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DESIGN AND IMPLEMENTATION OF A DATA BASED FUEL MANAGEMENT SYSTEM

BY

Abdullah Al Masum - ET 163022

Md Shahidul Islam - ET 141012R

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

Department of Electrical and Electronic Engineering
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DECEMBER, 2021

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A thesis/project
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Department of Electrical and Electronic Engineering
INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

DECEMBER, 2021

CERTIFICATE OF APPROVAL

The thesis/project entitled as **"DESIGN AND IMPLEMENTATION OF A DATA BASED FUEL MANAGEMENT SYSTEM"** Submitted by **Abdullah Al Masum** bearing Matric ID- ET 163022, **Md Shahidul Islam** bearing Matric ID - ET 141012R of session Spring 2021, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory in partial fulfilment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on 24 December, 2021.

_____

Supervisor
Engr. SK. Md. Golam Mostafa
Associate Professor,
Department of Electrical and Electronic Engineering
International Islamic University Chittagong.

DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this thesis/project has been submitted elsewhere for the award of any degree or diploma.

_____

Abdullah Al Masum

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Md Shahidul Islam

ACKNOWLEDGMENT

All praises and thanks to Allah, the Lord of the world, the most Beneficent, the most Merciful for helping us to accomplish this work.

We are beholden to a number of people, who supported us to carry out this work. It is a genuine pleasure, to express our deep sense of thanks and gratitude to our mentor, guide and supervisor, **Engr. Sk. Md. Golam Mostafa,** Associate Professor, Department of Electrical and Electronic Engineering, IIUC. His dedication and keen interest above all his overwhelming attitude to help his students and been solely and mainly responsible for completing our work. His timely advice, meticulous scrutiny, scholarly advice and scientific approach have helped us to a very extent to accomplish this task.

We are grateful to our parents and fellow classmates to enhance our spirit and interest towards this topic by providing enthusiastic encouragement.

In this project we have tried our best to achieve our goal. In early stage while we were collecting information relative to our project many individuals have contributed towards this project. We would like to render our gratitude and grateful thanks to each one of them.

Authors

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ABSTRACT

Day by day the number of vehicles and machines are increasing in the modern world. In the present day's scenario, the demand for fuel is increasing because vehicles and machines are depending on fuel. The long line in front of fuel stations, especially in front of gas pumps is a common scenario in daily life that wastes valuable time. In Bangladesh, the fuel stations are operated manually which causes the delay. The main aim of the project is to design a system which is capable of automatically deducting the amount of petrol dispensed from a user card based on RFID technology. Liquid dispensing systems are quite commonly found in our daily life in different places like offices, bus stands, railway stations, fuel pumps. This report presents a modern new era fuel dispensing system which is meant to be operated with prepaid cards using RFID technology. The project mainly aims in designing a prepaid card for fuel bunk system and also fuel dispensing system using RFID technology. In current days the fuel stations are operated manually. These fuel pumps are time consuming and require more man power. To place fuel stations in distant areas is very costly to provide excellent facilities to the consumers. All these problems are sorted out by the use of an unmanned power pump which requires less time to operate and it is effective and can be installed anywhere. We have also developed an automated fuel management system that can maintain the account of the fuel stations. The results of this experiment show a receipt automatically after every transaction via an excel sheet. This management system also helps the fuel stations to become faster and can reduce corruption in transactions of fuel stations

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CHAPTER 1

INTRODUCTION

1.1 Introduction to Fuel Management System

Fuel-management systems are used in any industry that relies on transportation, such as rail, road, water, and air, to maintain, regulate, and monitor fuel usage and stock. Fuel systems are used in the transportation and construction sectors to properly monitor and manage the usage of fuel. They're commonly utilized for fleets of vehicles, such as trains and planes, as well as any vehicle that requires fuel to run. They track and monitor fuel stockpiles, purchases, and dispensations using a variety of methods and technology. This data may then be saved in computerized systems, and reports based on it can be created to help managers make more informed decisions. The use of online services to give comprehensive fueling data, generally via the SMS back end of an automated fuel management system, seems to be how online fuel management is supplied. This allows for fuel purchase usage management, cost analysis, and tax accounting.

Fig. 1.1 Present Fuel Station in Bangladesh [1]

Fuel-management systems come in a number of different forms. **Figure 1.1** represents the typical Bangladeshi petrol station. Fuel transactions are often managed by card-based fuel management systems using a fueling credit card and the related driver PIN. Reports may then be created based on driver fuel use, and data can be downloaded

immediately. Fleet refueling services or bulk fuel tanks may be used by on-site fuel management systems. As fuel is supplied into vehicles, it is monitored, and on-site storage levels may be regulated.

Some fuel suppliers provide complete fuel management systems, which include components of a card-based system as well as on-site fuel delivery and refueling. A fleet of fuel trucks or tankers that deliver fuel to commercial fleets of trucks or construction equipment is referred to as mobile fuel management. Combining RFID technology to identify equipment and automated fuel management to append the specifics of each transaction to a unique piece of equipment might be part of the solution. The corporation may save man-hours by refilling vehicles in the evening when they are not in use, as the operators do not have to refuel and the vehicles do not need to go to the refueling station. They may also use more advanced systems that collect precise technical information about vehicle usage and performance factors such as mileage, hours of operation, and engine idle time via remote data collecting.

The increasing application of biofuel has created a new issue in terms of fuel management. There is a danger of microbial development with higher water content - depending on storage circumstances, the fuel quality will decline with time, resulting in clogged filters and lost production.

Fuel filtering and cleansing packs, which recycle the tank contents through a series of filters and UV treatments to remove microorganisms, have been launched by tank manufacturers. Data from fuel quality instruments can be transmitted over the Internet for remote monitoring [1].

Fig. 1.2 Hazard of purchases of Fuel [1]

1.2 Method

1.2.1 RFID Tags

The most frequent sort of ID token since it is the most dependable in the sometimes hostile environment of fueling. The use of an RFID tag eliminates the need for apertures in the fuel-management terminal, providing the highest protection against water and dust infiltration. RFID tags are inexpensive and dependable, and the reader does not need to be updated on a regular basis.

1.2.2 Magnetic Cards

A fleet that currently uses fuel cards will utilize the same cards at the fuel-island terminal, which is often considered as just a cost-effective alternative to acquiring RFID tags. Because the exposed nature of most fuel islands makes it difficult to utilize fuel cards, their dependability may be compromised, and hence reported savings may not be realized. If the readers are cleaned on a regular basis, a satisfactory degree of dependability can be attained.

1.2.3 Dallas Touch Keys / I Buttons

These keys, which are a popular alternative to RFID tags, include two electrical contacts that must be contacted by a reader. These keys are extremely dependable, requiring just little key reader maintenance.

1.2.4 Nozzle Based Technologies

A reader is installed on the fueling nozzle or integrated into the nozzle itself in this method. The vehicle ID is read when the refueling nozzle is placed into the vehicle filler neck or attached as part of a dry break fuel system. This vehicle identity is subsequently relayed through wires or RFID technology back to the FM terminal. The advantage of this technique is that before the fuel starts to flow, the fueling nozzle must be fully inserted or linked to the vehicle, and fueling stops if the nozzle is disconnected, making on-site fuel theft considerably more difficult. Unfortunately, it has no effect on off-site fuel theft, hence it should be used in connection with anti-siphoning technology to complete the system.

1.2.5 Hand Held Scanners

These are particularly beneficial for Mobile Refuelling Solutions if the fuller has located some distance from the pumping unit (e.g. Bowser) during the time of fueling. An RFID, Near Field, or Barcode Reader is included within the Hand Held Unit to scan a tag or barcode permanently connected to the fueling equipment. The HHU then sends the ID data back to the browser over a radio connection, where it is confirmed and the pump is turned on. Because the fuller is at the point of delivery, he or she can manage the hose, reducing spillage.

1.2.6 Bluetooth technology

Vehicles having a Bluetooth transponder can be upgraded to enable for vehicle identification as well as data transfer through the vehicle's CAN network.

1.3 Auto Management System

1.3.1 New Payment Method

The rapid growth in the number of automobiles in Bangladesh has resulted in traffic jams and congestion in practically all of the country's cities. In Bangladesh, the delivery of fuel to such a large number of automobiles at fuel stations has generated several issues. Because the station operator does not have tiny money change, the vehicle driver

must pay for fuel with cash and may have to pay more than the quantity of fuel provided. The goal of an RFID-based payment system is to decrease human work by developing an auto-guided mechanism and doing the task in a sequential manner. These systems are extremely dependable and time-saving technologies.

1.3.2 Automatic Exit Gate Control

An automated gate control system is used in this model, which is controlled by an IR sensor and a photodiode. It will take the consumer time and ensure payment for each vehicle.

1.3.3 Recent Systems in Bangladesh

Most gasoline stations nowadays are manually operated, which requires more people and takes time. It is extremely expensive to locate fuel stations in remote areas while yet providing quality service to customers. The fuel pumps distribute fuel to client vehicles using manpower and are extremely reliant on the loyalty of the person conducting the job. This distribution method has a number of drawbacks, including fuel theft, unauthorized fuel sales, and manpower loss. The majority of today's fuel stations also serve as traditional businesses, raising security problems enormously. The fuel pumps must be constantly monitored, which includes recording all operations and giving actual proof in the event of a crime. Public transportation companies try to incorporate high-quality, cutting-edge technology into their services in order to maximize the use of available resources. The use of technology in service delivery has altered how services are delivered and planned. Self-service technology such as self-service fuel dispensers and automated teller machines fall under this category. This has been made possible owing to the Internet and computers. Older identifying techniques were insufficiently reliable. In a system using paper vouchers, for example, there is a serious risk of false coupons that are difficult to identify from real ones. Furthermore, there is no clear picture of fuel dispensing on a daily, weekly, or monthly basis, nor of how many vouchers are still in circulation.

The introduction of radio-frequency technology has altered traditional data collection methods. RFID tags provide advantages over standard bar codes, magnetic cards, and IC cards in terms of non-contact, reading speed, no wear, extended life, user-friendliness, and security. RFID is displacing barcode technology and offers the key benefit of being line-of-sight independent and capable of scanning items from a

distance. It promises to cut labor costs, improve visibility, and improve inventory management. RFID has previously been widely tested for vehicle identification, toll collecting, traffic control, and vehicle parking management.

1.4 Objectives

The overall objective of this project work is to design and implement a data based fuel management system. This project will accomplish following:

- To develop an automatic fuel dispensing system by using RFID.
- To dispense the accurate amount of fuel which reduces the misuse of the fuel.
- To collect the information of the customer who dispensed the fuel.
- To reduce time and manpower in the fuel station to distribute fuel.
- To receive confirmation SMS automatically after every transaction.
- To reduce corruption in transactions of fuel stations, hence fuel stations become faster.
- To check how much balance available on user RFID card.

1.5 Chapter Outline

During the planning and creation of this project, six chapters have been covered. The chapter's contents are as follows:

- Chapter 1 (Introduction) The chapter presents the description, inspiration, and goal of the project.
- Chapter 2 (Literature Review) The chapter discussed previous work or research related to this project and comparisons with earlier work.
- Chapter 3 (Components) The components that are used in this project have been discussed in-depth in this chapter.
- Chapter 4 (System Design) The programming and interfaces between each module and Arduino Mega are covered in this portion of block diagram, flow chart, circuit diagram.
- Chapter 5 (Implementation and Result) is discussing about the implementation of the project and the results that we got from the project.

- Chapter 6 (Conclusion) Finally, this chapter addressed the description of this project in depth. The project's drawbacks and potential growth have been addressed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the previous 110 years, retail fuel dispensers have gone a long way. Hand-operated, the first curb-side pump, established in 1907, provided a precise quantity of fuel with each turn of the handle. This design, which isolated the pump from the tank, increased fuel capacity while also lowering the risk of fire, was revolutionary at the time. However, as vehicles became more popular, the curb-side pumps began to cause accidental traffic jams. Later that year, this resulted in the establishment of authorized service and refueling stations. Today, forecourts with up to 120 fueling stations and gas pumps that chat, upsell, and even report the weather are commonplace. Fuel dispensers currently include some of the most cutting-edge technologies available. For merchants and c-store owners, this technology opens up lots of new and exciting possibilities [1].

2.2 Previous Work

Some previous works based on smart fuel station management system has described below:

2.2.1 RFID Based Automated Petrol Pump

Wavekar Asrar A. and his colleague devised the system indicated in **Figure 2.1**, in which the RFID reader was utilized to swap RFID cards. The amount and PIN were displayed on the LCD. They used the keypad to type the money and pin. A dispensing device is also available for distributing the fuel.

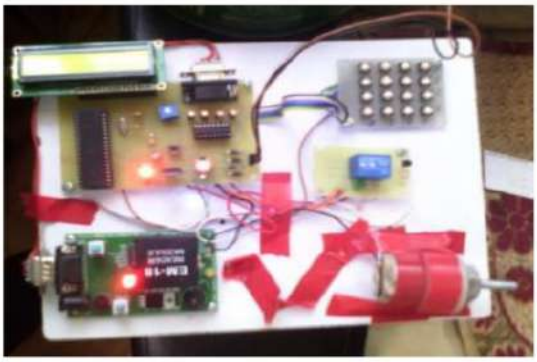


Fig. 2.1 RFID Based Automated Petrol Pump Made by Waver Assar A. and his Colleague [3]

Advantage and limitation

To prevent fuel robberies, this system utilizes RFID technology. Additionally, this technique saves both time and energy for the consumer. The consumer with an insufficient balance, on the other hand, has no options under this system.

2.2.2 RIDF Based Prepaid Card for Patrol Station

Mohammad Abdul Hakim and Mohammad Wali Hazi tried to investigate an automation system at petrol stations, the most commonly spelled phrase in the world of electronics. Many current technologies were revolutionized as a result of the desire for automation. RF communications are one of the technologies that have progressed the most. RFID cards, which transmit a unique identifying number, are the outcome of this. With the help of an RFID reader, this number transmitted by the RFID can be read.

Advantage and limitation

This technology delivers real-time authentication while consuming little power. Unauthorized individuals, on the other hand, are unable to obtain fuel.

2.3 Definition of Smart System

Smart system integrates sensing, actuation, and control functions to describe and evaluate a condition and make predictions or adaptive decisions based on the available data, resulting in smart actions. The autonomous function based on closed-loop control, energy efficiency, and networking capabilities may be attributed to the system's "smartness" in most situations.

CHAPTER 3

COMPONENTS

3.1 Introduction

To develop our project, we first created a broad concept and then examined it. After that, we had to choose certain equipment that was necessary for the project's completion. It's a demonstration of the Smart Fuel Pump Management System, in general. GSM module, relay, RF reader, LCD, keypad, obstacle sensor, and servo motor are all interfaced with the Arduino Mega.

3.2 Equipment

The equipment that we used to complete this project is as follows:

- Arduino Mega
- LCD Display
- Servo Motor
- Keypad
- RFID TAG
- RFID Reader
- IR Sensor
- GSM Module
- Pump Motor
- Relay
- Power Supply

3.3 Ardiuno Mega

The ATmega2560 is the basis for the Arduino Mega 2560 microcontroller board. It contains 54 digital input/output pins (14 of which are PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power connector, an ICSP header, and a reset button [8]. It comes with everything you'll need to get started with the microcontroller; simply plug it into a computer with a USB

wire or power it with an AC to DC converter or battery. Most shields designed for the Arduino Duemilanove or Diecimila are compatible with the Mega.

Table 3.1 represents the summary of Arduino Mega 2560.

Table 3.1 Summary of Arduino Mega 2560 [8]

Parameter Name	Value
Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by boot loader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

The Arduino Mega may be powered either by USB or by an external power supply. The power source is automatically selected. An AC-to-DC adapter (wall-wart) or a battery can provide external (non-USB) power. A 2.1mm center-positive plug may be plugged into the board's power port to connect the adapter. Battery leads can be put into the POWER connector's Gnd and Vin pin headers. The board may be powered from a 6 to 20-volts external source. If less than 7V is given, the 5V pin may supply fewer than five volts, making the board unstable. The voltage regulator may overheat and destroy the board if more than 12V is used. The voltage range recommended is 7 to 12 volts. The Arduino Mega 2560 is unique among previous boards in that it does not include the FTDI USB-to-Serial Driver chip. Instead, it uses an Atmega8U2 that has been programmed to act as a USB-to-serial converter. **Figure 3.1** depicts the physical construction of the Arduino Mega 2560.

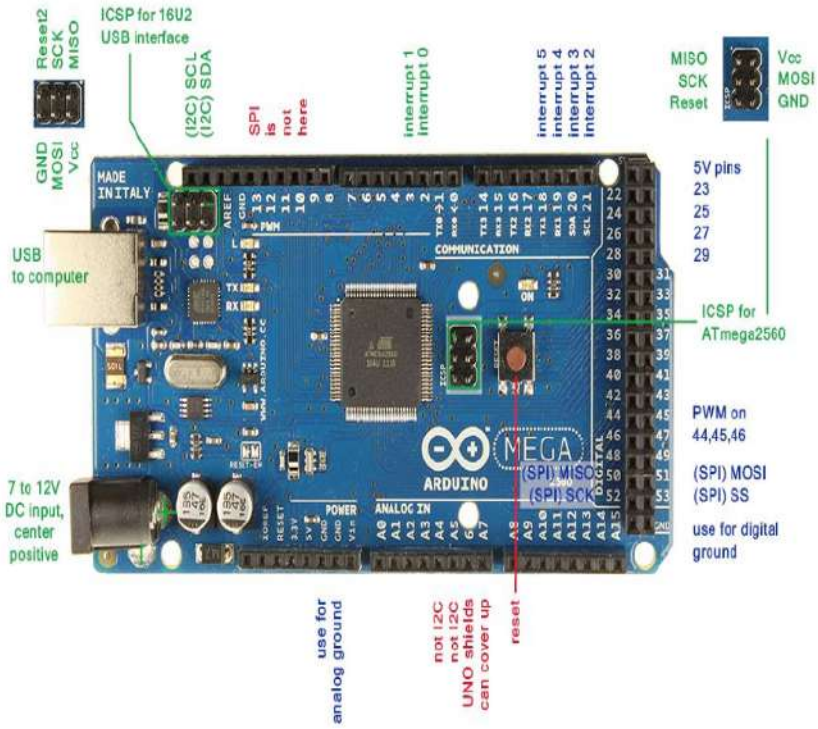


Fig. 3.1 Physical Structure of Arduino Mega 2560 [8]

The Arduino Mega2560 includes a lot of features for interacting with computers, other Arduinos, and other microcontrollers. For TTL (5V) serial transmission, the ATmega2560 has four hardware UARTs. One of them is channeled through USB by an ATmega8U2 on the board, which acts as a virtual com port for applications on the PC. Serial communication may be done on any of the Mega2560's digital pins using a Software Serial library. I2C (TWI) and SPI communication are also supported by the ATmega2560. The Arduino software comes with a Wire library that makes using the I2C bus a simple. It makes use of the SPI library for SPI communication.

3.3.1 ATmega2560

Microchip's ATmega2560 is an 8-bit AVR RISC-based microcontroller with strong performance and low power consumption. It has 256KB of ISP flash memory, 8KB of SRAM, 4KB of EEPROM, 86 general-purpose I/O lines, 32 general-purpose working registers, a real-time counter, six flexible timer/counters with compare modes, PWM, four USARTs, a byte-oriented 2-wire serial interface, a 16-channel 10-bit A/D converter, and a JTAG interface for on-chip debugging [13]. The device runs between

4.5 and 5.5 volts and has a throughput of 16 MIPS @ 16 MHz. The device achieves a throughput of around one MIPS per MHz by executing strong instructions in a single clock cycle, balancing power consumption and processing performance.

Table 3.2 represents the summary of ATmega328p Microcontroller.

Table 3.2 Summary of ATmega328p Microcontroller [8]

Parameter Name	**Value**
Program Memory Type	Flash
Program Memory (KB)	256
CPU Speed (MIPS)	16
RAM Bytes	8192
Data EEPROM (bytes)	4096
Digital Communication Peripherals	4-UART, 5-SPI, 1-12C
Capture/Compare/PWM Peripherals	4 Input Capture, 4 CCP, 16 PWM
Timers	2 x 8 bit, 4 x 16 bit
Comparators	1
Temperature Range (C)	-40 to 85
Operating Voltage Range (V)	1.8 to 5.5
Pin Count	100

3.4 LCD Display

LCD displays has seen everywhere. Computers, calculators, television sets, mobile phones, digital watches use some kind of display to display the time. An LCD is an LCDs have seen everywhere. Computers, calculators, television sets, mobile phones, digital watches use some kind of display to display the time. An LCD is an electronic display module, which uses liquid crystals to produce a visible image. The 16×2 LCD is a very basic module commonly used in DIYs and circuits. The 16×2 translates a display of 16 characters per line in two such lines. In this LCD, each character has displayed in

a 5×7 pixel matrix [9]. In our project, we also use a 20×4 LCD which is similar to the 16×2 LCD. But the 20×4 translates a display of 20 characters per line in four such lines. Physical structure of 16x2 LCD has shown in **Figure 3.1** and **Figure 3.2** and physical structure of 20x4 LCD has shown in **Figure 3.3**.

Fig. 3.2 16 x 4 LCD Display [10]

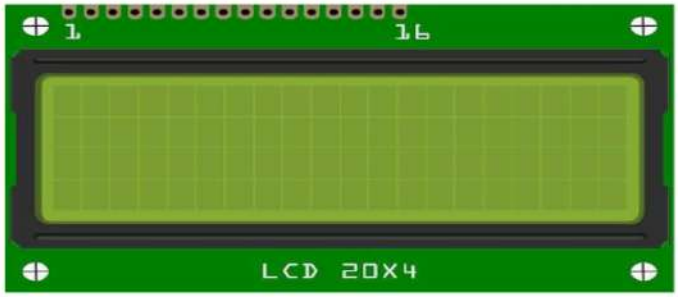


Fig.3.3 20 x 4 LCD Display [11]

Table 3.3 represents the pin function of 16x2 & 20x4 LCD.

Table 3.3 Pin function of a 16X2 & 20X4 LCD [9]

Pin No.	Description	Name
1	Ground (0V)	Ground
2	Supply voltage (5V)	Vcc
3	Contrast adjustment	V_0/ V_{ee}

4	Low for command register, high for data register	RS (Register select)
5	Low to write; High to read.	RE (Read/Write)
6	When low use as output device, when high use as input device. Generally grounded it.	E (Enable)
7	8-bit Data Pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Back light Vcc (5V)	Led+
16	Backlight Ground (0V)	Led-

3.5 Servo Motor

A servomotor is a closed-loop servomechanism that controls its motion and ultimate position via position feedback. A typical servo motor is shown in **Figure 3.4**. The position commanded for the output shaft is represented by a signal, either analog or digital, that is fed into its control [12].

Fig. 3.4 Servo Motor[13]

3.5.1 Description

To give position and speed feedback, the motor is connected to an encoder. Only the location is measured in the most basic case. The measured output position is compared to the command position, which is the controller's external input. If the output position does not match the desired position, an error signal is generated, causing the motor to rotate in either direction to bring the output shaft to the correct position. The error signal decreases as the locations approach zero, and the motor stops. One of the characteristics that make servos so dependable is their simplicity. A little direct current (DC) motor, comparable to what you'd find in a cheap toy, is at the core of a servo. These motors are powered by a battery and spin at a high RPM (rotations per minute), but they produce relatively little torque (a twisting force used to do work that applies torque). The rapid speed of the motor is slowed while the torque is increased via a gear arrangement. (Work Equals force x distance, according to the first rule of physics.) Although a little electric motor has little torque, it may spin quickly (small force, big distance). The output is converted to a significantly slower rotation speed but with higher torque because of the gear configuration within the servo casing (big force, little distance). The quantity of real effort is the same; the difference is that it is more helpful. Plastic gears are commonly used in low-cost servo motors to keep them lighter and less expensive. The gears of a servo designed to generate higher torque for heavy operations are constructed of metal and thus are more difficult to destroy. A sequence of pulses transmitted from the computer or radio are used to control the servos. A pulse is a brief shift from low to high voltage that remains high for a short period before returning to low. In battery devices like servos, "low" refers to the ground or 0 volts, whereas "high" refers to the battery voltage. Servos typically operate in the 4.5 to the 6-volts range, making them ideal for hobbyist computers. Have you ever taken one end of a rope fastened to a tree or held one end of a jump rope while a friend held the other? Consider moving your arm up and down while grasping the rope's end. From one end to the other, the rope would form a large hump. You applied a pulse, which went down the rope as a wave. Someone viewing from the side would see that the pulse in the rope is longer or broader as you raise and lower your hand. The pulse is shorter or more narrow if you bring your hand down sooner. The pulse width is the length of time between two consecutive pulses. You've constructed a pulse train if you keep moving your end up and down, creating a series of these pulses one after another. When did you last raise or

lower your end? Your pulse train's frequency is measured in pulses per second (Hz) (abbreviation of"hertz").

Table 3.4 represents the specification of servomotor.

Table 3.4 Specification for servomotor [12]

Weight	9g
Dimension	22.2 x 11.8 x 31 mm approx.
Stall Torque	1.8 kgf.cm
Operating Speed	0.1 s/60 degree
Operating Voltage	4.8 V (~5V)
Dead Band Width	10μs
Temperature Range	0°C-55°C

3.5.2 Working Principle

Servos are operated by transmitting a variable-width electrical pulse (PWM) through the control wire. As indicated in Figure 3.5, there are three types of pulses: minimum, maximum, and repetition rate. A servo motor can normally only rotate 90 degrees in either direction for a total movement of 180 degrees. The neutral position of the motor is defined as the point at which the servo has the same number of possible rotation in both clockwise and counter-clockwise directions. The position of the shaft is determined by the PWM given to the motor, and the rotor will turn to the appropriate position based on the duration of the pulse sent via the control wire. Every 20 milliseconds (ms), the servo motor expects to see a pulse, and the duration of the pulse determines how far the motor turns. A 1.5ms pulse, for example, will cause the motor to turn 90 degrees. Any time less than 1.5 milliseconds turns the servo counterclockwise toward the 0° position, while any time more than 1.5 milliseconds turns it clockwise toward the 180° position [14].

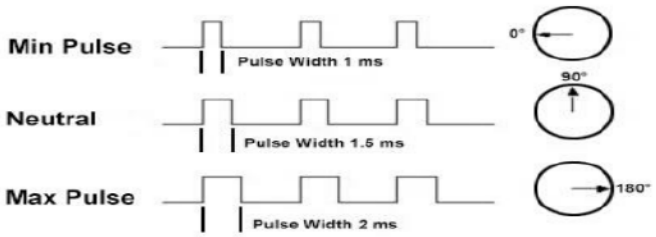


Fig. 3.5 Variable Pulse Width Control Servo Position[14]

When these servos are commanded to move, they will do so and stay put. When a servo is held in a place by an external force, the servo will resist moving out of that position. The torque rating of a servo refers to how much force it can exert at its maximum. Servos, on the other hand, will not stay in place permanently; the position pulse must be repeated to command the servo to remain in place.

3.5.3 Application

In radio-controlled airplanes, servos are used to position control surfaces such as elevators, rudders, walking robots, and controlling grippers. Servo motors are tiny, feature built-in control electronics, and have a high power-to-size ratio. The tools are designed for use in tougher areas, such as food services and pharmaceuticals, where the possibility for corrosion is greater owing to being cleaned at high pressures and temperatures frequently to maintain high quality standards. Servos are also employed in in-line production, where precision work with high repetition is required [14].

3.6 Keypad

Hex keypad is a very important component in embedded systems and the typical applications are

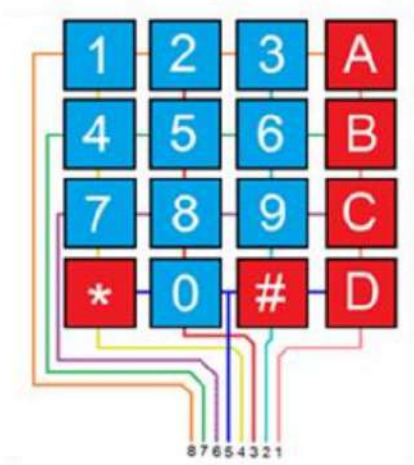


Fig. 3.6 Hex Keypad Visualization [15]

code locks, calculators, automation systems, or simply anything that requires a character or numeric input. The Hex keypad is simply an arrangement of 16 push button switches in a 4x4-matrix form. The structure of the hex keypad is shown in Figure 3.6. Typically a hex keypad will have keys for numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and letters A, B, C, D, *, #. The hex keypad will have eight connection wires namely R1, R2, R3, R4, and C1, C2, C3, C4

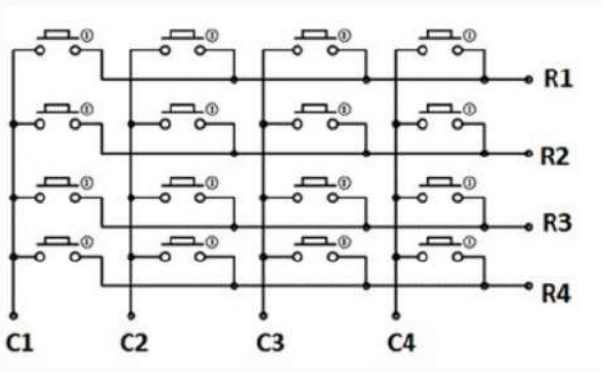


Fig. 3.7 Pinout of a Hex Keypad [15]

represent the rows and columns respectively. The schematic diagram and photo of a typical hex keypad is shown in **Figure 3.7**.

3.7 RFID Tag

Active tags are RFID tags that have their own power source. Passive tags are those that don't have a power source. The reader's radio frequency (RF) scan temporarily activates a passive tag. The electrical current is low, usually only enough to send an ID number. Active tags have more memory and can read from further distances. RFID tagging is increasingly being used in supply chain management as a replacement for bar code technology. RFID tags are more costly to use than bar code stickers since they don't get dirty or fall off, and they don't require a clear line of sight between the tag and the scanner. RFID tagging has an almost limitless number of applications. For more than a decade, injectable ID chips have been used to track wildlife and cattle. The VeriChip, an injected RFID chip, can be used to enable medical workers identify a patient who is unable to communicate and even gain access to the patient's medical information [16]. This is a simple RFID tag that may be used for things like presence sensing. The RF frequency range is 125kHz. These tags have a one-of-a-kind 32-bit ID and cannot be reprogrammed. On one side, the card is blank, smooth, and somewhat flexible.

Fig. 3.8 RFID Tag [17]

3.7.1 Feature

- EM4001 ISO based RFID IC
- 125kHz Carrier
- 2kbps ASK
- Manchester encoding
- 32-bit unique ID

- 64-bit data stream [Header + ID + Data + Parity] Dimensions: 2.13 x 3.35 x 0.03" (54 x 85.5 x 0.8mm

3.8 RFID Reader

The kind of tag and reader used in RFID systems may be categorised. A passive reader receives only radio signals from active tags in a Passive Reader Active Tag (PRAT) system (battery operated, transmit only). A PRAT system reader's reception range may be varied from 1–2,000 feet (0–600 m), giving it versatility in applications like asset protection and supervision. An active reader broadcasts interrogator signals and gets authentication responses from passive tags in an Active Reader Passive Tag (ARPT) system. Active tags are roused by an interrogator signal from the active reader in an Active Reader Active Tag (ARAT) system. A Battery-Assisted Passive (BAP) tag, which works like a passive tag but contains a tiny battery to power the tag's return reporting signal, might be used in a form of this system [18]. Fixed readers are set up to establish a tightly restricted interrogation zone. When tags enter and exit the interrogation zone, this provides for a well-defined reading region. Hand-held readers, as well as those mounted on carts or vehicles, are available. An RFID reader is depicted in **Figure 3.9**.

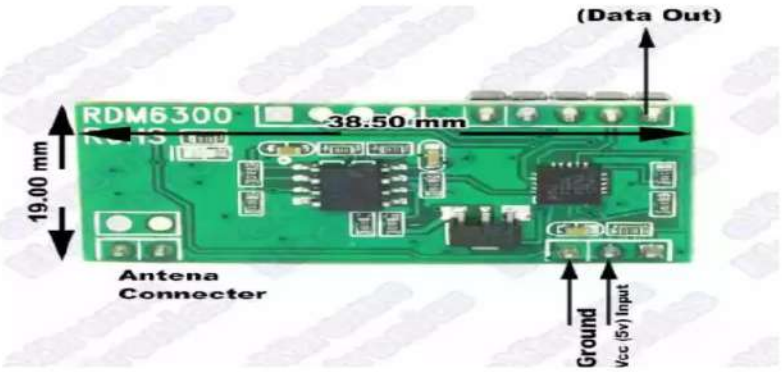


Fig. 3.9 RFID Reader. [19]

3.9 Obstacle Sensor

This IR obstacle sensor, illustrated in Figure 3.10, is straightforward to build, calibrate, and gives a detection range of 10- 30 cm, all while being based on a simple fundamental idea. Most interior applications where there is no significant ambient light

can benefit from this sensor. ALL Infra-Red proximity sensors work on the same concept. The basic principle is to emit infrared light by IR LEDs to any object in front of the sensor, which is subsequently reflected [20].

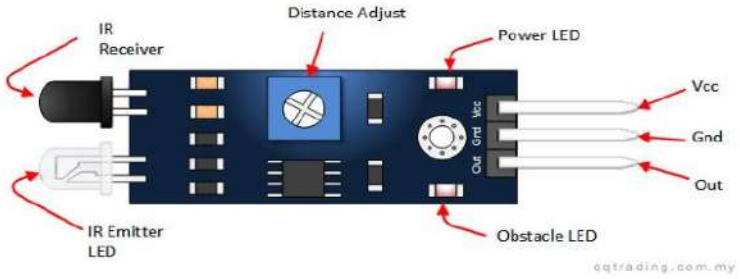


Fig. 3.10 Obstacle Sensor [20]

Table 3.5 represents pin specification of obstacle sensor.

Table 3.5 Pin specification for obstacle sensor [20]

Pin	Name	Details
1	OUT	Active High Output
2	GND	Power Supply ground
3	+5V	Power supply input

3.9.1 Feature

- IR obstacle based detector.
- Adjustable range with POT.
- Logic output 1 or 0.
- Sensitivity up to 30cm adjustable.

3.9.2 Application

- Industrial safety devices.
- Wheel encoder.
- Contact less tachometer.

3.9.3 Specification

Table 3.6 represents the specification of obstacle sensor.

Table 3.6 Specification for obstacle sensor [20]

Parameter	Value
Operating voltage	+5v DC regulated
Obstacle detection	Indicated by active high output

3.9.4 Working Principle

ALL Infra-Red proximity sensors work on the same concept. The fundamental concept is that infrared light is sent by IR-LEDs, which is subsequently reflected by any object in front of the sensor. Then all you have to do is pick up the IR light that has been reflected back to you. We'll utilize a unique way to detect reflected IR light. To detect the IR light generated by another led of the same type, we'll utilize another IR-LED! When a diode produces a voltage differential between its leads when exposed to light, this is an electrical feature of Light Emitting Diodes (LEDs). It works similarly to a photocell, but with a significantly smaller output current. In other words, the voltage created by LEDs can't be utilized to generate electrical power from light in any way, and it's scarcely detectable. As you can see in the diagram, we'll be using an Op-Amp (operational amplifier) to detect extremely small voltage changes [20].

3.10 SIM 800L GSM Module

GSM stands for "global system for mobile communication" and is a mobile communication modem (GSM). In 1970, Bell Laboratories came up with the concept of GSM. It is one of the most frequently utilized mobile communication systems on the planet. GSM (Global System for Mobile Communications) is an open, digital cellular technology for providing mobile voice and data services. The 850MHz, 900MHz, 1800MHz, and 1900MHz frequency bands are all used. The GSM system was created as a digital system that communicated using the time division multiple access (TDMA) mechanism. The data is digitized and reduced before being sent along a channel with two distinct streams of client data, each in its own time slot.

Fig. 3.11 SIM800L GSM Module [21]

In a GSM system, there are macro, micro, pico, and umbrella cells. Each cell differs depending on the implementation domain. A GSM network has five distinct cell sizes: macro, micro, pico, and umbrella cells. The SIM800L GSM module is seen in Figure 3.11. Each cell's coverage area changes depending on the implementation environment [21].

3.10.1 Working Principle of GSM Module

A GSM modem was connected to the MC through the level shifter IC Max232 in the configuration below. The SIM card-mounted GSM modem sends data to the MC through serial communication after receiving digit commands via SMS from any cell phone. The GSM modem gets the instruction 'STOP' while the software is running, causing it to generate an output at the MC, which is used to disable the ignition switch. The user's instruction is based on an intimation received through the GSM modem 'ALERT,' which is a programmed message that is only transmitted if the input is driven low. The complete operation is displayed over a 16×2 LCD. Directions are provided via GPS. A GPS receiver module is a piece of hardware that you can connect to other pieces of hardware (such as a vehicle head unit, Raspberry PI, Arduino, or even your computer) to allow it to receive GPS data. GPS receivers compute position and time practically anywhere on the earth using a constellation of satellites and ground stations.

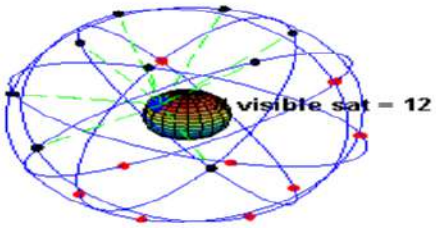


Fig. 3.12 Notice the moving point on the globe [21]

Figure 3.12 depicts at least 24 operational satellites circling over 12,000 miles above the planet at any given moment. The satellite placements are set up in such a manner that the sky over your location will always have at least 12 satellites. The major function of the 12 visible satellites is to send data back to Earth through radio frequency (ranging from 1.1 to 1.5 GHz). A ground-based receiver or GPS module can compute its position and time using this data and some arithmetic [21].

3.10.2 Hardware Overview of SIM800L GSM/GPRS Module

A SIM800L GSM cellular chip from SimCom is at the core of the module, as seen in **Figures 3.13 and 3.14**. The chip's operational voltage ranges from **3.4 to 4.4** volts, making it an excellent choice for a direct LiPo battery supply. As a result, it's a perfect match for projects that don't have ample space.

Fig. 3.13 SIM800L GSM/GPRS module [21]

The SIM800L GSM chip's data pins are all split off to 0.1" pitch headers. This provides pins for using UART to communicate with a microcontroller. With Auto-Baud detection, the module can handle baud rates ranging from 1200bps to 115200bps.

To connect to a network, the module will require an external antenna. The Helical Antenna is normally included with the module, and it connects to the NET connector on the PCB. If you wish to keep the antenna away from the board, the board also has a U.FL connection.

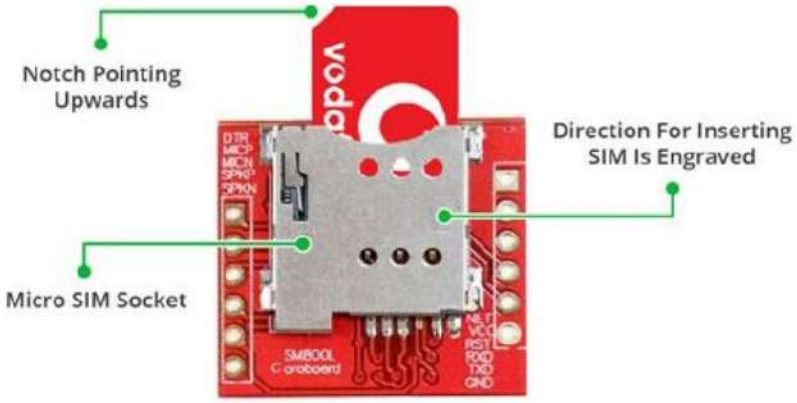


Fig. 3.14 SIM Specification [21]

On the rear, there is a SIM slot. Any 2G micro SIM card that has been activated will function well. On the surface of the SIM socket, the proper direction for inserting the SIM card is usually inscribed [21].

This module measures only 1 inch² but packs a surprising amount of features into its little frame. Some of them are listed below:

- Supports Quad-band: GSM850, EGSM900, DCS1800 and PCS1900
- Connect onto any global GSM network with any 2G SIM
- Accepts Micro SIM Card
- Serial Based AT Command Set
- Scan and receive FM radio broadcasts
- Send and receive GPRS data (TCP/IP, HTTP, etc).
- Send and receive SMS Messages.

3.10.3 Feature

- GPRS mobile station class B
- Controlled by AT Command (3GPP TS 27.007, 27.005, and SIMCOM enhanced AT Commands)
- Supports charging control for Li-Ion battery

- Supports Real-Time Clock
- Supply voltage range 3.4V ~ 4.4V
- Integrated GPS/CNSS and supports A-GPS
- Supports 3.0V to 5.0V logic level
- Low power consumption, 1mA in sleep mode
- Supports GPS NMEA protocol

3.11 Pump Motor

Pump motors are DC motors that are used to transfer fluids. A DC motor is a device that transforms direct current electrical energy into mechanical energy. When a current-carrying conductor is put in a magnetic field, it suffers torque and tends to move. This is referred to as driving activity.

Pumps use energy to do mechanical work by pushing fluid through a mechanism (usually reciprocating or rotating). Pumps can be powered by a variety of sources, including manual work, electricity, engines, or wind power, and they come in a variety of sizes, ranging from tiny pumps for medical purposes to large industrial pumps.

Fig. 3.15 DC Pump Motor [22]

Table 3.8 represents the technical specifications of dc pump motor.

Table 3.8 Technical Specifications for dc pump motor [22]

DC Voltage	2.5-6V
Maximum lift	40-110cm / 15.75"-43.4"
Flow rate	80-120L/H
Outside diameter of water outlet	7.5mm / 0.3"

Inside diameter of water outlet	5mm / 0.2″
Diameter	Approx. 24mm / 0.95″
Length	Approx. 45mm / 1.8″
Height	Approx. 30mm / 1.2″
Material	engineering plastic
Rated Voltage	3.0 VDC
Operating Voltage	2.7 ~ 3.3 VDC
Rated Current	60mA – 90 mA @ Rated Voltage
Operating Temp Range	-20 °C ~ +60 °C
Mechanical Noise	50 dB(A) Max
Rated Speed	9,000 RPM / 150Hz @ Rated Voltage

3.11.1 Application

- Controlled fountain water flow
- Controlled Garden watering systems
- Hydroponic Systems
- Fresh water intake or exhaust systems for fish aquarium

3.12 DC Relay

Figure 3.16 shows a relay, which is an electrically operated switch. Many relays use an electromagnet to mechanically activate a switch, although others, like solid-state relays, are also used. Relays are used when a circuit has to be controlled by a separate low-power signal or when several circuits need to be controlled by a single signal. The early relays were used as amplifiers in long-distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it on another. To conduct logical processes, relays were widely used in telephone exchanges and early computers. A contactor is a type of relay that can manage the high power needed to drive an electric motor or other loads directly. Solid-state relays use a semiconductor device to switch power circuits instead of mechanical elements. To safeguard electrical circuits from overload or defects, relays with calibrated operating characteristics and, in certain cases,

several operational coils are used; in current electric power systems, similar functions are fulfilled by digital instruments still referred to as "protective relays".

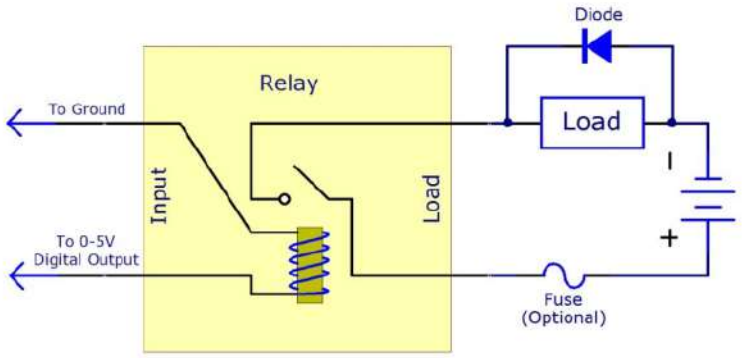


Fig. 3.16 Diagram of DC Relay [23]

3.12.2 Relay Switching Circuit

Relays are electromechanical devices that control a pair of movable contacts from an open to a closed position using an electromagnet. The advantage of relays is that they only require a little amount of electricity to run the relay coil, but they may be used to control motors, heaters, lights, or AC circuits that require significantly more power. The electro-mechanical relay is an output device (actuator) that comes in a variety of forms, sizes, and designs and is used in a variety of electrical circuits. While electrical relays can be used to switch relatively high currents or voltages "ON" or "OFF" in low-power electronic or computer-type circuits, a relay switch circuit is necessary to control it. Many small electrical projects use transistors and MOSFETs as their main switching device because transistors can give quick DC switching (ON-OFF) control of the relay coil from a variety of input sources. Here is a brief list of some of the most frequent techniques of switching relays.

3.12.2 NPN Relay Switching Circuit

Depending on the input voltage level, a typical relay switch circuit includes the coil operated by an NPN transistor switch, TR1. A NPN relay switching circuit is shown in Figure 3.17. The transistor is cut-off and acts as an open switch when the base voltage is 0 (or negative).

In this case, no Collector current flows and the relay coil is de-energized since, as a current device, no current flows through the relay coil if no current flows into the Base [19].

The current flowing from Base to Emitter (B to E) regulates the bigger relay coil current flowing through the transistor from the Collector to Emitter if a large enough positive current is presently fed into the Base to saturate the NPN transistor.

The amount of relay coil current flowing into the Collector for most bipolar switching transistors would be between 50 and 800 times the needed Base current to push the transistor into saturation. At 2mA, the current gain () of the general-purpose BC109 illustrated is normally about 290 (Datasheet).

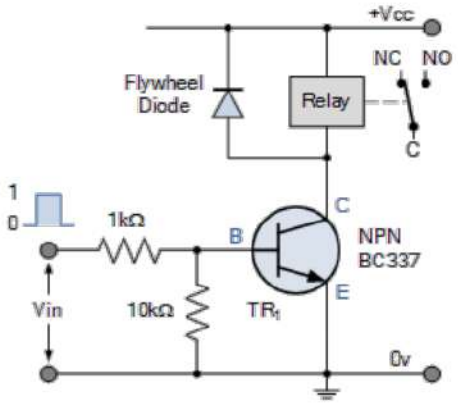


Fig. 3.17 NPN Relay Switching Circuit [23]

It's important to remember that the relay coil is both an electromagnet and an inductor. When power is delivered to the coil via the transistor's switching action, the coil's DC resistance, as specified by Ohms Law (I = V/R), causes a maximum current to flow. The magnetic field of the relay coil stores some of this electrical energy.

The current flowing through the relay coil reduces when the transistor is turned "OFF," and the magnetic field collapses. However, the stored energy in the magnetic field has to go somewhere, so a reverse voltage develops across the coil as it tries to keep the relay coil current flowing. If the voltage spike across the relay coil is allowed to grow up, it might harm the switching NPN transistor.

A "flywheel diode," also known as a freewheeling diode, is linked across the relay coil to protect the semiconductor transistor. The reverse voltage across the coil is clamped to around 0.7V by this flywheel diode, wasting the stored energy and protecting the switching transistor. Flywheel diodes can only be used when the power source is a polarized DC voltage. An RC shunt resistor circuit is utilized to protect an AC coil since it requires a separate protection approach [23].

3.13 Power Supply

A switched-mode power supply (also known as a switched-mode power supply, switched power supply, SMPS, or switcher) is an electronic power supply that integrates a switching regulator to effectively convert electrical power. A simple circuit schematic for an SMPS is shown in **Figure 3.18**. An SMPS, like other power supplies, converts voltage and current characteristics while transferring power from a DC or AC source (often mains power) to DC loads, such as a computer. Unlike a linear power supply, a switching-mode power supply's pass transistor alternates between low-dissipation, full-on and full-off states all the time, spending relatively little time in the high-dissipation transitions, reducing wasted energy. A switched-mode power supply, in theory, should not squander any energy. Variation in the ratio of on-to-off time is used to regulate voltage. A linear power supply, on the other hand, adjusts the output voltage by dissipating power in the pass transistor continuously. A switched-mode power supply has a greater power conversion efficiency, which is a major benefit. Due to the decreased transformer size and weight, switched-mode power supplies can be considerably smaller and lighter than linear power supplies [24].

We may change the stored energy in each cycle and hence adjust the output voltage by altering the duty cycle or switching frequency. Because just the energy needed to sustain the load current is pumped, there is no power dissipation, resulting in higher efficiency.

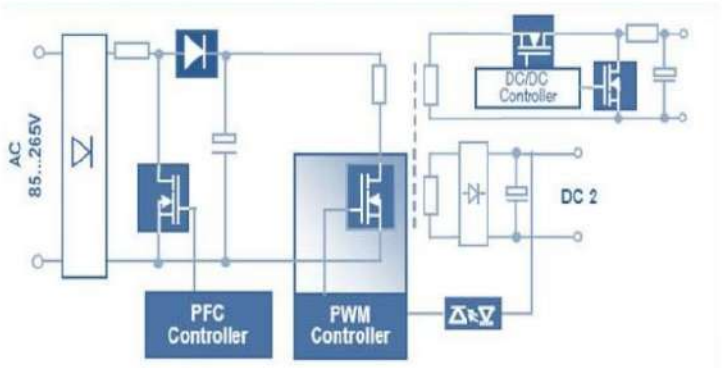


Fig. 3.18 Basic Circuit Diagram of Switched Mode Power Supply [24]

CHAPTER 4

METHODOLOGY

4.1 Introduction

This project's purpose is to use RFID technology to create a smart fuel station management system. The gate was controlled by a servo motor and an obstruction sensor. Furthermore, GSM SIM800L was used to send SMS to customers, and PLX-DRQ for Excel "Version-2" by Net Devil was used to document the transaction on a computer Excel Data Sheet.

4.2 Interfacing Different Devices with Arduino

We used Arduino as a microcontroller in our project. The Arduino is used to connect all of the components. The device's interface is briefly discussed in this chapter.

4.2.1 Obstacle Sensor

As an object detecting sensor, the obstacle sensor is used. An IR LED and an IR photodiode makes up this device. It's connected to the Arduino Mega's digital pin in our project.

4.2.2 Interfacing LCD Display

In our project, we use two LCDs 16x2 and 20x4. Here we are using the LCD module in 4-bit mode. Here we connect the LCD display with the digital pin of the Arduino mega.

4.2.3 Interfacing Keypad

In Our project, we use two 4x4 keypads. Each keypad has 8 pin.4 pins for the row and 4 pins for the column. We connect it with the digital pin of the Arduino mega.

4.2.4 Interfacing Servo Motor

A servo motor is made up of a DC motor, a position control system, and gearing. The control electronics in the servo modify the shaft position of the DC motor based on the duty ratio of the PWM signal at the signal pin.

4.2.5 Interfacing GSM Module

SIM800L is a small cellular module that can send and receive GPRS data as well as make and receive voice calls. Here we link the module's Tx to the Arduino's Rx. The module's Rx is connected to Arduino's Tx.

4.3 Block Diagram Description

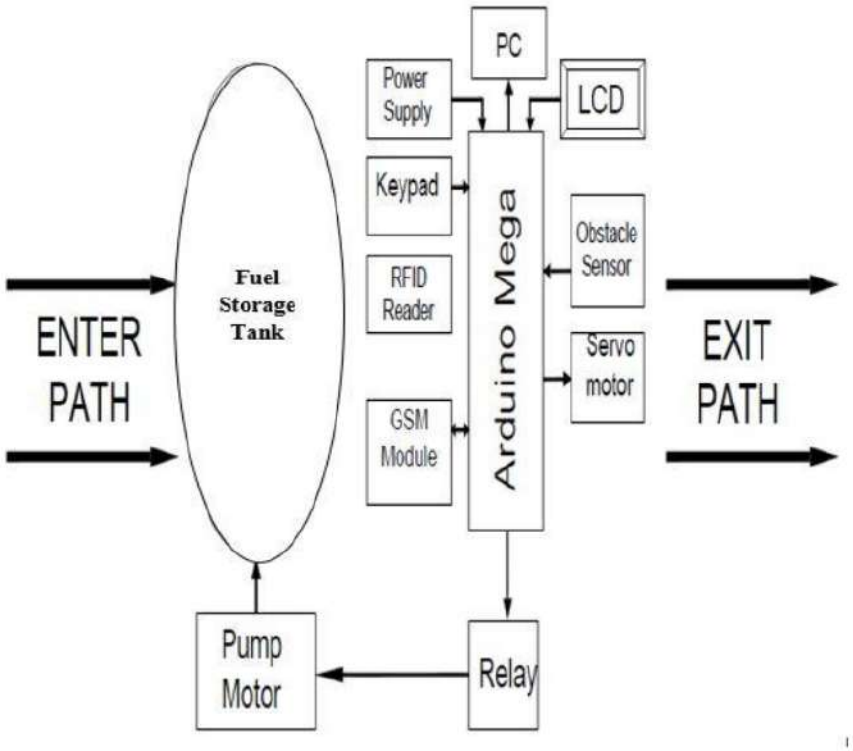


Fig. 4.1 Block Diagram of the System

4.3.1 Power Unit

A switched-mode power supply (SMPS) is an electrical circuit that transforms power using switching devices that are turned on and off at high frequencies, as well as storage components like inductors or capacitors to supply power while the switching device is not conducting. Switching power supplies are widely used in a range of electronic equipment, including computers and other sensitive equipment that requires a consistent and efficient power supply. Switched-mode power supplies are sometimes known as switching-mode power supplies or switching-mode power supplies.

4.3.2 Arduino Mega

A number of microprocessors and controllers are used in Arduino board designs. The boards consist of a number of digital and analog input/output (I/O) pins that may be used to connect to expansion boards, breadboards (shields), and other circuits. Serial communications ports, including USB on some versions, are used to load programs from personal computers. The C and C++ programming languages may be used to program the microcontrollers. The Arduino project offers an integrated development environment (IDE) based on the Processing language project, in addition to standard compiler toolchains.

4.3.3 Notification Section (GSM/GPS Module)

GPS receivers compute position and time practically anywhere on the planet using a constellation of satellites and ground stations. At any one moment, there are at least 24 operational satellites circling the planet at a distance of over 12,000 miles. The satellite placements are set up in such a manner that the sky over your location will always have at least 12 satellites. The major function of the 12 visible satellites is to send data back to Earth through radio frequency (ranging from 1.1 to 1.5 GHz). A ground-based receiver or GPS module can compute its position and time using this data and some arithmetic.

4.3.4 LCD Display

The 16×2 LCD is a very basic module commonly used in DIYs and circuits. The 16×2 translates a display of 16 characters per line in two such lines. In this LCD, each

character has displayed in a 5×7 pixel matrix [9]. In our project, we also use a 20×4 LCD which is similar to a 16×2 LCD. But the 20×4 translates a display of 20 characters per line in four such lines.

4.4 Flow Chart

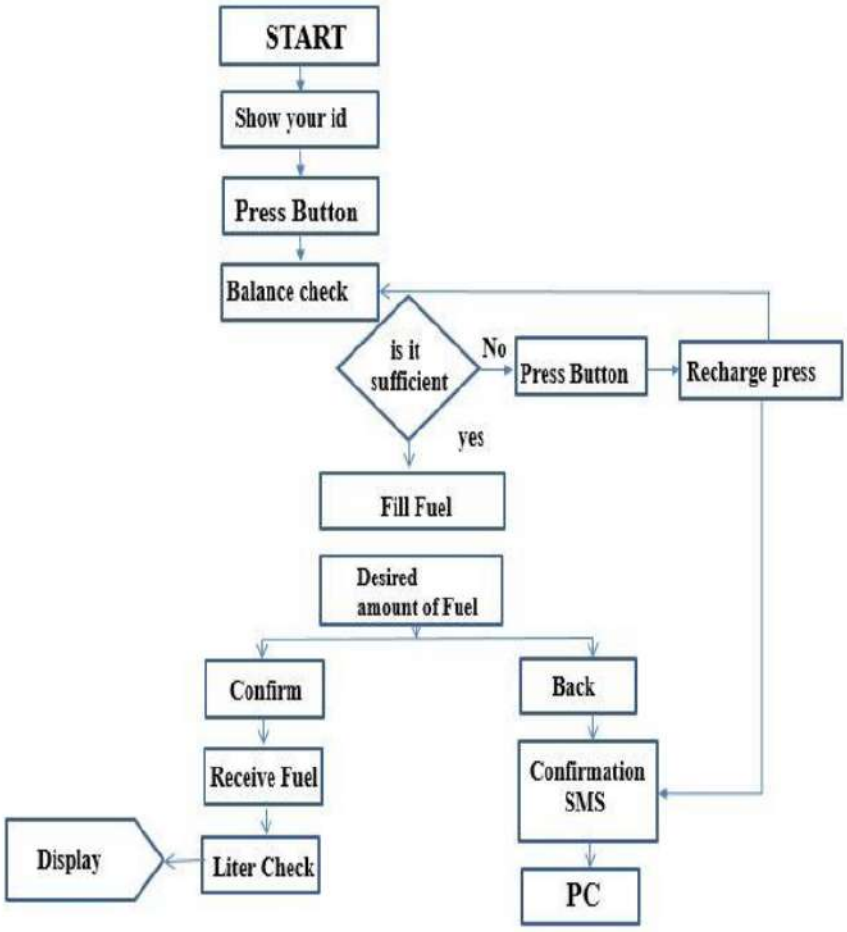


Fig. 4.2 Flow chart

4.5 Circuit Diagram

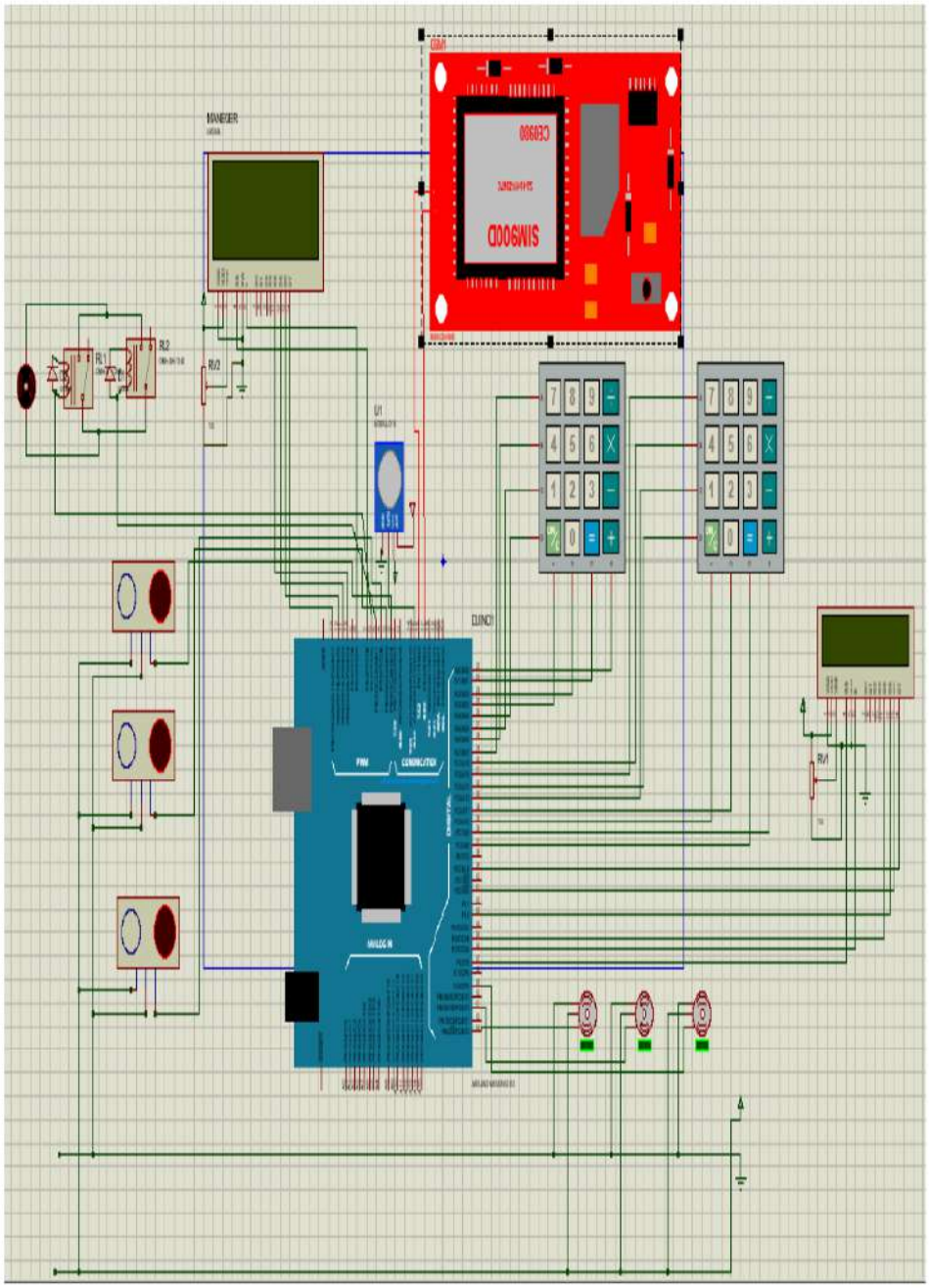


Fig.4.3 Circuit Diagram

4.5 Working Principle

A smart fuel management system allows a consumer to purchase fuel by showing his or her RFID card. In the beginning, the user must push a button. After clicking the button, the message 'Show your ID card' appears on the display. The user must swipe his card via an RFID reader. He then can check his balance as well. If his balance is sufficient, he can push another keypad button to fill the desired amount of Fuel. He receives a confirmation message on his phone after filling up an oil tank. If the user's balance is insufficient, he or she must pay the full amount in cash and repeat the process. If the user forgets his RFID card, he can pay cash to the management to fill up his tank. Unregistered customers can also pay cash for fuel. Two routes are used here. There are two types of customers: registered and unregistered. The management must receive payment from the unregistered customer in cash. The consumer receives the desired amount of fuel once the manager presses a button. With the Manager's support, the user may then fill up on fuel. The RFID card's information is saved on a computer. Exit gates controlled by the obstacle sensor use an automated gate control system. When a vehicle comes the IR sensor1 and IR sensor2 servo motors, they rotate in a certain direction. It indicates the entry gate opens, and when the vehicle reaches the IR sensor3, the servo motor reverses direction, opening the exit gate. The gate automatically closed after ten seconds.

4.6 Cost Estimation

Table 4.1 shows the total cost estimation of the project.

Table 4.1 Total cost estimation

Equipment's	Price
Power Supply (2)	**1000.00/=**
Arduino Mega	**800.00/=**
GSM Module	**650.00/=**
6V DC Pump Motor	**350.00/=**
Servomotor (3)	**160.00/=**
Obstacle Sensor (3)	**80.00/=**

Relay	**50.00/=**
16x2 LCD Display	**130.00/=**
20x4 LCD Display	**345.00/=**
RFID Tag (5)	**30/=**
RFID Reader	**350/=**
4×4 Matrix Keypad (2)	**300.00/=**
Other cost	**3000.00/=**
Total =	**7975.00/=**

CHAPTER 5

RESULT AND DISCUSSION

5.1 Introduction

In this chapter, the total results of this project are discussed. Since there is no output curve or value, several pictures of the output of this project are shown in this project.

5.2 Result Analysis for Authorised Person

This fuel station allows an authorized person to simply purchase fuel by following the instructions below. When clients swipe their RFID cards on the RFID reader, the LCD interface is shown in **Figure 5.1**.

Fig. 5.1 Customer Show his RFID card here

Customers can manually fill the fuel tank or use the manager's support to recharge the tag, as shown in **Figure 5.2**.

Fig. 5.2 Consumer choose the option of purchase

Figure 5.3 depicts the cost of fuel per litter and confirmation of fuel purchased.

Fig. 5.3 Per Litter Fuel Cost

Figure 5.4 shows the total bill of the fuel.

Fig. 5.4 Total bill of fuel purchases

When the consumer confirms the purchase of fuel, the fuel tank's motor turns on, as illustrated in **Figure 5.5**.

Fig. 5.5 Fuel pump motor ON

Figure 5.6 shows the whole system of our project work.

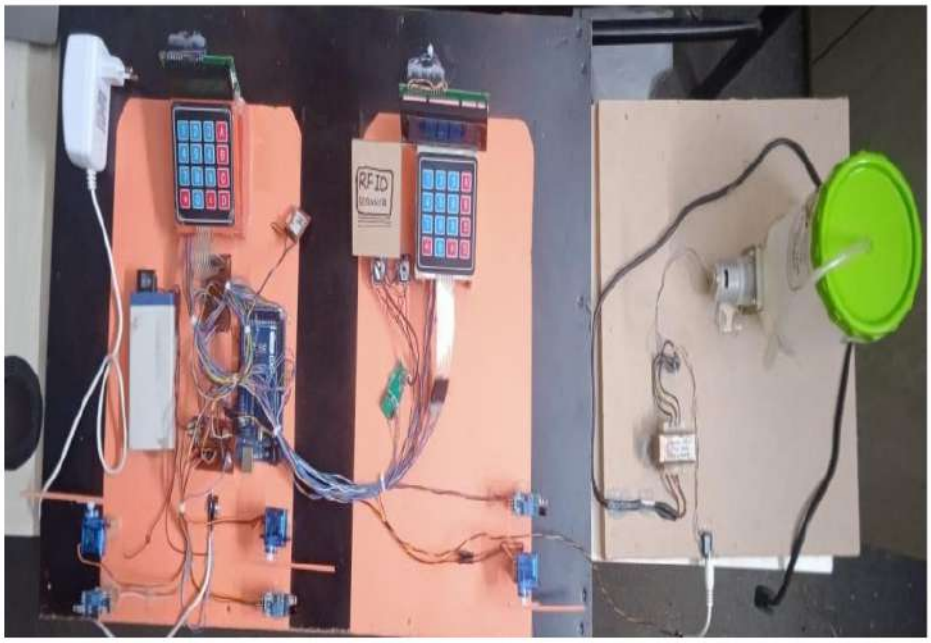
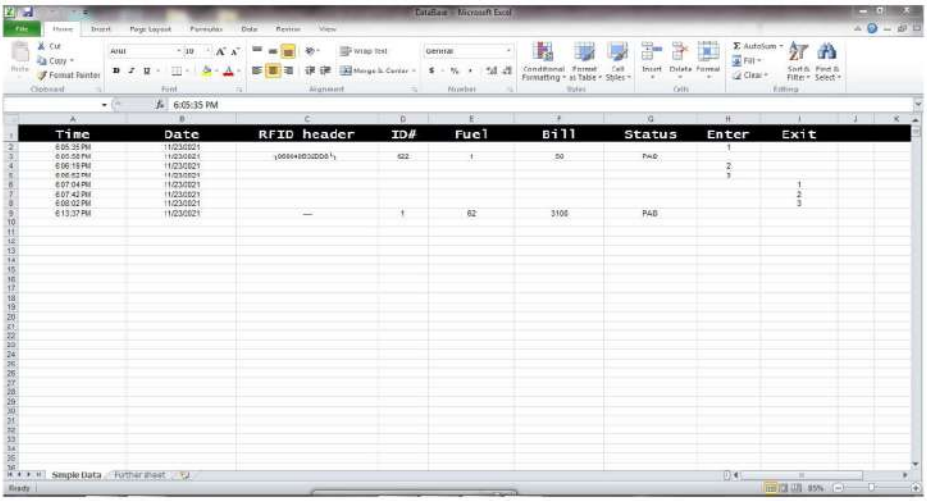


Fig. 5.6 Full System

The total information for the fuel station is recorded in the offline data-based software's Excel datasheet, as illustrated in **Figure 5.7**.



Time	Date	RFID header	ID#	Fuel	Bill	Status	Enter	Exit
6:05:35 PM	11/23/2021						1	
6:06:58 PM	11/23/2021	[illegible]	622	1	50	PAID		
6:06:19 PM	11/23/2021						2	
6:06:52 PM	11/23/2021						3	
6:07:04 PM	11/23/2021							1
6:07:42 PM	11/23/2021							2
6:08:02 PM	11/23/2021							3
6:13:37 PM	11/23/2021	—	1	62	3100	PAID		

Fig. 5.7 Data Collection of Excel Sheet

The consumer will get a confirmation SMS on their cell phone after filling the fuel tank, as illustrated in **Figure 5.8**.

Fig. 5.8 Transaction Notification of User

CHAPTER 6

CONCLUTION AND FUTURE WORK

6.1 Conclusion

RFID is a technology that may be used in a variety of ways. This system is used in a variety of applications, including real-time ones. The RFID technology in my application provides the exact amount of fuel, which reduces fuel misuse. It also minimizes manpower. If a client tries to swipe an unauthorized card, the RFID system will refuse it. In this way, the system is quite safe. RFID readers and tags must be of high quality to achieve the best results. I've also set up a GSM-based payment mechanism.

6.2 Future work

- Use of regular Master Card or Visa Card.
- Create a server system for more security and control.
- Develop a reliable continuous fuel measuring and monitoring system.
- Use of GSM module for more security in recharging money.
- Use of the nRF technology for wireless communication.
- A fuel level sensor is a device that is specially designed to make the precise measurement of the fuel level of commercial vehicle tanks.

6.3 Advantage

- Improving control reliability and quality.
- Better controlling and monitoring using sensor networks and communications.
- Better and faster balancing of supply and demand.
- Reduced operations and management costs.
- Enhancing the capacity and efficiency of the fuel station.
- This System reduced time and manpower in the fuel station.
- This system collects the information of customer.

6.4 Limitation

- Here no use of server system.
- Network problem.

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APPENDIX

Program code for controlling fuel station :

```
#include <Adafruit_Fingerprint.h>
#include <EEPROM.h>
#include <Keypad.h>
#include <LiquidCrystal.h>

#define ir_1 2
#define ir_2 3
#define ir_3 4
#define pump_1 5
#define pump_2 6
#define servo_1 49
#define servo_2 51
#define servo_3 53
#define rfid Serial3
#define gsm Serial2
#define fp_module Serial1


LiquidCrystal lcd_m(47, 46, 45, 43, 41, 39);
LiquidCrystal lcd_u(8, 9, 10, 11, 12, 13);

char hexaKeys[4][4] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};
byte rowPinu[4] = {31, 30, 33, 32};
byte colPinu[4] = {35, 34, 37, 36};

byte rowPinm[4] = {29, 28, 27, 26};
byte colPinm[4] = {25, 24, 23, 22};

Keypad keypad_u = Keypad( makeKeymap(hexaKeys), rowPinu, colPinu, 4, 4);
Keypad keypad_m = Keypad( makeKeymap(hexaKeys), rowPinm, colPinm, 4, 4);

char card[14];

const int card_01[] = {2, 48, 54, 48, 48, 52, 48, 67, 48, 50, 68, 65, 66, 3};
char number_01[] = "01839580041";
const char id_01[] = "197";
```

```
uint16_t balance_01;

const int card_02[] = {2, 48, 54, 48, 48, 56, 49, 52, 51, 50, 51, 69, 55, 3};
char number_02[] = "01816705216";
const char id_02[] = "187";
uint16_t balance_02;

const int card_03[] = {2, 48, 54, 48, 48, 52, 48, 67, 48, 48, 50, 56, 52, 3};
char number_03[] = "01816705216";
const char id_03[] = "154";
uint16_t balance_03;

const int card_04[] = {2, 51, 67, 48, 48, 49, 66, 48, 49, 69, 50, 67, 52, 3};
char number_04[] = "01816705216";
const char id_04[] = "482";
uint16_t balance_04;

const int card_05[] = {2, 48, 54, 48, 48, 52, 48, 51, 55, 48, 68, 55, 67, 3};
char number_05[] = "01839580041";
const char id_05[] = "093";
uint16_t balance_05;

char msg_01[] = "Recharge Successfully. Balance: ";
char msg_02[] = "Sorry, your current account balance is unsufficient. Balance: ";
char msg_03[] = "Payment successful. Happy journey. Thank you. Balance: ";

void setup() {
  Serial.begin(9600);
  finger.begin(57600);
  gsm.begin(9600);
  rfid.begin(9600);
  lcd_u.begin(20,4);
  lcd_m.begin(16,2);
  GSM_init();
  pinMode(ir_1, INPUT);
  pinMode(ir_2, INPUT);
  pinMode(ir_3, INPUT);
  pinMode(pump_1, OUTPUT);
  pinMode(pump_2, OUTPUT);
  pinMode(servo_1, OUTPUT);
  pinMode(servo_2, OUTPUT);
  pinMode(servo_3, OUTPUT);

  if(EEPROM.read(0) == 0xFF) EEPROM.write(0, 0);
  if(EEPROM.read(1) == 0xFF) EEPROM.write(1, 0);
  if(EEPROM.read(2) == 0xFF) EEPROM.write(2, 0);
  if(EEPROM.read(3) == 0xFF) EEPROM.write(3, 0);
  if(EEPROM.read(4) == 0xFF) EEPROM.write(4, 0);
  if(EEPROM.read(5) == 0xFF) EEPROM.write(5, 0);
  if(EEPROM.read(6) == 0xFF) EEPROM.write(6, 0);
  if(EEPROM.read(7) == 0xFF) EEPROM.write(7, 0);
```

```
 if(EEPROM.read(8) == 0xFF) EEPROM.write(8, 0);
 if(EEPROM.read(9) == 0xFF) EEPROM.write(9, 0);
 if(EEPROM.read(10) == 0xFF) EEPROM.write(10, 0);



 IDs = EEPROMread(10);

 Serial.println("CLEARSHEET");
 Serial.println("LABEL,Time,Date,RFID header,ID#,Fuel,Bill,Status,Enter,Exit");
}

 }
}
void servo0(byte servo){
 for(int x = 0; x < 27; x++){
  digitalWrite(servo, HIGH);
  delayMicroseconds(750);
  digitalWrite(servo, LOW);
  delayMicroseconds(19250);
 }
}

void get_rfid(){
 bool newCard = false;
 static int temp[14];
 static bool idSuccess;

 if(rfid.available()>0){
  if(idSuccess == true) {
   for(int x = 0; x < rfid.available(); x++) rfid.read();
   return;
  }
  for(int x = 0; x < 14; x++) {
   temp[x] = rfid.read();
   delay(10);
  }

  if(temp[0] == 2 && temp[13] == 3) idSuccess = true;
  //for(int x = 0; x < 14; x++) if(temp[x] != card[x]) newCard = true;

  //if(newCard == true){
   for(int x = 0; x < 14; x++) card[x] = temp[x];
   show_info(match_card());
  //}
 }
 else idSuccess = false;
}

byte match_card(){
```

```
  byte matched;

  matched = 1;
  for(int x = 0; x < 14; x++) if(card_01[x] != card[x]) {matched = 0; break;}
  if(matched != 0) return matched;

  matched = 2;
  for(int x = 0; x < 14; x++) if(card_02[x] != card[x]) {matched = 0; break;}
  if(matched != 0) return matched;

  matched = 3;
  for(int x = 0; x < 14; x++) if(card_03[x] != card[x]) {matched = 0; break;}
  if(matched != 0) return matched;

  matched = 4;
  for(int x = 0; x < 14; x++) if(card_04[x] != card[x]) {matched = 0; break;}
  if(matched != 0) return matched;

  matched = 5;
  for(int x = 0; x < 14; x++) if(card_05[x] != card[x]) {matched = 0; break;}
  return matched;
}

void show_info(byte id){
   lcd_u.clear();
   if(id == 1){
      lcd_u.setCursor(0,1);
      lcd_u.print("ID Matched. ");
      lcd_u.print(id_01);
      delay(2000);
      menu(id);
   }
   else if(id == 2){
      lcd_u.setCursor(0,1);
      lcd_u.print("ID Matched. ");
      lcd_u.print(id_02);
      delay(2000);
      menu(id);
    }
   else if(id == 3){
      lcd_u.setCursor(0,1);
      lcd_u.print("ID Matched. ");
      lcd_u.print(id_03);
      delay(2000);
      menu(id);
    }
   else if(id == 4){
      lcd_u.setCursor(0,1);
      lcd_u.print("ID Matched. ");
      lcd_u.print(id_04);
      delay(2000);
```

```
      menu(id);
     }
   else if(id == 5){
      lcd_u.setCursor(0,1);
      lcd_u.print("ID Matched. ");
      lcd_u.print(id_05);
      delay(2000);
      menu(id);
     }
   else {
      lcd_u.setCursor(0,1);
      lcd_u.print("Unauthorized ID");
      lcd_u.setCursor(0,3);
      lcd_u.print("Pls use Fingerprint");
      delay(2000);
     }
   lcd_u.clear();
 }

void menu(byte id){
   lcd_u.clear();
   lcd_u.print("Fuel Management Sys.");
   lcd_u.setCursor(0,1);
   lcd_u.print("A = Fuel Refill");
   lcd_u.setCursor(0,2);
   lcd_u.print("B = Check Balance");
   lcd_u.setCursor(0,3);
   lcd_u.print("C = Cancel.");
   while(1){
     char key = keypad_u.getKey();
     if(key == 'A') {refill(id); break;}
     if(key == 'B') {show_balance(id); break;}
     if(key == 'C') break;
     }
   lcd_u.clear();
 }

void show_balance(byte id){
   lcd_u.clear();
   lcd_u.print("Current Balance: ");
   if(id == 1){
      EEPROMread(balance_01);
      lcd_u.setCursor(0,2);
      lcd_u.print(balance_01);
      lcd_u.print("  TAKA");
      delay(3000);
     }
    else if(id == 2){
      EEPROMread(balance_02);
      lcd_u.setCursor(0,2);
      lcd_u.print(balance_02);
```

```
      lcd_u.print("  TAKA");
      delay(3000);
     }
     else if(id == 3){
      EEPROMread(balance_03);
      lcd_u.setCursor(0,2);
      lcd_u.print(balance_03);
      lcd_u.print("  TAKA");
      delay(3000);
     }
     else if(id == 4){
      EEPROMread(balance_04);
      lcd_u.setCursor(0,2);
      lcd_u.print(balance_04);
      lcd_u.print("  TAKA");
      delay(3000);
     }
     else if(id == 5){
      EEPROMread(balance_05);
      lcd_u.setCursor(0,2);
      lcd_u.print(balance_05);
      lcd_u.print("  TAKA");
      delay(3000);
     }
  }

void refill(byte id[11]
   char text[3], x=0;
   lcd_u.clear();
   lcd_u.print("Enter Litre[1L=50TK]");
   while(68
     char key = keypad_u.getKey();
     if(key >= '0' && key <= '9'){
       text[x] = key;
       lcd_u.setCursor(x,1);
       lcd_u.print(key);
       x++;
       if(x > 1) break;
       delay(300);
      }
     }
     text[2] = 0;
     int fuel = atoi(text);
     int bill = fuel * 50;
     lcd_u.setCursor(0,2);
     lcd_u.print("Bill = ");
     lcd_u.print(bill, DEC);
     lcd_u.print(" TAKA");
     lcd_u.setCursor(0,3);
     lcd_u.print("A: Confirm B: Cancel");
```

```
Serial.print("DATA,TIME,DATE,");
Serial.print(card);
Serial.print(",");
if(id == 1) Serial.print(id_01);
if(id == 2) Serial.print(id_02);
if(id == 3) Serial.print(id_03);
if(id == 4) Serial.print(id_04);
if(id == 5) Serial.print(id_05);
Serial.print(",");
Serial.print(fuel);
Serial.print(",");
Serial.print(bill);
Serial.print(",");

while(1){
  char key = keypad_u.getKey();
  if(key == 'A') {
    if(id == 1) {
      if(EEPROMread(0) >= bill){
        balance_01 -= bill;
        EEPROMwrite(0,balance_01);
        send_SMS(number_01, msg_03, balance_01);
        pump_01(fuel);
      }
      else no_balance();
    }
    else if(id == 2) {
      if(EEPROMread(2) >= bill){
        balance_02 -= bill;
        EEPROMwrite(2,balance_02);
        send_SMS(number_02, msg_03, balance_02);
        pump_01(fuel);
      }
      else no_balance();
    }
    else if(id == 3) {
      if(EEPROMread(4) >= bill){
        balance_03 -= bill;
        EEPROMwrite(4,balance_03);
        send_SMS(number_03, msg_03, balance_03);
        pump_01(fuel);
      }
      else no_balance();
    }
    else if(id == 4) {
      if(EEPROMread(6) >= bill){
        balance_04 -= bill;
        EEPROMwrite(6,balance_04);
        send_SMS(number_04, msg_03, balance_04);
        pump_01(fuel);
      }
```

```
            else no_balance();
           }
           else if(id == 5) {
            if(EEPROMread(8) >= bill){
              balance_05 -= bill;
              EEPROMwrite(8,balance_05);
              send_SMS(number_05, msg_03, balance_05);
              pump_01(fuel);
            }
            else no_balance();
           }
           Serial.println("PAID");
           break;
         }
        if(key == 'B') {Serial.println("Cancelled"); break;}

      }
    lcd_u.clear();

  }

void no_balance(){
    lcd_u.clear();
    lcd_u.setCursor(0,1);
    lcd_u.print("Unsufficient Balance");
    delay(2000);
  }

void pump_01(byte fuel){
   lcd_u.clear();
   lcd_u.print("Pump_01 is ON");
   digitalWrite(pump_1,HIGH);
   for(int x = fuel*5; x>=0; x--){
       lcd_u.setCursor(0,2);
       lcd_u.print(x,DEC);
       lcd_u.print("  SEC ");
       delay(1000);
       }
   digitalWrite(pump_1,LOW);
}

uint16_t EEPROMread(byte adrs){
  byte one = EEPROM.read(adrs);
  byte two = EEPROM.read(adrs + 1);
  return (two << 8) + one;
}

void EEPROMwrite(byte adrs, uint16_t value){
  byte one = value;
  byte two = value >> 8;
```

```
  EEPROM.write(adrs, one);
  EEPROM.write(adrs + 1, two);
}

void GSM_init(){
  lcd_u.print("Connecting GSM..");
  lcd_m.print("Connecting GSM..");
  delay(5000);
  gsm.println("AT");
  delay(1000);
  gsm.println("ATE0");
  delay(1000);
  gsm.println("AT+CMGF=1");
  delay(1000);
  gsm.println("AT+CNMI=1,2,0,0,0");
  delay(1000);
  gsm.println("AT+CMGD=4");
  delay(1000);
  lcd_u.clear();
}

void send_SMS(char *number, char *text, int text2){
  lcd_u.clear();
  lcd_m.clear();
  lcd_u.print("Sending SMS...");
  lcd_m.print("Sending SMS...");
  gsm.print("AT+CMGF=1\r\n");
  delay(200);
  gsm.print("AT+CMGS=\"");
  delay(200);
  gsm.print(number);
  gsm.print("\"\r\n");
  delay(200);
  gsm.print(text);
  gsm.print(text2, DEC);
  gsm.write(0x1A);
  gsm.print("\r\n");
  delay(3000);
  lcd_u.clear();
  lcd_m.clear();
}

byte find_id(){
    char text[3];
    char key, x = 0;
    lcd_m.clear();
    lcd_m.print("Enter ID: ");
    while(1){
      key = keypad_m.getKey();
      if(key >= '0' && key <= '9'){
        lcd_m.setCursor(10+x,0);
```

```
      lcd_m.print(key);
      text[x] = key;
      delay(300);
      x++;
      if(x > 2) break;
     }
    }
  if(text[0] == id_01[0] && text[1] == id_01[1] && text[2] == id_01[2]) return 1;
  else if(text[0] == id_02[0] && text[1] == id_02[1] && text[2] == id_02[2]) return 2;
  else if(text[0] == id_03[0] && text[1] == id_03[1] && text[2] == id_03[2]) return 3;
  else if(text[0] == id_04[0] && text[1] == id_04[1] && text[2] == id_04[2]) return 4;
  else if(text[0] == id_05[0] && text[1] == id_05[1] && text[2] == id_05[2]) return 5;
  return 0;
 }

void recharge(){
  char text[5], key, x = 0;
  byte id = find_id();
  if(id == 11)
   lcd_m.setCursor(0, 1);
   lcd_m.print("ID not matched.");
   delay(2000);
   }
  else{
   lcd_m.clear();
   lcd_m.print("Enter Amount:[4]");
   while(1){
    key = keypad_m.getKey();
    if(key >= '0' && key <= '9'){
     lcd_m.setCursor(x, 1);
     lcd_m.print(key);
     text[x] = key;
     delay(300);
     x++;
     if(x > 3) break;
     }
    }
   text[4] = 0;
   int amount = atoi(text);
   if(id == 1){
    balance_01 += amount;
    EEPROMwrite(0, balance_01);
    send_SMS(number_01, msg_01, balance_01);
    }
   else if(id == 2){
    balance_02 += amount;
    EEPROMwrite(2, balance_02);
    send_SMS(number_02, msg_01, balance_02);
    }
   else if(id == 3){
    balance_03 += amount;
```

```
      EEPROM.write(4, balance_03);
      send_SMS(number_03, msg_01, balance_03);
      }
    else if(id == 4){
      balance_04 += amount;
      EEPROM.write(6, balance_04);
      send_SMS(number_04, msg_01, balance_04);
      }
    else if(id == 5){
      balance_05 += amount;
      EEPROM.write(8, balance_05);
      send_SMS(number_05, msg_01, balance_05);
      }
   }
  }

bool fp_enroll(byte id){
  lcd_u.clear();
  lcd_m.clear();
  lcd_u.print("Put your finger...");
  lcd_m.print("New ID enrolling");
  lcd_m.setCursor(0,1);
  lcd_m.print("ID: #0");
  lcd_m.print(id);

  int p = -1;


  Serial.print("DATA,TIME,DATE,");

  while ((index < 256) && ((millis() - starttime) < 1000)){
   if (fp_module.available()){
     Serial.print(fp_module.read());
     index++;
   }
  }
  Serial.print(",");
}

void pump_02(byte fuel){
   lcd_u.clear();
   lcd_m.clear();
   lcd_u.print("Pump_02 is ON");
   digitalWrite(pump_2,HIGH);
   for(int x = fuel*5; x>=0; x--){
     lcd_u.setCursor(0,2);
     lcd_u.print(x,DEC);
     lcd_u.print("  SEC ");
     delay(1000);
   }
   digitalWrite(pump_2,LOW);
```

```
}

void fp_system(){
  lcd_u.clear();
  lcd_m.clear();

  if(IDs > 255) IDs = 0;
  IDs++;
//  bool add = fp_enroll(IDs);
//  if(add == 0) {
//    IDs--;
//    lcd_u.clear();
//    lcd_m.clear();
//    return;
//  }
//  download_template(IDs);

    byte x = 0;
    char text[3];
    lcd_m.clear();
    lcd_m.print("Fuel[In Litre]:");
    while(1){
     char key = keypad_m.getKey();
     if(key >= '0' && key <= '9'){
       lcd_m.setCursor(x, 1);
       lcd_m.print(key);
       text[x] = key;
       delay(300);
       x++;
       if(x > 1) break;
       }
     }
    text[2] = 0;
    int fuel = atoi(text);
    int bill = fuel * 50;

    Serial.print("DATA,TIME,DATE,---,");
    Serial.print(IDs, DEC);
    Serial.print(",");
    Serial.print(fuel, DEC);
    Serial.print(",");
    Serial.print(bill, DEC);
    Serial.print(",");

    lcd_m.clear();
    lcd_u.clear();
    lcd_u.print("Fuel: ");
    lcd_u.print(fuel, DEC);
    lcd_u.print(" Litre");
    lcd_u.setCursor(0,1);
    lcd_u.print("Bill: ");
```

```
    lcd_u.print(bill, DEC);
    lcd_u.print(" TK");

    lcd_m.print("Bill:");
    lcd_m.print(bill, DEC);
    lcd_m.print(" TK");
    lcd_m.setCursor(0,1);
    lcd_m.print("*:Confirm #:Back");

    while(1){
     char key = keypad_m.getKey();
     if(key == '*') {
       pump_02(fuel);
       Serial.println("PAID");
       break;
     }
     if(key == '#') {
       Serial.println("Cancelled");
       break;
     }
    }
   lcd_u.clear();
   lcd_m.clear();
 }

void loop() {
  char key = keypad_m.getKey();
  lcd_u.setCursor(0,0);
  lcd_u.print("Fuel Management Sys.");
  lcd_m.setCursor(0,0);
  lcd_m.print("Fuel Manage Sys.");
  lcd_u.setCursor(4,2);
  lcd_u.print("Show Your ID");
  lcd_m.setCursor(0,1);
  lcd_m.print("*:Cash #:Rechrge");
  if(key == '#') recharge();
  if(key == '*') fp_system();

  get_rfid();

  if(digitalRead(ir_1) == LOW) {
   lcd_u.clear();
   lcd_u.print("Gate 01 [IN]");
   lcd_u.setCursor(0,1);
   lcd_u.print("Openning...");
   servo90(servo_1);
   lcd_u.setCursor(0,2);
   lcd_u.print("Gate will close in");
   for(byte x = 10; x >= 0; x--) {
    lcd_u.setCursor(0, 3);
    lcd_u.print(x, DEC);
```

```
    lcd_u.print(" sec...  ");
    delay(1000);
    if(x == 0) break;
   }
   tEnter++;
   Serial.println((String)"DATA,TIME,DATE,,,,,," + tEnter + ",");
   servo20(servo_1);
   lcd_u.clear();
 }

 if(digitalRead(ir_2) == LOW) {
   lcd_u.clear();
   lcd_u.print("Gate 02 [IN]");
   lcd_u.setCursor(0,1);
   lcd_u.print("Openning...");
   servo90(servo_2);
   lcd_u.setCursor(0,2);
   lcd_u.print("Gate will close in");
   for(byte x = 10; x >= 0; x--) {
     lcd_u.setCursor(0, 3);
     lcd_u.print(x, DEC);
     lcd_u.print(" sec...  ");
     delay(1000);
     if(x == 0) break;
   }
   tEnter++;
   Serial.println((String)"DATA,TIME,DATE,,,,,," + tEnter + ",");
   servo20(servo_2);
   lcd_u.clear();
 }

 if(digitalRead(ir_3) == LOW) {
   lcd_u.clear();
   lcd_u.print("Gate 01 [OUT]");
   lcd_u.setCursor(0,1);
   lcd_u.print("Openning...");
   servo90(servo_3);
   lcd_u.setCursor(0,2);
   lcd_u.print("Gate will close in");
   for(byte x = 10; x >= 0; x--) {
     lcd_u.setCursor(0, 3);
     lcd_u.print(x, DEC);
     lcd_u.print(" sec...  ");
     delay(1000);
     if(x == 0) break;
   }
   tExit++;
   Serial.println((String)"DATA,TIME,DATE,,,,,," + tExit);
   servo20(servo_3);
   lcd_u.clear();
 }
```

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