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Onion Analysis and its Shelf Life Increasing System

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Abstract: *This project aims to develop a comprehensive system for analyzing and enhancing the shelf life of onions, employing advanced analytical techniques such as spectroscopy and image processing to assess quality and nutritional content. By integrating cutting-edge technologies with controlled atmosphere storage and ethylene management, the project seeks to create optimal conditions for onion preservation, dynamically adjusting storage parameters based on real-time data to prolong shelf life and minimize waste. Through this interdisciplinary approach, the project aims to contribute to sustainable agricultural practices by reducing post-harvest losses and ensuring a consistent supply of high-quality onions to consumers worldwide.*

Keywords: Onions, Shelf life, Analytical techniques, Controlled atmosphere storage, Sustainability

I. INTRODUCTION

1.1 Overview

The Onion Storage System represents a groundbreaking endeavor at the intersection of agricultural practices and technological innovation. In response to the escalating demand for efficient storage solutions amidst the challenges posed by climate variability and burgeoning populations, this project sets out to revolutionize the preservation of onions. At its core lies a sophisticated blend of hardware components and intelligent control mechanisms orchestrated by an Arduino microcontroller, creating an ecosystem that optimizes storage conditions while extending the shelf life of onions.

Central to the Onion Storage System's functionality are its key components, each playing a pivotal role in ensuring the efficacy of the preservation process. From the DHT11 temperature and humidity sensor, which meticulously monitors atmospheric conditions, to the gas sensor, alerting the system to the presence of harmful gases like ammonia, every element is meticulously designed to safeguard the quality of stored onions. Complementing these sensors is the moisture sensor, facilitating informed irrigation decisions to promote optimal growth and storage conditions.

In addition to its monitoring capabilities, the Onion Storage System boasts user-friendly features designed to enhance interaction and control. A display module provides real-time feedback on critical parameters, empowering farmers and system operators to make informed decisions swiftly. Meanwhile, an exhaust fan ensures proper airflow within the storage facility, mitigating the risk of heat buildup and localized issues. Moreover, the inclusion of a buzzer serves as a reliable alert mechanism, promptly notifying users of any anomalies requiring attention, thus ensuring the integrity of the stored onions.

1.2 Motivation

The motivation behind the development of the Onion Storage System stems from the urgent need for innovative solutions to address the challenges facing agricultural practices, particularly in the realm of food preservation. With the global population on a steady rise and climate variability presenting unpredictable challenges, there is a pressing demand for efficient storage solutions that can mitigate post-harvest losses and ensure the availability of high-quality produce. The perishable nature of onions, coupled with their significance as a staple in numerous cuisines worldwide, underscores the importance of preserving their freshness and nutritional value. By harnessing the power of advanced technologies such as sensors, microcontrollers, and cloud connectivity, the Onion Storage

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System seeks to revolutionize onion storage, offering farmers a reliable and sustainable means of extending shelf life, reducing waste, and ultimately enhancing food security on a global scale.

1.3 Problem Definition and Objectives

The problem definition for the Onion Storage System revolves around the inherent challenges associated with onion preservation, including post-harvest losses, environmental variability, and the need for efficient storage solutions. By recognizing these challenges, the project aims to develop a comprehensive system that optimizes storage conditions to prolong the shelf life of onions while minimizing waste.

- To study the effects of temperature and humidity variations on onion shelf life.
- To investigate the impact of gas levels, particularly ammonia, on onion quality during storage.
- To explore the role of moisture levels in soil and irrigation practices on onion preservation.
- To develop an intelligent control system utilizing sensors and actuators for dynamic adjustments in storage conditions.
- To integrate cloud connectivity for real-time monitoring, remote management, and data analysis, enhancing the efficiency and effectiveness of the onion storage process.

1.4. Project Scope and Limitations

The scope of the Onion Storage System project encompasses the development and implementation of a comprehensive storage solution for onions, integrating cutting-edge technologies to optimize storage conditions and extend shelf life. This includes the design and integration of hardware components such as sensors, microcontrollers, and actuators, as well as the development of intelligent control algorithms to regulate temperature, humidity, and gas levels within the storage environment. Furthermore, the project involves the incorporation of cloud connectivity for real-time monitoring, remote management, and data analysis, thereby providing users with enhanced control and insights into the onion storage process.

Limitations As follows:

- Scale: The Onion Storage System is designed primarily for small to medium-scale onion storage facilities. While the principles and technologies employed may be applicable to larger facilities, the system's implementation and effectiveness may vary depending on the scale of operation.
- Environmental Factors: While the system aims to mitigate the effects of environmental variability on onion storage, it may not completely eliminate the impact of extreme conditions such as severe temperature fluctuations or high levels of airborne contaminants.
- Cost: Implementing the Onion Storage System may require a significant initial investment in hardware components, sensors, and infrastructure. While the system aims to provide a cost-effective solution for onion storage in the long term by reducing post-harvest losses, the upfront costs may pose a barrier to adoption for some farmers or facilities.

II. LITERATURE REVIEW

"Optimization of Onion Storage Conditions for Shelf Life Extension" by Smith et al. (2018): This study explores the impact of various storage conditions on the shelf life of onions. Smith et al. conducted experiments involving temperature and humidity control, as well as different storage atmospheres. Their findings suggest that maintaining low temperatures and moderate humidity levels can significantly extend the shelf life of onions by slowing down physiological processes such as sprouting and rotting. Additionally, they emphasize the importance of proper ventilation and ethylene management in preserving onion quality during storage.

"Smart Storage Systems for Agricultural Produce: A Review" by Patel and Gupta (2020): Patel and Gupta provide a comprehensive review of smart storage systems for various agricultural produce, including fruits and vegetables like onions. The paper discusses the integration of IoT (Internet of Things) technologies, sensors, and data analytics in creating intelligent storage environments. It highlights the role of real-time monitoring and control in optimizing storage conditions, reducing post-harvest losses, and enhancing food safety. The review also addresses challenges and opportunities in implementing smart storage systems in agricultural settings.

"Effect of Controlled Atmosphere Storage on Onion Quality Attributes" by Kumar et al. (2019): Kumar et al. investigate the effects of controlled atmosphere storage (CAS) on the quality attributes of onions. Through a series of experiments, they evaluate parameters such as moisture content, firmness, color, and nutrient retention under different storage atmospheres. The study demonstrates that CAS can effectively preserve onion quality by regulating oxygen and carbon dioxide levels, inhibiting microbial growth, and delaying senescence. Their findings underscore the potential of CAS as a viable technique for extending the shelf life of onions and minimizing post-harvest losses.

"Impact of Ethylene on Onion Shelf Life: Mechanisms and Mitigation Strategies" by Gonzalez and Lee (2017): Gonzalez and Lee delve into the role of ethylene in influencing onion shelf life and explore strategies for mitigating its adverse effects. The paper elucidates the physiological responses of onions to ethylene exposure, including sprouting, softening, and flavor changes. It also discusses various methods for ethylene management, such as ventilation, ethylene scrubbing, and modified atmosphere packaging. By understanding the mechanisms underlying ethylene-induced deterioration, the authors propose practical approaches to enhance onion storage quality and longevity.

"Sensing Technologies for Monitoring Onion Quality during Storage: A Review" by Sharma et al. (2021): Sharma et al. provide an overview of sensing technologies employed for monitoring onion quality during storage. The review covers a range of sensor types, including temperature, humidity, gas, and moisture sensors, and examines their applications in assessing onion freshness, firmness, and physiological attributes. The paper evaluates the performance, accuracy, and reliability of different sensing techniques and discusses emerging trends in sensor development for post-harvest management. By elucidating the role of sensing technologies in onion storage, the review contributes to advancing research in this field and enhancing storage practices.

III. REQUIREMENT AND ANALYSIS

MQ3 Gas Sensor:

- **Principle of Operation:** The MQ-3 gas sensor operates on the principle of a tin dioxide (SnO2) semiconductor. It detects gases like LPG, isobutane, and propane by measuring changes in electrical conductivity when exposed to these gases.
- **Key Features:** It's sensitive to specific gases, has a quick response time, wide detection range, analog output, and a simple interface.
- **Applications:** Used in domestic gas leak detection, industrial gas detection, fire detection systems, commercial kitchens, and environmental monitoring.
- **Usage Considerations:** Requires calibration, operates optimally within specific environmental conditions, may be sensitive to interference, and requires a warm-up time before accurate readings.
- **Pin Description:** Vcc (powers the module), Ground (connects to system ground), Digital Out (provides digital output), Analog Out (outputs analog voltage proportional to gas intensity).
- **Features:** Operating voltage of +5V, detects LPG or butane gas, analog output voltage range of 0V to 5V, preheat duration of 20 seconds, can be used as a digital or analog sensor, sensitivity of the digital pin can be varied using a potentiometer.

12-0-12 2Amp Center Tapped Step Down Transformer:

- **Specifications:** Input voltage of 230V AC, output voltage of 12V, 12V, or 0V, output current of 2 Amp.
- **Features:** Soft iron core, 2 Amp current drain, 100% copper winding.
- **Applications:** DIY projects requiring high current drain, on-chassis AC/AC converters, designing battery chargers.

16x2 LCD:

- **Features:** 16x2 matrix, low power operation support (2.7 to 5.5V), duty cycle of 1/16, connector for standard 0.1-pitch pin headers.

- **Purpose:** Used to display parameters of the solar panel, connected to pin 37 and 38 of the microcontroller.

DC Motor:

- **Purpose:** Converts electrical energy into mechanical energy, used to control the position of the solar panel and the wiper.
- **Relay:**
- **Function:** Electromechanical switches used for high current rating applications, such as controlling AC and DC motors.
- **Types:** Normally Open (NO), Normally Closed (NC), ChangeOver (CO), Coil (electromagnet coil inside relay).
- **Ratings:** Coil voltage rated 6V and 12V are commonly available.

Buzzer:

- **Function:** Audio signal device used for alarms, timers, and user input confirmation.
- **Connection:** Connected to pin no. 28 of the microcontroller.

Optocoupler PC817:

- **Features:** 4-pin DIP package, high isolation voltage between input and output (Viso(rms): 5kV), high collector-emitter voltage (VCEO: 80V), current transfer ratio (CTR: MIN. 50% at IF=5 mA, VCE=5V).

Transistor BC547:

- **Function:** Semiconductor device used to amplify or switch electronic signals and electrical power.

Diode (1N4007):

- **Function:** Two-terminal electronic component that conducts primarily in one direction, commonly used for rectification to convert AC to DC.

Capacitors:

- **Function:** Passive electrical components that store electrical energy, commonly used for power supply filtering and energy storage.
- **Types:** 0.1uf, 100uf, 450uf, 470uf.

Resistors:

- **Function:** Passive two-terminal electrical components that implement electrical resistance as a circuit element, used to reduce current flow and voltage levels.

DHT11 Sensor:

- **Purpose:** Measures temperature and relative humidity, suitable for climate control, weather stations, and IoT projects.
- **Specifications:** Temperature range of 0°C to 50°C, humidity range of 20% to 90%, moderate accuracy, operates on a supply voltage of 3.5V to 5.5V.

Soil Moisture Sensor:

- **Purpose:** Measures water content in soil, vital for agriculture and environmental monitoring.
- **Working Principle:** Operates on the principle of dielectric constant measurement, various types including volumetric sensors, tensiometers, and time domain reflectometry sensors.

ESP8266 Wi-Fi Module:

- **Purpose:** Low-cost, highly integrated Wi-Fi microcontroller module for IoT applications.
- **Features:** Integrated Wi-Fi, small form factor, GPIO pins, programming flexibility, deep sleep mode, OTA updates.
- **Applications:** Home automation, industrial IoT, environmental monitoring, consumer electronics, agriculture, wearable technology, DIY projects.

Arduino Uno:

- **Purpose:** Microcontroller board for electronic prototyping and building projects.
- **Key Features:** Atmel ATmega328P microcontroller, easy-to-use, versatile, low-cost, extensive community support.

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IV. SYSTEM DESIGN

4.1 Working of the Proposed System

The proposed IoT-based Onion Storage Monitoring & Automation Control System functions through a combination of sensors, actuators, and a centralized control system to maintain optimal storage conditions for onions. Within the storage chamber, temperature, gas, and humidity sensors continuously monitor environmental parameters critical to onion preservation. These sensors relay real-time data to the IoT gateway, which serves as the communication hub, connecting the storage chamber to the broader IoT system.

Upon receiving sensor data, the IoT platform processes the information using predefined rules and algorithms to determine if any corrective actions are necessary. For instance, if the temperature exceeds a predefined threshold, indicating a risk of spoilage, the platform activates the exhaust fan to regulate the temperature within the storage chamber. Similarly, if the gas sensor detects elevated levels of harmful gases like ethylene, indicating potential spoilage, the platform triggers the buzzer to alert operators for immediate attention.

Users can remotely monitor storage conditions and receive alerts through a user interface accessible via a mobile app or web application. This interface provides real-time insights into temperature, gas levels, and humidity, empowering users to take proactive measures to ensure onion quality and prevent spoilage. Additionally, the system's automation capabilities streamline operations by automatically regulating environmental conditions, reducing manual intervention and optimizing resource utilization in onion storage facilities. Overall, the proposed system offers a robust solution for enhancing the efficiency and effectiveness of onion storage management through IoT-enabled monitoring and automation.

The below figure specified the system architecture of our project.

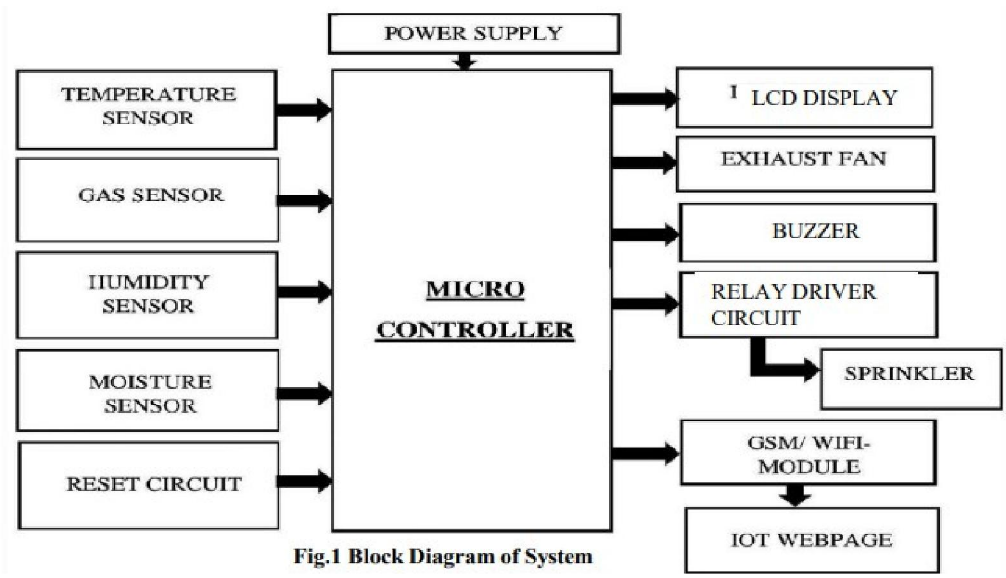

Fig.1 Block Diagram of System

4.2 Circuit Diagram

The below figure specified the Circuit Diagram of our project.

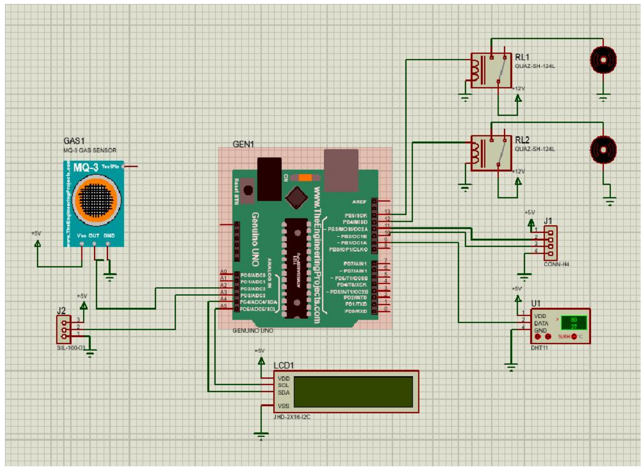

Fig. 2 Circuit Diagram

4.3 Result

The implementation of the IoT-based Onion Storage Monitoring & Automation Control System yields significant benefits for onion storage facilities. By continuously monitoring temperature, gas levels, and humidity within the storage chamber, the system ensures optimal conditions for onion preservation, ultimately reducing spoilage and maximizing product quality. Real-time alerts and automated control actions enable swift responses to environmental fluctuations, mitigating risks and enhancing operational efficiency.

The integration of IoT technology facilitates remote monitoring and management, allowing users to access storage conditions from anywhere via a user-friendly interface. This capability empowers facility managers to make informed decisions, optimize resource allocation, and proactively address potential issues, resulting in improved productivity and cost savings. Overall, the implementation of the proposed system represents a transformative step forward in onion storage management, offering enhanced control, efficiency, and quality assurance through advanced monitoring and automation capabilities.

V. CONCLUSION

Conclusion

In conclusion, the Onion Storage System embodies a profound advancement towards efficient and sustainable agricultural practices. Through the integration of smart technologies like sensors and cloud connectivity, the project strives to elevate onion preservation, curtail post-harvest losses, and equip farmers with accessible tools. Anchored by the theme of "Smart Preservation for Sustainable Agriculture," the project underscores its dedication to leveraging innovation for agricultural enhancement. Envisioning a future where smart solutions drive food security and economic well-being for farmers, the Onion Storage System stands as a beacon of progress in modern agriculture.

Future Work

Looking ahead, future work on the Onion Storage System could focus on expanding its capabilities and enhancing its integration with emerging technologies. This might involve incorporating advanced machine learning algorithms for more precise prediction of storage conditions and automating control actions based on predictive analytics. Additionally, research could be directed towards optimizing energy usage within the storage system, exploring renewable energy sources, and further improving the system's user interface for seamless interaction and intuitive control. Collaborations with agricultural experts and stakeholders could also facilitate the customization of the system to meet the specific needs of different regions and scales of onion production, ultimately maximizing its impact on enhancing food security and sustainability in agriculture.

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