IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 2, March 2024

# IoT Based Onion Storage Monitoring and Automation Control System

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**Abstract:** *Onions are a staple crop globally, consumed in various culinary dishes and food products. However, their post-harvest preservation presents a significant challenge. Onions are sensitive to moisture, temperature, and humidity variations, making them prone to rot and spoilage during storage. Traditional storage methods often rely on periodic manual checks and manual intervention, which can be ineffective and resource-intensive. This project aims to address these challenges by implementing an Internet of Things (IoT) based solution that leverages moisture sensors, temperature and humidity sensors, microcontrollers, and an IoT platform to continuously monitor and regulate storage conditions, ensuring optimal onion quality and extended shelf life.*

*Onions, a fundamental and widely consumed vegetable in global culinary traditions, face significant post-harvest preservation challenges. Sensitivity to variations in storage conditions, such as temperature, humidity, and moisture levels, often leads to spoilage and a rapid decline in quality. Traditional storage methods reliant on manual monitoring prove resource-intensive, prone to human error, and lack real-time insights into the evolving storage environment. This project introduces an innovative solution, an Internet of Things (IoT)-based onion storage monitoring system, to address these challenges. The system deploys sensors to continuously collect data on storage conditions, transmitting it to a cloud-based platform for real-time analysis. The analysis identifies trends and anomalies, triggering alerts and recommendations via a user-friendly interface.*

*The anticipated outcomes of this project include enhanced onion quality, reduced spoilage, and increased resource efficiency for farmers and storage facility operators. This technology-driven approach contributes to the availability of high-quality onions in the market, serving both agricultural and culinary sectors. The IoT-based onion storage monitoring system represents a substantial step forward in post-harvest preservation, marking a promising advancement in the agriculture industry.*

**Keywords:** Onion Storage

## I. INTRODUCTION

Onions, a versatile and widely consumed vegetable, play a fundamental role in various culinary traditions and cuisines worldwide. However, their extended post-harvest preservation presents a formidable challenge. Onions are notably sensitive to variations in moisture, temperature, and humidity levels during storage. These variations can lead to rot, sprouting, and a rapid decline in quality, which is a critical concern for both farmers and consumers.

Traditional onion storage methods often rely on manual monitoring and intervention, where periodic checks are performed to assess the condition of the stored crop. These methods, although practiced for generations, have inherent limitations. They are resource-intensive, prone to human error, and may not provide real-time insights into the evolving storage environment. To address these challenges and improve the efficiency and effectiveness of onion storage, this project introduces an innovative solution: an Internet of Things (IoT)-based onion storage monitoring system.

**The IoT-Based Solution:**

The Internet of Things (IoT) offers a promising avenue for addressing the complex challenges associated with agricultural storage. By integrating sensors, microcontrollers, and data communication technologies, the IoT enables the

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creation of smart systems that can continuously monitor and control storage conditions, thereby improving the shelf life and quality of agricultural produce.

In the context of onion storage, this project explores the integration of moisture sensors, temperature and humidity sensors, microcontrollers, and an IoT platform to build an advanced monitoring and control system. This system is designed to create a conducive environment for onions during storage, effectively mitigating issues related to rot, sprouting, and spoilage.

## II. LITERATURE SURVEY AND TECHNOLOGICAL SURVEY

The success of any project relies on a comprehensive understanding of the existing knowledge and available technologies. In this section, we provide a literature and technological survey to contextualize the IoT-based onion storage monitoring system.

### 2.1 Literature Survey

- Onion Post-Harvest Challenges: Numerous studies emphasize the challenges associated with onion storage, including vulnerability to moisture, temperature fluctuations, and humidity levels. Research has highlighted the impact of these factors on onion quality and shelf life.
- Traditional Storage Methods: Literature also documents traditional storage practices, such as drying, curing, and ventilated storage rooms. These methods have been practiced for generations but are limited by their inability to provide real-time insights into the storage environment.
- IoT in Agriculture: A significant body of literature explores the applications of IoT in agriculture. IoT has been employed in monitoring soil conditions, crop growth, and pest control. However, there is limited research on its application in onion storage.
- Sensor Technologies: The literature reveals various sensor technologies used in agricultural applications. For onion storage, sensors measuring temperature, humidity, and moisture levels are crucial. These sensors can be integrated into IoT systems.
- Cloud-Based Monitoring: The adoption of cloud-based data storage and processing for agricultural monitoring has gained attention. The scalability, accessibility, and real-time capabilities of cloud platforms have advantages for onion storage.
- Data Processing and Analytics: Research has shown the importance of data processing and analytics for identifying trends and anomalies in agricultural data. Machine learning and predictive analytics can enhance the effectiveness of monitoring systems.

### 2.2 Technological Survey

- **IoT Sensors**: Various sensor types are available for monitoring environmental conditions. These include temperature sensors, humidity sensors, and moisture sensors. Advancements in sensor technology have improved accuracy and reliability.
- **Gateway Devices:** Gateways are essential for collecting data from sensors and transmitting it to the cloud. They come in various forms, such as IoT gateways and edge computing devices, and may offer features like data preprocessing.
- **Cloud Platforms:** Leading cloud service providers, such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud, offer IoT and data storage solutions. These platforms facilitate data storage, processing, and real-time analysis.
- **Data Processing Tools:** For data processing and analytics, tools like Python, R, and specialized agricultural analytics software can be used. Machine learning libraries and algorithms enable the development of predictive models.
- **User Interfaces:** User interfaces can be web-based applications or mobile apps, enabling users to access real-time data, set alerts, and receive recommendations. Development frameworks like React and Flutter are commonly used for user interface design.

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- **Communication Protocols:** IoT devices communicate using various protocols, including MQTT, CoAP, and HTTP. The choice of protocol affects data transmission efficiency and security.
- **Security Measures:** Data security is crucial in IoT applications. Technologies such as SSL/TLS encryption, device authentication, and network security protocols are employed to protect data integrity and privacy. The literature and technological survey informs the development and implementation of the IoT-based onion storage monitoring system. By leveraging existing knowledge and technologies, this project aims to address the post-harvest challenges of onions and enhance their storage management

## III. OVERVIEW OF THE PROJECT

### Aim of Project

The primary aim of this project is to design, develop, and implement an Internet of Things (IoT)-based onion storage monitoring system to revolutionize the post-harvest preservation of onions.

The project's specific objectives are as follows:

- **Real-Time Monitoring:** Create a system that continuously monitors and collects data on temperature, humidity, and moisture levels within onion storage facilities. This real-time monitoring will provide an accurate and up-to-date picture of the storage conditions.
- **Data Processing and Analysis:** Implement data processing algorithms that analyze the collected data to identify trends and anomalies. This analysis will enable the system to provide actionable insights into the onion storage environment.
- **Alerts and Recommendations:** Develop a user interface that allows farmers and other stakeholders to access real-time data, historical trends, and receive alerts and recommendations. These alerts will prompt timely interventions to address deviations from optimal storage conditions.
- **Reduction of Onion Spoilage:** The project aims to reduce onion spoilage and quality degradation by enabling proactive measures based on real-time insights. This reduction in spoilage will lead to cost savings for farmers and improved quality for consumers.
- **Resource Efficiency:** By reducing the need for manual monitoring and providing efficient insights into storage conditions, the project aims to save time and labor costs for farmers and storage facility operators.
- **Enhanced Availability of High-Quality Onions:** Ultimately, the project aims to ensure a consistent supply of high-quality onions to the market by improving post-harvest storage management.The IoT- based onion storage monitoring system will provide a technological solution to the longstanding challenges associated with onion storage. By achieving these objectives, the project aims to offer a practical and efficient tool for onion farmers, storage facility operators, and consumers to ensure the freshness and quality of stored onions, ultimately benefiting both the agricultural and culinary sectors.

### Objective

The primary objective of this project is to develop a sophisticated IoT-based system that enables continuous monitoring and control of onion storage conditions.

The system's specific objectives include:

- **Moisture Sensing:** Implementing moisture sensors to continuously monitor onion moisture levels and prevent excess moisture, which can lead to rot.
- **Temperature and Humidity Control:** Monitoring and regulating the temperature and humidity within the storage environment to ensure that they remain within the optimal range of 35°F to 40°F (approximately 1.7°C to 4.4°C) and at ideal humidity levels.
- **Real-time Data Monitoring:** Creating a system that provides real-time data to users and stakeholders, enabling remote monitoring and timely interventions.
- **Alert Mechanism:** Implementing an alert system that promptly notifies users in case of deviations from optimal storage conditions.

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- **User Interface:** Developing a user-friendly interface that allows users to visualize storage conditions and make necessary adjustments remotely.
- **Practical Demonstration:** Demonstrating the practicality and effectiveness of the system in preserving onion quality and prolonging shelf life.The subsequent sections of this project report will delve into the methodology, hardware and software components, system design, implementation details, and results, providing a comprehensive and detailed account of the IoT-based onion storage monitoring system. This system not only holds the potential to significantly reduce food waste but also to serve as a model for the application of IoT technologies in agriculture, paving the way for more efficient and sustainable farming practices.

## IV. METHODOLOGY

The methodology for the IoT-based onion storage monitoring system encompasses several key steps, from selecting the necessary hardware components to the implementation of the software and system architecture. This section provides a comprehensive overview of the project's approach.

**Hardware Component Selection:**

- **Moisture Sensors:** Choose suitable moisture sensors that can accurately measure the moisture content in the onion storage environment. These sensors should be compatible with the microcontroller of choice and provide real-time data.
- **Temperature and Humidity Sensors:** Select temperature and humidity sensors capable of monitoring and reporting environmental conditions within the desired range (35°F to 40°F and optimal humidity levels).
- **Microcontroller:** Opt for a microcontroller such as Arduino, ESP8266, or ESP32, which will serve as the central processing unit for data collection, analysis, and control.
- IoT Module: Choose an IoT module (e.g., ESP8266, ESP32, or similar) that supports Wi-Fi or cellular connectivity to enable data transmission to an IoT platform.
- **Power Supply:** Design or select an appropriate power supply system, considering factors like power efficiency and redundancy
- **Data Storage:** Determine whether data will be stored locally on the device or in the cloud, based on the project's requirements.

**Tools:**

Several tools and technologies are used in the development of the IoT-based onion storage monitoring system.

- **IoT Sensors:** Various types of sensors, such as temperature sensors, humidity sensors, and moisture sensors, are selected based on their accuracy and suitability for onion storage conditions.
- **IoT Gateway Device:** An IoT gateway device is used to collect data from sensors and transmit it to the cloud. The choice of gateway technology depends on compatibility and data transmission requirements.
- **Cloud Platform:** A cloud service, such as Amazon Web Services (AWS), Microsoft Azure, or Google Cloud, is used for data storage and processing. These platforms offer scalability and real-time capabilities.
- **Data Processing Tools:** Data processing and analysis are performed using software tools like Python, R, and machine learning libraries. These tools enable the identification of trends and anomalies.
- **User Interface Development:** Web development tools and frameworks, such as React or similar technologies, are used to create the user interface for real-time data monitoring and interaction.
- **Communication Protocols:** IoT devices communicate using various protocols, including MQTT, CoAP, or HTTP, depending on the chosen technology stack.
- **Security Measures:** Security measures, such as SSL/TLS encryption and device authentication, are implemented to ensure the privacy and integrity of data.

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**Theoretical details of topic and analysis**

**Project Specification**

- The IoT-based onion storage monitoring system is specified to have the following features and requirements.

**Sensor Deployment:**

- Multiple sensors, including temperature, humidity, and moisture sensors, will be deployed within the onion storage facility.
- Sensors should be distributed strategically to ensure comprehensive coverage of the storage environment.

**Data Collection and Transmission:**

- Sensor data will be collected and transmitted to a central gateway device.
- The gateway will aggregate the data and transmit it securely to the cloud for further processing.

**Cloud-Based Data Processing:**

- The cloud platform will perform real-time data processing and analysis using algorithms.
- The system should be capable of identifying trends and anomalies in storage conditions.

**User Interface:**

A user-friendly web-based interface will be developed, allowing users to:

- Access real-time data from sensors.
- View historical trends in storage conditions.
- Receive alerts in case of deviations from optimal parameters.
- Receive recommendations for corrective actions

**Alerts and Recommendations:**

- The system will issue alerts and recommendations when storage conditions deviate from predefined optimal parameters. Users will be able to customize alert thresholds and notification preferences.

**Integration of IoT Components:**

- The system components, including sensors, gateways, and cloud services, will be integrated to form a cohesive monitoring system.
- Compatibility and communication protocols will be standardized.

**Data Security:**

- The system will implement robust data security measures, including encryption, access control, and authentication, to protect sensitive data.

**Scalability:**

- The system should be scalable to accommodate different sizes of onion storage facilities and adapt to changing needs.

**Compatibility:**

- The system should be compatible with various sensor models and cloud platforms to offer flexibility to users.

**Ease of Use:**

- The user interface should be intuitive and user-friendly, requiring minimal training for operation.

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By adhering to these project specifications, the IoT-based onion storage monitoring system aims to provide a comprehensive and efficient solution to the challenges of onion storage, ultimately benefiting farmers, storage facility operators, and consumers alike.

**Software Configuration:**

- Microcontroller Programming: Write and upload code to the microcontroller for data collection from moisture sensors, temperature, and humidity sensors, and handling communication with the IoT module.
- IoT Platform Configuration: Set up and configure the selected IoT platform (e.g., AWS IoT, Google Cloud IoT) to receive data from the device. Define topics, subscriptions, and security settings.
- Data Visualization and Analysis: Develop software components that allow for data visualization, analysis, and alert generation based on the received data. This may include building a web or mobile application interface.

**System Architecture Design:**

Create a comprehensive system architecture diagram that illustrates the flow of data from the sensors to the microcontroller, then to the IoT module and finally to the IoT platform. This diagram should also incorporate data storage components.

**Hardware Implementation:**

Assemble the selected hardware components, including the moisture sensors, temperature, and humidity sensors, microcontroller, IoT module, and power supply. Ensure proper connections and functionality.

**Data Collection and Monitoring:**

- Calibrate the moisture sensors to ensure accurate measurements.
- Configure the system to collect data from all sensors in real-time.
- Implement data transmission protocols to send this information to the IoT platform at defined intervals.

**Alert Mechanism:**

Design and implement an alert system that can promptly notify users and stakeholders when deviations from the optimal storage conditions occur. Alerts can be sent via email, SMS, or mobile app notifications.

**User Interface Development:**

Develop a user-friendly interface for real-time data visualization and remote control. This interface should allow users to monitor storage conditions, receive alerts, and make necessary adjustments if required.

**Demonstration:**

Conduct practical demonstrations to showcase the system's effectiveness in preserving onion quality and prolonging shelf life. Collect and analyze data during these demonstrations to validate the system's performance.This methodology forms the foundation for the development and deployment of the IoT- based onion storage monitoring system. By following these steps, the project will result in a comprehensive solution that effectively addresses the challenges associated with onion storage, enhances food security, and provides a template for similar IoT applications in agriculture and food preservation.

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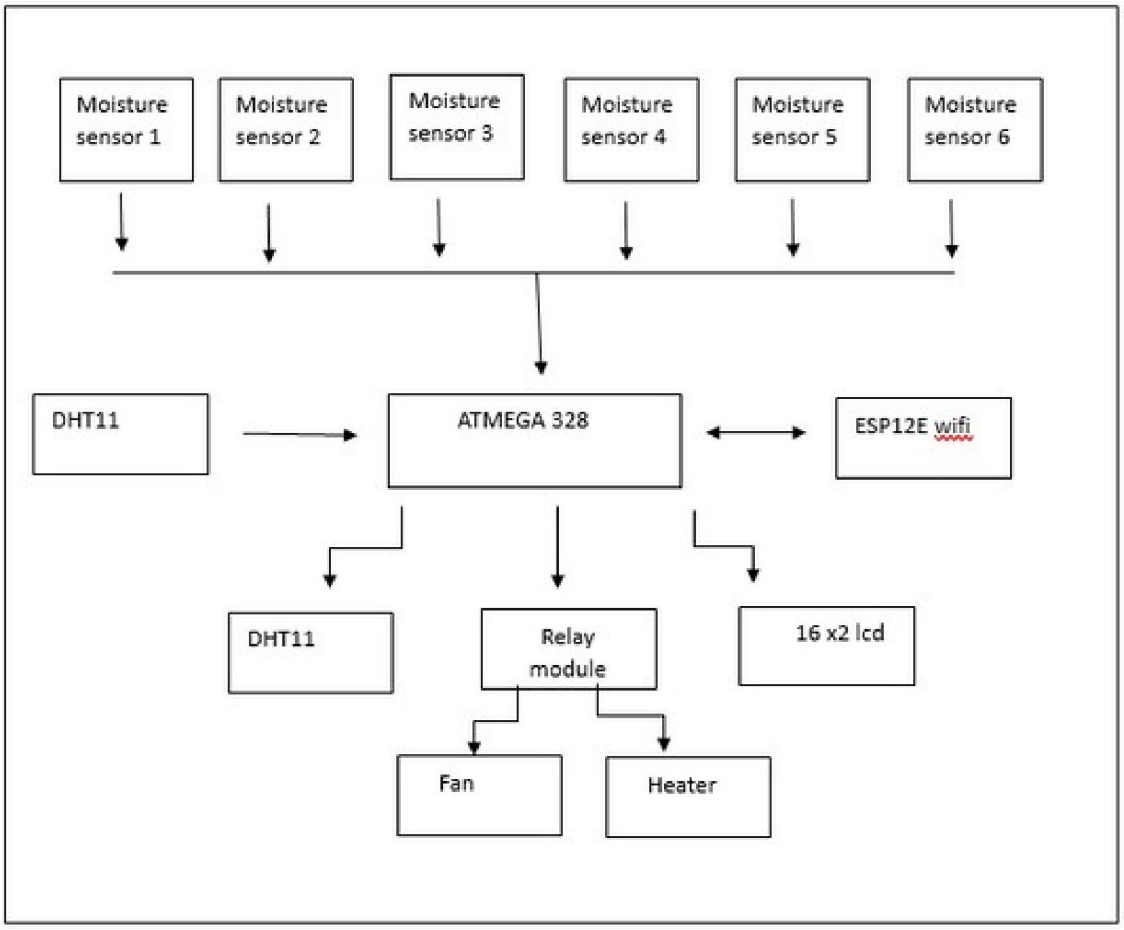
## IV. PROTOTYPE

Block diagram




**Hardware :**

1. Atmega 328
2. Capacitive moisture sensor
3. DHt11
4. 16x2 Lcd Display
5. Fan
6. 100 w lamp
7. 12v 5 amp relay
8. Esp12e wifi module
9. Pcb
10. I2c module
11. Power supply

**Software**

1. Arduino IDE
2. Google chrome
3. Easy eda
4. Protus simulation


DOI: 10.48175/IJARSCT-15726

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