need for food while reducing the impact on the environment. Hydroponic farming has become well-known among these cutting-edge techniques due to its capacity to yield premium crops with low water and space requirements. Further revolutionizing agricultural operations has been the incorporation of Internet of Things (IOT) technology, which allows for the real-time monitoring and management of many parameters essential to crop growth. Thus, the creation of an Internet of Things (IOT)-based Onion Farming Solar Powered Hydroponics Monitoring System is a state-of-the-art method to maximize onion production while utilizing renewable energy sources. The soilless farming method known as hydroponics grows plants in a nutrient-rich water solution that is supplied straight to the roots. This technique

4) Rachmat-Suwarjono, Hariyanto , Research On Utilization of IoT for Soil Moisture and Temperature Monitoring System for Onion Growth : This study investigates the application of IOT to the creation of a temperature and moisture monitoring system designed especially for onion farming. Growers are able to keep an eye on temperature fluctuations and soil moisture levels all along the onion growing cycle by incorporating Internet of Things sensors into the soil environment. With the help of these wirelessly transmitted sensors, producers may access real-time

Insights and make well-informed decisions about environmental control, nutrient management, and irrigation scheduling. Comparing IOT-based monitoring systems to conventional techniques reveals a number of benefits. First of

all, it gives growers rapid access to precise and comprehensive information regarding soil conditions, allowing for proactive measures to maximize onion yield and growth. Second, IOT sensors can be installed throughout expansive onion fields, offering thorough coverage and removing

5) Zahid Khan, Muhammad Zahid Khan Research Paper on Internet of Things-Based Smart Farming Monitoring System for Bolting Reduction in Onion Farms: For onion growers around the world, bolting the early blooming and seeding of onions presents a serious problem since it lowers bulb quality, lowers production, and causes financial losses. Conventional bolting monitoring and management techniques frequently produce less-than-ideal results since they mostly rely on historical data and manual inspection. But the development of Internet of Things (IOT) technology, which makes proactive intervention and real-time monitoring possible, presents a viable remedy for this problem. Thus, a state-of-the-art method for enhancing onion farming techniques is the creation of an Internet of Things (IOT)-based Smart Farming Monitoring System for Bolting Reduction in Onion Farms. This study examines the planning and execution of an Internet of Things-based surveillance system intended to identify and lessen onion field bolting incidents.

### III. METHODOLOGY

The methodology of this research encompasses the design and implementation of the Smart Onion Storage System utilizing IoT sensors and the ThingSpeak cloud platform. This section describes the sequential steps undertaken from system setup, data acquisition, processing, and control execution based on sensor inputs to ultimately achieve an optimized storage environment for onions.

1) System Design and Configuration the system is designed with a focus on scalability and real-time monitoring. Key components include:

- IoT Sensors: Selection and deployment of IoT sensors capable of detecting temperature and ethylene gas concentrations. These sensors are strategically placed throughout the storage facility to ensure comprehensive coverage and accurate detection of environmental variables.
- Microcontroller Units (MCUs): Utilization of MCUs (such as Arduino or Raspberry Pi or NodeMCU) for collecting data from sensors and transmitting it to the cloud.
- Network Connectivity: Establishment of a stable Wi-Fi or cellular network connection to facilitate uninterrupted data transmission to the cloud.

2) Data Transmission to ThingSpeak

- Integration with ThingSpeak: Configuration of the IoT system to send collected data to the ThingSpeak platform. This involves setting up channels on ThingSpeak for each sensor type and configuring the MCUs to push data to these channels at regular intervals.
- Real-Time Data Streaming: Implementation of a protocol for continuous data streaming, ensuring that the data visualizations and analytics on ThingSpeak are updated in real-time.

### 3) Data Analysis and Decision Making

- Analytics on ThingSpeak: Utilization of ThingSpeak’s built-in MATLAB-based analytics tools to process and analyze the incoming data. This step involves setting thresholds for temperature and ethylene levels, beyond which specific actions should be triggered.
- Algorithm Development: Development of algorithms that decide the necessary adjustments in storage conditions based on the analyzed data. These decisions are automated through programmable logic coded into the MCUs.

### 4) Actuation and Control

- Automated Control Systems: Connection of actuators to the MCUs to manage environmental conditions. For example, activation of exhaust fans or adjustment of air conditioning systems when threshold levels are exceeded.

### 5) Testing and Optimization

- Prototype Testing: Initial testing of the system in a controlled environment to validate the functionality of sensors, data transmission, and actuator response

### 6) Customized Solution for Small Scale Farmer

- The needs of small-scale onion farmers can be satisfied by custom IOT solutions that are inexpensive, scalable, and simple to use. These technologies can enable smallholder farmers to enhance their storage practices and competitiveness in the Market by giving them access to low-cost sensors, cloud-based analytics, and mobile applications.

## IV. SYSTEM DESIGN

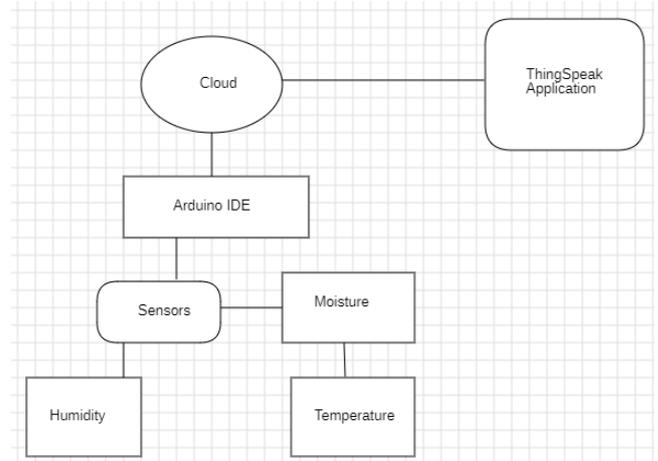


Figure 1: Data Flow Diagram

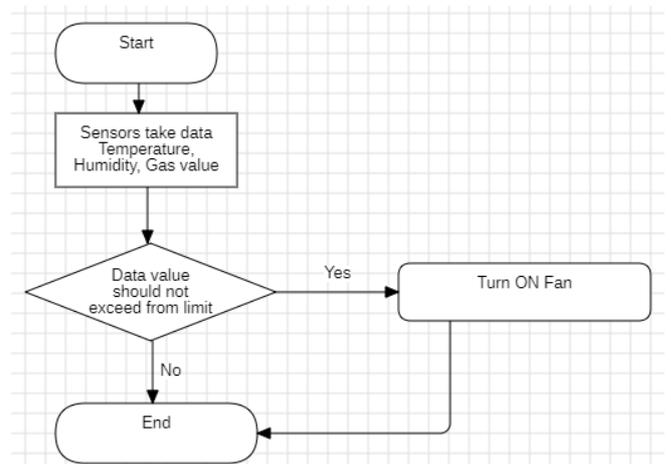


Figure 2: Flow Chart Diagram

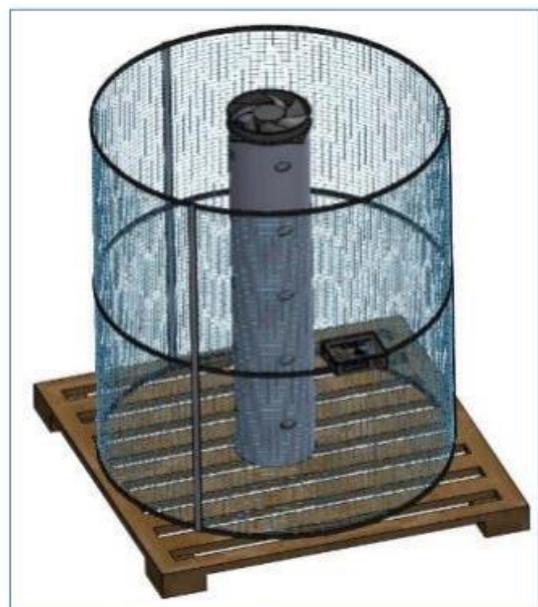


Figure 3: CAD Model



Figure 4: Prototype Model

## V. IMPLIMENTATION

**Temperature:** To maintain the quality of onions that have been preserved, ideal temperature conditions must be maintained. The recommended range for onions to be stored is between 0°C and 4°C (32°F and 39°F). By keeping an eye on the temperature, you can make sure that the storage environment stays within this range and avoid sprouting or premature decay.

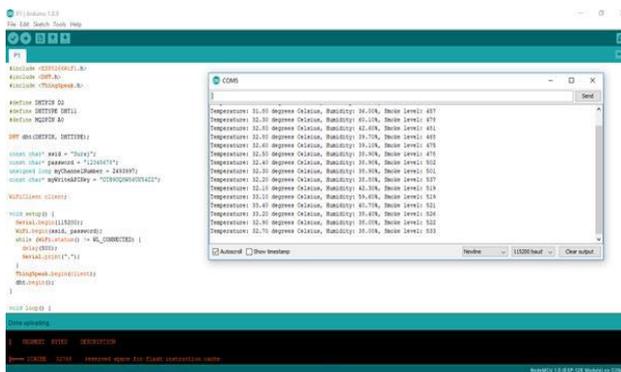


Figure 5: Representation of Data on ThingSpeak for every 20sec

**Humidity:** Controlling humidity is another important aspect in storing onions. For onions to stay crisp and flavorful and avoid dehydration, high humidity levels are necessary. For storing onions, the recommended humidity range is between

65% and 70%. Onions will shrivel and lose quality if there is too little moisture, which can result in rot and fungal growth.

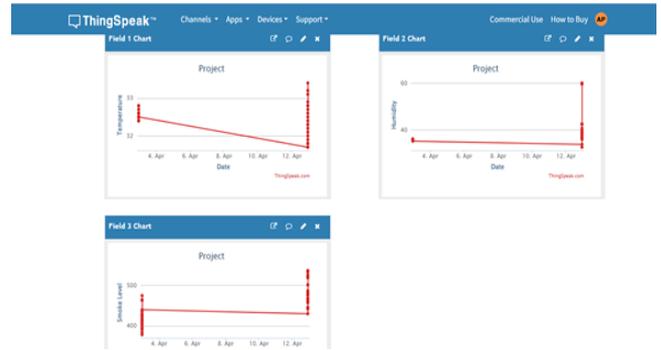


Figure 6: Graphical Representation of Data on ThingSpeak for every 20sec

**Temperature Graph:** This chart shows the changes in temperature over time within the storage facility. It sheds light on how successfully the cooling systems are preserving the ideal temperature range for storing onions.

**Humidity Graph:** This graph shows how the humidity levels within the storage facility fluctuate. By keeping the humidity within the proper range for storing onions, it helps stakeholders avoid problems like rot or dehydration

## VI. SYSREM FEATURE

Onion Storage System incorporates various features leveraging technology to optimize the storage conditions for onions

### 1) Climate Monitoring:

- Temperature Control: The system monitors and controls the storage temperature to prevent spoilage. Onions typically require cool and dry conditions for long-term storage.
- Humidity Control: Humidity levels are monitored to prevent mold growth and sprouting. The system adjusts humidity as needed.

**2) IoT-based Sensors:** The system should support various types of sensors such as temperature, humidity, soil moisture, light exposure, and ethylene gas sensors. These sensors must be compatible with the IoT platform and capable of transmitting data seamlessly.

### 3) Energy-Efficient Cooling Systems:

- Energy Management: Implements energy-efficient cooling systems to maintain the Required temperature without unnecessary energy consumption.
- Solar-Powered Options: Incorporates solar-powered solutions to reduce reliance on traditional power sources.

**4) Smart Storage Layout:** Storage Planning: Utilizes algorithms to optimize the layout of onions within the storage facility, considering factors like air circulation, temperature variations, and storage capacity.

**5) Cloud Platform Interface:** Integration with a cloud-based platform is essential for storing, processing, and analyzing sensor data. The system should be able to communicate with the cloud platform for data storage and retrieval, as well as to facilitate remote monitoring and management.

**6) Security Protocols:** Implementing robust security protocols is essential to protect sensitive farm data and prevent unauthorized access. The system should support encryption, authentication, and access control mechanisms to ensure data integrity and privacy.

**7) Scalability:** The system should be designed to scale easily to accommodate the needs of farms of varying sizes. It should support the addition of new sensors, devices, and users without significant modifications to the infrastructure.

## VII. CHALLENGES

**a) Power Supply:** It can be difficult to provide dependable power sources for Internet of Things devices, particularly in isolated or off-grid areas. It might be essential to implement energy-efficient solutions or switch to other power sources like solar or battery backup.

**b) Network Connectivity:** It might be difficult to establish dependable network connectivity in isolated or rural locations, which are frequently home to traditional onion storage facilities. For real-time monitoring and control, problems like slow internet connectivity or patchy network coverage must be fixed.

**c) Cultural and Behavioral issues:** It's critical to address cultural and behavioral issues that could have an impact on how IOT technology is adopted and used inside the company. IOT solutions can be more effectively tailored to the needs and preferences of stakeholders by taking into account factors like work habits, communication preferences, and organizational culture.

**d) Risk of System Failures:** Hardware issues, software defects, and cybersecurity breaches can all lead to IOT system failures. To ensure continuous operation, it's critical to implement redundancy measures and fail-safe systems to lessen the impact of system failures.

## VIII. CONCLUSION

In conclusion, the implementation of a Smart Onion Storage System utilizing IoT sensors and the ThingSpeak

cloud platform presents a significant advancement in agricultural storage practices. By leveraging real-time monitoring of temperature and gas levels, this system offers precise control over storage conditions, thereby extending the shelf life and preserving the quality of stored onions.

Through the integration of IoT technology, the system provides farmers and distributors with valuable insights into environmental conditions within storage facilities, enabling proactive measures to mitigate spoilage and reduce postharvest losses. The use of ThingSpeak as a cloud platform facilitates data aggregation, analysis, and remote monitoring, enhancing efficiency and accessibility in storage management.

As advancements in IoT technology continue to evolve, further research and development in smart storage systems hold the key to addressing global challenges in food preservation and distribution. The successful implementation of such systems not only benefits agricultural stakeholders but also contributes to broader societal goals of reducing food waste and promoting sustainable resource management.

## IX. FUTURE SCOPE

**1) Enhanced Data Analytics:** Growers will be able to gain deeper insights from the massive amounts of data generated by IOT sensors thanks to future developments in data analytics techniques. It is possible to improve decision-making processes, optimize resource allocation, and predict onion storage conditions by further developing machine learning algorithms and predictive analytics models.

**2) Integration of Artificial Intelligence:** Intelligent automation (AI) technologies like natural language processing and computer vision can be used to create more advanced control and monitoring systems. Algorithms driven by artificial intelligence (AI) may examine photos of onions to find disease or deterioration indicators, facilitating prompt treatment and better quality control.

**3) Block chain Technology:** Future developments could involve Food safety, traceability, and transparency can all be improved in onion storage facilities by implementing block chain technology. Block chain technology can boost consumer confidence in the quality and authenticity of onions by securely recording and exchanging information on the origins, handling procedures, and storage conditions of onions.

**4) Energy Optimization:** IOT developments in the future may concentrate on optimizing energy use in onion storage facilities. Using real-time data and demand patterns, smart energy management systems can dynamically modify the lighting, ventilation, and refrigeration systems, improving energy efficiency and reducing costs.

**5) Collaborative Platform:** To promote knowledge exchange, research cooperation, and technology adoption among onion growers, researchers, and industry stakeholders, collaborative platforms and networks can be built. These platforms can operate as focal points for the sharing of innovations, best practices, and knowledge about IOT enabled onion storage management.

## REFERENCES

- [1] Sekaran, K., M. N. Meqdad, P. Kumar, S. rajan, and S. Kadry, "Smart agriculture management system using internet of things" TELKOMNIKA (Telecommunication Computing Electronics and Control) 18, no. 03 (June 2020): 1275-1284. doi:10.12928/TELKOMNIKA.v18i3.14029
- [2] Podder, A. K., A. A. Bukhari, S. Islam, S. Mia, M. A. Mohammed, N. M. Kumar, K. Cengiz, and K. H. Abdulkareem, "IoT based smart agrotech system for verification of Urban farming parameters." Microprocessors and Microsystems 82, no. 104025 (April 2021): 01-10. doi:10.1016/j.micpro.2021.104025.
- [3] Ezirim, O. N., Okpoechi, C.U. "Community-driven Development Strategy for Sustainable Infrastructure" Journal of Human, Earth, and Future 01, no 2 (June 2020): 48-59. doi:10.28991/HEF-2020-01-02-01.
- [4] Wahyuni, S, J Hestina, I A Setiajie, and E Suryani. "Enhancing Red Onion Agribusiness Development: e-Planting Calendar and Production Allocation." IOP Conference Series: Earth and Environmental Science 653, no. 1 (February 1, 2021): 012006. doi:10.1088/1755-1315/653/1/012006.
- [5] Alfiani, A, F Haring, and E Syam'un. "Growth and Production of Red Onion (*Allium Ascalonicum* L.) with the Application of Monosodium Glutamate and Endophytic Fungi." Journal of Physics: Conference Series 1899, no. 1 (May 1, 2021): 012001. doi:10.1088/1742-6596/1899/1/012001
- [6] Gupta, S., W. A. Stirk, L. Plackova, M. G. Kulkarni, K. Dolezal and J. V. Staden, "Interactive effects of plant growth-promoting rhizobacteria and a seaweed extract on the growth and physiology of *Allium cepa* L. (onion)." Journal of Plant Physiology 262, no. 153437 (July 2021): 01-11. doi:10.1016/j.jplph.2021.153437.
- [7] Ekata Ghadage, Vibhavari Kharate, Parnika Mane, Samruddhi Pimpale," Smart Irrigation and Crop Planning System using Arduino Microcontroller", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 6, Issue 1, January 2017, DOI 10.17148/IJARCCCE.2017.6186.
- [8] Md. Tahmid Shakoor, Karishma Rahman, Sumaiya Nasrin Rayta, Amitabha Chakrabarty, "Agricultural Production Output Prediction Using Supervised Machine Learning Techniques", IEEE, 2017.

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