AUTOMATIC VENDING MACHINE

B Tech Thesis

Submitted in partial fulfillment for the award of the Degree of Bachelor of Technology in Electrical and Electronics Engineering

by

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CERTIFICATE

This is to certify that the report entitled "AUTOMATIC VENDING MACHINE" is a bona fide record of the major project done by ***DEVI NANDANA A.V.*** *(Roll No. B120635EE),* ***NAKUL H.*** *(Roll No. B120131EE),* ***NASHID AHMED SHAH*** *(Roll No. B120315EE) and* ***ROOPESH B. JOSE*** *(Roll No. B120513EE) under my supervision and guidance, in partial fulfillment of the requirements for the award of Degree of Bachelor of Technology in Electrical & Electronic Engineering from National Institute of Technology, Calicut for the year 2016.*

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ABSTRACT

A vending machine is a machine that dispenses items such as snacks, beverages, alcohol, cigarettes, lottery tickets to customers automatically, after the customer inserts currency or credit into the machine.

The vending machine prototype that has been developed consists of the following

a) RFID based user recognition system

b) Spring based dispensing mechanism using 2 motors controlled by IR sensors.

c) Personal account recharging facility using GSM module.

The users can purchase their RFID tags from the machine operator / shop owner after paying an amount which will be credited into the accounts. The account information is stored in the EEPROM of the microcontroller used. The user can register his/her choice of product using two externally connected switches. Once the product is selected and user is identified, the account balance is checked to ensure that it will be sufficient to complete the transaction. The motors of the dispensing unit are controlled using an electro-mechanical drive (relay) operated using a transistor connected to the microcontroller. Each motor drives a spring which moves the product stacked between its turns and once a product reaches the brim, it falls down the dispenser. The falling product intercepts an IR sensor which gives signal to the microcontroller to stop the rotation after one unit is dispensed. If the balance is inadequate, the user gets an alert on his mobile phone. The account can be recharged after paying the concerned amount to the vending machine operated who maintains a secure code for recharging the accounts using the GSM module. The customer can continue hassle free purchase thereafter.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

A vending machine is a machine that dispenses items such as snacks, beverages, alcohol, cigarettes and tickets to customers automatically, after the customer inserts currency or credit into the machine. The first modern vending machines were developed in England in the early 20th century and dispensed postcards. In this project, the importance of a modern vending machine using Arduino has been undertaken.

1.2 Significance

The first modern coin-operated vending machines were introduced in London, England in the early 1880s, dispensing postcards. The machine was invented by Percival Everitt in 1883 and soon became a widespread feature at railway stations and post offices, dispensing envelopes, postcards, and notepaper. The Sweetmeat Automatic Delivery Company was founded in 1887 in England as the first company to deal primarily with the installation and maintenance of vending machines.

The first vending machine in the U.S. was built in 1888 by the Thomas Adams Gum Company, selling gum on New York City train platforms. The idea of adding games to these machines as a further incentive to buy came in 1897 when the Pulver Manufacturing Company added small figures, which would move around whenever somebody bought some gum from their machines. This idea spawned a whole new type of mechanical device known as the "trade stimulators".

1.3 Popularity in India

Vending machines are not very common in India and are usually found only in major cities or along some national highways. Seaga India, a 100% subsidiary of the Seaga Group of USA, is the pioneer for bringing the concept of vending machines to India. Seaga India's machines are being used by the Delhi Metro, the State and Central Government, IT parks, factories, BPO, etc.

Vending machines are used to sell snacks, beverages, condoms, public transit tickets, jewellery and change for currency notes.

Several reasons have been attributed to the lack of success of vending machines in India. The availability of cheap labour makes operating stores or kiosks economical; customers lack of technical knowledge and feel uneasy using vending machines; a lack of machines that accept a wide variety of payment methods; vandalism, rough use, and poor maintenance of the machines. However, vending machines are relatively new in India and analysts believe that usage will rise.

1.4 Outline of the report

Chapter 2 reviews the existing models.

Chapter 3 describes the mechanism of modern vending machines.

Chapter 4 analyses the results obtained.

Chapter 5 concludes the project.

References are included at the end.

CHAPTER 2

REVIEW OF MODELS

2.1 Introduction

Automatic vending machines are a common sight in business centers, malls and airports, etc. where easy dispensation of products without employing manpower is required. This project aims to make a similar unit, replicating the basic functions and modifying others to suit the purview of this project.

The conceptualization of the project at various stages relies on existing models and literature. The following is a brief discussion on the models reviewed is given on section.

2.2 Literature review

2.2.1 Design and implementation of coin vending machine using Verilog HDL –

Vending machine is implemented using FPGA board. The mechanism uses three different coins to supply four products. Coins are accepted as inputs in any sequence and when the required amount is deposited the product is dispensed. Change reclamation is also incorporated as a feature if entered amount is greater than the price of the product. The customer is entitled to cancel the order at will at any time and the money deposited will be returned. The proposed algorithm is implemented in Verilog HDL and simulated using Xilinx ISE simulator tool. The design is implemented on Xilinx Spartan-3A FPGA development board. The process of differentiating the coins is a complex and costly one.

2.3 Research gap

The major problem with having a coin operated vending machine is the process of differentiating the coins. In our country, there are a lot of coins available for the same denomination; this makes the segregating procedure difficult. Furthermore, the sizes of the coins are more or less the same, hence the gravity sorting mechanism cannot be used. The magnetic circuit method which measures the current generated by a change in the magnetic field is inefficient as the magnetic material content in the Indian coins is more or less the same. Technology is taking over the world and coins won't last long. Coins get tampered and may not be differentiated properly. The only advantage of coin-based vending machine is that hacking is difficult. The technology-based NFC (Near Field Communication) and RFID (Radio Frequency Identification) are prone to hacking.

2.4 Objectives

- Developing a centralized dispensation unit which reduces labour.
- Developing a user-friendly mechanism to dispense goods which are required on a day-to-day basis or demanded by many.
- Reducing manpower input, wastage of time and energy associated with conventional purchases.
- Popularizing this alternative in India where vending machines are yet to garner wide appreciation
- Decomposing the complexity involved and build a prototype satisfying the requirements mentioned above.

2.5 Summary

Various models were reviewed to obtain a plausible method for this project. The next chapter gives a description on the mechanism of vending machine.

CHAPTER 3

COMPONENTS

3.1 Introduction

The components required are

- Arduino Board
- GSM Module: SIM900A
- RFID Module/ RFID cards with RS232 interfacing protocol
- EM-18 reader module (baud rate (9600 for our project))
- LCD – 16x2
- Power supply 220/9V
- Relay (Goodsky RWH-SH-1120)
- External switches
- Spring coil (10 turns, 8cm)
- DC motor (12V)

3.2 Arduino

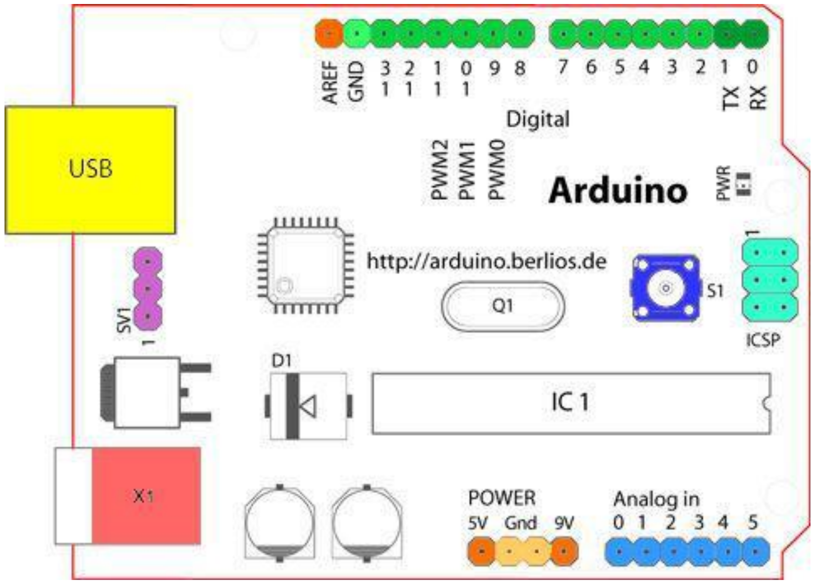
3.1.1 Introduction

Arduino is an open-source prototyping platform based on easy-to-use hardware and software. Arduino boardsare able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language(based onWiring), and the Arduino Software (IDE), based on Processing.

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

3.1.2 Arduino board



Starting clockwise from the top center:

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 2-13 (green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - *These pins cannot be used for digital i/o (*digitalRead *and* digitalWrite*) if you are also using serial communication (e.g.,* Serial.begin*).*
- Reset Button - S1 (dark blue)
- In-circuit Serial Programmer (blue-green)
- Analog In Pins 0-5 (light blue)
- Power and Ground Pins (power: orange, grounds: light orange)

- External Power Supply In (9-12VDC) - X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)
- USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

Digital Pins:

In addition to the specific functions listed below, the digital pins on an Arduino board can be used for general purpose input and output via the pinMode(), digitalRead(), and digitalWrite() commands. Each pin has an internal pull-up resistor which can be turned on and off using digitalWrite() (w/ a value of HIGH or LOW, respectively) when the pin is configured as an input. The maximum current per pin is 40 mA.

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. On the Arduino Diecimila, these pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip. On the Arduino BT, they are connected to the corresponding pins of the WT11 Bluetooth module. On the Arduino Mini and LilyPad Arduino, they are intended for use with an external TTL serial module (e.g., the Mini-USB Adapter).
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.

- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function. On boards with an ATmega8, PWM output is available only on pins 9, 10, and 11.

- BT Reset: 7. (Arduino BT-only) Connected to the reset line of the Bluetooth module.

- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.

- LED: 13. On the Diecimila and LilyPad, there is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

Analog Pins:

In addition to the specific functions listed below, the analog input pins support 10-bit analog-to-digital conversion (ADC) using the analogRead() function. Most of the analog inputs can also be used as digital pins: analog input 0 as digital pin 14 through analog input 5 as digital pin 19. Analog inputs 6 and 7 (present on the Mini and BT) cannot be used as digital pins.

- I^2C: 4 (SDA) and 5 (SCL). Support I^2C (TWI) communication using the Wire library(documentation on the Wiring website).

Power Pins

V_{IN} (sometimes labelled "9V"). The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin. Note that different boards accept different input voltages ranges, please see the documentation for your board. Also note that the LilyPad has no V_{IN} pin and accepts only a regulated input.

- 5V. The regulated power supply used to power the microcontroller and other components on the board. This can come either from V_{IN} via an on-board regulator, or be supplied by USB or another regulated 5V supply.

- 3V3. (Diecimila-only) A 3.3 volt supply generated by the on-board FTDI chip.

- GND. Ground pins.

Other Pins

- AREF. Reference voltage for the analog inputs. Not currently supported by the Arduino software.

- Reset. (Diecimila-only) Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

3.2 GSM/GPRS & GPS modem with SIM900/SIM908 module

3.2.1 Introduction

GSM (Global System for Mobile Communications, originally Groupe Spécial Mobile), is a standard developed by the European Telecommunications Standards Institute (ETSI) to describe the protocols for second-generation (2G) digital cellular networks used by mobile phones. It was first deployed in July 1991 in Finland. It has now become the default global standard for mobile communications. It is being used in over 219 countries and territories with over 90% market share.

(2G) networks developed as a replacement for first generation (1G) analog cellular networks, subsequently, the 3GPP developed third-generation (3G) UMTS standards followed by fourth-generation (4G) LTE Advanced standards. (4G) do not form part of the ETSI GSM standard. "GSM" is a trademark owned by the GSM Association.

3.2.2 Technical details

The basic network consists of the basic 4 parts:

- Base Station Subsystem – the base stations and their controllers explained
- Network and Switching Subsystem – the part of the network most similar to a fixed network, sometimes just called the "core network"
- GPRS Core Network – the optional part which allows packet-based Internet connections
- Operations support system (OSS) – network maintenance

3.2.3 Base station subsystem

GSM is a cellular network, which means that cell phones connect to it by searching for cells in the immediate vicinity. There are five different cell sizes in a GSM network—macro, micro, pico, femto, and umbrella cells. The coverage area of each cell varies according to the implementation environment.

1. Macro cells can be regarded as cells where the base station antenna is installed on a mast or a building above average rooftop level.

2. Micro cells are cells whose antenna height is under average rooftop level; they are typically used in urban areas.

3. Picocells are small cells whose coverage diameter is a few dozen metres; they are mainly used indoors.

4. Femtocells are cells designed for use in residential or small business environments and connect to the service provider's network via a broadband internet connection.

5. Umbrella cells are used to cover shadowed regions of smaller cells and fill in gaps in coverage between those cells.

Cell horizontal radius varies depending on antenna height, antenna gain, and propagation conditions from a couple of hundred meters to several tens of kilometres. The longest distance that the GSM supports is 35 kilometres or 22 miles. There are also several implementations of the concept of an extended cell, where the cell radius could be double or even more, depending on the antenna system, the type of terrain, and the timing advance.

Indoor coverage is also supported by GSM. This may be achieved by using an indoor picocell base station, or an indoor repeater with distributed indoor antennas fed through power splitters. The power splitters are used to deliver the radio signals from an antenna outdoors to the separate indoor distributed antenna system. These are typically deployed when significant call capacity is needed indoors, like in shopping centres or airports. However, this is not a prerequisite, since indoor coverage is also provided by in-building penetration of the radio signals from any nearby cell.

3.2.4 GSM carrier frequencies

GSM networks operate in a number of different carrier frequency ranges. This bandwidth is separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G, with most 2G GSM networks operating in the 900 MHz or 1800 MHz bands. Most 3G networks in Europe operate in the 2100 MHz frequency band.

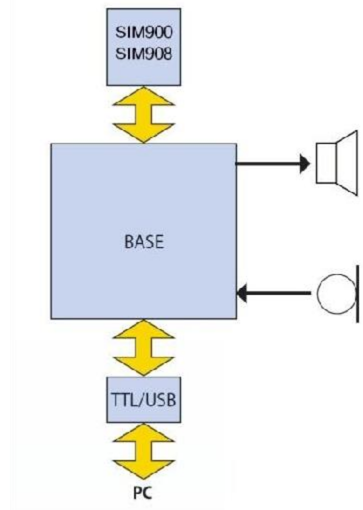
3.2.5 Voice codecs

Originally, on the basis of the types of data channel that was allocated, two basic codecs were used. These used a system based on linear predictive coding (LPC). They were Half Rate (6.5 kbit/s) and Full Rate (13 kbit/s).

In addition to being efficient with bitrates, these codecs also made it easier to identify more important parts of the audio, allowing the air interface layer to prioritize and better protect these parts of the signal. As GSM was further enhanced in 1997 with the Enhanced Full Rate (EFR) codec, a 12.2 kbit/s codec that uses a full-rate channel. Finally, with the development of UMTS, EFR was refactored into a variable-rate codec called AMR-Narrowband, which is high quality and robust against interference when used on full-rate channels, or less robust but still relatively high quality when used in good radio conditions on half-rate channel.

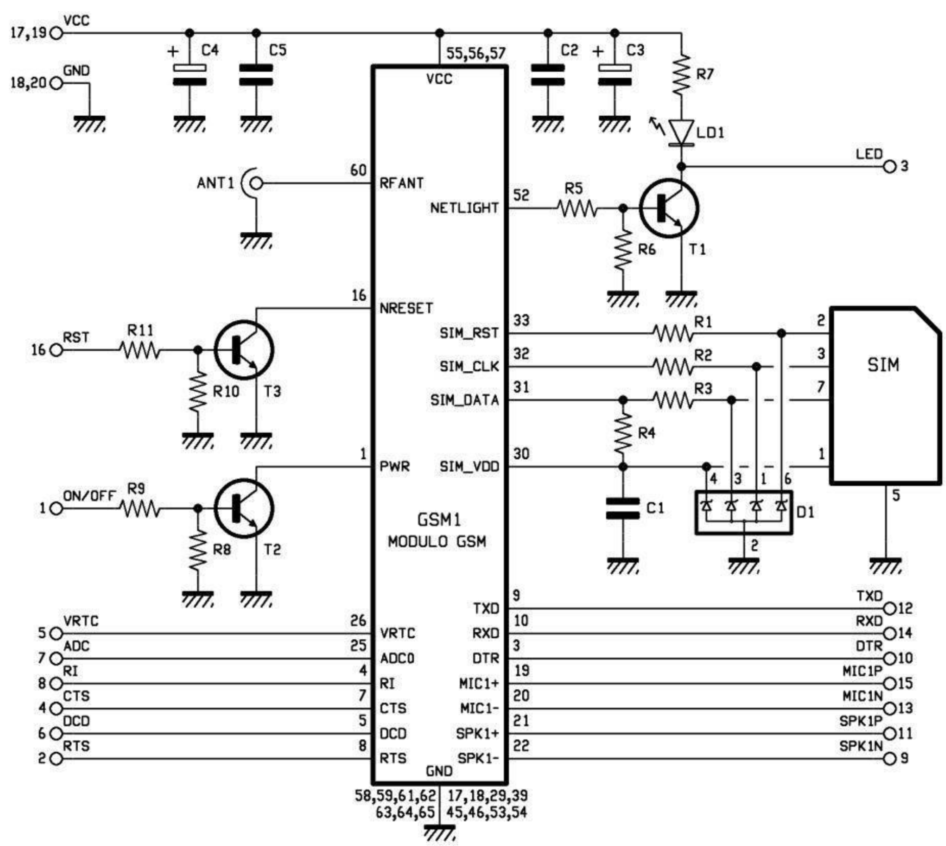
3.2.6 Circuit details

The circuit is made simply by the adoption of a mobile phone module of Simcom SIM908 and SIM900 of the SIMCom. The USB connection is implemented with the aid of a converter TTL / USB type FT782M. The modem used is ideal to perform data links without access to the GPRS network or in any case to the Internet and allows, for example, the use in point-to-point mode, locators GPS / GSM or GSM only so as to obtain instantly data positioning and follow moves on live. In short, it allows direct data connection with another modem or mobile phone provider of a modem, but without going through the web connections are made directly to the GSM data channel.



3.2.7 Wiring diagram

The circuit consists in a Simcom module and a few discrete active and passive electronic components; the conversion interface from TTL to USB is a small module that applies to USB contacts and connects to RX and TX cell module.



The ON/OFF line is connected to an R/C circuit that, at power of the entire circuit, considering that C11 is discharged puts it to hte logical zero; this condition leaves the transistor T2 of the mobile phone module interdict and maintains logical 1 to the PWR Contact of the SIM900/SIM908. When the capacitor is charged enough to saturate the T2 transistor, these places at the bottom level the PWR line of the GSM and turn on the mobile phone.

There are two contacts for the microphone (differential input) and two contacts for the speaker: pins 19, 20, 21, 22, which correspond respectively to MIC1P and MIC1N (positive and negative) and SPK1N and SPK1P (respectively negative and positive of the speaker). The antenna of the GSM module is connected directly on the PCB of the cell on a special type of miniature coaxial MMCX connector. The main power is provided by the 5 volts coming from USB, the absorption of the mobile phone module does not exceed the granted limit (500 mA) from this type of connection.

C1 and C2 filter the voltage and D1 and D2 subtract about 1.4 volts, because SIM900/SIM908 work with a maximum of 4 volts, filtered by C3 and C4 to reduce noise (note the resistor R1, which discharges such capacitor when the circuit is private of supply). Light emitting diodes LD1 and LD2 are used to monitor data traffic, respectively, received on the RX line and sent from the TX.

3.2.8 Use of modem

Before the modem is initialized, first a virtual serial port loading on the computer FT232RL drivers must be installed, downloadable for free from www.ftdichip.com. Once the drivers are installed, connect the modem, with USB/mini-USB cable, and wait while it is found and the drivers are actually installed.

After that, the product can be used by opening a terminal window (Windows Hyper Terminal is fine …) which can handle the modem by issuing the AT commands for the SIM900/SIM908.

The communication session from a terminal must be opened on the virtual COM assigned by the operating system with the following parameters: speed 115.200 bps, 8 data bits, 1 stop bit, no parity and hardware flow control is disabled.

After starting the communication session with Hyper Terminal, the screen shows all the time diagnostic information and other data coming from the SIM900/SIM908 modem; appropriate commands can then be given, perhaps starting with a reset (ATZ).

Before starting an initial test is to be conducted, giving the command ATD NNNNNNNNN where NNNNNNNNN is the number to dial, putting the number of mobile phone with a modem and pressing Enter, the incoming message will be displayed on a window in the screen soon enough. If the command ATD NNNNNNNNN followed by ‘;' is given then, the call will be on a normal mode (vocals) and the called phone display will show only the incoming call alert.

3.3 Radio Frequency Identification (RFID)

Radio frequency identification (RFID) uses electromagnetic fields to automatically identify and track tags attached to objects. The tags contain electronically stored information. Passive tags collect energy from a nearby RFID reader's interrogating radio waves. Active tags have a local power source such as a battery and may operate at hundreds of meters from the RFID reader. Unlike a barcode, the tag need not be within the line of sight of the reader, so it may be embedded in the tracked object. RFID is one method for Automatic Identification and Data Capture (AIDC).

RFID tags are used in many industries, for example, an RFID tag attached to an automobile during production can be used to track its progress through the assembly line; RFID-tagged pharmaceuticals can be tracked through warehouses; and implanting RFID microchips in livestock and pets allows positive identification of animals.

Since RFID tags can be attached to cash, clothing, and possessions, or implanted in animals and people, the possibility of reading personally-linked information without consent has raised serious privacy concerns. These concerns resulted in standard specifications development addressing privacy and security issues. ISO/IEC 18000 and ISO/IEC 29167 use on-chip cryptography methods for untraceability, tag and reader authentication, and over-the-air privacy. ISO/IEC 20248 specifies a digital signature data structure for RFID and barcodes providing data, source and read method authenticity. This work is done within ISO/IEC JTC 1/SC 31 Automatic identification and data capture techniques.

In 2014, the world RFID market is worth US$8.89 billion, up from US$7.77 billion in 2013 and US$6.96 billion in 2012. This includes tags, readers, and software/services for RFID cards, labels, fobs, and all other form factors. The market value is expected to rise to US$18.68 billion by 2026.

3.3.1 Design

Readers

RFID systems can be classified by the type of tag and reader. A Passive Reader Active Tag (PRAT) system has a passive reader which only receives radio signals from active tags (battery operated, transmit only). The reception range of a PRAT system reader can be adjusted from 1–2,000 feet (0–600 m), allowing flexibility in applications such as asset protection and supervision.

An Active Reader Passive Tag (ARPT) system has an active reader, which transmits interrogator signals and also receives authentication replies from passive tags.

An Active Reader Active Tag (ARAT) system uses active tags awoken with an interrogator signal from the active reader. A variation of this system could also use a Battery-Assisted Passive (BAP) tag which acts like a passive tag but has a small battery to power the tag's return reporting signal.

Fixed readers are set up to create a specific interrogation zone which can be tightly controlled. This allows a highly defined reading area for when tags go in and out of the interrogation zone. Mobile readers may be hand-held or mounted on carts or vehicles.

Tags (Cards)

A radio-frequency identification system uses tags, or labels attached to the objects to be identified. Two-way radio transmitter-receivers called interrogators or readers send a signal to the tag and read its response.

RFID tags can be either passive, active or battery-assisted passive. An active tag has an on-board battery and periodically transmits its ID signal. A battery-assisted passive (BAP) has a small battery on board and is activated when in the presence of an RFID reader. A passive tag is cheaper and smaller because it has no battery; instead, the tag uses the radio energy transmitted by the reader. However, to operate a passive tag, it must be illuminated with a power level roughly a thousand times stronger than for signal transmission. That makes a difference in interference and in exposure to radiation.

Tags may either be read-only, having a factory-assigned serial number that is used as a key into a database, or may be read/write, where object-specific data can be written into the tag by the system user. Field programmable tags may be write-once, read-multiple; "blank" tags may be written with an electronic product code by the user.

RFID tags contain at least two parts: an integrated circuit for storing and processing information, modulating and demodulating a radio-frequency (RF) signal, collecting DC power from the incident reader signal, and other specialized functions; and an antenna for receiving and transmitting the signal. The tag information is stored in a non-volatile memory. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively.

An RFID reader transmits an encoded radio signal to interrogate the tag. The RFID tag receives the message and then responds with its identification and other information. This may be only a unique tag serial number, or may be product-related information such as a stock number, lot or batch number, production date, or other specific information. Since tags have individual serial numbers, the RFID system design can discriminate among several tags that might be within the range of the RFID reader and read them simultaneously.

3.4 EM-18 RFID reader

This module directly connects to any microcontroller UART or through a RS232 converter to PC. It gives UART/Wiegand26 output. This RFID Reader Module works with any 125 KHz RFID tags.

Specifications

- 5VDC through USB (External 5V supply will boost range of the module)
- Current: <50mA
- Operating Frequency: 125Khz
- Read Distance: 10cm
- Size of RFID reader module: 32mm(length) * 32mm(width) * 8mm(height)

3.4.1 Baud

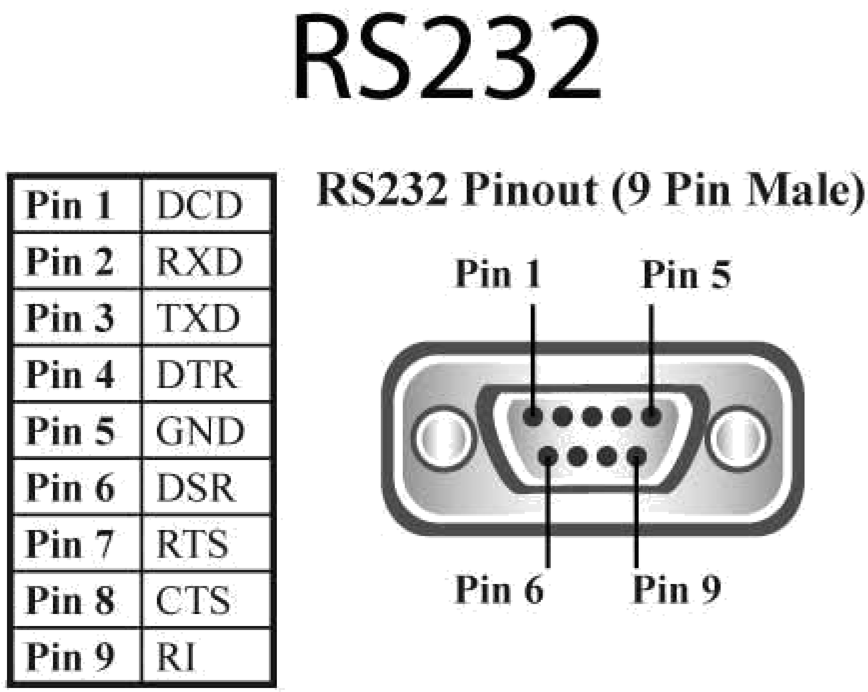
In telecommunication and electronics, baud is the unit for symbol rate or modulation rate in symbols per second or pulses per second. It is the number of distinct symbol changes (signaling events) made to the transmission medium per second in a digitally modulated signal or a line code.

Digital data modem manufacturers commonly define the baud as the modulation rate of data transmission and express it as bits per second. Baud is related to gross bit rate expressed as bits per second.

3.4.2 RS-232

In telecommunications, RS-232 is a standard for serial communication transmission of data. It formally defines the signals connecting between a DTE (data terminal equipment) such as a computer terminal, and a DCE (data circuit-terminating equipment or data communication equipment), such as a modem. The RS-232 standard is commonly used in computer serial ports. The standard defines the electrical characteristics and timing of signals, the meaning of signals, and the physical size and pinout of connectors. The current version of the standard is TIA-232-F Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange, issued in 1997.

An RS-232 serial port was once a standard feature of a personal computer, used for connections to modems, printers, mice, data storage, uninterruptible power supplies, and other peripheral devices. However, RS-232 is hampered by low transmission speed, large voltage swing, and large standard connectors. In modern personal computers, USB has displaced RS-232 from most of its peripheral interface roles. Many computers do not come equipped with RS-232 ports and must use either an external USB-to-RS-232 converter or an internal expansion card with one or more serial ports to connect to RS-232 peripherals. Nevertheless, RS-232 devices are still used, especially in industrial machines, networking equipment, and scientific instruments.



3.4.3 Limitations of the standard

Because RS-232 is used beyond the original purpose of interconnecting a terminal with a modem, successor standards have been developed to address the limitations. Issues with the RS-232 standard include:

- The large voltage swings and requirement for positive and negative supplies increases power consumption of the interface and complicates power supply design. The voltage swing requirement also limits the upper speed of a compatible interface.

- Single-ended signaling referred to a common signal ground limits the noise immunity and transmission distance.

- Multi-drop connection among more than two devices is not defined. While multi-drop "work-arounds" have been devised, they have limitations in speed and compatibility.

- The definitions of the two ends of the link are asymmetric. This makes the assignment of the role of a newly developed device problematic; the designer must decide on either a DTE-like or DCE-like interface and which connector pin assignments to use.
- The handshaking and control lines of the interface are intended for the setup and takedown of a dial-up communication circuit; in particular, the use of handshake lines for flow control is not reliably implemented in many devices.
- No method is specified for sending power to a device. While a small amount of current can be extracted from the DTR and RTS lines, this is only suitable for low-power devices such as mice.
- The 25-way connector recommended in the standard is large compared to current practice.
- The standard does not address the possibility of connecting a DTE directly to a DTE, or a DCE to a DCE. Null modem cables can be used to achieve these connections, but these are not defined by the standard, and some such cables use different connections than others.

3.4.4 RS-232 interface format:

10 ASCII DATA (card no.) + 2 ASCII DATA (XOR result)

E.g., Card number is 4500C5D1E9B8 read from reader then the card number on card will be as below.

45 - Preamble

00C5D1E9 value in Hex = 12964329. B8 is XOR value for (45 XOR 00 XOR C5 XOR D1 XOR E9)

Hence number on the card is 0012964329.

- Data baud rate: 9600 bps
- Data bit 8 bits
- Parity check: None
- Stop bit

CHAPTER 4

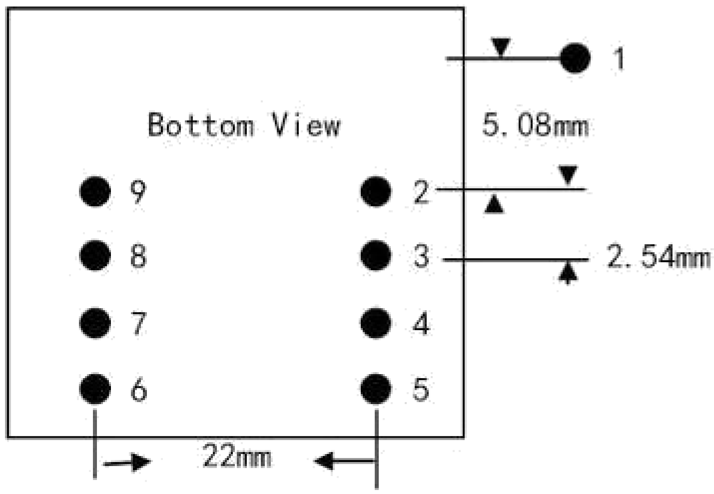
WORKING METHODOLOGIES

The assembly consists of an RFID module, a GSM module and a dispensing unit.

4.1 RFID module

The RFID module consists of an EM18 module and 2 RFID tags. For the purpose of demonstration, we use 2 tags representing 2 users (user 1 and user 2). The account information of the users is stored at 2 locations in the EEPROM (15 and 30 in this case). The values stored in the EEPROM are retained in the case of power failure. Since the EEPROM size varies from board to board and can be a maximum of 1024 bytes, with increasing number of users, the data will have to be monitored using a web server as is the case with ATMs and vending machines in supermarkets. Pin numbers 6 and 7 are configured as digital input pins. These pins are externally connected to switches using which the user can register his choice of the product from a list of 2 products. The price of the 2 products are Rs 5 and Rs 10 respectively. A baud rate of 9600 is set.2 sets of serial pins are needed, one for RFID and the other for GSM module. Since arduino has only two pins for serial, we configure two digital pins as serial for GSM (pins 2,3). The user is prompted to select a product. The serial input is checked at regular intervals to see if garbage values are being fed by the GSM which was found to cause unwanted errors. (flushrcv()). The digital input pins are monitored to check whether the user has registered a choice. If the condition is true, the read_user() function reads the user from the card swiped over the RFID module.

The data stored in the tags are compared with the stored tag details of each user using string compare function and if a match is found, transaction is initiated. The price of the product, current account balance and updated account balance after deducting the price of the product are shown. If the account balance is inadequate, a message indicating the same is sent to the user.



Pin No.	Name	Function
1	VCC	5V
2	GND	Ground
3	BEEP	BEEP and LED
4	ANT	No Use
5	ANT	No Use
6	SEL	HIGH selects RS232, LOW selects WEIGAND
7	TX	UART TX, When RS232 is Selected
8	D1	WIEGAND Data 1
9	D0	WIEGAND Data 0

4.2 GSM Module

The transactions are reflected as a deduction of account for purchase and addition of account balance for recharge. This is made possible using a GSM module SIM900. The GSM module consists of an antenna which detects the signal. GSM module is mainly used to recharge the RFID tags. After the payment, the owner of the vending machine sends a unique code to the SIM in the GSM Module and the corresponding customer's account in the EEPROM is recharged with the paid amount.

4.3 DISPENSING UNIT

Once the user's account balance is verified and found feasible for account transaction, the product will be dispensed by the dispensing unit. 2 motors have been set up to control two springs, whereby two different products can be dispensed. Pins 18 and 19 of the microcontroller control motor1 and motor2 and each of these pins have to be set high according to the product chosen.

When one of the above pins is set high, the base voltage of the transistor becomes high enough (VBE >0.7) and the relay coil is energized. When the relay coil is energized, the NC and C which were earlier in contact are disconnected and the connection is transferred so as to establish a contact between NO and C. This results in 12V appearing across the motor and the spring connected to it starts rotating.

The product is stacked between the turns and as the spring rotates, it advances forward and on reaching the opening of the orifice provided, it slides down. The product on its way down intercepts an IR sensor and this signal reaches pin 4 which instructs the microcontroller to stop the rotation of the concerned motor by making the respective pin LOW.

CHAPTER 5

RESULTS AND ANALYSIS

5.1 Introduction

The vending machine chosen for evaluation for this project was determined to be a good example of a product that was designed for functionality only. Due to innovations in design areas, more innovative features must reinforce functionality. It was this aspect of modern design that were applied in the evaluation of this project.

5.2 Project research

Evaluating the project, it was decided to look into how similar type of machines worked. The vending machine used here uses RFID tags as the mode of transfer of payment unlike conventional vending machines. Most vending machines use direct mode of payment like coins or tokens. Establishing the credibility of the payment received is a hectic process within the system and takes both time and money.

Hence, it was concluded upon that incorporating the RFID technology or BARCODE technology to the ID tags best solves the short-comings.

The advantages of RFID over Barcode technology:

1. No line-of-sight requirement.
2. The tag can stand a harsh environment.
3. Long read range.
4. Portable database.

5. Multiple tag read/write.

5.3 Targeted users

The main users targeted for this study were guests to the college, students, staff, and faculty.

5.4 Task analysis

In order to receive the product from the vending machine the person(user) must perform the following simple tasks.

1. Be able to find information if needed to operate machine
2. The customer's RFID tag must be produced at the RFID sensor
3. When the machine senses the tag, it displays the amount of balance in his/her account. The user has to then choose among the options, his/her desired choice of product.
4. Press enter and wait till it dispenses your choice.
5. The new account balance is then displayed on the LCD.
6. Collect the delivery from dispenser.

Users are given as much time as needed to complete these tasks. This is to determine the usability of using the vending machine without outside assistance. It is assumed that all the instructions that they will need will be available through the vending machine interface. These seem like simple steps but the design of the machine supports the ease of these straightforward tasks.

5.5 Results obtained

The following results were obtained based on the study that was conducted.

1. The working of various parts of the vending machine was studied.
2. The machine was designed to read and recognize the RFID tags unlike the commonly seen vending machines in India which uses coins.
3. The machine was designed to have an outwardly simple design and user-friendly technology which would drive away the stigma associated with complex machines and reduce the reluctance of common people.
4. Microcontroller (Arduino Uno) was programmed to read the tags and dispense products accordingly.
5. The microcontroller was also enabled to recharge the amount in every user's account via a GSM incorporated in the vending machine.
6. An LCD displaying the amount deposited and sequential user prompts was implemented.
7. Interfacing of a DC motor with the microcontroller to segregate the valid coins from other deposits was attempted and partial success was registered.

5.6 Challenges faced

1. The sorter body being a mechanical structure induced slight errors and reduction of these errors was a difficult task.
2. The user needs to recharge accounts personally by depositing cash to the owner or at the place defined by the owner.

5.7 Merits

Many features like the usage of smart ID cards incorporated with RFID reading display and the programming behind it makes it advanced. Due to the absence of human element, the vending machine has many advantages. It can be available 24x7, even on holidays. It requires less maintenance.

The user interface is such that all age groups are easily accessible, for example, old people and kids don't have to waste time explaining about their order to the shop vendor. They can be income producing work machines that doesn't have flaws. There are no bad checks written and no outstanding accounts receivables to collect.

There are very few overhead costs associated with the vending machine business. Managing the route yourself eliminates the need for employees. This translates to no dealing with payroll, benefits and scrambling when someone calls in sick. Your fully-stocked machine speaks for itself, so there are no advertising costs. By basing the business out of your home, there is no need for leasing, renting or purchasing an office space.

5.8 Summary

The results obtained were summarized in this chapter. The analysis was done to improve the existing design to get an efficient, smart, self-sufficient, user friendly and economically feasible model.

CHAPTER 6

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