KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

PROJECT REPORT

ELEVATOR SYSTEM

A **second year project progress report** submitted in partial fulfilment
of the requirements for the degree of
Bachelor of Engineering

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June 2023

CERTIFICATION

SECOND YEAR PROJECT REPORT

ON

ELEVATOR CONTROL SYSTEM

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ABSTRACT

This project aims to construct an elevator system, an essential vertical transportation mechanism in buildings. The primary focus is on selecting a suitable DC Motor for the elevator. Additionally, the project addresses the challenge of developing a mechanism for top height detection and facilitating the elevator's descent once the final height is reached. The circuit was initially simulated using Proteus software and later implemented on a breadboard. Emphasis was placed on constructing logic equations using basic digital logic components.The designed circuit was then simulated using Proteus software to demonstrate its functionality.

ACKNOWLEDGMENT

The team would like to express sincere gratitude to the Department of Electrical and Electronics Engineering of Kathmandu University for granting permission and supporting the project. The team would like to thank the project supervisor Assistant Professor Mr. Om Nath Acharya for proper guidance to start through basics and carry on the project. The team is also grateful to our project co-ordinator Assistant Professor Mr. Pramish Shrestha for providing necessary assistance and motivation during the project. Furthermore, we convey regards to all the teachers, non-teaching staff and seniors of the Department of Electrical and Electronics who helped the team directly or indirectly throughout the project.

SYMBOLS AND ABBREVIATIONS

S.N	Symbol	Description
1	PCB	Printed Circuit Board
2	R	Resistor
3	IC	Integrated Circuit
4	V	Voltage
5	A	Ampere
6	RPM	Revolution Per Minutes
7	SPDT	Single Pole Double Throw
8	LED	Light Emitting Diode
9	Ω	Ohm
10	μF	Microfarad
11	nF	Nanofarad
12	LSV	Left Side View
13	Hi-Z	High Impedance
14	Cm	Centi-meter

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CHAPTER I : INTRODUCTION

1.1 Background

An elevator or lift is a vertical vehicle that efficiently moves people or goods between floors of a building or a structure. They are generally powered by electric motors. We are using DC motor in this project for the function of elevator. The working principle of an elevator is that the motor is placed on the top of the design of elevator system with some shaft through which the car is pulled up to the desired location input by user. Basically, an elevator is a metal box in different shapes which is connected to a very tough metal rope. The system is operated by a motor. When the switch is ON, the motor can be activated when the elevator goes up, down or stops. The elevator can be constructed with various elevator components or elevator parts containing digital display, DC motor, start/stop mechanism, and floor system. The use of elevators reduces the time of walking and makes ease of travelling high buildings.

1.2 Motivation

We have seen in many office buildings, hospitals, malls, which requires easy transportation between different floors of the building, for this our project can prove to be effective means of transport of loads and resources. We did this project to implement our knowledge of flipflops, latch, timer circuit, and ICs and to build our skills in this subject. Through our study, we found a way to implement those in building the elevator system through the logic circuits and without using any microcontroller. This will benefit us by helping us in understanding these components through practical implementation as in the form of a project work.

1.3 Problem Description

While doing the study of this projects we mainly find the problem in choosing the right motor and the lifting of the car and some mass inside it. Many of these projects are done through the microcontroller and PLC but we are not given to use any of it so very few studies and projects are done through the digital logic for elevator system due to which we are facing some difficulties for choosing the component and IC directly. As we may face some difficulties, we are mainly focused on the working principle of various components and IC's and as per the course related, we are focused on digital electronics.

1.4 Objectives

- To design Elevator System with display through logic circuits.
- To Control the elevator floor level.
- To construct elevator prototype that can be used to lift the lighter load.

1.5 Methodology

- Thorough research is done based on the literature review
- Individual circuits are be designed and all the different parts of the system was done in circuit simulation software.
- All of the parts are implemented first on a breadboard and then troubleshot.
- After completion of the best implementation of every part, they were assembled on breadboards to create a smooth of a system possible by the hardware available to us.
- The completed circuit was further tested for reliability.
- After the finalization of the final system circuit, PCB design will be started for the monitor unit of the system.
- The core of the system will then be fabricated onto the PCB.
- The PCB will be fitted on the elevator system.
- The facility will be armed and prepared for demo.

1.6 Limitations

- Our elevator can lift lighter load only.
- The floor cannot be stopped at the middle position because of only two floors.
- It doesn't have any safety measures.

1.7 Organisation of report

This project work is organized in the following order.

Chapter one: Chapter one is an introduction to the research/project. This chapter is all about the problems which the project intends to solve and the means through which it can be solved. The relevance of the project, the scope of the project and finally it's limitations.

Chapter two: This chapter is the literature review. It reviews the relevant works other researchers have done in the field of overhead protection and the problems they are having in those researchers. It also reviews the available technology through which the project can be realized and also the characteristics of the components used.

Chapter three: This chapter deals with the methodology and design of the system. The most important aspect of this chapter is the block diagram of the system.

CHAPTER II: LITERATURE SURVEY

Many elevator system projects have already been done using PLCs and microcontrollers. PLCs and microcontrollers are easy to use but simply, it is also expensive. So, we decided to control our system using logic gates and DC motors. The first written report of an elevator came in the 1st century BC when the Roman architect Vitruvius mentioned that the Greek mathematician and inventor Archimedes built his first elevator around 235 BC.

The revolution in elevator technology began with the invention of hydraulics and electricity. Hydraulic lifts were often used to transport goods over short distances. They operated on the principle that the water pump increases the pressure of the main plunger which pushes the cargo compartment upwards. This solution was not feasible for tall buildings and was soon replaced in 1850 with a manifold bridge with a rope-gear lift invented by Henry Waterman of New York.

The elevator design used today was first presented in 1852 with the invention of safety equipment that prevents the cabin from falling when the main cable is broken. The inventor of this device, Elisha Graves Otis, demonstrated such a lift at the New York Crystal Palace 1854 exhibition of technical achievements. A few years later his elevator was installed in the first building in New York City[1].

In this Paper[2], an elevator control system based on digital logic was proposed for an eight-story building. The workflow chart was created keeping in mind the events that take place during the movement of the elevator. It was used to come up with the functions required to perform a flowchart lift control. These functions were then translated into logic equations and implemented using digital logic ICs available at basic logic gates and sub-circuits. By combining all these circuit a full control circuit was created.

CHAPTER III: METHODOLOGY AND EXPERIMENTAL SETUP

3.1 Block Diagram

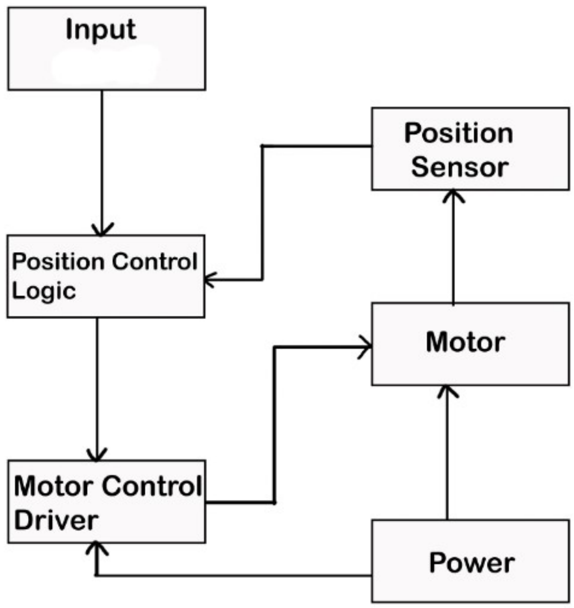

Figure 3.1 Block Diagram of Elevator System

The input section contains the user input which is given by the user. This is achieved by the help of push button. The user selects the desired floor level. As soon as the input signal is given, through the position logic, the appropriate position is selected. This gives signal to the motor control driver. Here we haves used L293D IC as a motor driver that contains H-bridge conncetion. This drives the motor in the clockwise or anticlockwise direction, depending on the position required. The power supply of 12 volts is given to the motor. At top and bottom, the position sensor is placed. Here, it is limit switch. The limit switch helps to dertermine the top and bottom position when the cart of the elevator touches it.

As soon as the upper limit switch is pressed by the cart of the elevator while it is moving upward, it determines the top floor (floor 2 in our case) . So, the logic of upper limit switch becomes high. And through this, the enable pin of the octal buffer gets on. This in return provides high impedance to the output side and so the input pin 1 to the motor driver of L293D IC gets low. Eventually, the motor stops rotating. This brings the elevator to hault in the current positiion. At this moment, when the second switch is pressed, the motor rotates in opposite direction and the elevator moves downward. Also, the output of the first buffer remains high since the upper limit switch is opened. This will continue to rotate the motor until it touches the lower limit switch. When the lower limit switch is closed, the motor stops rotating and the position of the elevator comes to rest. The floor level is displayed on the seven segment display.

3.2 Components and Devices Used

DC Motor

Figure 3.2 DC Motor

A DC motor is an electric motor that converts electrical energy into mechanical energy using direct current (DC). It is one of the most common types of motors and finds widespread applications in various industries and devices.

In this project we are using DC gear motor of 300 RPM. A DC gear motor, also known as a gearhead motor, is a type of electric motor that incorporates a gearbox to provide torque multiplication and speed reduction. It combines a DC motor with a set of gears to increase the motor's output torque while decreasing its rotational speed.

The advantages of using DC gear motors include:

Increased Torque: The gear reduction mechanism enables higher torque output compared to a standard DC motor of the same size.

Precise Speed Control: The gear ratio allows for fine-tuned control of the motor's rotational speed, making it suitable for applications that require precise speed adjustments.

Enhanced Durability: The gearbox provides protection to the motor by reducing the load on the motor shaft, resulting in improved longevity and reliability.

Versatility: DC gear motors are available in various sizes, power ratings, and gear ratios, making them adaptable to a wide range of applications.

The elevator’s cart movement is possible by the clockwise and anti clockwise rotation of this DC motor. Through dataheet the maximum torque was found to be 3kg-cm at 12Volts [3]. The further specifications of the motor is given in the appendix.

Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, divide voltages, bias active elements, and terminate transmission lines, among other uses. In our project, for the 555 timer IC circuit, we have used resistors of value 10 kΩ and 100 kΩ

Figure 3.3 Resistor

Capacitor

A capacitor is a passive two-terminal electronic component that stores electrical energy in an electric field. The effect of a capacitor is known as capacitance.

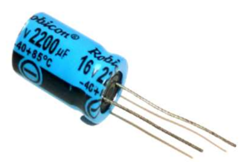

Figure 3.4 Capacitor

When two conductors experience a potential difference, for example, when a capacitor is attached across a battery, an electric field develops across the dielectric, causing a net positive charge to collect on one plate and a net negative charge to collect on the other plate. No current flows through the dielectric. However, there is a flow of charge through the source circuit. If the condition is maintained sufficiently long, the current through the source circuit ceases. For our project, we have used a capacitor of 10 μF and 10 nF.

Timer IC

The 555 timer IC is an integral part of electronics projects. These provide time delays, as an oscillator and as a flip-flop element among other applications.

Figure 3.5 Timer IC

In this project we are using 555 timer in monostable mode. A monostable 555 timer, also known as a one-shot or single-shot 555 timer, is a popular integrated circuit (IC) used in electronic circuits for generating a single, precisely timed pulse. It belongs to the family of timers based on the NE555 or LM555 IC. In monostable mode, the 555 timer generates a pulse of fixed duration in response to a trigger input. When the trigger input is momentarily brought low (logic 0) or triggered with a negative edge, the timer output transitions from its stable state to a temporary unstable state. This unstable state lasts for a specific duration determined by the values of an external resistor (R) and capacitor (C) connected to the timer. After the elapsed time, the output automatically returns to its stable state.

Display

For display we used seven segment display. Seven segment displays are the output display device that provide a way to display information in the form of image or text or decimal numbers which is an alternative to the more complex dot matrix display[4]. It is widely used in digital clocks, basic calculators, electronic meters, and other electronic devices that display numerical information. It consists of seven segments of light emitting diodes (LEDs) which is assembled like numerical 8

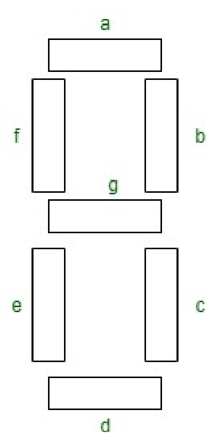

Figure 3.6 Seven Segment Display

Working

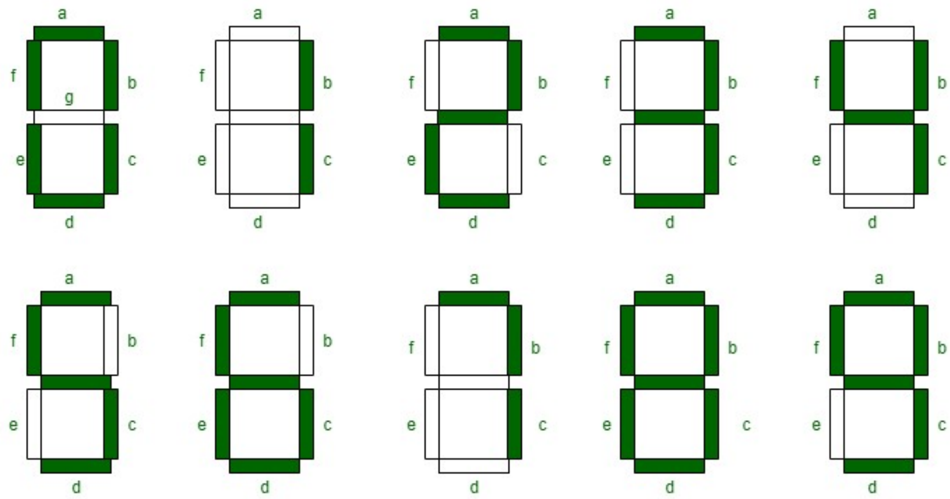

Figure 3.7 Working of Seven Segment Display

Boolean expressions for each decimal digit which requires respective light emitting diodes (LEDs) are ON or OFF. The number of segments used by digit: 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 are 6, 2, 5, 5, 4, 5, 6, 3, 7, and 6 respectively. Seven segment displays must be controlled by other external devices where different types of microcontrollers are useful to communicate with these external devices, like switches, keypads, and memory.

D-FlipFlop (IC 4013)

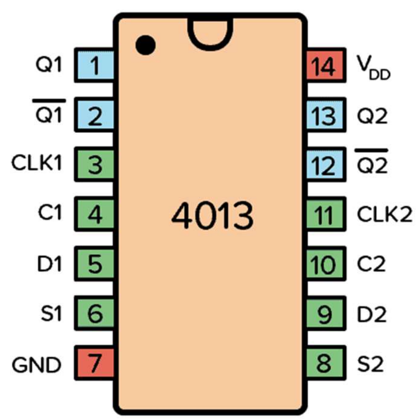

Figure 3.8 Dual D flip flop IC pinout

A D flip-flop, also known as a D latch or data latch, is a sequential logic device that stores and outputs a single bit of data based on the state of its inputs and a clock signal. It is one of the most commonly used flip-flop types in digital circuits.

The truth table for a D flip-flop with a single input (D), a clock input (CLK), and a single output (Q) is as follows:

CLK	**D**	**Q(t)**	**Q(t+1)**
0	X	Q(t)	Q(t)
1	0	Q(t)	0
1	1	Q(t)	1

Here's an explanation of the truth table:

When the CLK input is 0, the output Q remains unchanged (Q(t)) regardless of the value on the D input. This state is often referred to as the "hold" state, where the flip-flop retains its previous output value.

When the CLK input transitions from 0 to 1 (rising edge or positive edge), the flip-flop is triggered, and the input data (D) is captured and stored. The stored data becomes the output Q(t+1) at the next rising edge of the clock.

When the CLK input is 1, if the D input is 0, the output Q(t+1) becomes 0. Conversely, if the D input is 1, the output Q(t+1) becomes 1. The flip-flop reflects the input data at the rising edge of the clock.

The truth table demonstrates that the D flip-flop operates as a simple memory element, storing and propagating the input data to the output based on the clock signal. It captures the D input on the rising edge of the clock and maintains that value until the next clock cycle. In our project, D- flipflop is used as a memory.

Push Button

For keypad four push button switch will be used for controlling. A Push Button switch is a type of switch which consists of a simple electric mechanism or air switch mechanism to turn something on or off. Depending on model they could operate with momentary or

Figure 3.9 Push Button

latching action function. The button itself is usually constructed of a strong durable material such as metal or plastic. Push Button Switches come in a range of shapes and sizes.

Limit switch

A limit switch is an electromechanical device operated by a physical force applied to it by an object. Limit switches are used to detect the presence or absence of an object. These switches were originally used to define the limit of travel of an object, and as a result, they were named Limit Switch.

Motor Driver

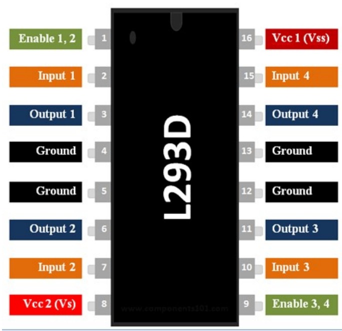

Figure: 3.10 A simple Motor Driver Simulation

A motor driver is an electronic device or circuit that is used to control and drive electric motors. The primary function of a motor driver is to supply the necessary electrical current and voltage to the motor while handling the motor's load characteristics. It provides the power amplification and protection circuits required to drive the motor effectively.

In this project, we have use L293D IC as a motor driver. A H bridge is an electronic circuit that allows a voltage to be applied across a load in any direction. H-bridge circuits are frequently used in robotics and many other applications to allow DC motors to run forward & backward. Generally, the H-bridge motor driver circuit is used to reverse the direction of the motor and also to break the motor.

Tri- State Octal Buffer

The output of an active-high inverting tri-state buffer, such as the 74LS240 octal buffer, is activated when a logic level "1" is applied to its "enable" control line. The data at the input is passes through to the output but is inverted producing a complement of the input. When the enable line is LOW at logic level “0”, the buffer output is disabled and at a high impedance condition, Hi-Z.

Table: Truth Table

Enable	IN	Out
0	0	Hi-Z
0	1	Hi-Z
1	0	1
1	1	0

IC 4511 (BCD to 7 segment Decoder)

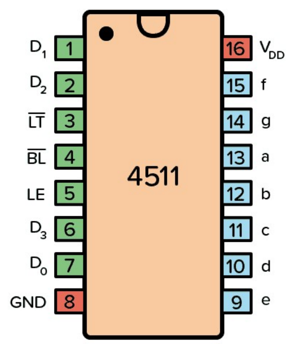

Figure 3.11 Seven Segment Display Driver

IC 4511 is an integrated circuit (IC) commonly known as a BCD to 7-segment decoder/driver. It is used in digital electronics and is specifically designed to convert binary-coded decimal (BCD) inputs into signals that can drive a 7-segment display.

The IC 4511 can decode a 4-bit BCD input (0-9) and generate the appropriate outputs to display the corresponding digit on a 7-segment display. It has four BCD input pins (A, B, C, and D) and seven output pins (a, b, c, d, e, f, and g) that correspond to the segments of a 7-segment display.

PCB

Printed Circuit Boards (PCBs) can be defined as rugged nonconductive boards built on substrate-based structure. The PCBs are mainly used to provide electrical connection and mechanical support to the electrical components of a circuit.. The connection among the components on a PCB are established with copper interconnects (routes), which act as the pathway for the electrical signals.

CHAPTER IV: SYSTEM ANALYSIS

4.1 Conceptual Framework

The project is divided into five main parts i.e

- 555 Timer IC in Monostable Mode
- D-flipflop as Memory
- Tristate Octal Buffer
- Limit Switch
- L293D IC Motor Driver
- 7 Segment Display

➢ 555 Timer (Monostable Mode)

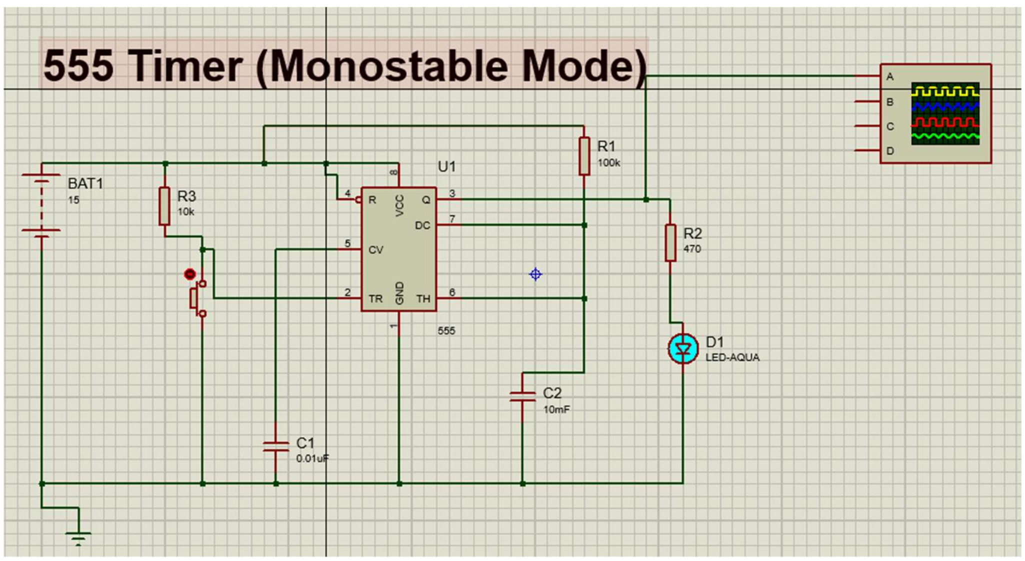

Figure 4.1 555 Timer Circuit Simulation

We have used 555timer in monostable mode. This circuit is made as a delay circuit. Normally, it is on low voltage. When the user gives the input from the push button, it acts as a trigger. As soon as the trigger is on, the logic is set to high for a short period of time. The timer period of the 555 timer is calculated as:

$T = 1.1 * R * C$

$R = Resistor$

$C = Capacitor$

Here, $R = 100\ k\Omega$, $C = 10\ \mu F$

So, T =   1.1 sec.

It is observed that the time delay of the timer is 1.1 second. Here, the value of capacitor is small, so it charges fast. But the discharge time is less. So, once the trigger pin is activated, high clock pulse is achieved.

The operation of this circuit is simple, Pins 6 and 2 of 555 timer chip are at half dc voltage. When pin 3 which is the output is high then capacitor C1 is charged and when it is low capacitor is discharged. When momentary switch is pressed capacitor voltage appears on pin 6 and2 and output pin 3 changes state as well as capacitor voltage changes.

In order to run the timer circuit, a low volt of 5 Volts is provided to the IC as a power supply.

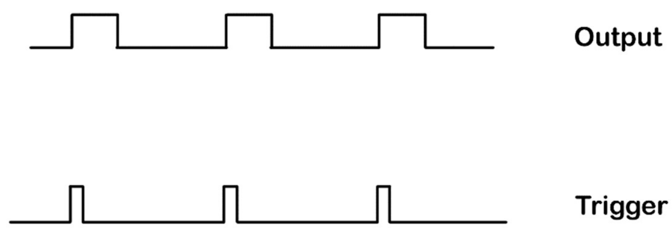

Figure 4.2 555 timer output in monostable mode

The pulse generated from the 555 timer is sent to the D- flipflop as a clock signal. The clock pulse is in the form of a square wave.

- **Memory**

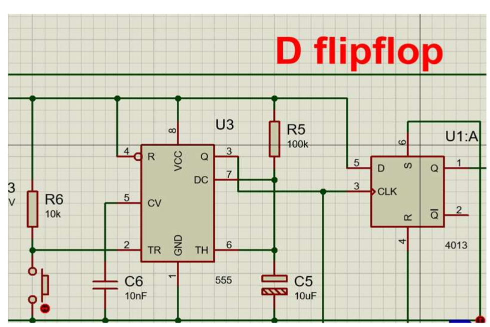

Figure 4.3 Circuit Simulation of D flipflop uesd as memory

In our project, D flipflop is used as a memory. The circuit connection is shown in the figure above. We can see that the pin 3 of the flipflop is given a clock pulse from the output pin (pin 3) form the 555 timer IC.

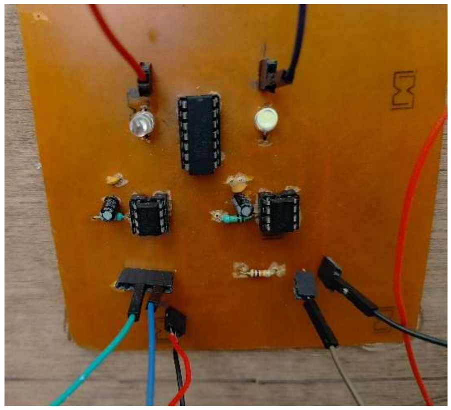

Figure 4.4 D flipflop as a memory

Here, the data set, D is always set high**.** We have used two D flip flops for 2 floor elevator system. When the user touches the first push button, giving input to go to the second floor, the 555 timer is triggered and the clock pulse is sent to the first flip flop. So, the output remains on. This output is sent to the tristate octal buffer. Here, the logic 1, i.e. output high is stored as a memory. This memory is reset through pin 4 and takes to logic zero. This was achieved when second clock pulse is given in the second switch as an input. This gives clock input to the second flip flop and sets its output high. And the memory is stored as logic 1. This output is also given to the second octal buffer as input.

In the figure above, there are two D flip flop in IC 4013, two 555 timer IC, and two LED. When the input is given by the user through push button, the trigger is sent to the first timer and it sends the clock pulse to the first D flipflop. Hence, the output of the first flip flop is High as the data latch is always connected to the high voltage, which gives the same output of logic high. This is stored as a memory. When the second input is given, the memory is reset to logic 0.

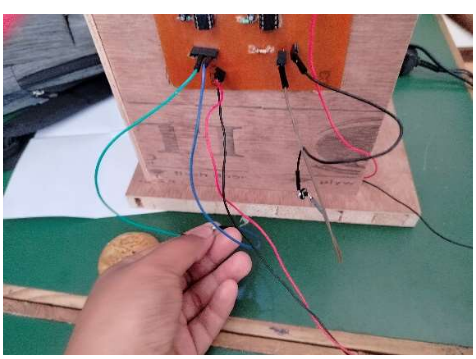

Figure 4.2 Input given through push button

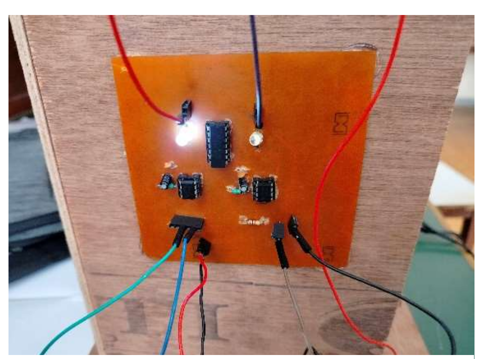

Figure 1.6 First LED is On

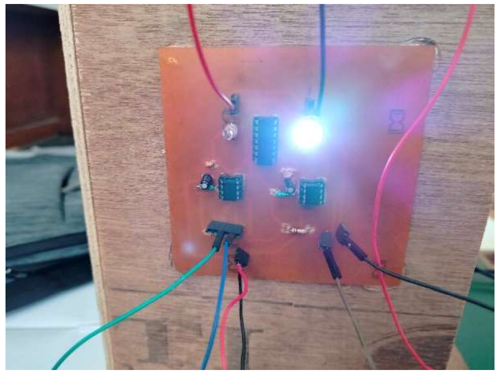

Figure 4.7 Second LED is ON

As shown in the figure above, when the second switch is pressed on, the first LED is off. This resets the memory of the first flip flop to zero. As the clock pulse is given to the second flip flop, it gets on and the output sets to logic high. This sets the memory to logic 1. And it is again reset to zero when the first LED gets on, i.e. when the first switch is pressed on.

- **Tri state Octal Buffer**

The tristate octal buffer is playing the main role of position control logic in our circuit. When the memory of floor 1 is set of the “HIGH” then the output will be “LOW” as we have used the active high inverting tri state buffer. Then the motor will run in a clockwise direction. When the cart reaches the desired floor then the limit switch is pressed and active high which gives the output as the high impedance and the motor is off. Similarly, when the next floor is selected the previous memory of first floor flush out and the memory state of the second floor is active “HIGH” which gives the “LOW” output and the motor driver will start to move in the anticlockwise direction until it reaches to the second floor, since the memory of the first floor is “LOW” which gives the output as “HIGH”. When the cart reaches the second floor the limit switch is pressed again, and the output will be high impedance and the motor stops. This way our position is detected on the desired floor.

- **L293D IC**

We have used L293D IC for H- bridge circuit. As a requirement of the project, we have used the motor driver to control the DC motor direction. Due to the ease of easy access and easy to use we have use L293D as a motor driver. When input 1(pin 2) is High and Enable

Pin (pin 1) is high, but input pin (pin 7) is low than motor will rotate at clockwise direction which is attached to the output pin of motor driver (pin 3 and 6). Similarly, when input 2(pin 7) and enable pin (pin 1) is high but input 1(pin 2) is low than the motor runs in anti-clockwise direction. When the enable pin is low or other pins are high at the same time then there will be no rotation of the motor.

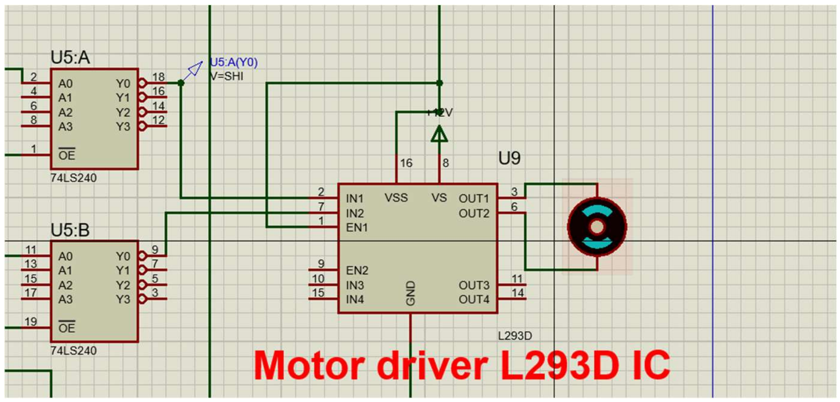

Figure 4.8 Motor Driver Circuit Simulation

➢ Limit Switch

Figure 4.9 Position of Limit Switch

In this project we have used two limit switches. One is placed on the bottom and the next is placed on the top. Limit switch act as position sensor. When the cart of the elevator reaches the top position, the upper limit switch gets pressed and the motor stops rotating. This halts the position of the elevator and brings it to rest until the next input is given by the user. Similarly, when moving down, the bottom part of the elevator touches the lower limit switch. This rests the elevator on the base.

Elevator Control Circuit

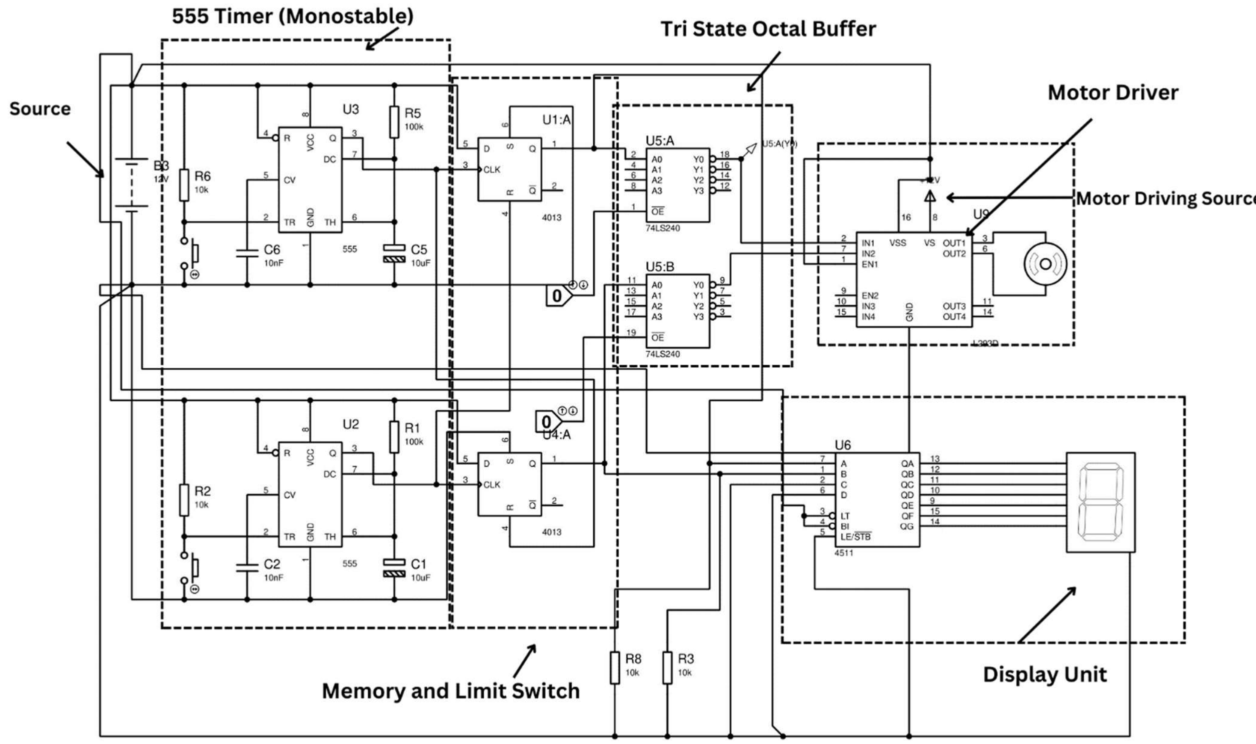

Figure 4.10 Elevator System of 2 floor

The circuit contains five different blocks, 555 timer IC as a monostable mode, D flipflop as a memory, limit switch as a position sensor, tri state octal buffer and L293D IC as a motor driver. The circuit is powered by a 12 V battery supply. At first, through 555timer, a clock pulse is generated which is sent to the flip flop and since through it, the signal is sent to the octal buffer. The buffer controls the input given to the motor driver, through the enable pin which gets on only when either of the limit switch is closed. The L293D IC is used to control the direction of the DC motor. When the elevator is moving upwards, the motor rotates in anti-clockwise direction and when the elevator is going downwards, the motor rotates in clockwise direction. The motor driver contains of a H- bridge connection that acts as a switch which helps to control the direction of the motor. To display the floor level, the 7 -segment display is used. Since, our elevator is for 2 floor system, floor level 1 and floor level 2 is shown on the display. The simulated result is shown in the figure.

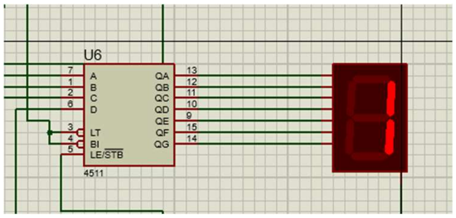

Figure 4.12 Displaying Floor 1

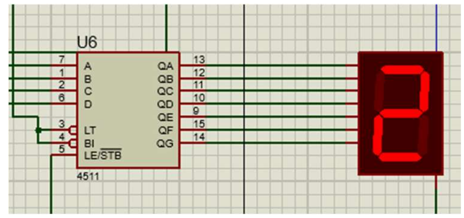

Figure 4.13 Displaying Floor 2

Mechanical Design of Elevator

Figure 4.14 Structure of Elevator System

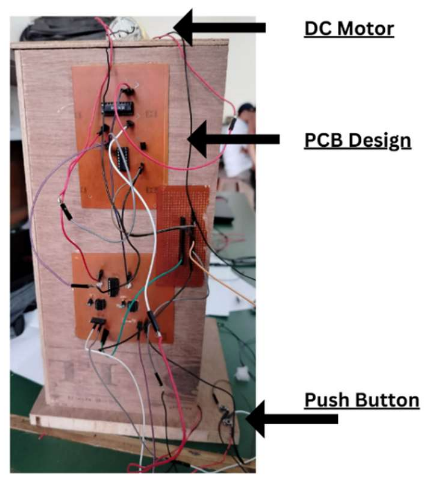

Figure 4.15 PCB implementation on elevator (LSV)

The vertical height of the elevator is 35cm. The base is made of 25cm length in square shape. The cart of the elevator is a 15cm square box, enclosed in all the side except the front side. On the top of the elevator, DC motor is placed and it is connected to the cart with the help of a thread. The wire connection is shown in the figure 4.15 above. Two push buttons are placed at the bottom through which the user gives the input.

Calculation of Torque

To calculate the torque required to carry a load of 348 grams with a distance of 35 cm, we can use the following formula:

Torque (kg-cm) = (Weight (kg) × Distance (cm)) / 9.8

First, let's convert the weight of the load from grams to kilograms:

Weight (kg) = 348 grams / 1000

Weight (kg) = 0.348 kg

Now we can calculate the torque:

Torque (kg-cm) = (0.348 kg × 35 cm) / 9.8

Torque (kg-cm) = 1.2451 kg-cm

Therefore, based on the given distance of 35 cm and a load of 348 grams, the torque required is 1.2451 kg-cm.

CHAPTER V: CONCLUSION AND FUTURE WORK

We bulit an elevator floor control system with two floor levels by using the logic gates and flip flop ICs without the use of micro controller. The elevator was built with 555 timer IC in monostable mode, D flip flop as memory, limit switch as a position sensor, L293D IC as motor control driver and seven segment display as a display unit. The elevator was operated through the DC motor which carried the cart in upward and downward direction. This work was for the two floor level but can be scalable to any level of heights.

CHAPTER VI REFERENCES

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