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Development of an IOT-Based Inventory Management System Using Arduino and Weight Sensors

Khader Basha Sk, P. Leela Bhargavi, V. Sumanohar Reddy, M. Varun Teja, Sk. Khaja

Department of CSE – Data Science, Chalapathi Institute of Technology, Guntur-522016, A.P, India

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KEYWORDS

Internet of Things (IoT), Smart retail shelf, Inventory monitoring, Load cell sensor, Arduino Uno, I2C

ABSTRACT

This paper presents an IoT-based smart retail shelf inventory monitoring system using a load cell, Arduino, I2C LCD, and GSM modem. The proposed system is designed to automate inventory tracking and reduce manual intervention in retail environments. A load cell sensor is used to measure the weight of products placed on the shelf, and the Arduino microcontroller processes the sensed data to estimate the available stock based on predefined threshold values.The system provides real-time display of inventory status on an I2C LCD module. When the stock level falls below a specified threshold (e.g., 200 grams), the GSM modem is triggered to send an alert message to the user, ensuring timely restocking. This approach enhances accuracy, reduces human effort, and minimizes the risk of stockouts.The proposed system is cost-effective, reliable, and suitable for small and medium-scale retail stores. It demonstrates how embedded systems and communication technologies can be effectively integrated to improve inventory management.

I. INTRODUCTION

In recent years, the rapid growth of retail industries has increased the need for efficient and automated inventory management systems. Traditional methods of stock monitoring rely on manual checking, which is time-consuming, labor-intensive, and prone to human errors. These limitations often lead to issues such as stock shortages, overstocking, and reduced customer satisfaction.

With the advancement of embedded systems and communication technologies, the integration of Internet of Things (IoT) solutions in retail environments has become more practical and effective. This paper presents a smart retail shelf inventory monitoring system using a load cell, Arduino, I2C LCD, and GSM modem. The system continuously monitors the weight of products placed on the shelf using a load cell sensor, which provides accurate information about stock levels.

The Arduino microcontroller processes the sensor data and compares it with predefined threshold values to determine whether the stock level is sufficient. The real-time inventory status is displayed on an I2C LCD,

allowing easy monitoring within the store. When the stock level falls below the minimum threshold, the GSM modem automatically sends an alert message to the store manager, enabling timely restocking.

The proposed system aims to reduce manual effort, improve accuracy, and ensure efficient inventory management. It is particularly suitable for small and medium retail stores due to its low cost, simplicity, and reliability. This work demonstrates the effective use of embedded systems and communication technology in developing smart retail solutions.

2. REVIEW LITERATURE SURVEY

Recent advancements in inventory management systems have focused on automation and real-time monitoring using embedded systems and Internet of Things (IoT) technologies. Traditional inventory systems based on manual supervision and barcode scanning are widely used; however, they suffer from limitations such as increased human effort, time consumption, and susceptibility to errors [1].

To address these issues, Radio Frequency Identification (RFID)-based systems have been proposed by several researchers. RFID technology enables automatic identification and tracking of products without direct human involvement. Although these systems improve efficiency, they involve high implementation costs and require specialized infrastructure, making them less suitable for small-scale retail applications [2].

In recent years, IoT-based inventory monitoring systems have gained significant attention. These systems utilize microcontrollers and sensors to collect real-time data and transmit it to cloud platforms for analysis and monitoring. Some studies have employed Raspberry Pi-based systems integrated with cameras and image processing techniques for product detection. While these approaches offer high accuracy, they increase system complexity and cost [3].

Alternatively, weight-based inventory systems using load cells have been proposed as a simple and cost-effective solution. These systems estimate stock levels by measuring the weight of items on shelves. Research has shown that load cell-based systems provide reliable and accurate results with minimal hardware requirements.

Furthermore, GSM-based communication systems have been widely used for sending alerts and notifications in real time without relying on internet connectivity. This makes them suitable for remote or low-network areas.

Based on the reviewed literature, it is evident that a combination of load cell sensors, Arduino microcontroller, and GSM communication offers a low-cost, efficient, and reliable solution for smart retail inventory monitoring. The proposed system builds upon these existing approaches to provide an optimized and practical implementation for retail environments.

3. RESEARCH METHODOLOGY

The proposed system is designed to monitor retail shelf inventory using a load cell, Arduino microcontroller, I2C LCD, and GSM modem. The methodology focuses on measuring the weight of products, processing the data, and sending alerts when stock levels fall below a predefined threshold.

A. System Design

The system consists of a load cell sensor placed beneath the retail shelf to measure the weight of products. The load cell is connected to an HX711 amplifier module, which converts the analog signal into a digital signal. This data is then sent to the Arduino for processing.

B. Data Acquisition

The load cell continuously senses the weight of items on the shelf. The Arduino reads this data at regular intervals and converts it into meaningful values (grams or kilograms). The measured weight is used to estimate the number of items available.

C. Data Processing

The Arduino compares the measured weight with a predefined threshold value. This threshold is set based on the minimum stock level required. If the measured weight is greater than the threshold, the system continues normal monitoring. If the weight falls below the threshold, the system identifies it as a low-stock condition.

D. Display Unit

An I2C LCD is used to display real-time information such as current weight and stock status. This allows store personnel to easily monitor inventory directly at the shelf.

E. Alert Mechanism

When a low-stock condition is detected, the GSM modem is activated. The Arduino sends a command to the GSM module to transmit an SMS alert to the

registered mobile number. This ensures that the store manager is immediately notified for restocking.

4. PROPOSED METHODOLOGY

The proposed system presents a smart and automated approach for retail shelf inventory monitoring using a load cell, Arduino microcontroller, I2C LCD, and GSM modem. The system is designed to continuously monitor product availability and provide real-time updates along with alert notifications.

In this methodology, a load cell is installed beneath the retail shelf to measure the weight of the products placed on it. The load cell converts the applied weight into an electrical signal, which is amplified and digitized using an HX711 module. This processed signal is then transmitted to the Arduino microcontroller.

The Arduino acts as the central processing unit, where the received data is analyzed and compared with predefined threshold values corresponding to minimum stock levels. Based on this comparison, the system determines whether the stock is sufficient or requires replenishment.

An I2C LCD module is interfaced with the Arduino to display real-time information such as current weight and stock status. This provides an easy and immediate way for store personnel to monitor inventory locally.

When the stock level falls below the set threshold (e.g., 200 grams), the Arduino triggers the GSM modem to send an SMS alert to the user or store manager. This notification ensures timely restocking and prevents stockouts.

The system operates continuously, providing automated monitoring without the need for manual intervention. Its simple architecture, low cost, and independence from internet connectivity make it highly suitable for small and medium-scale retail stores.

WORKING PRINCIPLE

working principle of the proposed smart retail shelf inventory monitoring system is based on weight measurement and automated alert generation. The system uses a load cell sensor to continuously monitor the weight of products placed on the retail shelf.

Initially, the load cell senses the weight of the items and converts it into a small electrical signal. This signal is amplified and converted into digital form using the HX711 amplifier module. The processed data is then sent to the Arduino microcontroller.

The Arduino reads the weight data at regular intervals and calculates the current stock level. A predefined threshold value is set in the system to represent the minimum allowable stock. The measured weight is continuously compared with this threshold value.

The real-time weight and stock status are displayed on the I2C LCD module for local monitoring. If the measured weight is greater than the threshold, the system indicates that sufficient stock is available. However, when the weight falls below the threshold level, the system identifies it as a low-stock condition.

In such a case, the Arduino activates the GSM modem to send an SMS alert to the registered user or store manager. This notification enables quick action for restocking the products. The entire process is repeated continuously, ensuring real-time monitoring and automatic updates.

Thus, the system provides an efficient and reliable method for inventory management by combining sensing, processing, display, and communication technologies.

BLOCK DIAGRAM

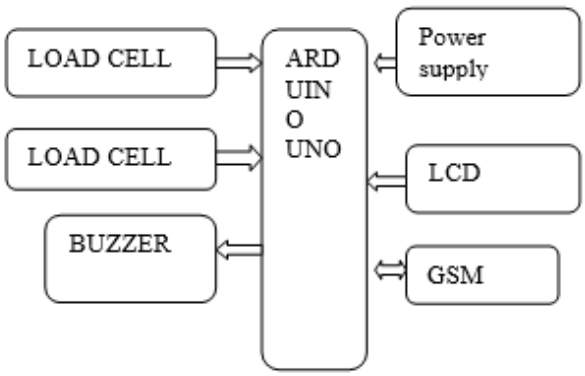

Fig 4.1: Block Diagram

5. RESULTS AND OUTCOMES

The proposed smart retail shelf inventory monitoring system was successfully designed and implemented using a load cell, Arduino microcontroller, I2C LCD, and GSM modem. The system was tested under different conditions to evaluate its performance and reliability.

The load cell accurately measured the weight of products placed on the shelf, and the Arduino processed the data effectively to determine stock levels. The

real-time weight and stock status were correctly displayed on the I2C LCD, providing clear and continuous monitoring.

When the stock level dropped below the predefined threshold value (e.g., 200 grams), the GSM modem successfully sent alert messages to the registered user without delay. The system responded quickly to changes in weight, ensuring timely notifications for restocking.

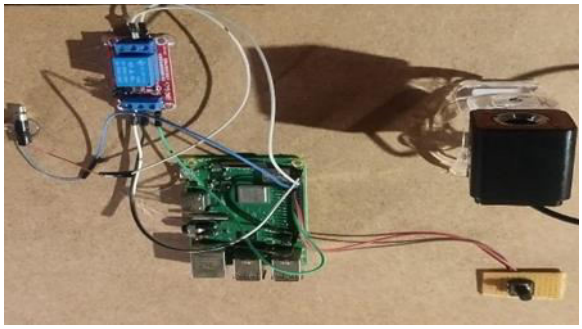

Fig 5.1: Output1

Fig 5.2: Output2

The overall performance of the system was found to be stable, accurate, and efficient. It reduced the need for manual checking and minimized human errors. The system demonstrated reliability in continuous operation and proved to be a cost-effective solution for small and medium-scale retail stores. The outcomes of this project show that the proposed system can significantly improve inventory management by providing real-time monitoring, automatic alerts, and reduced operational effort

6. CONCLUSION

The proposed smart retail shelf inventory monitoring system was successfully implemented using a load cell, Arduino microcontroller, I2C LCD, and GSM modem. The system effectively monitored the weight of products placed on the shelf and accurately determined stock levels in real time.

The load cell sensor provided reliable weight measurements, and the Arduino processed the data efficiently. The I2C LCD displayed the current stock status clearly, enabling easy monitoring. When the stock level dropped below the predefined threshold value (e.g., 200 grams), the GSM modem successfully sent alert messages to the user, ensuring timely restocking.

The system demonstrated consistent performance during testing, with quick response to changes in stock levels and accurate alert generation. It reduced manual effort, minimized human errors, and improved overall efficiency in inventory management.

In conclusion, the developed system provides a simple, cost-effective, and reliable solution for retail inventory monitoring. It is particularly suitable for small and medium-scale stores, offering real-time tracking and automated notifications without requiring internet connectivity. The project highlights the effectiveness of integrating embedded systems and communication technologies in modern retail applications.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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