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DEVELOPMENT OF WIRELESS RFID BASED SMART INVENTORY MANAGEMENT SYSTEM FOR EGGS AND MUSHROOMS

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ABSTRACT
Proposing an intelligent inventory system designed for perishable items like eggs and mushrooms. Each item is tagged with an RFID chip, and an RFID reader at the storage location tracks additions and removals. A central processing unit (Node MCU) interprets the RFID data, generates timestamps, and displays information on a small OLED screen. This data is then uploaded to a cloud storage service for further analysis. The system is powered by a lead-acid battery and features power-saving measures in the RFID system programming. For user interaction, a separate RFID reader can be used to scan items and retrieve information about them from the cloud, potentially through a web application. After rigorous testing, all components will be integrated into a permanent enclosure suitable for the desired location (indoors or outdoors). The final system will continuously monitor inventory levels and alert users of expiring products.

Keywords
RFID, Smart Inventory Management, Egg, Mushrooms, High Quality Assurance

1. INTRODUCTION

The global food supply chain faces significant challenges, particularly with perishable items like eggs and mushrooms. Traditional inventory management methods often rely on manual counting, which is prone to human error and lacks real-time data on product freshness. This can lead to stockouts, overstocking, and ultimately, food waste. This project proposes a novel solution – a smart inventory management system utilizing Radio Frequency Identification (RFID) technology to address these shortcomings and revolutionize perishable goods management.

Problem Statement: The High Cost of Inaccurate Inventory Management

Inaccurate inventory data for perishables creates a domino effect of problems. Inventory shortages result in missed revenue opportunities and dissatisfaction among customers. Conversely, overstocking perishable items increases the risk of spoilage, resulting in significant financial losses and food waste. Traditional methods, reliant on manual counting and visual inspection, are time-consuming, labor-intensive, and susceptible to human error. Additionally, they lack the ability to track product age and expiration dates in real-time, making it difficult to optimize ordering and prevent waste. These limitations highlight the need for a more efficient and data-driven approach to perishable inventory management.

Advantages: Streamlined Operations and Reduced Waste

The proposed smart inventory system offers a multitude of advantages over traditional methods. Firstly, RFID tags provide automatic and accurate identification of each individual item, eliminating the need for manual counting and minimizing human error. This translates to real-time inventory data, enabling businesses to maintain optimal stock levels and avoid stockouts. Secondly, the system tracks the age of each product, allowing for informed decisions about product placement and prioritizing sales of older items to prevent spoilage. Furthermore, cloud storage facilitates data analysis, revealing trends in demand fluctuations and enabling businesses to optimize ordering schedules to minimize waste. These functionalities contribute to cost savings, improved operational efficiency, and a significant reduction in food waste, promoting a more sustainable food supply chain.

Necessity: A Data-Driven Approach for Food Security

The growing global population intensifies the need for efficient food production and distribution systems. Perishable goods like eggs and mushrooms are a vital source of nutrition, yet their susceptibility to spoilage

presents a significant challenge to food security. Implementing this smart inventory system offers a compelling solution. Real-time data on inventory levels and product freshness empowers businesses to make data-driven decisions regarding ordering and product placement, minimizing waste and ensuring sufficient availability of these essential food items. Additionally, the system can be integrated with expiration date alerts, further reducing spoilage and contributing to a more sustainable food supply chain. This project, therefore, addresses a critical need within the food industry, promoting food security and responsible resource management.

Technology Stack: Building a Smart and Connected System

The core of this system lies in the Node MCU (ESP8266), a versatile microcontroller that serves as the central processing unit. The Node MCU interacts with the RFID reader, interpreting data from the tags attached to each egg or mushroom container. An OLED display connected to the Node MCU provides a local visual representation of inventory changes and product movement. For secure and scalable data storage, the system leverages a cloud storage service. The Node MCU transmits collected data (RFID tags and timestamps) to the cloud, enabling comprehensive data analysis and trend identification. For user interaction, a separate RFID reader can be employed. This reader retrieves information about scanned items from the cloud storage, potentially displayed on a user-friendly web application interface. The system prioritizes power efficiency through software optimization of the RFID functionalities, ensuring optimal battery life and sustainable operation. This combination of technologies – RFID tags, Node MCU, cloud storage, and user interface – creates a robust and connected system, revolutionizing perishable inventory management.

IOT USES:

The smart inventory system described here is a prime example of the Internet of Things (IoT) in action. IoT refers to the interconnected network of physical devices embedded with sensors, software, and other technologies that enable them to collect and exchange data over the internet. In this project, RFID tags function as the intelligent "things" within the IoT network. Each tag, attached to an egg or mushroom container, becomes a data point, transmitting unique identification information to the RFID reader. The reader, another element of the IoT network, acts as a communication bridge, capturing tag data and relaying it to the Node MCU. The Node MCU, the brain of the system, interprets this data and interacts with other IoT components. It transmits the data to the cloud storage, another facet of the IoT ecosystem, for secure storage and analysis. The user interface, potentially a web application, also falls under the IoT umbrella, as it facilitates interaction with the data collected from the physical RFID tags. This interconnected web of intelligent devices – RFID tags, reader, Node MCU, cloud storage, and user interface – working together seamlessly exemplifies the power of IoT in transforming traditional inventory management into a data-driven and efficient process.

2. REVIEW OF LITERATURE

1. Title: IOT-Based Smart Inventory Management System

Authors: J K Kiruthika,S Manikandan,U Nithya,M Preethika,S Poorna,

Publication: 2023 International Conference on Computer Communication and Informatics (ICCCI)

With the rapid advancement of technology, tasks in our lives are becoming increasingly simple. The most important aspect of efficient retail management is inventory control. The world is moving toward a more intelligent future in which everything is automated and remotely controllable by using sensor technologies. This process not only takes time but sometimes results in mistakes that were not intended. Large storerooms present a particularly complex situation that makes it exceedingly challenging for humans to manually check the inventory on a regular basis. The well-known Node MCU ESP8266 microcontroller, which is based on the Internet of Things and sensors, can properly provide the weight of a specific good as well as supports high in automatically counting the number of items on a shelf.

2. Title: Machine learning and its applications: A review

Authors: Sheena Angra, Sachin Ahuja,

Publication: 2017 International Conference on Big Data Analytics and Computational Intelligence (ICBDAC)

false, Nowadays, large amount of data is available everywhere. Therefore, it is very important to analyze this data in order to extract some useful information and to develop an algorithm based on this analysis. This can be achieved through data mining and machine learning. Machine learning is an integral part of artificial intelligence, which is used to design algorithms based on the data trends and historical relationships between data. Machine learning is used in various fields such as bioinformatics, intrusion detection, Information retrieval, game playing,

marketing, malware detection, image deconvolution and so on. This paper presents the work done by various authors in the field of machine learning in various application areas.

3. Title: IoT Based Smart Inventory Management System for Kitchen Using Weight Sensors LDR LED Arduino Mega and NodeMCU (ESP8266) Wi-Fi Module with Website and App

Authors: Sifat Rezwan,Wasit Ahmed,Mahrin Alam Mahia,Mohammad Rezaul Islam,
Publication: 2018 Fourth International Conference on Advances in Computing Communication & Automation (ICACCA)
false, Smart kitchen inventory management system (SIMS) is a system that is based on IoT, which will make managing kitchen, medicine, restaurant inventory more efficient and hassle free. This will not only notify users of their current inventory but also automatically order for new items if quantity gets low. Users can also manually order online to get any items delivered at their doorstep directly from their SIMS app. User can also generate list of a given timeframe so that user will be able to know about their expenditure. In addition, user can track their order status and order history through website. With the help of Smart Kitchen Inventory (SKI), a part of SIMS, people can forget about the hassle of grocery shopping as it can be operated from anywhere through the website or the android app and order anything they need anytime they want.

4. Title: Smart Inventory Access Monitoring System (SIAMS) using Embedded System with Face Recognition

Authors: Kanjana Eiamsaard, Pongsakon Bamrungthai, Songchai Jitpakdeebodin,
Publication: 2021 18th International Joint Conference on Computer Science and Software Engineering (JCSSE)
"abstract": In this paper, we present a system called Smart Inventory Access Monitoring System (SIAMS) that integrates an embedded system with face recognition into an inventory system. It is developed to prevent theft in warehouses from authorized staff. The embedded system is attached with an RGB camera and deployed three software modules: image capturing, face detection, and face recognition. The face detection module sends detected face images to the face recognition module to identify a person as the personu2019s name or unknown class using a deep learning approach. The system achieved competitive accuracy by performing standard evaluation metrics for face detection and recognition. The inventory system that was developed will receive data via TCP/IP socket communication to log access history. The retrieved information can be used to investigate an unusual situation. The system can be improved with object detection and person tracking system to detect theft in real-time.

5. Title: IoT Based Smart Inventory Management System for Kitchen Using Weight Sensors LDR LED Arduino Mega and NodeMCU (ESP8266) Wi-Fi Module with Website and App

Authors: Sifat Rezwan, Wasit Ahmed, Mahrin Alam Mahia, Mohammad Rezaul Islam,
Publication: 2018 Fourth International Conference on Advances in Computing Communication & Automation (ICACCA)
Communication & Automation (ICACCA)"abstract

6. Title: Smart Spare Part Inventory Management System with Sensor Data Updating

Authors: Jie Lin, Meimei Zheng, Jiayu Chen, Kai He, Ershun Pan,
Publication: 2019 IEEE International Conference on Industrial Cyber Physical Systems (ICPS)
false, With the advent of Industry 4.0, more and more data can be available to companies. Especially in Cyber-Physical Systems (CPS) where sensors are connected to machines, rich sensor data can be collected. However, there is still a challenge to transform the data into useful information that enables a better decision. In this paper, we focus on the inventory decisions for the spare parts. The spare parts are expensive and it takes long lead time to procure them from overseas. It is critical for companies to make better inventory decisions for spare parts. We proposed a smart inventory management system for spare parts, which can take advantage of the updated sensor data and allow better decisions through modeling the degradation process of critical operating components. In this system, the ordering decision is updated dynamically based on real time sensor data.

7. Title: Smart RFID application in health care: Using RFID technology for smart inventory and logistic systems in hospitals

Authors: Arne Bochem, Ahed Abugabah, Ahmad Al Smadi,
Publication: 2022 45th Jubilee International Convention on Information Communication and Electronic Technology (MIPRO)
false, In todayu2019s hospital environments, many medical devices and tools are used. While some of these will be stationary due to size and bulk, many devices can also be moved from room to room. To facilitate an efficiently running hospital environment and protect expensive devices from being lost, it is important to keep track of the

whereabouts of every medical device or utensil. We propose an RFID based system with a smartphone application - based frontend for tracking the locations of medical devices and utensils in a hospital environment, both enabling medical professionals to quickly locate required devices as well as allowing hospital administration to keep track of when and where devices leave hospital premises, optionally alerting security after a configurable grace period. In addition to this, our proposed application allows doctors and other medical personnel to reserve equipment and rooms such as examination or operating rooms and to easily find which rooms or pieces of equipment are available at a given time. This reduces administrative overhead and allows a smoother operation of the hospital, where efficiency is needed not only for the sake of profits but also to ensure the continued well-being of patients.

8. Title: Development of an IoT-based Inventory Management System for Retail Stores
Authors: V. Saillaja,M. Menaka,V. Kumaravel, Kamalakannan Machap,
Publication: 2023 International Conference on Sustainable Computing and Smart Systems (ICSCSS)
Controlling inventory is the essential component of an effective retail management system. Maintaining accurate records of inventories enables the user to engage in preplanning and decision-making. These days, the neighborhood stores and giant industries keep their inventory on enormous shelves or in enormous areas devoted to storage. To ascertain the current inventory level, the proprietors of these shops or enterprises must count the packets by hand. This paper proposes developing an IoT-based stock administration framework for retail locations to improve stock accuracy, optimize production network cycles, and enhance customer experience. The system integrates cloud-based analytics with IoT-enabled sensors to monitor and manage real-time inventory levels. As a result, retailers obtain current data on inventory levels, product availability, and demand trends. The proposed system enables retailers to optimize inventory levels, reduce stockouts and overstock, and improve sales performance by ensuring that popular products are always available. In addition, the system provides retailers with insight into their customersu00e2u20acu2122 purchasing patterns and preferences, enabling them to personalize products and increase consumer loyalty.

9. Title: Smart inventory control by using PID ACO controller and fuzzy logic controller
Authors: Hicham Sarir, Benkacem Abderhmane,
Publication: 2022 14th International Colloquium of Logistics and Supply Chain Management (LOGISTIQUA)

3. DESIGN METHODOLOGY

The implementation of the IoT-based monitoring and quality analysis system for alcoholic fermented beverages involves several key steps:

Sensor Integration:
Integrate pH and electrical conductivity (EC) sensors into the fermentation vessel. Ensure proper calibration and validation of sensor readings for accurate data collection.

NodeMCU Configuration:
Configure the NodeMCU microcontroller to read data from the sensors. Set up the WiFi module on the NodeMCU to establish a connection with the internet and the designated cloud platform.

Cloud Platform Setup:
Choose a suitable cloud platform (e.g., AWS, Azure, Google Cloud) and set up a dedicated account. Develop a data storage and retrieval mechanism to handle incoming sensor data securely.

Data Transmission:
Program the NodeMCU to transmit sensor data to the cloud at regular intervals. Implement error-handling mechanisms to ensure reliable data transfer.

Web Application Development:
Develop a web application using relevant technologies (HTML, CSS, JavaScript) to visualize the real-time status of the fermentation process. Integrate with the cloud platform to fetch and display data dynamically.

User Interface Design:
Create a user-friendly and intuitive design for the web application interface. Include features such as data visualization, historical trend analysis, and alert notifications for out-of-range conditions.

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4. CONCLUSION

The proposed smart inventory management system for perishables offers a compelling solution to the challenges faced in the food supply chain. By leveraging RFID technology and the power of the Internet of Things, this system provides real-time data on inventory levels and product freshness. This data empowers businesses to optimize stock management, minimize food waste, and promote a more sustainable food ecosystem. The detailed methodology outlined in this document equips developers with the necessary knowledge to build and deploy this system, paving the way for improved efficiency and reduced waste within the perishable goods industry.

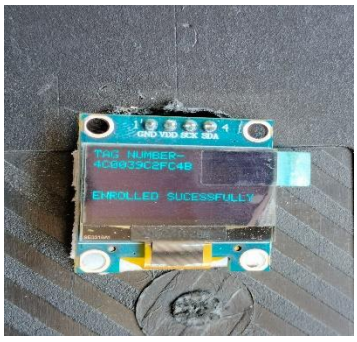
5. FUTURE SCOPE

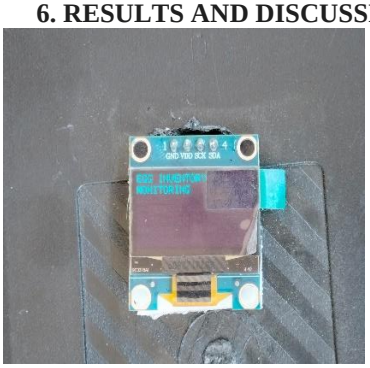
This project serves as a foundation for further exploration and potential advancements. Here are some exciting possibilities for future development:

- **Integration with Machine Learning:** Machine learning algorithms can be incorporated to analyze historical data on inventory trends, product demand fluctuations, and expiration dates. This can lead to predictive inventory management, enabling businesses to proactively order supplies and minimize stockouts.
- **Environmental Monitoring:** Additional sensors can be integrated into the system to monitor environmental conditions like temperature and humidity within the storage unit. This data, coupled with product freshness information, can provide valuable insights for optimizing storage conditions and further minimizing spoilage.
- **Mobile App Development:** A mobile application can be developed to provide real-time inventory data and product information to users on the go. This user-friendly interface can empower store managers and staff to make informed decisions regarding inventory management and product placement.

By exploring these future possibilities, the smart inventory management system can evolve into an even more robust and comprehensive solution, fostering a more efficient and sustainable food supply chain for the years to come.

6. RESULTS AND DISCUSSION:





- The proposed smart inventory system for perishable items, utilizing RFID technology, offers an innovative solution for efficient inventory management. By tagging each item with an RFID chip and implementing an RFID reader at the storage location, the system enables real-time tracking of additions

and removals. This not only enhances inventory accuracy but also facilitates better stock management, particularly for perishable items like eggs and mushrooms.

- The central processing unit, Node MCU, plays a pivotal role in interpreting RFID data, generating timestamps, and displaying relevant information on the OLED screen. This provides users with immediate access to inventory status, enabling quick decision-making and reducing the risk of stockouts or overstocking. Moreover, the integration of power-saving measures in the RFID system programming ensures optimal energy efficiency, prolonging the system's battery life and reducing operational costs.
- Furthermore, the system's capability to upload data to a cloud storage service enhances accessibility and scalability. By leveraging cloud technology, users can remotely access inventory information, enabling timely decision-making regardless of their physical location. This not only improves operational efficiency but also facilitates data analysis and trend identification, supporting informed business decisions and strategic planning.
- For user interaction, the incorporation of a separate RFID reader enables convenient scanning of items and retrieval of information from the cloud. This offers a seamless user experience, empowering users to obtain real-time inventory updates and product details effortlessly. Additionally, the potential integration of a web application allows for enhanced functionality, such as product expiration alerts and customized reporting.
- By utilizing the Thingspeak cloud platform for data storage and management, the system can efficiently handle large volumes of data while ensuring data integrity and security. The integration of Thingspeak's APIs enables seamless communication between the smart inventory system and the web application, facilitating real-time data exchange and enabling timely alerts for expiring products.
- During the testing phase, rigorous testing protocols will be employed to validate the system's performance and reliability. This includes testing for accuracy, responsiveness, and robustness under various environmental conditions. Any identified issues or areas for improvement will be addressed iteratively to ensure the system meets the desired specifications and performance standards.
- Upon successful testing, all components will be integrated into a permanent enclosure suitable for the desired location, whether indoors or outdoors. This enclosure will provide protection against environmental factors and ensure the longevity of the system in its operational environment.
- In conclusion, the proposed smart inventory system offers a comprehensive solution for perishable item management, leveraging RFID technology, cloud computing, and web integration. By providing real-time inventory monitoring, data analytics capabilities, and user-friendly interfaces, the system enhances operational efficiency, reduces costs, and facilitates informed decision-making. With thorough testing and integration into a durable enclosure, the final system is poised to deliver tangible benefits for businesses and organizations seeking to optimize their perishable item management processes.

6. REFERENCES:

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