Protection of foodstuffs in storage warehouses system

[1]Nowf Sulaiman Nasser SULAIMAN AL HABSI, [2]Shaik Mazhar Hussain
[1,]16F15582@mec.edu.om, [2]mazhar@mec.edu.om
[1,2] Middle East College, Muscat, Oman,

ABSTRACT

Stores face many challenges in preserving foodstuffs, ranging from marketing, viruses, microbes, spoilage, theft of stores, and difficulty in storing. In this paper, a system was proposed to dispose of and analyze the conditions in which foodstuffs are stored, and this paper developed advanced and new methods that can be used to sense the intrusion into warehouses, track expired materials, and set alerts on changing temperature and humidity inside the warehouse. In addition, the paper will also include the development of IoT (Internet of Things) from Arduino mega, GSM, PIR Motion sensor, LCD Screen, Rtc Realtime, and DH T22 sensor. To reduce the theft or entry of animals inside the warehouse, this system used motion sensor by using the PIR Motion sensor, Arduino mega and GSM technology, the sensor will send alerts to the Arduino. Likewise, when the temperature and humidity change, the DH T22 sensor is used, and it will send notifications and alerts. Finally, the expiration dates of the product are stored inside the Rtc Realtime and it is compared and integrated with the Arduino mega by sending notifications in the GSM responsible for tracking the products. Due to the reliance on the Internet of Things, theft will be reduced, and result to an improved warehouse management by efficiently monitoring temperature and humidity inside the warehouse.

INTRODUCTION

The first chapter of this paper report discusses the idea and purpose of the paper. It also talks about the paper background, Paper Objectives, Paper limitations, and defined overview of the paper. It is possible to use the paper idea in food companies that contain large foodstuffs to prevent their dispersal due to the external and internal conditions that the store is exposed to. Thus, providing an adequate store to preserve the foodstuff and urging this system to provide alerts to the workers will prevent the dispersal. Sometimes the warehouse is exposed to dangers that may lead to the destruction of foodstuffs such as high temperature, the entry of insects inside the warehouse and knowing the expired products to get rid of them. The creative idea for this paper is that the worker can know the state of the store remotely and track the products before they are finished. Furthermore, this paper will save the financial costs and preserve the food products from spoilage.

Background of the Paper

The food warehouse is a facility of various sizes and structures. Foodstuffs are stored in small or large quantities, whether for short or long periods, before they leave to be distributed in various places. Storage structures are generally used to maintain the quality of foodstuffs stored for long periods with minimal microbial losses and pests. Most of the foodstuffs have resulted in spoilage due to improper storage structure and inappropriate storage practices, thus resulting in foodstuff losses having a very high monetary value at the global level. Maintaining the storage of foodstuffs is extremely important as it facilitates trade and economic growth and prevents cash losses for store owners. On 4 January 2011, an organization known as The Food Safety Modernization Act (FSMA) was established by the Food and Drug Administration (FDA) to preserve foodstuffs inside warehouses. These laws significantly helped preserve food products due to the organization enacting these laws that must be available inside the stores to provide an appropriate environment for food products and verify their safety before distribution and use. Good food preservation depends on knowing the appropriate conditions for storing each type of food to protect it from contamination, as high humidity and temperature help the growth and reproduction of microbes, and temperature control is considered one of the most effective means in reducing the risk of microbes and preventing them from reproducing and destroying food during Storage. In addition, one of the most important factors that lead to the destruction of foodstuffs is the entry of insects and animals into the stores. This is the most recurring reason that leads to the destruction of food and may lead to food poisoning. The validity of the foodstuffs must be monitored and preserved in a correct and hygienic manner, away from strong-smelling substances and detergents *(Cohen, M. and Davis, N., 1994).*

This paper discusses mechanisms to get rid of problems that lead to the destruction of foodstuffs, such as Temperature change of the store and the entry of pests such as rodents and insects, and if the product expires, its location in the store is tracked and disposed of using the PIR sensor.

Proposed Approach

Paper Aim

The main objective of this paper is to form a special system to protect food stores and to preserve the foodstuffs in them and to keep them inside the store for long periods. Moreover, to avoid exposure to external problems such as high temperature, the entry of rodents and insects and setting up a system that helps and facilitates store owners to keep track of the expired product.

Paper Objectives

The aim of the paper:

- Discuss about a design of a store prepared with special systems to protect foodstuffs from spoilage.
- Enhancing sensor technology opportunities in protecting food stores.
- Verification and analysis of the designed system, such as its full effectiveness, efficiency of use, error, accuracy, and reliability when operating the system.

METHODOLOGY

The Specific Methods section describes the procedures that must be verified through a research problem and the rationale for identifying, testing, and processing information to understand the problem. The importance of the methodology is an essential aspect for any work that is presented because an incorrect method leads to incorrect results. Therefore, the methodology guarantees a correct commitment to complete the paper in a specific time and meet the mentioned specifications. There are many methodologies, each with its own principles and rules. The methodology applied in this paper is V-Model, this model was chosen for many reasons including the fact that it reduces the risks in the paper, by identifying errors at an early stage leading to more effectiveness in the paper.

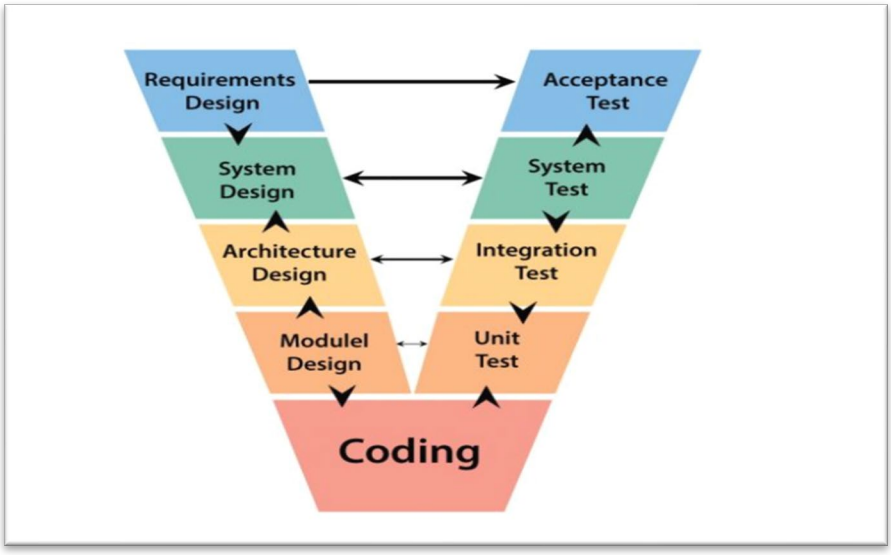


Figure1: phases of V model

LITERATURE REVIEW/THEORY

This chapter includes a set of literary articles that concern and explain the details or some of the parts of the paper's work. These articles helped explain and work the paper in the correct way, which helps to know the paper's working methods.

Table 1. Summary of papers reviewed on" Protection of foodstuffs in storage warehouses system."

Title, Author, Year	Concepts, approach, methods, and analysis,	Inconsistencies, gaps, contradictions, differences	Improvements
An IoT-based cargo monitoring system for enhancing operational effectiveness under a cold chain environment. (Tsang et al., 2017)	Information and data are gathered in real time using TI SimpleLinkTM sensor tags that support many sensing technologies such as temperature, humidity, light, and direction. Hence, this information is collected and sent to a cloud database for storage and processing	The module used to collect the information and the actual time is not very accurate.	SD CARD is characterized by storing more data and can be used to make comparison to end time products.
WSN based Online Parameter Monitoring in Cold Storage Warehouses in Cloud using IOT concepts. (*CVA, 2017).*	A PIC18 controller is used to monitor the temperature and humidity, the system provides a way to control the temperature remotely using the android app to control the (on / off) of the air conditioning system to maintain the desired temperature.	The module used to review temperature and humidity has limited accuracy.	The DHT11 Sensor is a good and high-precision component to measure the temperature and humidity that is controlled by the Arduino, and this was used in the paper.
GSM Based Smart Security System Using Arduino. (T.L, C.O and C.E, 2019).	The whole system is controlled by the Arduino Uno. The system also contains a temperature sensor (LM35).	The type of Arduino and the temperature sensor used in the system has limited accuracy.	The Arduino mega 2560 is better than the Arduino Uno, in terms of accuracy and number of outputs and inputs. And the use of the DHT11 Sensor to measure temperature and

			humidity simultaneously.
PIR Sensor Characterization and a Novel Localization Technique using PIRs. (Nicholas et al., 2016)	Using the PIR sensor to detect moving objects inside warehouses, such as animals and insects. The exploitation of the analog signals from the sensors made it possible to easily capture the angle, direction of movement and speed to quickly capture the analog signal.	The signals from the PIR sensor are very weak and need to be amplified several times to get a reasonable signal to work with. The system has been tested with only one person on the FoV. However, if there is more than one person, the system may not function.	An attempt to program the PIR sensor in the Arduino to sense the entry of more than one object at the same time.
An IoT based Warehouse Intrusion Detection (E-Perimeter) and Grain Tracking Model for Food Reserve Agency. (Chihana et al., 2018)	The motion sensing PIR connects to the Arduino and sends the alerts through the GMS	The module used to transmit and program the signals is the Arduino Uno has limited accuracy	The Arduino mega 2560 is better than the Arduino Uno, in terms of accuracy and number of outputs and inputs.

DESIGN AND ANALYSIS

This paper includes the concept of Protection of foodstuffs in storage warehouses system, which explains the operation of System Analysis such as System Block diagram and System Flow chart. This chapter explains requirements analysis by explaining the principal components of the system and the relationship between the input and output parameters and stating the constraints in paper design.

System Analysis

System Block diagram

The block diagram of the food storage system is shown in Figure 2, it includes Arduino mega, GSM, Pir Motion sensor, LCD Screen, Rtc Realtime, and DH T22 sensor. The system consists of inputs and outputs, the commands are recorded in Rtc Realtime and KEYPAD as the password for the gate and the commands are given to deactivate the motion sensor and add the expiration date of the products and to be linked to the Arduino, and save all these data in the SD CARD. The DH T22 sensor and the Pir Motion sensor are connected to the Arduino mega channels, and the

temperature and humidity results are processed in the Arduino mega, thus, the alerts are sent in GSM and displayed in the LCD Screen.

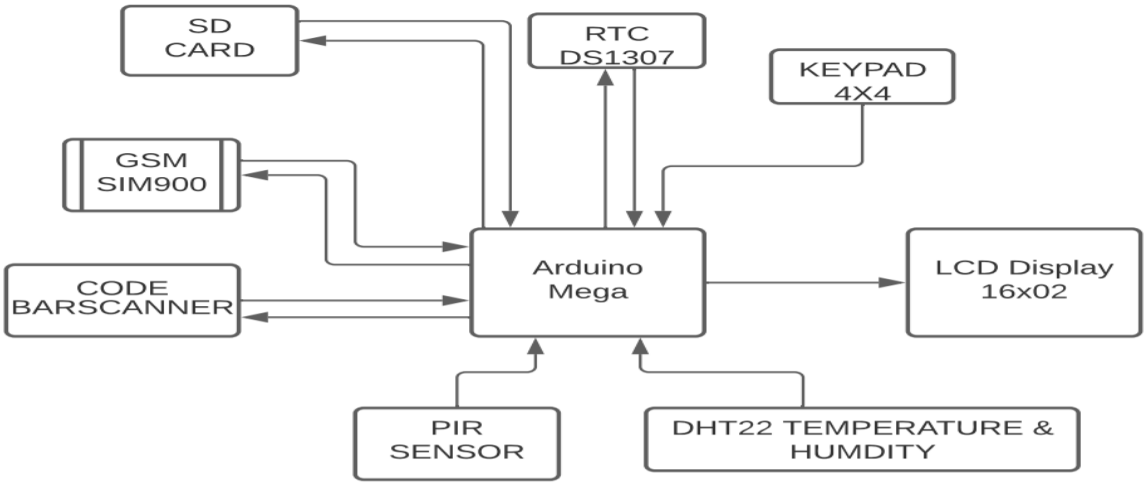
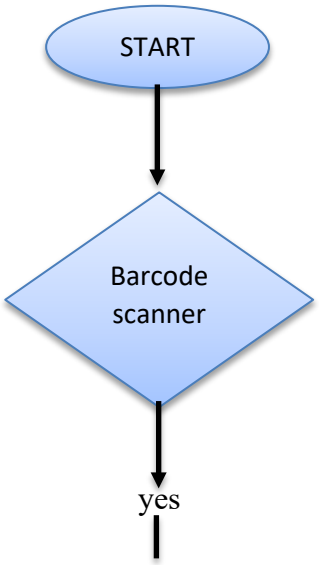
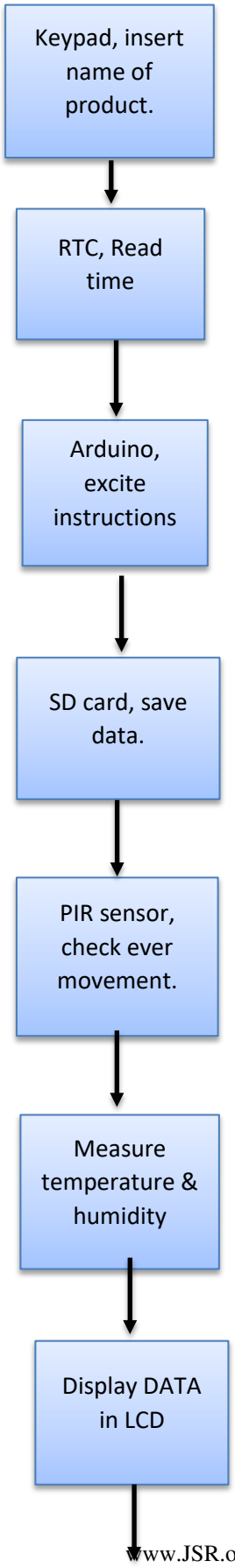


Figure 2: System Block diagram

System Flow chart

The flow chart of the system is shown in Figure 3. The system first will be initialized and made operational. Preparation is that all paper components are programmed to start and prepare to receive orders and important information from the controller. The first stage is to check and put the information about the products inside the warehouse by Barcode scanner. After this stage, the steps are confirmed, the keypad is turned on, and the expiry date of the product is added with the name of the required product. RTC read the real time and send it to the controller. In the next stage, all information is received and sent to the Arduino, and thus saved in the SD card. The PIR sensor detects any movement that is not inside the warehouse, and for the temperature and humidity sensor, it detects if the value exceeds the limit set. By collecting the required information and sending it to the Arduino in the event of any unwanted change, such as high temperature or humidity, entry of any object, or in the event of the expiration of the date of a product, this information is sent to the Arduino and then it displays data in LCD and sends alerts by GSM to workers.




Keypad, insert name of product.
RTC, Read time
Arduino, excite instructions
SD card, save data.
PIR sensor, check ever movement.
Measure temperature & humidity
Display DATA in LCD

System Design

The security system designed to protect foodstuffs inside warehouses based on GSM using the Arduino mega 2560 is a two-part system, the first section is responsible for entering and recording food information as the date of production and expiration, while the second section is responsible for protecting the store from environmental conditions or external, such as temperature, humidity, and the entry of insects and animals into the store. The DHT11 temperature and humidity sensor notes every abnormal rise inside the store, if the temperature is from 0 ° C to 50 ° C and the humidity is from 20 ° C to 90 ° C. As for the Pir Motion sensor, when it encounters any energy or movement within the sensor's range, it sends signals and receives them the Arduino mega 2560 and sends alerts directly to GSM. The second section of the system, the keypad is turned on, and the expiry date of the product is added with the name of the required product. RTC read the real time and send it to the controller. In the event of an increase in temperature and humidity, or any sensation of movement or expiration of the products, the sensors will send this information to the Arduino mega 2560 and thus send alerts to the employee.

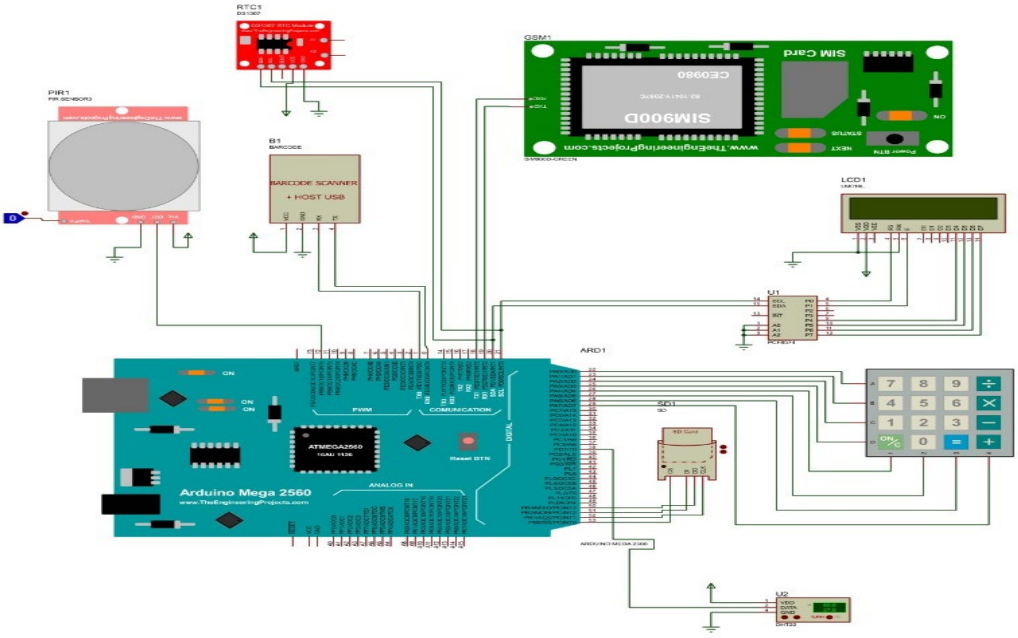


Figure 5.3.1: Schematic diagram of system.

- There are two types of "timeouts" related to the PIR sensor. One is the timeout "Tx" which is the time the LED lights up after motion is detected, and the other is the "Ti" timeout which is the time the LED turns off when there is no movement.

$$T_X = 24576 \times R \times C$$

$$T_i = 24 \times R \times C$$

- The DHT11 temperature / temperature range provides, temperatures between 0 ° C and + 50 ° C and humidity between 0% to 100%. The DHT11 data pin is attached to the Arduino digital IO pin. The Arduino reads the temperature and humidity at a 2-second interval and sends to the serial port. the Conversion formula from Celsius to Fahrenheit is

$$T(°F) = T(°C) \times 9/5 + 32$$

- PIR sensors operate on the principle of pyroelectricity that makes them respond to a change in the incident radiation. The radiation W which the sensor receives from the human at temperature Th and the background at temperature Tbg is given by

$$W = K(T_h^4 - T_{bg}^4)$$

where, K is a constant that is a function of distance from the sensor.

Conclusion

This paper proposes the integration of several open-source hardware and software systems applied to control and protect food stores. Stores face many challenges in preserving foodstuffs, ranging from marketing, viruses, microbes, spoilage, theft of stores, and difficulty in storing. In this paper, a system was proposed to dispose of and analyze the conditions in which foodstuffs are stored, and this paper developed advanced and new methods that can be used to sense the intrusion into warehouses, track expired materials, and set alerts on changing temperature and humidity inside the warehouse. The proposed system improves control over warehouse management and monitoring by means of the Internet of Things.

Acknowledgements

The search for the paper idea was not simple and easy, so I faced difficulties and obstacles to complete this paper successfully. I thank everyone who helped and support to be able to overcome all problems and obstacles in completing the paper with merit and excellence.
I would like to thank everyone who helped us, encouraged us, guided us during this period, and helped us complete this paper successfully. I would like to express my special thanks to the teachers of (Shaik Mazhar Hussain) as well as to all the teachers and supervisors and all teaching members in the Department of Communications and Electron Engineering who had the primary role in the success of this paper and devoted their time to us.
I also thank my family and friends who provided me with moral assistance and good motivation to finish the paper in a timely manner. Also thank you to your supervisor for reading this article and semester background.

References

Nicholas, D., Clark, D. and Herman, E., 2016. ResearchGate: Reputation uncovered. Learned Publishing, 29(3), pp.173-182. https://www.researchgate.net/publication/289446262_PIR_sensors

Chihana, S., Phiri, J. and Kunda, D., 2018. An IoT based Warehouse Intrusion Detection(E-Perimeter) and Grain Tracking Model for Food Reserve Agency. *International Journal of Advanced Computer Science and Applications*, 9(9). https://www.researchgate.net/publication/327984762_An_IoT_based_Warehouse_Intrusion_Detection_E-Perimeter_and_Grain_Tracking_Model_for_Food_Reserve_Agency

Vörös, T., Takács, K. and Réger, P., 2020. https://epitoanyag.org.hu/wp-content/uploads/2020/12/10.14382_epitoanyag-jsbcm.2020.32.pdf. *Epitoanyag - Journal of Silicate Based and Composite Materials*, 72(6), pp.205-209. https://www.circuitbasics.com/wp-content/uploads/2015/11/DHT11-Datasheet.pdf