RFID BASED SHOPPING CART

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ABSTRACT

Large grocery stores are nowadays used by millions of people for the acquisition of an enlarging number of products. Product acquisition represents a complex process that comprises time spent in corridors, product location and checkout queues. On the other hand, it is becoming increasingly difficult for retailers to keep their clients loyal and to predict their needs due to the influence of competition and the lack of tools that discriminate consumption patterns.

Now days purchasing and shopping at big malls is becoming a daily activity in metro cities. We can see huge rush at malls on holidays and weekends. The rush is even more when there are special offers and discount. People purchase different items and put them in trolley. After total purchase one needs to go to billing counter for payments. At the billing counter the cashier prepare the bill using bar code reader which is a time consuming process and results in long queues at billing counters. Our aim is to develop a system that can be used in shopping malls to solve the above mentioned challenge. The system will be placed in all the trolleys. It will consist of a RFID reader. All the products in the mall will be equipped with RFID tags. When a person puts any products in the trolley, its code will be detected and the price of those products will be stored in memory. As we put the products, the costs will get added to total bill. Thus the billing will be done in the trolley itself. Item name and its cost will be displayed on TOUCH SCREEN. Also the products name and its cost can be announced using headset. At the billing Counter the total bill data will be transferred to PC by ZigBee Modules.

In this project it is presented the proposal of an architecture and solution of an innovative system for the acquisition of products in grocery stores (Intelligent Cart). The Intelligent Cart explores emerging mobile technologies and automatic identification technologies (such as RFID) as a way to improve the quality of services provided by retailers and to augment the consumer value thus allowing to save time and money.

Keywords

Automatic Product Identification; Electronic Services; Grocery Stores, RFID, Intelligent cart

1. INTRODUCTION

Shopping mall is a place where people get their daily necessities ranging from food products, clothing, electrical appliances etc. Nowadays, a numbers of large as well as small shopping malls have increased around the globe due to increasing public demand & spending. Sometimes customers have problems regarding the incomplete information about the product on sale and waste of unnecessary time at the billing counters. Continuous improvement is required in the traditional billing system to improve the quality of shopping experience to the customers.

To overcome these problems and to improve the existing system, we have designed a RFID BASED SHOPPING CART. This can be done by simply attaching RFID tags to the products and a RFID reader with a TOUCH PANEL display on the shopping trolley. With this system, customer will have the information about price of every item that is scanned in, total price of the item and also brief about the product. This system will save time of customers and manpower required in mall and cost associated with the product.

Fig. 1.1 RFID BASED SHOPPING CART

2. HARDWARE DESCRIPTION

2.1 RFID Technology

In recent years, radio frequency identification technology has moved from obscurity into mainstream applications that help speed the handling of manufactured goods and materials. RFID enables identification from a distance and unlike earlier bar-code technology; it does so without requiring a line of sight. RFID tags support a larger set of unique IDs than bar codes and can incorporate additional data such as manufacturer, product type and even measure environmental factors such as temperature. Furthermore, RFID systems can discern many different tags located in the same general area without human assistance.

Fig. 2.1 Three different RFID tags they come in all shapes and sizes.

2.1.1 Definition of RFID technology

Radio frequency identification (RFID) is a general term that is used to describe a system that transmits the identity (in the form of a unique serial number) of an object wirelessly using radio waves. RFID technologies are grouped under the more generic Automatic Identification (Auto ID) technologies.

2.1.2 Earlier scenario in identification stream:

The barcode labels that triggered a revolution in identification systems long time ago are inadequate in an increasing number of cases. They are cheap but the stumbling block is their low storage capacity and the fact that they cannot be reprogrammed.

A feasible solution was putting the data on silicon chips. The ideal situation is contactless transfer of data between the data carrying device and its reader. The power required to operate the electronic data carrying device would also be transferred from the reader using contactless technology. These procedures give RFID its name.

In a not so distant future, RFID enabled stores will monitor the consumption in real time. Shelf will signal the inventory when it needs more stuff and inventory will pull supplies from the manufacturer based on its level of stock.

2.1.2 Differences between Barcode Reader and RFID Reader:

Table 2.1 Differences between Barcode Reader and RFID Reader

RFID	**BARCODE**
Counterfeiting is difficult	**Counterfeiting is easy**
Scanner not required. No need to bring the tag near reader	**Scanner needs to see the barcode to scan it**
RFID is comparatively fast	
Can read multiple tags **Relatively expensive as compared to Bar codes**	**Can read one tag at a time**
Can be reusable	**Cannot be reused**

2.1.3 RFID principles

Many types of RFID exist, but at the highest level, we can divide RFID devices into two classes:
active and **passive**.

Fig. 2.2 RFID Principles

- Active tags require a power source i.e., they are either connected to a powered infrastructure or use energy stored in an integrated battery. In the latter case, a tag's lifetime is limited by the stored energy, balanced against the number of read operations the device must undergo. However, batteries make the cost, size, and lifetime of active tags impractical for the retail trade.
- Passive RFID is of interest because the tags don't require batteries or maintenance. The tags also have an indefinite operational life and are small enough to fit into a practical adhesive label. A passive tag consists of three parts: an antenna, a semiconductor chip attached to the antenna and some form of encapsulation. The tag reader is responsible for powering and communicating with a tag. The tag antenna captures energy and transfers the tag's ID (the tag's chip coordinates this process). The encapsulation maintains the tag's integrity and protects the antenna and chip from environmental conditions or reagents.

2.1.5 RFID Technology and Architecture

Before RFID can be understood completely, it is essential to understand how Radio Frequency communication occurs. RF (Radio Frequency) communication occurs by the transference of data over electromagnetic waves. By generating a specific electromagnetic wave at the source, its effect can be noticed at the receiver far from the source, which then identifies it and thus the information.

In an RFID system, the RFID tag which contains the tagged data of the object generates a signal containing the respective information which is read by the RFID reader, which then may pass this information to a processor for processing the obtained information for that particular application.

Thus, an RFID System can be visualized as the sum of the following three components:

- RFID tag or transponder
- RFID reader or transceiver
- Data processing subsystem

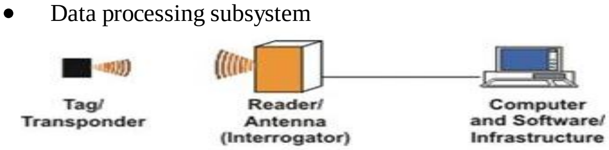

Fig. 2.3 RFID System

An RFID tag is composed of an antenna, a wireless transducer and an encapsulating material. These tags can be either active or passive. While the active tags have on-chip power, passive tags use the power induced by the magnetic field of the RFID reader. Thus passive tags are cheaper but with lower range (<10mts) and more sensitive to regulatory and environmental constraints, as compared to active tags.

An RFID reader consists of an antenna, transceiver and decoder, which sends periodic signals to inquire about any tag in vicinity. On receiving any signal from a tag it passes on that information to the data processor. The data processing subsystem provides the means of processing and storing the data.

2.1.6 RFID Frequencies

Much like tuning in to the favourite radio station, RFID tags and readers must be tuned into the same frequency to enable communications. RFID systems can use a variety of frequencies to communicate, but because radio waves work and act differently at different frequencies, a frequency for a specific RFID system is often dependent on its application. High frequency RFID systems (850 MHz to 950 MHz and 2.3 GHz to 2.5 GHz) offer transmission ranges of more than 90 feet, although wavelengths in the 2.3 GHz range are absorbed by water, which includes the human body and therefore has limitations.

2.2 ARM7 LPC2131/32/33/36/38

2.2.1 General description

The LPC2131/32/33/36/38 microcontrollers are based on a 16-bit/22-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine microcontroller with embedded high speed flash memory ranging from 22 kB to 512 kB. A 128-bit wide memory interface and a unique accelerator architecture enable 22-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 20 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2131/32/33/36/38 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale. Serial communications interfaces ranging from a USB 2.0 Full-speed device, multiple UARTs, SPI, SSP to I2C-bus and on-chip SRAM of 8 kB up to 30 kB, make these devices very well suited for communication gateways and protocol converters, soft modems, voice recognition and low end imaging, providing both large buffer size and high processing power. Various 22-bit timers, single or dual 10-bit ADC(s), 10-bit DAC, PWM channels and 35 fast GPIO lines with up to nine edge or level sensitive external interrupt pins make these microcontrollers suitable for industrial control and medical systems.

2.2.2 Features

- 16-bit/22-bit ARM7TDMI-S microcontroller in a tiny LQFP63 package.
- 8 kB to 30 kB of on-chip static RAM and 22 kB to 512 kB of on-chip flash memory. 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader software. Single flash sector or full chip erase in 300 ms and programming of 256 bytes in 1 ms.
- Embedded ICE RT and Embedded Trace interfaces offer real-time debugging with the on-chip Real Monitor software and high-speed tracing of instruction execution.
- USB 2.0 Full-speed compliant device controller with 2 kB of endpoint RAM. In addition, the LPC2136/38 provides 8 kB of on-chip RAM accessible to USB by DMA.
- One or two (LPC2131/32 vs. LPC2133/36/38) 10-bit ADCs provide a total of 6/13 analog inputs, with conversion times as low as 2.33 µs per channel.
- Single 10-bit DAC provides variable analog output (LPC2132/33/36/38 only).
- Two 22-bit timers/external event counters (with four capture and four compare channels each), PWM unit (six outputs) and watchdog.
- Low power Real-Time Clock (RTC) with independent power and 22 kHz clock input.

2.2.2 Single-chip 16-bit/22-bit microcontrollers

- Multiple serial interfaces including two UARTs (16C550), two Fast I2C-bus (300 Kbit/s), SPI and SSP with buffering and variable data length capabilities.
- Vectored Interrupt Controller (VIC) with configurable priorities and vector addresses.
- Up to 35 of 5 V tolerant fast general purpose I/O pins in a tiny LQFP63 package.
- Up to 21 external interrupt pins available.
- 60 MHz maximum CPU clock available from programmable on-chip PLL with settling time of 100 µs.
- On-chip integrated oscillator operates with an external crystal from 1 MHz to 25 MHz
- Power saving modes include idle and Power-down.
- Individual enable/disable of peripheral functions as well as peripheral clock scaling for additional power optimization.
- Processor wake-up from Power-down mode via external interrupt or BOD.
- Single power supply chip with POR and BOD circuits:
- CPU operating

Block diagram of ARM7

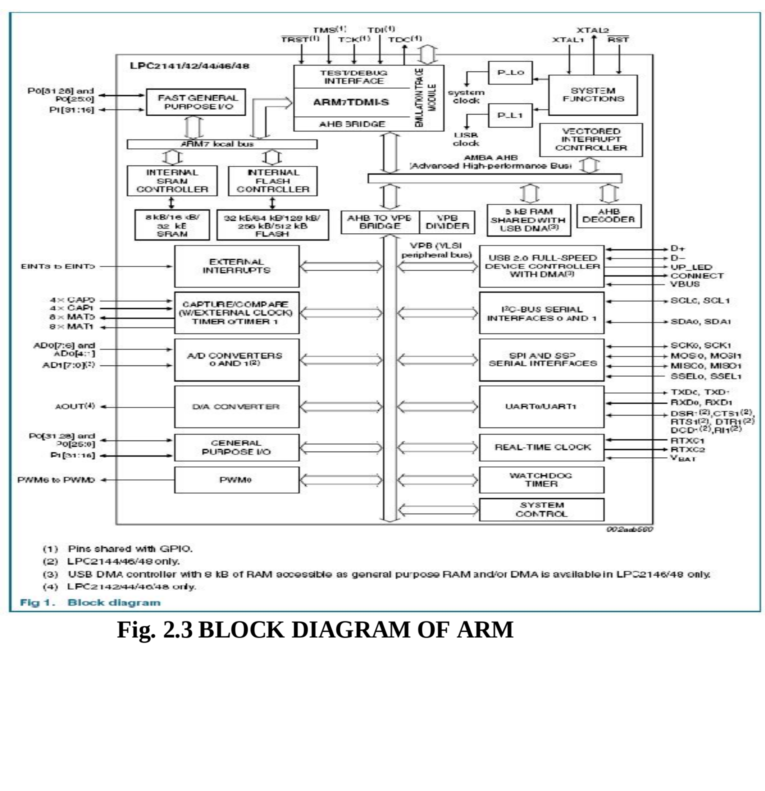

Fig. 2.3 BLOCK DIAGRAM OF ARM

2.3 ZigBee Technology:

ZigBee is an IEEE 802.15.3 standard for data communications with business and consumer devices. It is designed around low-power consumption allowing batteries to essentially last forever. The ZigBee standard provides network, security and application support services operating on top of the IEEE 802.15.3 Medium Access Control (MAC) and Physical Layer (PHY) wireless standard. It employs a suite of technologies to enable scalable, self-organizing, self-healing networks that can manage various data traffic patterns.

ZigBee is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, the low power-usage allows longer life with smaller batteries and the mesh networking provides high reliability and larger range. ZigBee has been developed to meet the growing demand for capable wireless networking between numerous low power devices. In industry, ZigBee is being used for next generation automated manufacturing, with small transmitters in every device on the floor, allowing for communication between devices to a central computer. This new level of communication permits finely tuned remote monitoring and manipulation.

Standard	Bandwidth	Power Consumption	Protocol Stack Size	Stronghold	Applications
Wi-Fi	Up to 54Mbps	400+mA TX, standby 20mA	100+KB	High data rate	Internet browsing, PC networking, file transfers
Bluetooth	1Mbps	40mA TX, standby 0.2mA	~100+KB	Interoperability, cable replacement	Wireless USB, handset, headset
ZigBee	250kbps	30mA TX, standby 3#&956;A	4"32KB	Long battery life, low cost	Remote control, battery-operated products, sensors

Table: Wireless technology comparison chart

Table 2.2 Wireless technology comparison chart

2.4 Touch Screen Specifications

The Easy TFT board as shown on Figure 2.15 contains 2.82" TFT color display MI0282QT-9A with 220x230 pixel resolution, which is driven by ILI9231 display controller, capable of showing advanced graphical content. Each pixel can display 262K different colors. TFT display is covered with a resistive touch panel which can be used as input device. The board is primarily designed to be used as a display board on ARM7 boards. It perfectly fits with the uniquely designed plastic distancer on the GLCD Easy development board socket. For further connectivity there are two female headers, with data and control pinout lines (CN1 and CN2). After testing and building the final program, this card can also be used in your final device. The board also contains mounting holes for easier integration into your designs.

Fig.2.5 Touch screen

- 220x230 pixel 2.82" color **TFT display** with LED back-light,
- **ILI9231** controller and resistive touch panel.

CN1 female header pinout:

- **RD** - Read signal line
- **WR** - Write signal line
- **GND** - Reference ground
- **VCC** - Power supply
- **RS** - Command/data select line
- **CS** - Chip selection line
- **D0-D7** - Data lines
- **RST** - Display reset line
- **+5V** - 5V back-light power supply
- **BPWM** - Back-light PWM line

CN2 female header pinout:

- **XR** - Right side touch panel coordinate
- **YU** - Up side touch panel coordinate
- **XL** - Left side touch panel coordinate
- **YD** - Down side touch panel coordinate

3. SOFTWARE DESCRIPTION

3.1 Keil µVision

The Keil Development Tools are designed for the professional software developer, however programmers of all levels can use them to get the most out of the embedded microcontroller architectures that are supported.

Tools developed by Keil endorse the most popular microcontrollers and are distributed in several packages and configurations, dependent on the architecture.

- **MDK-ARM**: Microcontroller Development Kit, for several ARM7, ARM9, and Cortex-Mx based devices
- **PK166**: Keil Professional Developer's Kit, for C166, XE166, and XC2000 devices
- **DK251**: Keil 251 Development Tools, for 251 devices
- **PK51**: Keil 8051 Development Tools, for Classic & Extended 8051 devices

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In addition to the software packages, Keil offers a variety of evaluation boards, USB-JTAG adapters, emulators, and third-party tools, which completes the range of products.

The following illustrations show the generic component blocks of µVision in conjunction with tools provided by Keil, or tools from other vendors, and the way the components relate.

3.1.1 Software Development Tools

Like all software based on Keil's µVision IDE, the toolsets provide a powerful, easy to use and easy to learn environment for developing embedded applications. They include the components you need to create, debug, and assemble your C/C++ source files, and incorporate simulation for microcontrollers and related peripherals. The RTX RTOS Kernel helps you to implement complex and time-critical software.

Fig.3.1 Software Development Tools

3.1.2 RTOS and Middleware Components

These components are designed to solve communication and real-time challenges of embedded systems. While it is possible to implement embedded applications without using a real-time kernel, a proven kernel saves time and shortens the development cycle. This component also includes the source code files for the operating system.

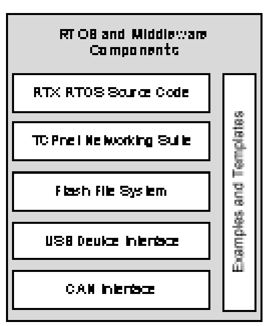


Fig.3.2 RTOS and Middleware Components

3.1.3 Hardware Debug Adapters

The µVision Debugger fully supports several emulators provided by Keil, and other vendors. The Keil ULINK USB-JTAG family of adapters connect the USB port of a PC to the target hardware. They enable you to download, test, and debug your embedded application on real hardware.

Fig.3.3 Hardware Debug Adapters

3.1.3 Microcontroller Architectures

The Keil µVision Integrated Development Environment (µVision IDE) supports three major microcontroller architectures and sustains the development of a wide range of applications.

- **8-bit (classic and extended 8051)** devices include an efficient interrupt system designed for real-time performance and are found in more than 65% of all 8-bit applications. Over 1000 variants are available, with peripherals that include analog I/O, timer/counters, PWM, serial interfaces like UART, I2C, LIN, SPI, USB, CAN, and on-chip RF transmitter supporting low-power wireless applications. Some architecture extensions provide up to 16MB memory with an enriched 16/32-bit instruction set. The µVision IDE supports the latest trends, like custom chip designs based on IP cores, which integrate application-specific peripherals on a single chip.
- **16-bit (Infineon C166**, **XE166**, **XC2000)** devices are tuned for optimum real-time and interrupt performance and provide a rich set of on-chip peripherals closely coupled with the microcontroller core. They include a Peripheral Event Controller (similar to memory-to-memory DMA) for high-speed data collection with little or no microcontroller overhead. These devices are the best choice for applications requiring extremely fast responses to external events.
- **32-bit (ARM7 and ARM9 based)** devices support complex applications, which require greater processing power. These cores provide high-speed 32-bit arithmetic within a 3GB address space. The RISC instruction set has been extended with a Thumb mode for high code density.ARM7 and ARM9 devices provide separate stack spaces for high-speed context switching enabling efficient multi-tasking operating systems. Bit addressing and dedicated peripheral address spaces are not supported. Only two interrupt priority levels, - Interrupt Request (IRQ) and Fast Interrupt Request (FIQ), are available.
- **32-bit (Cortex-Mx based)** devices combine the cost benefits of 8-bit and 16-bit devices with the flexibility and performance of 32-bit devices at extremely low power consumption. The architecture delivers state of the art implementations for FPGAs and SoCs. With the improved Thumb2 instruction set, Cortex-Mx1 based microcontrollers support a 3GB address space, provide bit-addressing (bit-banding), and several interrupts with at least 8 interrupt priority levels.

3.1.5 Creating Embedded Programs

µVision is a Windows application that encapsulates the Keil microcontroller development tools as well as several third-party utilities. µVision provides everything you need to start creating embedded programs quickly.

µVision includes an advanced editor, project manager, and make utility, which work together to ease your development efforts, decreases the learning curve, and helps you to get started with creating embedded applications quickly.

There are several tasks involved in creating a new embedded project:

- Creating a Project File
- Using the Project Windows
- Creating Source Files
- Adding Source Files to the Project

- Using Targets, Groups, and Files
- Setting Target Options, Groups Options, and File Options
- Configuring the Startup Code
- Building the Project
- Creating a HEX File
- Working with Multi-Projects

The section provides a step-by-step tutorial that shows you how to create an embedded project using the µVision IDE.

3.1.6 Creating a Project File

Creating a new µVision project requires just three steps:
1. Select the Project Folder and Project Filename
2. Select the Target Microcontroller
3. Copy the Startup Code to the Project Folder

3.2 Source Code

3.2.1 Algorithm

Step1: Start
Step2: Initialize System
Step3: search for RFID
Step4: check RFID tag
Step5: Read related data from memory
Step6: Display data on LCD
Step7: **A**dd item cost as items are added
Step8: When upload key is pressed send data to the counter
Step9: Print the Bill
Step10: Stop

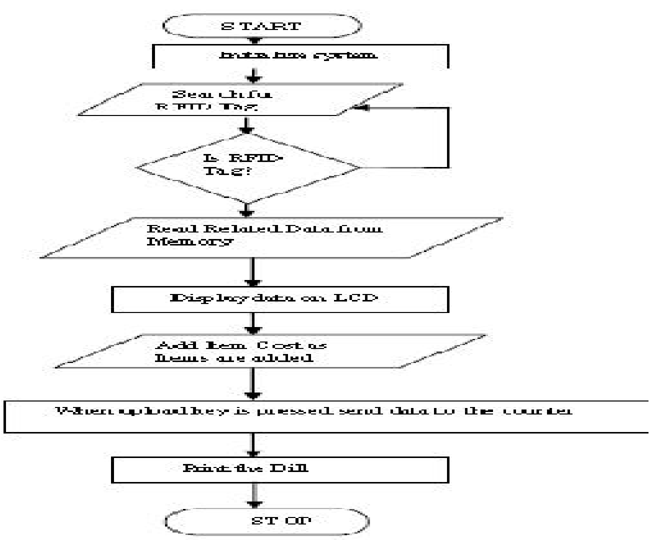


Fig 3.3 Flow Chart of Source Code

4.WORKING PRINCIPLE

A customer enters into a shopping mall. On entering,she/he first picks up a trolley. Each trolley is associated with a RFID reader and a barcode reader. The functioning of the system is explaining below:

• When the customer purchase a product, she/he first scans the RF tag of the product using the RFID reader and then places it into the trolley .While the customer is scanning the RF tag of the product, a price of the product is taken and stored in the system's memory.

• Information stored in system's memory is compared with the lookup table. If matches are found then cost, name of respective product gets displayed on the LCD. At the same time ARM processor sends the same information to computer for billing purpose with the help of RS232 protocol.

• Here we have used IR sensor for counting purpose. This works as the IR sensor continuously emits IR rays. If we put a product in a trolley ant at that time there is obstacle for IR rays, then it would result in interruption in counting of products in trolley. This recorded data is stored in arm processor.

• Counting is mainly done for security purpose. If in case while wandering round the mall someone removes the RFID tag and puts the product in trolley then counting the no of items helps to get information of items purchased. Thus counting is done but there is no addition of cost respective product in bill. This shows the increase in number of products but not increase in bill.

• If an unwanted product is removed from trolley then it decreases the number of products as well as bill. Double entry of product deletes the product name with respective to cost of product.

• After completion of shopping, a key is pressed indicating final billing of all the products. Thus the final information of all products is transmitted to a computer with the help of serial communication & the final billing is done by VB software on computer.

• There is a barcode system in our project. It is impossible to stick the RFID tag to some product like coconut, vegetables etc. Hence in such cases conventional scanning of barcode is more sophisticated than RFID technique.

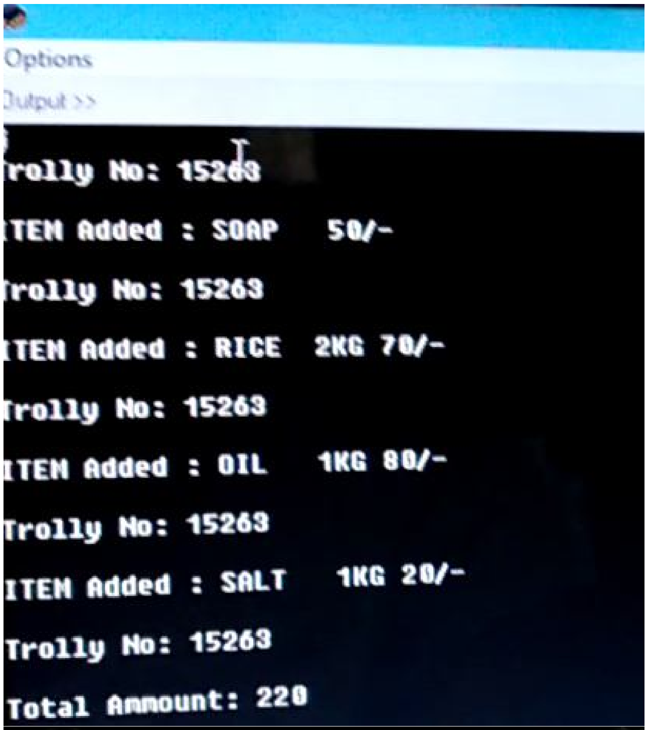
ADVANTAGES:

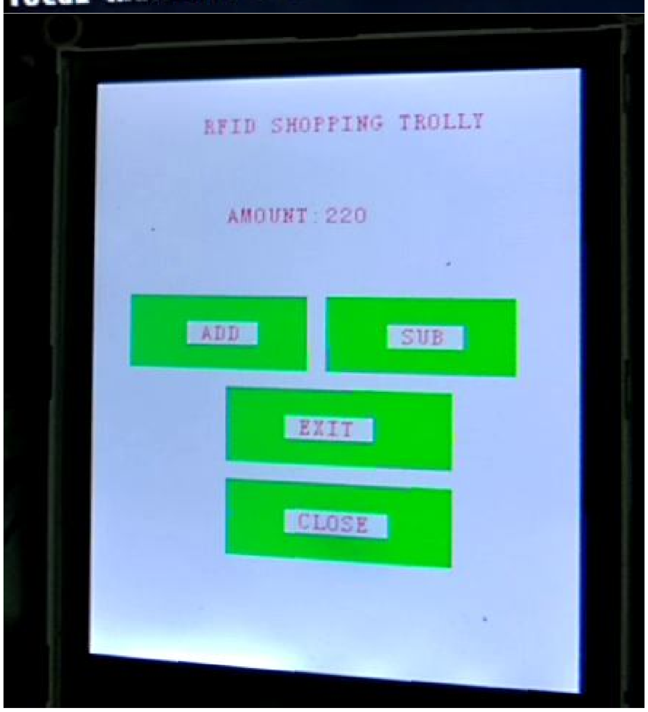
- Enhance shopping experience of customers in super-markets.
- Minimize shopping time.
- Notify customers of total cost for items in cart.
- Alert users when going over estimated budget.
- Reduce the checkout time while eliminating the time taken to wait in a queue.

APPLICATIONS:

- Can be used in Grocery stores.
- Clothing showrooms.
- Super markets.
- All retail shopping malls

RESULTS





5. CONCLUSION

The progress in science & technology is a non-stop process. New things and new technology are being invented. As the technology grows day by day, we can imagine about the future in which thing we may occupy every place. This project is used in shopping complex for purchase the products. In this project RFID card is used as security access for product. If the product is put in to the trolley means it will shows the amount and also the total amount. But in this project RFID card is used for accessing the products. So this project improves the security performance and also the speed. By means of this project we intent to simplify the billing process, make it swift & increase the security using RFID technique. This will take the overall shopping experience to a different level.

Different parameters such as the system parameters of smart trolley like products name, products cost, product weight etc. are continuously display

Thus with the help of the conclusion we can say that-

1. Automatic billing of products by using RFID technique will be a more viable option in the future.
2. The system based on RFID technique is efficient, compact and shows promising performance

6. FUTURE SCOPE

We believe in "RENOVATION" is as important as "INNOVATION", and keeping this in mind, we had some more features that we could not implement in our project but can be included to enhance it. Some of them are,

- Using a GSM module, we can transfer the bill to the mobile instead of printing it. This saves paper.
- With E-banking or net banking enabled, the need of paying bill can also be eliminated, in which case the billing which was already dynamic can also be made mobile.
- There can be voice assistance included.
- Robotic ARM can used for picking and dropping products in which case theft can be avoided.

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