Real-Time Secure Smart Shelf Managementfor Supermarkets

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Abstract—**Out of stock of products is one of the main hitches for any hypermarkets as it leads to purchaser' discontent and losses in sales of products too.The real-time secure smart shelf described in this project aims to solve the out of stock problem and burglary of products which is common in supermarkets now a days. Here wedesign a shelf which is intelligent enough to show the activities going on it automatically in real-timevia wireless network to the host PC by creating a GUI. The security side of the shelf will be taken care by using RFID mechanism and the load cell sensors will be used for determining off-limits of the products on the shelf. The proposed work is implemented onCypress CY8C4245AXI-483 containing Cortex M0 core. By establishing this technique the shelf out of stock and stealing of products would be determined and resolved in real-time, which in turn will satisfy the customers and will also protect the items from being stolen.**

Keywords—**PSoC (Programmable system on chip),RFID(Radio Frequency Identification), Shelf out of stock (SOOS) Load Cell, Wireless sensor network**

I.INTRODUCTION

Customer' gratification is a vital aspect for any commercial. Each time a customer does not get its anticipated product on the shelf the situation leads to out of stock. This causes the customer to switch on another product, to postpone their shopping or to shop in another shop. It also happens that the products are filched away from the shops illegally. This situations arrives due to lack of human attention because it is difficult for human beings to keep minute check on every bustle that happens in the shops. Under all these circumstances there is direct loss of the retailer and manufacturer. Thus there is the need of an hour to design such technology which will be able to remove this drawbacks at minimum cost and maximum efficiency. Here we present a modest tactic through which we can overcome this drawbacks in best conceivable and economical way. The main application of this work is to design an intelligent shelf which will pay attention to every commotion going on it microscopically. The shelf is also proficient to detect the identity of the person who is using it, which is made possible by using RFID technology. The RFID cards are provided to each buyer as their unique identity cards. By swiping these cards to the RFID reader the shelf door will open only after the customer' uniqueness matches it. By using this practice it will be clear that which customer is opening which shelf thusthe merchandises will be saved from getting embezzled. The unavailability of the products on the shelf is exposed by load cell. By use of the load cell technology the total weight of the product is identified and as the products will be picked from the shelf the load will decline.When the weight will be reduced than the threshold value, an alert message will be sent to the host PC via wireless network before out of stock situation arises. The whole situation is monitored in real-time so there are very less chances of products burglary and their insufficiency.

II. RELATED WORK

Many types of researches and technologies have been developed for designing smart shelf. As the technology advances the smart shelves are getting smarter. Many researchers have presented their perspective for this work.The idea of managing shelf was emerged from the idea of the library shelf management system [1]. The technology used in this system was Radio Frequency Identification (RFID). The study was advanced by launching the connection via RFID system and PC. The idea behind this project is to develop a system which will help a librarian to find misplaced books and lost one. GUI is used to keep account of the data of each and every book. The shelf unique id is created and attached with RFID tag. The same phenomenon can be used in designing a smart shelf. By designing a smart shelf for supermarketsthe owner can get notifications about the items on it and which items are out of stock.Frontoni, Mancini presented about the growth of the shelf detector system maintained at low cost and based on wireless communication [2]. The shelf can automatically notify about the items on it. If we move towards hardware of the smart shelf we can describe it as a system of wireless sensor networks which will show all activities going through it in real-time. The shelf consists of various sensors which monitors physical conditions and also used to measure other parameters like temperature, pressure etc. This system is controlled by a RF transmitter that is embedded into a software through a microcontroller. In this proposed system instead of using RFID tags for enabling the products the use of load cell sensors for determining out of stock situations and RFID will be used for security of the shelf.Luo Zhengshan has described the intelligent supermarket where RFID technology based on IOT has been used to develop smart shopping environment [3].The smart supermarket described here is described as a three tier structure containing Client layer, Communication layer ,Database layer. The database layer works as a sender for communication layer which demonstrationsclient and goodsdata in real-time. To improve the performance of the smart shelves using RFID technology SoheylSoodmand has presented a method to increase the range of RFID antenna by increasing the bandwidth [4]. The books are tagged with RFID tags to keep their informationupdated in real-time. The

2085

antenna' range is improved to advance the ability of the system.

The main purpose behind designing smart shelf is to remove the shelf out of stock problem [5].Frontoni has given the concept of smart shelves using RFID technology with some peripherals like sensors, bars, gears etc. The system has installed for long time and has given appreciable results. Thisguided the seller to understand the purchaser' behavior, their product loyalty and the sale of products on weekly and monthly basis. It increased the customers' satisfactionsince no items were out of stock.

III. THE PROPOSED SYSTEM

The proposed design aims at designing a shelf which is economical and user friendly. It will be able to perform multiple tasks at a time. It will keep check on the items insufficiency and will also notify about the items which are kept or removed on the shelf. Apart from this security check will also be taken care of by providing a unique iden only via which the shelf door will open. The proposed syst for designing this shelf consists of load cell sensors, RF Technology, Wi-Fi technology and a host PC/Laptop wh consists of GUI. The Cypress CY8C4245AXI-483 contain Cortex M0 core is used for programming the whole syst .The input for the microcontroller is the information obtain from the value of load cell and the RFID card .T information is send to the Wi-Fi, the Wi-Fi acts as an out for the microcontroller which transmits the obtain information to the host PC which finally displays it on screen via GUI. The general block diagram of the setup of system is shown.

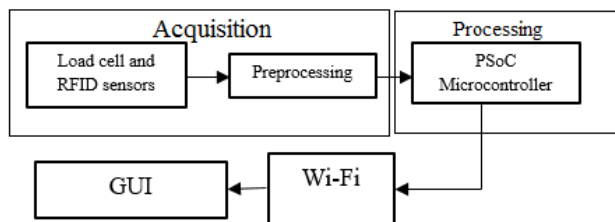Fig.1: Block Diagram

IV. PROCESS FLOW

The flow chart for the designing of smart shelf system is shown as below. It clearly explains how the system starts and step by step process is carried out. After following these steps we are now able to get the real-time information of the activities going on the shelf. Each block in the shelf will contain similar kind of products for convenience of retailer and customer. When the items will be kept on the shelf, the total weight of the products will be measured by load cell and then total weight of the shelf will be send to the main control room by using Wi-Fi technology. This will show the supplier about the total number of items in the shelf in real-time. The system is divided into two parts one is user end and other is admin end. The steps followed for designing the system are:

1) The flow chart shows the initialization of the system where the customer and the admin both opens the door by swiping the unique RFID card through the RFID card reader.After this

their identity will be send to the control room where it will be matched. The shelf door will open only if identity is matched, otherwise the shelf door will not open.   Thus the system will get total information of the person who is using which shelf.
2) If the person picks up any item the weight of that item will be subtracted from the total weight and the person sitting in the control room will be able to identify how many items are remaining in the shelf.
3) If the level of weight decreases from the threshold value the notification will be send to the control room.
4) The person (admin) who monitors the whole situation will get the notification about the shelf items getting extinct. Thus the admin will refill the items which are out of stock. Thus out of stock problem will be resolved.
5) Finally the door will be closed after some time if no activity occurs.

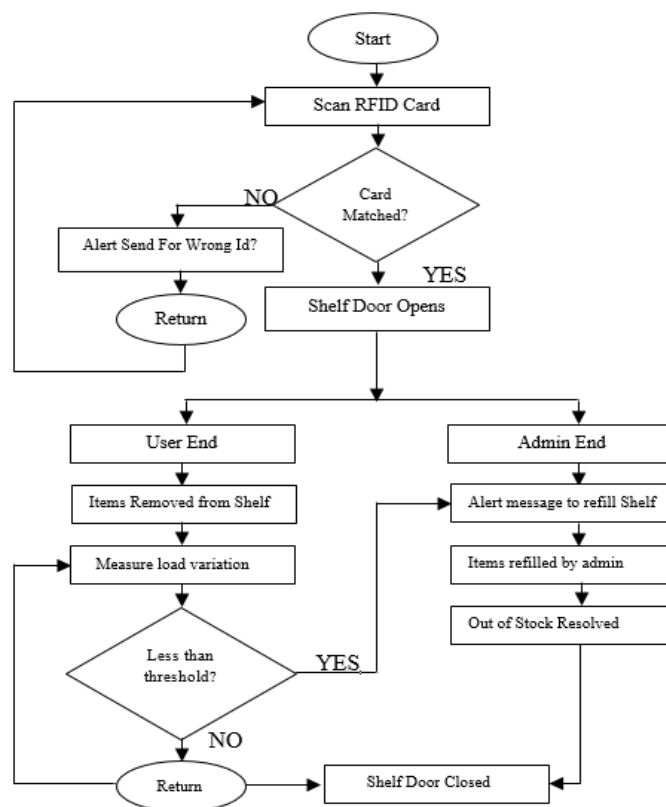The flow chart given below will explain this steps more reliably.

Fig:2 Flow Chart

V. HARDWARE DESIGN
A. PSoC CY8C4245AXI-483:

PSoC® 4 is a mountable and reconfigurable platform design for a family of mixed-signal programmable embedded system controllers with an ARM® Cortex™-M0 CPU. It is a combination of programmable and reconfigurable analog and digital blocks with elastic programmed routing. The PSoC 4200 product family consists of a microcontroller with high-performance analog-to-digital conversion, digital programmable logic, opamps with Comparator mode, and standard communication and timing

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peripherals. In this project we have used Cypress Chip which consists of:

- 48MHz ARM Cortex-M0 CPU with Single Cycle Multiply
- 32kb Flash with Read accelerator
- No. of Pins 44Pins
- No. of I/O's 36I/O's
- Embedded Interface Type I2C, SPI, UART
- Min Supply Voltage 1.71V Max V 5.5V.

sleep / wake patterns, with low-power action adaptive radio bias, front-end signal dispensationpurposes, troubleshooting and radio systems coexist featuresremove cellular / Bluetooth / DDR / LVDS / LCD intervention. Wi-Fi module used here contains following specifications:

- 802.11 b / g / n
- Wi-Fi Direct (P2P), soft-AP
- TCP / IP protocol stack
- PLL, voltage controller and power organizationmechanisms
- 802.11b mode + 19.5dBm output power
- Temperature device
- Support antenna variety
- off leakage current is less than 10uA
- Low-power 32-bit CPU: can double as an application processor
- UART ,SDIO 2.0, SPI,
- 1x1 MIMO, STBC, 2x1 MIMO
- A-MPDU, A-MSDU mixture

VI. RESULT:

The smart shelf designed here can detect out of stock of products and show them in real time on the GUI via wireless embedded network. It also allows the customer to take the products only if their unique ID (RFID) card is matched. It is artificial intelligent shelf whose doors are automated and there is very less margin of burglary of items. Theshelf design is economical and robust. It is one time investment and life time assurance of proper working. It is low maintenance system which does not requires time to time check, it does not require high power to operate.
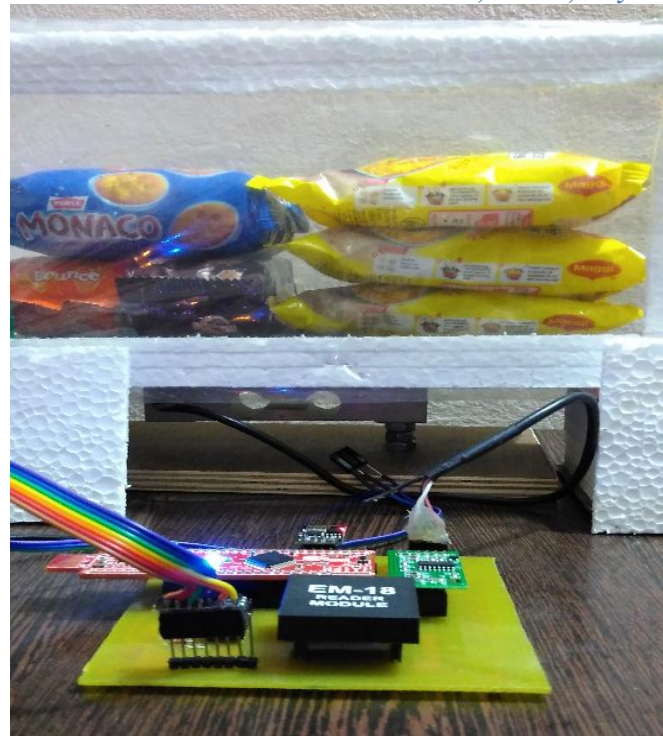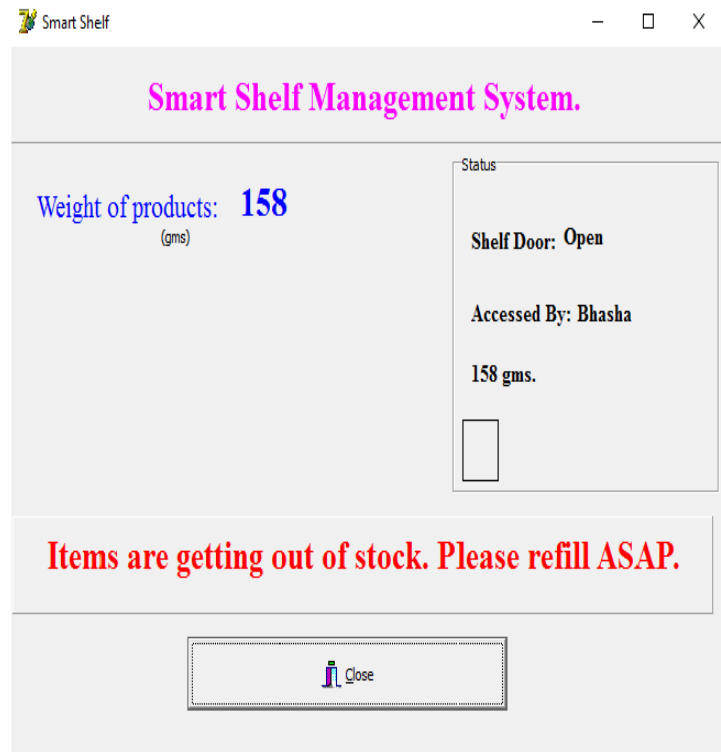

Fig:3 Hardware of the Smart Shelf

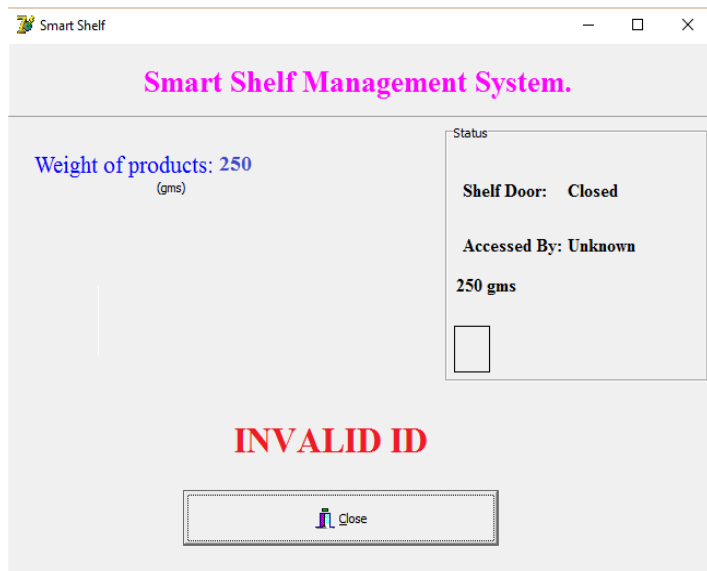Fig.4: ID matched, Door Opened and out of stock of items shown

Fig 5: Door does not open because of INVALID ID

of same weight cannot be misplaced from the shelf. The webcam can also be used for real time visualizations of the products.

VII.   CONCLUSION AND FUTURE SCOPE:

The smart shelf proposed in this project is capable of identifying the activities going on it in real-time. It is notifying the out of stock of items. On the other side it will show the identity of the person who is buying the products from it. The future work to improve this system will be to design a smart trolley with it so that the items

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