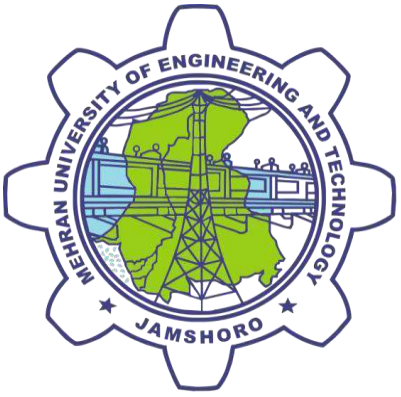
Design and development of a Low-Cost Stair Lift



A thesis submitted by

Muhammad Saleem Umrani(GL) (18ES32)

Ali Gohar Khaskheli (18ES44)

Muhammad Kaleem Gaho (18ES68)

Supervisor

Prof. Dr. Attiya Baqai

Co-Supervisor

Engr. Burhan Aslam

Prof. Dr. Tanweer Hussain

Submitted in the partial fulfillment of the requirements for the degree of Bachelor of Engineering in Electronics

Faculty of Electrical, Electronics & Computer Engineering

MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO

October 2022

CERTIFICATE

This is to certify that Project/Thesis Report on **"Design and development of a Low-Cost Stair Lift "** is submitted in partial fulfillment of the requirement for the degree of Bachelor of Electronic Engineering by the following students:

Muhammad Saleem Umrani(GL) (18ES32)

Ali Gohar Khaskheli (18ES44)

Muhammad Kaleem Gaho (18ES68)

Supervisor

Dr. Attiya Baqai

Co-Supervisor

Engr. Burhan Aslam

Prof. Dr Tanweer Hussain

(Chairperson, Department of Electronic Engineering)

Date: 26-10-2022

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful Alhamdulillah, all praises to Allah for the strengths and His blessing in completing this thesis. Special appreciation goes to our supervisor, Prof. Dr Attiya Baqai(Professor, Department of Electronic Engineering, Mehran University of Engineering and Technology Jamshoro) for her supervision and constant support. Her invaluable help of constructive comments and suggestions throughout the experimental and thesis work has contributed to the success of this research. Not forgotten, appreciation to our co-supervisor, Engr Burhan Aslam (Lab supervisor, Department of Electronics Engineering, MUET, Jamshoro for his support, assistance, time, dedication, and facilitation by all means, and co- supervisor Prof Dr. Tanweer Hussain (Professor, Mechanical Engineering Department Mehran UET Jamshoro)for help in knowledge regarding Mechanical part in this project. We are highly thankful for his help from market survey to choose and purchase the motor and motor driver. Also for the debugging and resolution of issues raised during implementation phase of the mechanical assembly of the project

We would like to express our appreciation to the Vice Chancellor of Mehran University of Engineering and Technology Jamshoro, Prof. Dr. Tauha Hussain Ali for permitting us to install our system at the stairs of (new building) Electronic Engineering department of MUET, and same to the

Chairperson, Department of Electronics Engineering, Prof. Dr. Arbab Nighat for her support and help towards our undergraduate affairs. Our acknowledgement also goes to Munawar Ali(Lab technician, Mechanical workshop Mehran UET Jamshoro) and all other technicians and office staff of Department of Electronic Engineering, MUET Jamshoro as well the office staff of whole university including DEAN of FEECE faculty, Prof. Dr. Mukhtiar Ali Unar and director PD office MUET, Engr. Saghir Ahmed Memon.

In addition, we would also like to express our gratitude to our loving parents and friends who have helped and given us encouragement.

ABSTRACT

As we know diseases are part of life. Either they come naturally or accidentally but are accountable for affecting the human mobility. The people with locomotive disabilities cannot move along an up story building.There are number of solutions like (elevators and escalators) to help them and overcome this issue but alongside with them we have proposed an affordable solution named “stair lift”. According to “The Accessibility code of Pakistan 2006”[1]. It’s necessary requirement of HEC to have accessibility options in the multistory (Low rise Buildings) public places which the universities have to follow, but as the lifts are quite expensive so limited facilities are available and many institutes do not follow this law.

This Project is a comprehensive study about design and development of a low cost stair lift. In which, a low-cost stair lift design is proposed for disabled people whose mobility is affected due to various diseases.A stair lift is a chair that glides up and down on preinstalled track and carries the person up story to the building. The designed stair lift has two main parts- i.e. a body part and a chassis part. Body part contains all physical structure of chair whereas the chassis part contain-power source, motor and gear circuitry and braking system mechanism and manually controlling panel as well remote control system.

Table of Contents

List of Tables

List of Figures

List of Equations

List of Abbreviations

WHO:	World Health Organization
TDOF:	Two-degrees-of-freedom
3D:	3 Dimensions
CNC:	American Thorax Society
SMPS:	Switched mode power supply
UGV:	Unmanned ground vehicle
RPM:	Revolution per minute
DC:	Direct Currrent
AC:	Alternative Current
QR	Quick Response
GSM	Global System for Mobile Communications
WIFI	Wireless Fidelity

CHAPTER 01

INTRODUCTION

1.1 INTRODUCTION

The project idea is to design a Stairlift (a single chair that glides up and down on preinstalled track and carries the disabled to up story building), as people with locomotive disabilities (due to various diseases like arthritis, post-polio syndrome, and, vascular disease) cannot travel through any low-rise(Multistory) building so stairlifts are used to carry those people to any low rise building, besides there are number of solutions like (elevators and escalators) to help them, but are expensive and having structural limitations and the already available stairlifts are very expensive($2000 to $6000) that's people cannot afford, so In order to fill this cost based product gap, a low-cost stairlift is manufactured by utilizing easily/locally available material with few additional features which are rarely available in existing stairlifts.

An already available model is shown in Figure 1.1.

Figure 1.1: Already available stairlift(Expensive)

1.2 BASIC TERMS OF STAIRLIFT

Few basic and technical words with description are given below. These words represent the components, concept or mechanism used in the project.

Stairlift: a single chair that glides up and down on preinstalled track and carries the disabled to up story building

Frame:A 10 feet iron flat track with 10 inches width on which the rack(gear) is welded.

Rack : A toothed bar that engages the pinion gear.

Track/Rail: Track or the rack is the way for the stairlift on which the moving part i.e chassis and the chair, is fixed and is combination of the frame and rack (a toothed bar that engages the pinion gear)

Pinion gear: It is a round mechanical gear with teeth on its outer face, it's engaged with the rack and motor shaft to drive the chair up or down.

Motor: It is mechanical device that produces the rotational effect when the power is provided, the motor that is used in the designed stairlift is an servo motor that runs along with the servo drive (i.e. MR J2s-40A).

Servo drive: It's an embedded system that control the mode of the motor, rotation direction, rotation speed of servo motor through encoder and helps in serial communication.

Navigation: The term refers to the direction of the stairlift i.e whether its going up or down onto the track/rail.

Control Panel: A combined unit to control the stairlift, that's to move the chair up, down, stop, lock, or unlock through guided and unguided media as well.

Armrest: A support on which the seated person keeps the arms comfortably, also the guided control panel is installed on the right armrest of the stairlift

Footrest: A support on which the seated person keeps the feet comfortably.

Low rise Buildings: A building having two or more than two stories.

Luggage carrier: A platform integrated with the chassis of the stairlift to place the luggage of the patient (or the traveler).

TFT Display: A digital display integrated along with the control panel that shows the status of the stairlift (Up, down, or Stop), remaining stairs and time to reach destination.

1.3 USE OF STAIRLIFT IN HEALTH

- As we know diseases are part of life. Either they come naturally or accidentally but are accountable for affecting human mobility. The people with locomotive disabilities (due to various diseases like arthritis, post-polio syndrome, and vascular disease) cannot move along an up-story building, so stairlifts will help them to travel through any low-rise building.
- The purpose of the project idea is to design a system to optimize "access" and make disabled people inclusive by giving equal access and opportunities to everyone wherever possible. In education, this involves reducing and overcoming the barriers that might occur. Figure 1.2 shows the persons with some kind of disability

Figure 1.2:Differently abled persons

1.4 HELP IN INDUSTRIAL PROBLEMS:

- The stairlifts are rarely manufactured in the country due to its high price, thus, after applying the proposed idea the budget can be noticeably reduced, and industries can examine a positive edge.
- Market opportunity of 31M people can be achieved, as according to the 6th Population and Housing Census of 2017, the population of Pakistan is around 207 million, Considering the (WHO)'s estimation, around 31 million people in Pakistan are expected to be living with some form of disability

1.5 PROBLEM STATEMENT:

- As people with locomotive disabilities are incapable of climbing the stairs on their own, stairlifts are used to carry them. However, existing stairlifts are prohibitively expensive ($2000-$6000). To fill this cost-based product gap, a low-cost stairlift is being manufactured using readily available/locally available materials.
- Launching Lifts or Elevators at low-rise buildings is a costly, area in-efficient and difficult task.
- The proposed idea helps to follow a law mentioned in "The Accessibility Code of Pakistan 2006":[1] which states "it's necessary requirement of HEC to have accessibility facilities(say ramps,elevators, or stairlift)for differently abled persons in the multistory(Low rise Buildings) public places which the universities have to follow, but as the lifts are quite expensive they are not in common use.".

1.6 AIM AND OBJECTIVES.

The aim of the project is to design and develop a low-cost Stair Lift to facilitate and provide mobility to the injured/ disabled/ old people and patients whose mobility is affected due to various such diseases like arthritis post-polio syndrome, and vascular disease.

Objective 1: To design and install the track on the stairs.

Objective 2: To design the upper structure (sitting area) and the chassis of the chair.

Objective 3: To design motor drive, gears, power source, and integrate with other components.

Objective 4: To assemble the whole system and install it in department of Electronic Engineering.

1.7 MOTIVATION

We got the motivation to design the stairlift after knowing the facts that:

- Diseases are a part of nature; they can occur naturally or as a result of an accident. When a patient suffers from diseases such as arthritis, post-polio syndrome, or vascular disease, his or her mobility is severely impaired. Stair lifts can assist patients in overcoming this issue, as shown in Figure 1.3, to go to the up-story or glide through any low-rise building.

Figure 1.3:Differently abled persons

- There also exist scenarios where both elevators and escalators cannot be used due to limitations in architecture as shown in Figure 1.4.

Figure 1.4:Complex architecture of the building

- According to "The Accessibility code of Pakistan 2006 "[1] it's necessary requirement of HEC to have the stair lifts in the multistory(Low rise Buildings) public places which the universities have to follow, but as the lifts are quite expensive and are not in common use, so many institute do not follow this law.

1.8 THESIS LAYOUT

The first chapter is an introduction to the project, describing what it is and why we worked on it, as well as its aims and objectives. We have covered all of the necessary introductory information for potential readers in this section.

The second chapter is a literature review based on research papers. We studied nearly twenty-five research papers from which we gathered information for our project, which greatly aided us in thoroughly understanding this project; we have presented an analysis of 12 research papers here, as well as the project's main thrust.

The third chapter is about methodology, which describes how the project is designed and developed. It also demonstrates the feasibility of the project and the steps we took in designing it. In our case project methodology is based on both hardware and software.

- First, in Software, we designed software-based 3D model of the design of the stairlift. Also debugged and simulated the Arduino programming for control mechanism. In addition, we customized an android app to control stairlift remotely.
- Secondly, in hardware, we designed the complete system of the stairlift including, rack and pinion setup, chassis and upper structure of the stairlift, casing of the control panel and electronic circuitry using CNC, covers for the chassis, and integrated the motor, motor driver, and electronic components each other

The fourth chapter is about the results and how we got them. Here, we verified our results and displayed the output. In our case, we first performed tests to verify speed, smoothness, weight bearing capacity, and obtained the results and compared them to the expected results, which confirmed our findings.

The fifth chapter contains the conclusion and future recommendations, which brings our work to a close. What have we achieved, and how can we improve?
We also included future work, which refers to what is possible in terms of this work in the future and what changes are possible in terms of its efficiency and performance.

CHAPTER 02
LITERATURE REVIEW

2.1 INTRODUCTION

A stair case lift is a safe and secure method of human transportation that is a mechanical device that lifts people up and down stairs. Earlier, after many design changing elevators were designed to carry people up by using old mechanism of rope or chain, and was launched to the market, but the design requirements of the lift like, more space, extra depth for installation, and replacing cost of the elevators made people think about alternatives. Also, Escalators were in use but they were having same design issues. Besides, it was not cost effective to install it for two story building.

So to overcome this issue, an stair lift was designed which uses one side of the stairs, and is mounted through rack, different techniques are used to design stairlift.

The issue is its high cost, so to overcome this issue, locally available material has been used in our design that is cheap. Rack and pinion gear technique with 8 bearing mechanism is used to attach the chair with the rack, and motor is used to drive the chair up and down

2.2 PUBLIC PLACES SURVEY

We visited different public places, like big restaurants, shopping malls, medical centers, and universities to see installed stairlifts, but didn't find any single, instead escalators and elevators was used in some many story buildings. Although, According to “The Accessibility code of Pakistan 2006 ”[1] it’s necessary for HEC recognized universities and public places to have the stair lifts in the multistory(Low rise)

Buildings, which the universities have to follow, but as the lifts are quite expensive and are not in common use, so many institutes do not follow this law.

2.3 LITERATURE SURVEY

According to paper [2], the authors designed an stairlift in which the horizontal level of the stair lift is controlled by two-degrees-of-freedom control system operated by a sliding mode controller, as the stairlift was made to travel through stairway having different inclination, so TDOF is responsible for real-time position of the chair.

In paper [3] authors have designed structure of stairlift in solidworks software, in the proposed designed they used Rack and pinion gear, DC motor with 2400 r.p.m and 12V D.C driving voltage to drive the pinion gear, a chair for disables to sit, and two rails one of them for connecting the track gear and the other for supporting the chair. Also they analyzed the the von mises stress, strain, deformation and factor of safety (FOS) for maximum weight 95 kg.

W. Sulistiyo et al. in their paper[4] proposed stairlift design in which they mounted guide rails made up of steel on the stairs, attached the seat frame on which patient will be sitting, inside seat frame, there is a drive motor, gearbox, and gears to continue rotation from the motor to the driving mechanism. Seat frame can be moved up or down by a rope or chain, also there is seat swivel function with a switch, and if switch is unlocked the stairlift will not move.They used Arduino Nano along with 2-channel relay module to control the movement of the stairlift.

In paper [5], authors designed an IOT based fordable stairlift which can be controlled through mobile application, they used Node MCU to connect stairlift control system with mobile application via “Wi-Fi”, MD30C motor driver, and winch LT2000 motor to drive the lift up or down, also they used Force sensors to automate stairlift i.e stairlift will automatically move up or down soon after patient sits on the chair, and limit switches are used to stop the chair automatically when reaches to end of the rail/track. SMPS (switched mode power supply) is used to energize the motor, motor driver and control system.

In the research papers [6-9] authors used star-type legs or similar techniques to make the chair capable of climbing over the stairs and travel on floor same time, a visual of star-type legs is shown in figure 2.1.

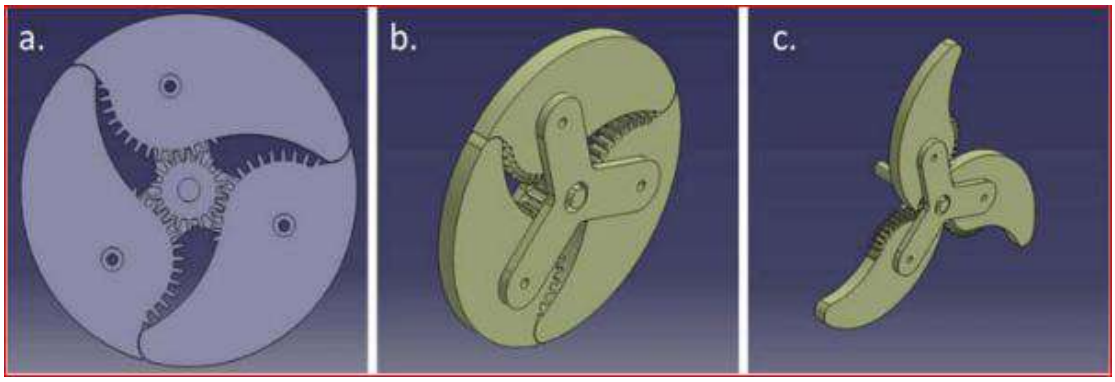


Figure 2.1:3D visual of star-type legs

Similarly, roller chain UGV based robot is designed which can climb to stairs as well can run on ground. All these occupies more space and have slippage issue.

In the project report [10] authors designed a portable stairlift system in Solidworks software that carries heavy furniture and appliances to low-rise buildings, they used telescopic rail that moves the object up the stairs, a cart on which load will be placed, a rope and pulley system, DC motors, and Arduino UNO based control system.

In paper [11] authors designed a small prototype of Bluetooth based remote control stairlift, in which they used PIC18F4525 controller to connect system with mobile application, pulley system to lift the chair up or down, a TA8428K chip that has an internal “H- bridge” to switch the direction, and a DC motor to drive the system.

In the user manual [12], an stairlift company HARMAR designed stairlift model “SUMMIT SL350OD”, with Swivel seat cut-off switch, Slack cable brake with switch Constant to stop the chair, constant-pressure functionality to stop the lift immediately if the control is released, aluminum rail mounted to the stair, passive seat belt.

CHAPTER 03

METHODOLOGY

Among several methods to design stair lifts. The rack and pinion method was chosen to achieve the aim of the idea i.e “Design and development of low-cost stair lift”.

The design mainly contains the following parameters to be implemented.

- Chair
- Track
- Drive control
- Motor and power source

Firstly the path through which the chair will move i.e “track” has been mounted on the stairs followed by a frame. Then a custom design chair is scaled on that track with the control unit on the arm rest.The chair has a chassis part inside which the motor, motor driver and electronic circuit is installed. The general diagram is shown in Figure 3.1.

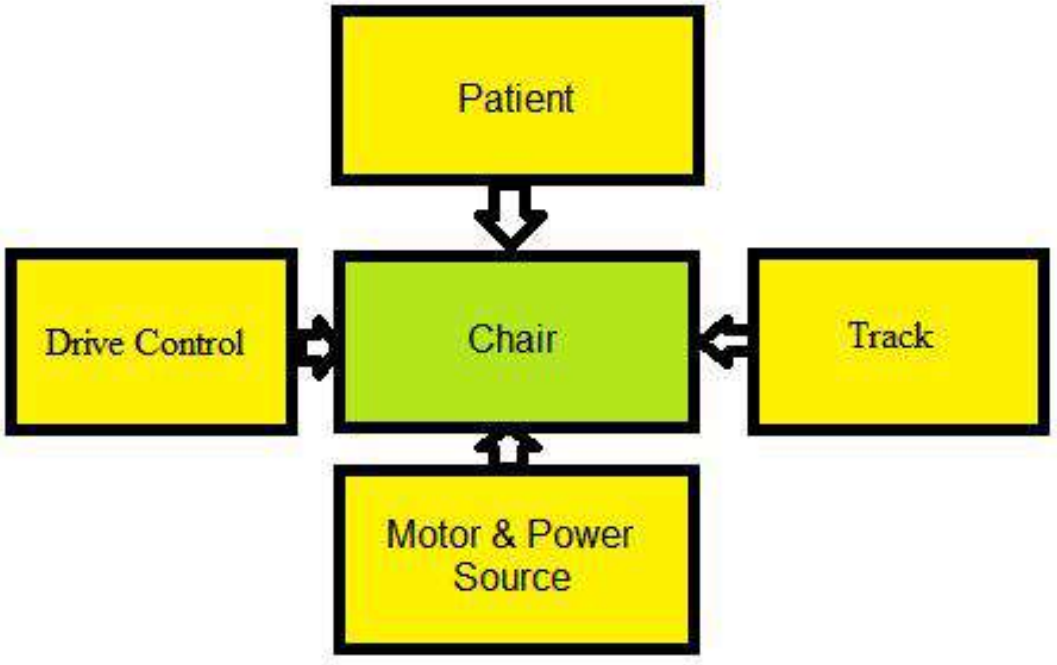


Figure 3.1: methodology general block diagram

Design methodology of how the design of proposed system will go through different implementation phases contains:

- Hardware Components
- Software design
- Hardware design

3.1 HARDWARE COMPONENTS:

The description of each components is given below:

- Ultrasonic
- Bluetooth
- Keypad
- Arduino Mega
- TFT Display
- Relay board
- Servo Motor
- Servo Drive
- Rack and Frame
- Pinion Gear

3.1.1 Ultrasonic:

The Ultrasonic sensor (also called sonar sensor) is an object detecting and distance measuring device that detects the obstacle and tells how far is that object from the sensor position. The working principle of the sonar sensors is based on the sound waves, as it contains a transmitter that sends the sound waves and a receiver that receives the reflected sound waves. When objects comes in front of the sound wave beam it reflects back and few waves strikes to the receiver. Once the wave is received, the time taken by the received signal from transmission to reception is used further used to measure the distance. The mathematical formula to measure distance is shown in equation-1.

$$distance = \frac{time\ taken\ x\ speed\ of\ sound}{2}$$

Equation-1: Formula to measure the distance in Ultrasonic

The working of sonar is shown in **Figure 3.2.**

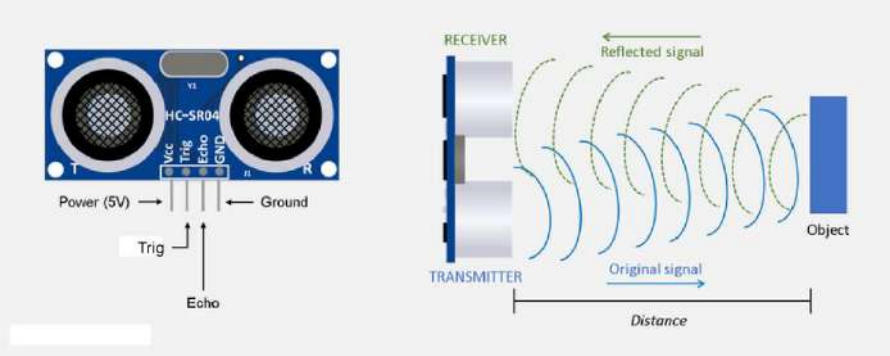


Figure 3.2 b: Working of mechanism of Ultrasonic

3.1.2 Bluetooth :

A short-range wireless technology standard called Bluetooth is used to create personal area networks and exchange data over short distances between stationary and mobile devices (PANs). It uses UHF radio waves between 2.402 GHz and 2.48 GHz in the ISM bands. It is mostly used as an alternative to wired connections, to transfer files between adjacent portable devices, and to pair wireless headphones with cell phones and music players. Transmission power in the most popular mode is restricted to 2.5 milliwatts, giving it a fairly short range of up to 10 meters (33 ft).The module is shown in **Figure 3.3.**

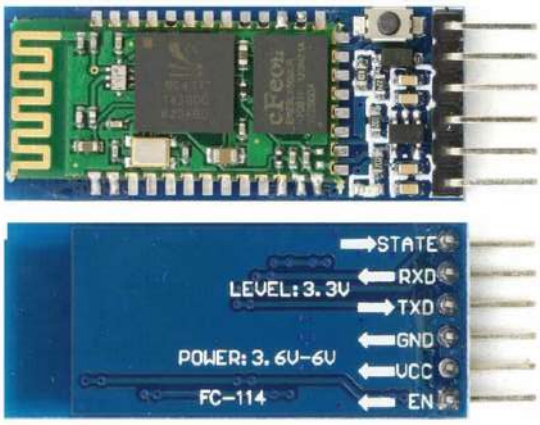


Figure 3.3 : HS-05 Bluetooth module

3.1.3 Arduino (Mega):

An open source development board called the Arduino Mega 2560 is built around the Atmega2560 AVR microcontroller. An 8-bit microcontroller, such as this one. It makes use of microchip technology ATmega16U2. This board can be configured by wire or processing languages.The microcontroller is shown in **Figure 3.4.**

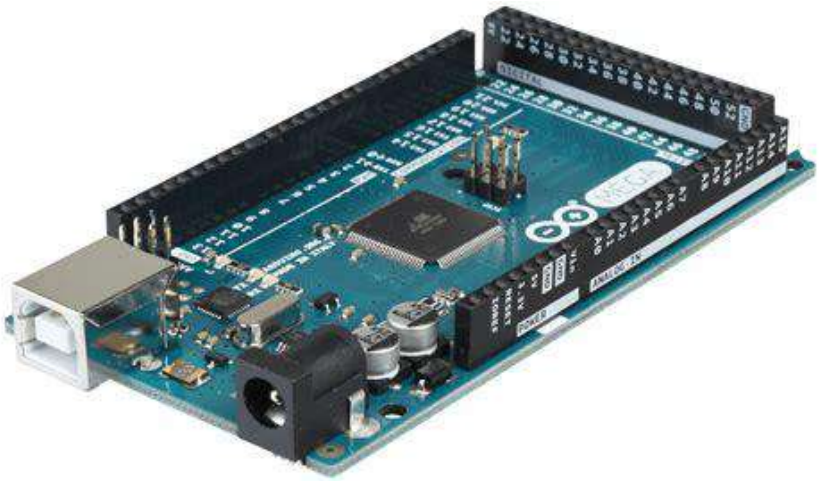


Figure 3.4: Arduino Mega

3.1.4 4 by 4 Keypad membrane:

A keypad is a set of buttons that are set up with an arrangement of digits, symbols, or alphabetical letters. Numbers and keys are most commonly used on numeric keypads. Keypads are found on devices that require mostly numeric input, such as calculators, television remotes, push-button telephones, vending machines, ATMs, point of sale terminals, combination locks, safes, and digital door locks.The membrane is shown in **Figure 3.5.**

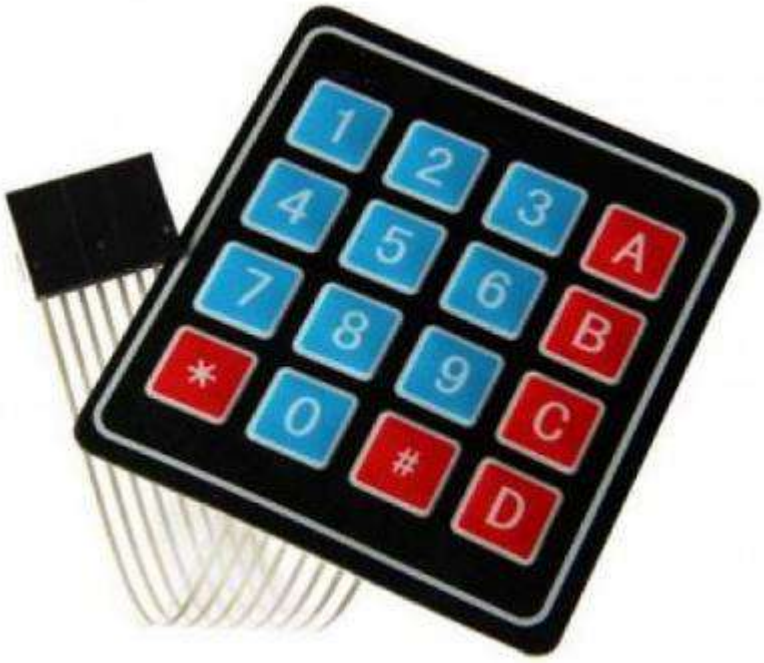


Figure 3.5: 4 by 4 Keypad membrane

3.1.5 TFT Display:

TFT displays offer bright, vivid colors that are able to show quick animations, complex graphics, and custom fonts with different touchscreen options. We have a variety of sizes and resolutions available for your needs. This display type is a standard, premium MVA display with a variety of interface options including HDMI, SPI and LVDS. Our TFT modules include a custom PCB that supports an HDMI interface, audio support, or HMI solutions with an embedded video engine.The display is shown in **Figure 3.6.**

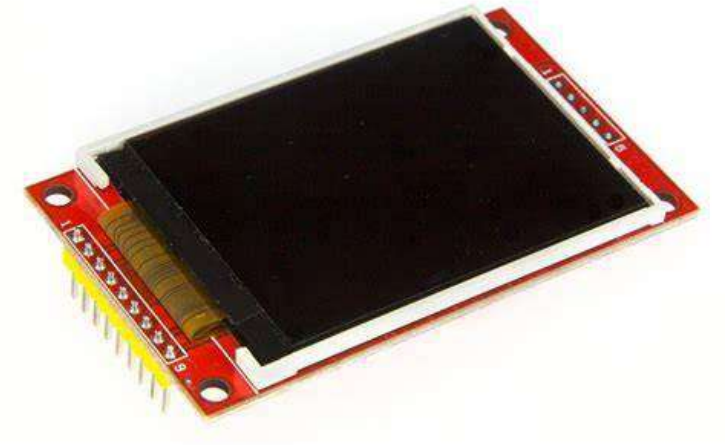


Figure 3.6: TFT display

3.1.6 Relay Board:

A relay is an electrically operated switch that can be used to connect two or more devices. This module consists of input terminals for a single or multiple control signals, and operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make, break, or combinations thereof. Relays are used to control circuits by controlling a low-power signal. For multiple relay function a relay board is used which consists of 4 or 8 relays with names 4 channel or 8 channel relay board.The board is shown in **Figure 3.7.**

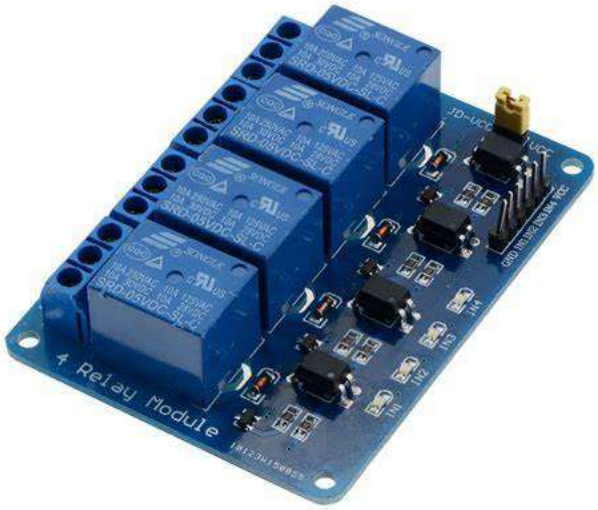


Figure 3.7: 4 Channel relay board

3.1.7 Servo Motor:

A servo motor is a type of motor that can rotate at great speed. A common type of motor uses a control circuit that provides feedback on the current position of the motor shaft. This feedback allows the servo motors to rotate with great precision. You can rotate an object at some specific angles or distances by using a servo motor. This is just a motor that runs through a servo mechanism. If a motor is powered by a DC power supply, it is called a DC servo motor, and if it is powered by an AC power supply, it is called an AC servo motor.The motor is shown in **Figure 3.8.**

Figure 3.8: Servo motor

3.1.8 Servo Drive (MR J2s-40A):

A servo drive receives a control signal from a control system, amplifies the signal, and transmits electric current to a servo motor in order to produce movement proportional to the control signal. Typically, the command signal represents a desired velocity, but can also represent a desired torque or position. A sensor attached to the servo motor can send back the servo motor's actual status to the servo drive. The servo drive determines whether the motor is actually moving and then compares the two statuses. It corrects the voltage, frequency, or pulse width to ensure that the motor is in conformity with the commanded status.The driver is shown in **Figure 3.9.**

Figure 3.9: Servo drive

The speed of the stairlift is also controlled by servo drive, the potentiometer is connected with the CN1B port of the servo drive, when the resistance is varied the RPM of the motor also varies and as a result speed of the stairlift also varies. Similarly, direction of the rotation is also controlled by servo drives CN1B communication port. It gives options to rotate the motor in clockwise or anti clockwise direction.

The circuit diagram of the connection of motor, motor driver and power source is given in Figure 3.10.

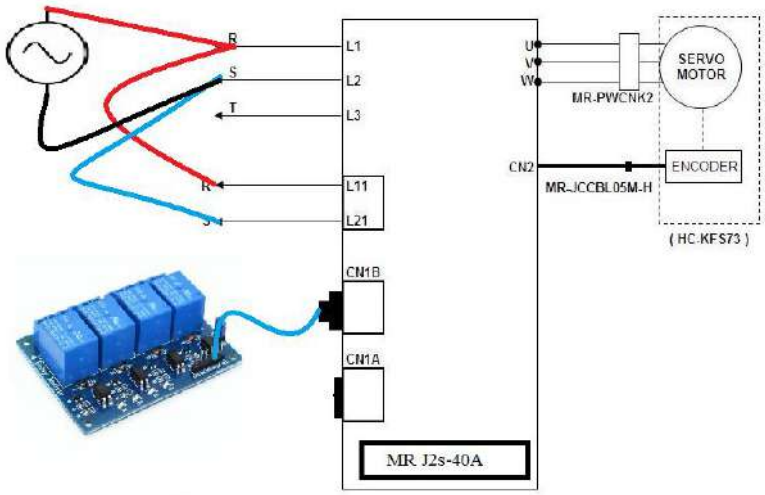


Figure 3.10: Circuit diagram of motor and motor driver

3.1.9 Rack and pinion:

A rack is hard metal with teeth on one side, while the pinion is like a round tire with teeth on its outer surface, It engages the rack and converts the rotational motion into a linear motion. The pinion is attached with motor shaft when motor rotates, pinion gear also rotates and resultantly the chair moves in particular direction(depending upon the direction of rotation) The frame is just a flat track that supports the rack, figure xx shows the rack and pinion mechanism..The mechanism is shown in **Figure 3.11.**

Figure 3.11: Rack and Pinion gear

3. 1 SOFTWARE DESIGN

Before going to implement the idea of a stair lift physically. A software-based model of the design was created using some software tools, the software part includes:

3. 1.1 Blender design

Blender is a 3d visualizer of a model. A complete structure of the project that how it's going to be planted is done through a blender. Firstly all components are created by taking a 3D object. Then they are assembled, like a rack is diffused on a frame having a chair upon it. The chassis of the chair contains a motor, motor driver, power source, and upper part. 8 bearing mechanism has been used to fix the whole chassis onto the rack. (Mechanism contains four bearings on the upper side and four on the lower side of the frame. Which holds the chassis with a rack, as shown in Figure 3.12 a and b

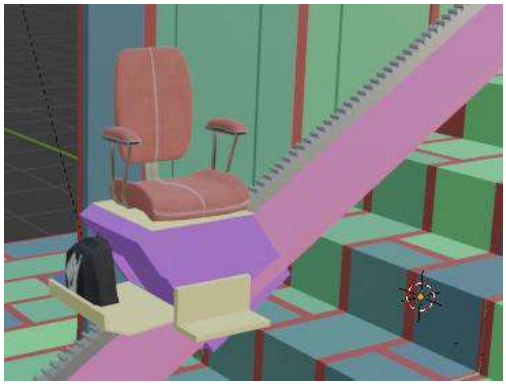


Figure 3.12 a: 3D design of stair lift

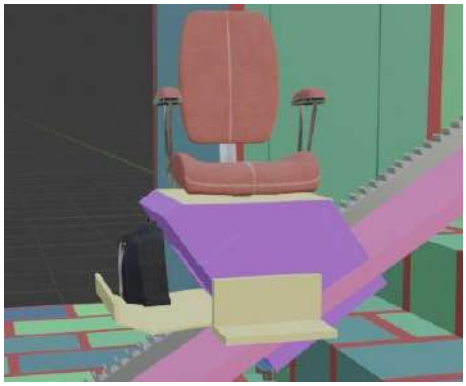


Figure 3.12 b: 3D design of stair lift

The 8 bearings mechanism is shown in Figure 3.13.

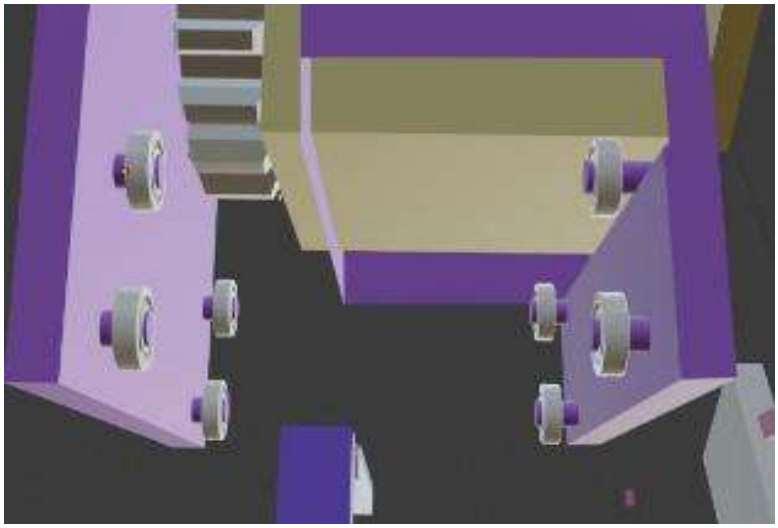


Figure 3.13: 3D visualization of 8-bearing mechanism

After the analysis and selection of the assembly design we modeled it with perfect dimensions as shown in Figure 3.14 and Figure 3.15.

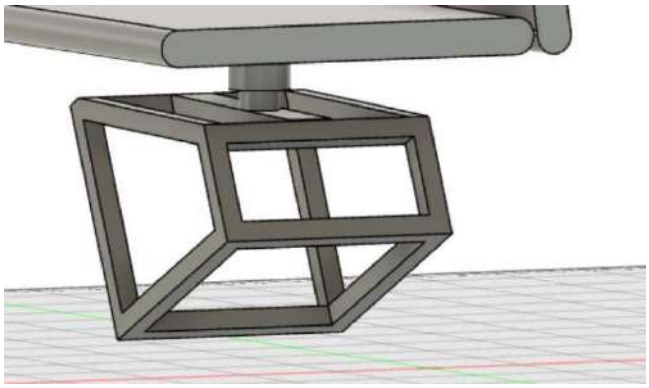


Figure 3.14: Dimensions of the chassis

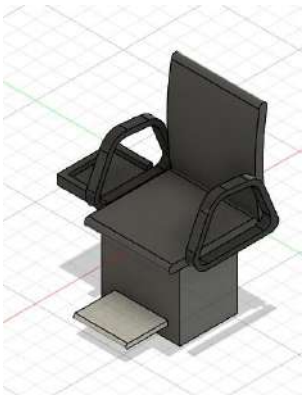


Figure 3.15:CAD model of the chair

3.1.2 Arduino coding :

The microcontroller I.e Arduino has been coded in a way that when patient comes and presses the power button the embedded TFT display prompts for the security password and Arduino takes input from user through 4x4 keyboard matrix membrane and proceeds the user for next controls including up, down brake and lock and shows the status on TFT display. Besides Arduino takes input from integrated sonar sensors to measure the remaining steps and time to cover those steps, the code to control limits switches is also included in the sketch to stop the chair while it reaches the destination.

The Arduino sketch also includes the instructions to get data from mobile through Bluetooth module to give user the ability to control the stairlift remotely.The sketch view of the Arduino environment is shown in figure3.6.The flow chart is given in figure 3.16.

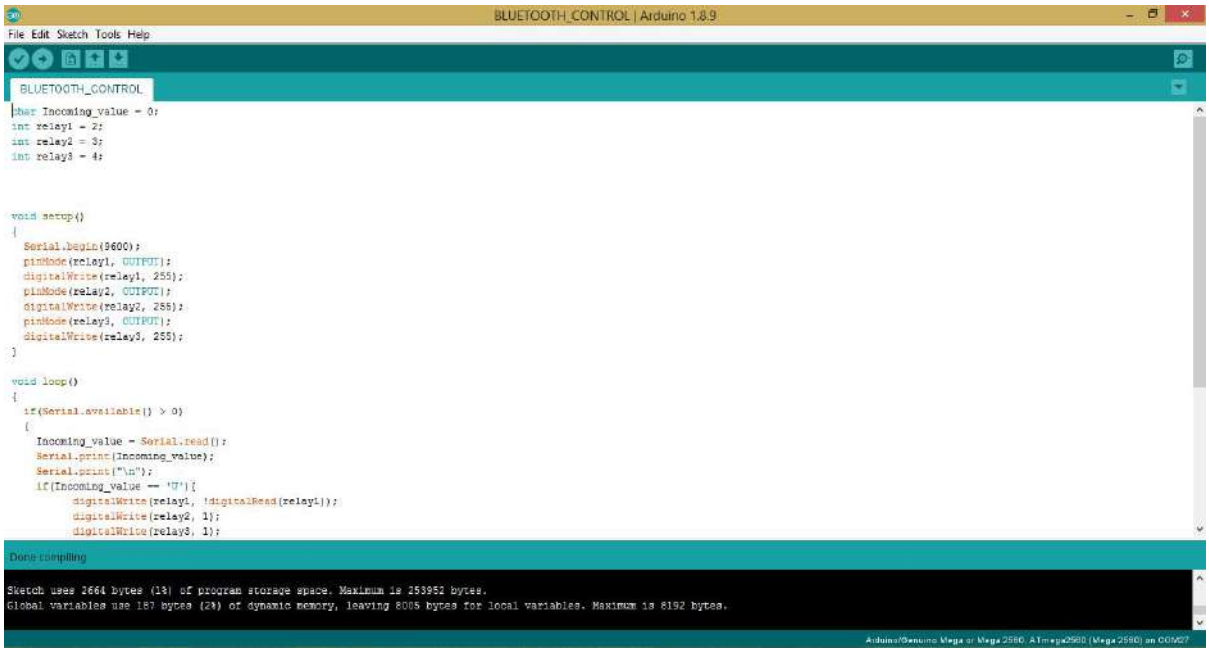


Figure 3.16: Editor screen of the Arduino IDE

The flow chart is given in figure 3.17.

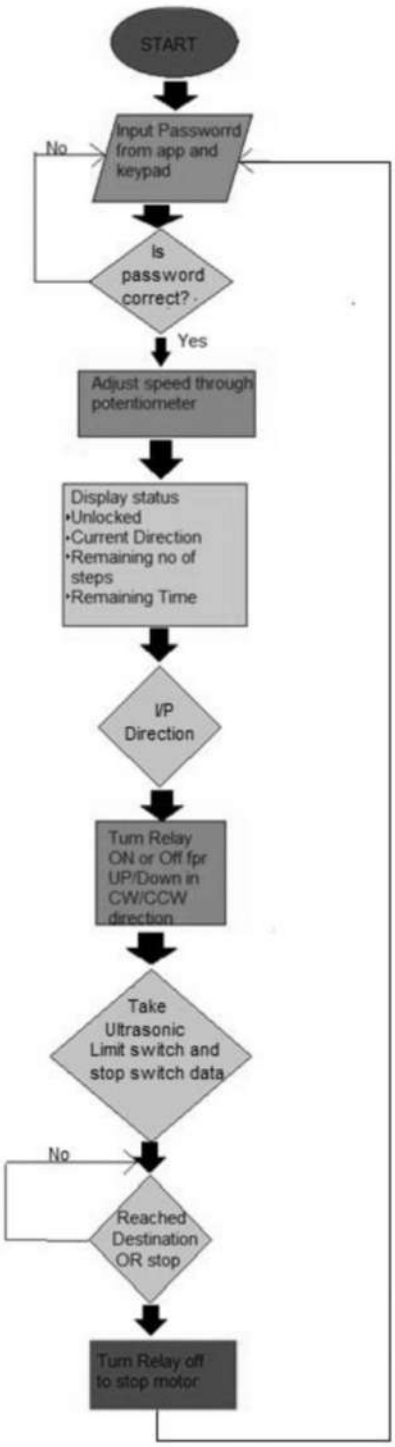


Figure 3.17: Flow chart of the project programming

3.1.3 Controlling app development.

To control all functionalities easily and remotely the system can be operated via an android app that will have features like.

- Remote control.
- Remaining steps counting feature.
- Time required to travel remaining stairs.
- Sustainable and secure (Password required to operate)

The MIT made android app is mainly integrated to give the users facility to control it remotely and send commands for stairlift to come down when the stairlift is standing at 2nd floor and the user is standing at 1st floor or vice versa, the App makes communication with the microcontroller with help of Bluetooth module, the GUI of the app is shown in Figure 3.18.

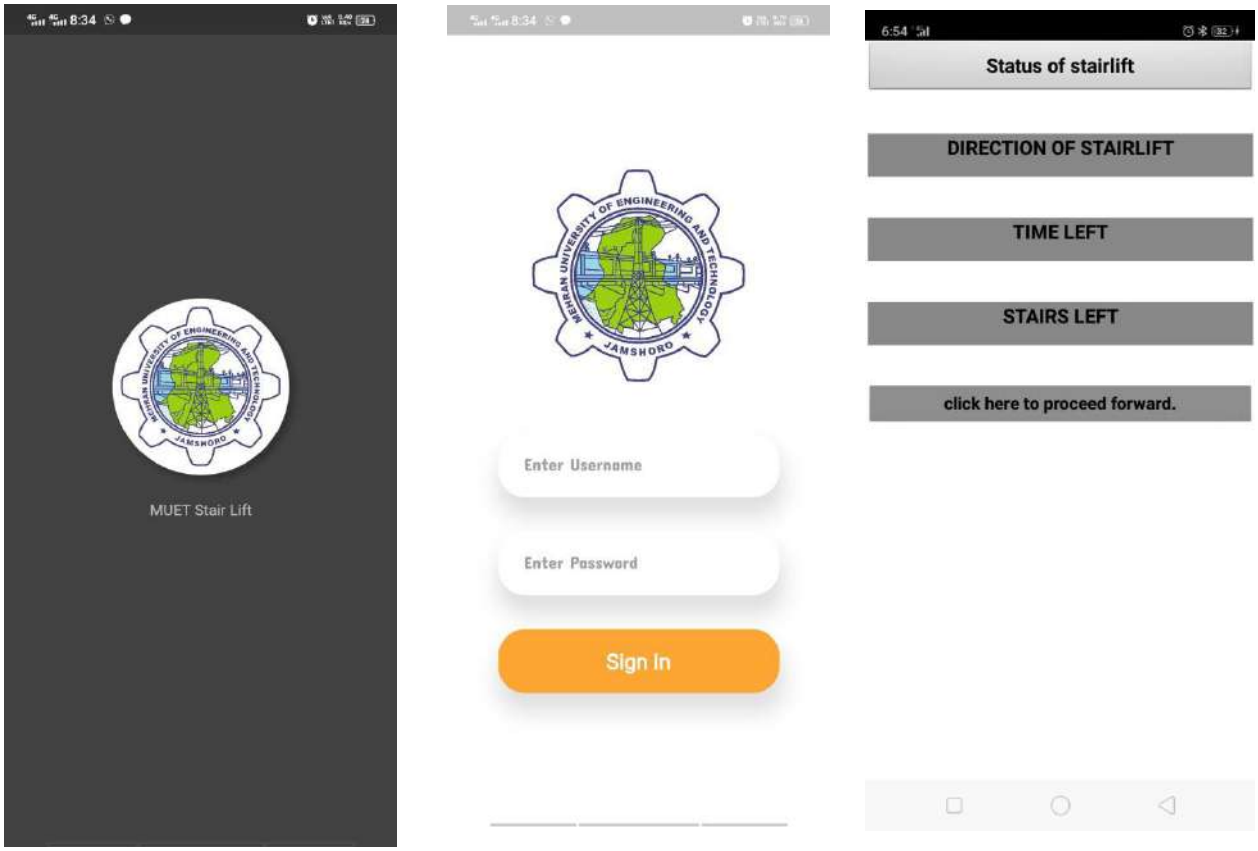


Figure 3.18:The GUI of the mobile App to control stairlift remotely.

3.2 HARDWARE DESIGN

After 3D analysis and modeling, the hardware design of the stairlift has been brought into reality, following are the steps through which the design has been proceeded and installed at department of Electronics Engineering(new building) MUET.

- Installed a Frame on stairs by using long screws.
- Installed Reck on the Frame
- Designed and installed chassis on a frame by using 8 Bearings
- Designed and installed power system, motor, and motor driver on chassis
- Designed and installed Upper structure (Sitting area) onto chassis
- Installed a control panel at armrest along with digital display and keypad.

Besides the installed Rack/track stair lift has two parts, the body part, and the Chassis part.

3.2.1 Body part:

In the body part, there is an armrest, footrest, and seat part which contains cushions, buckle, safety belt, and the complete structure of the chair (Patient sitting area) and Armrest contains the control panel through which the stair lift can be driven up and down, or can be stopped.

The casing design of the control panel is proceeded through CNC cutting router having model Vhf placed in the FYP Lab of Electronic department MUET by using the acrylic sheet to get a design with perfect dimensions as shown in Figure 3.19.

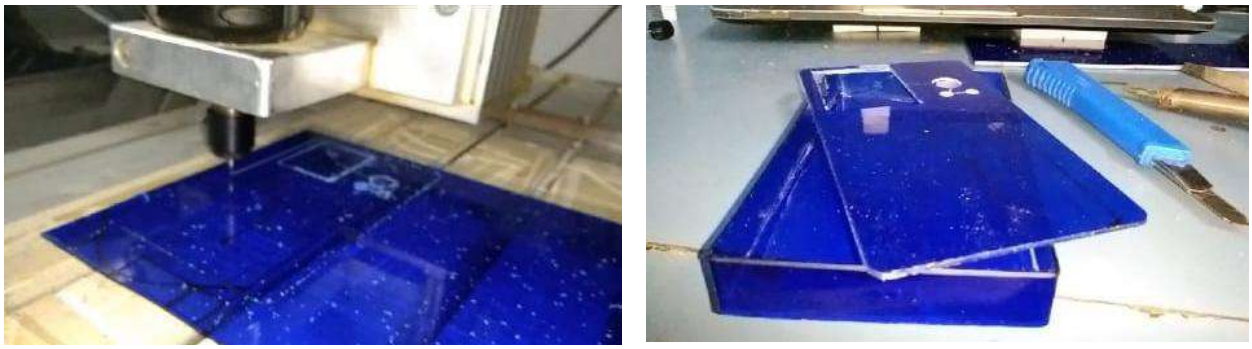


Figure 3.19: Design cutting of the casing of control unit.

The final design of the control unit along with integrated electronics components is shown in Figure 3.20.

Figure 3.20:The control unit

3.2.2 Chassis part

In the chassis part there is a power system that drives the motor, motor driver, and indicating components e.g. LEDs, buzzers, the motor with the Pinion gear, motor driver, and Breaking system (For which Clutch motor will be used).

The body of the chassis is designed by using the iron angle by following the previously designed CAD model.The skeleton of the chassis is shown in Figure 3.21.

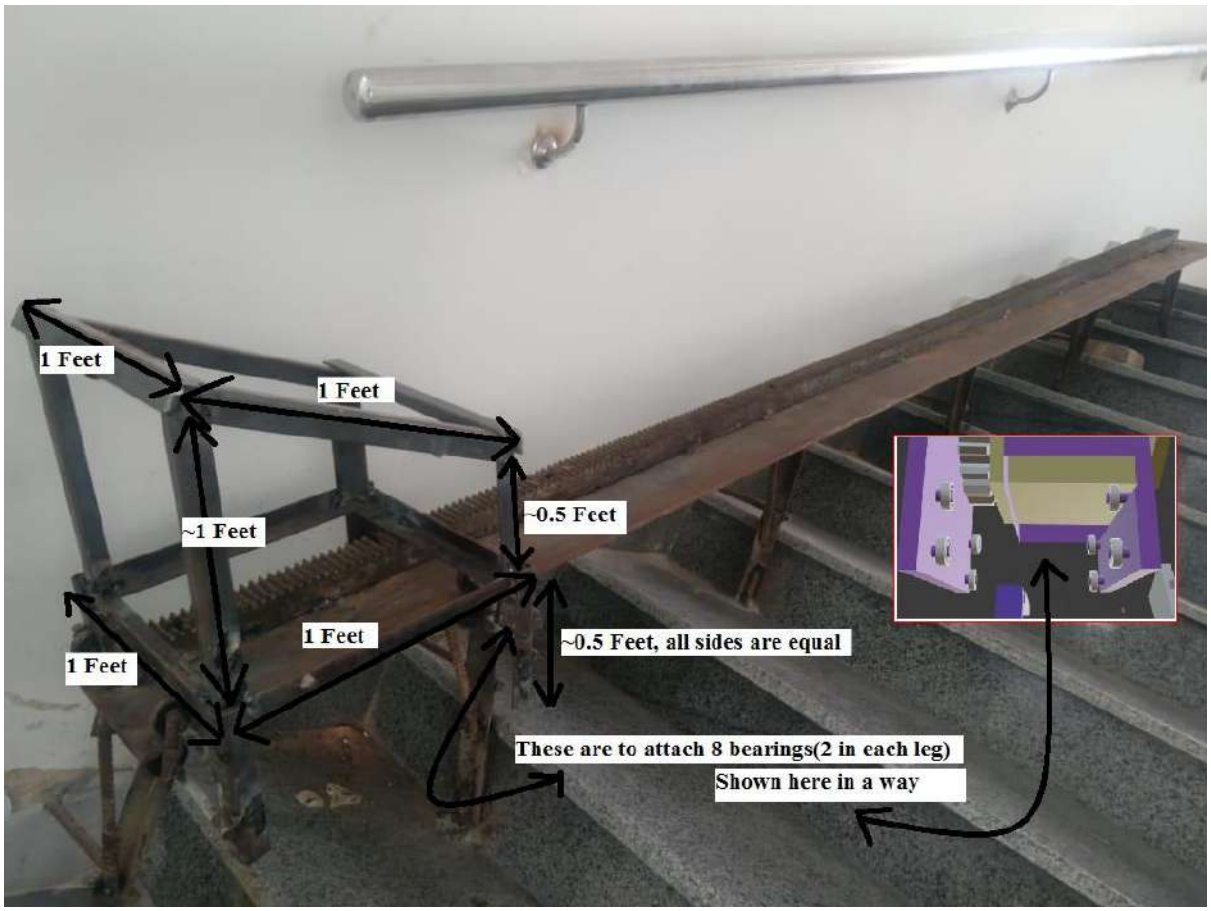


Figure 3.21: The skeleton of the chassis based on 8 bearing mechanism

After designing the skeleton motor, motor driver and electronic components is installed inside the chassis and skeleton is covered by using iron sheet and acrylic sheet at the front side as shown in Figure 3.22.

Figure 3.22:Skeleton coverage using iron sheets through welding

The above two parts show the respective design processes of the hardware design of the stairlift, the conceptual flow diagram of the stairlift is shown is Figure 3.23.

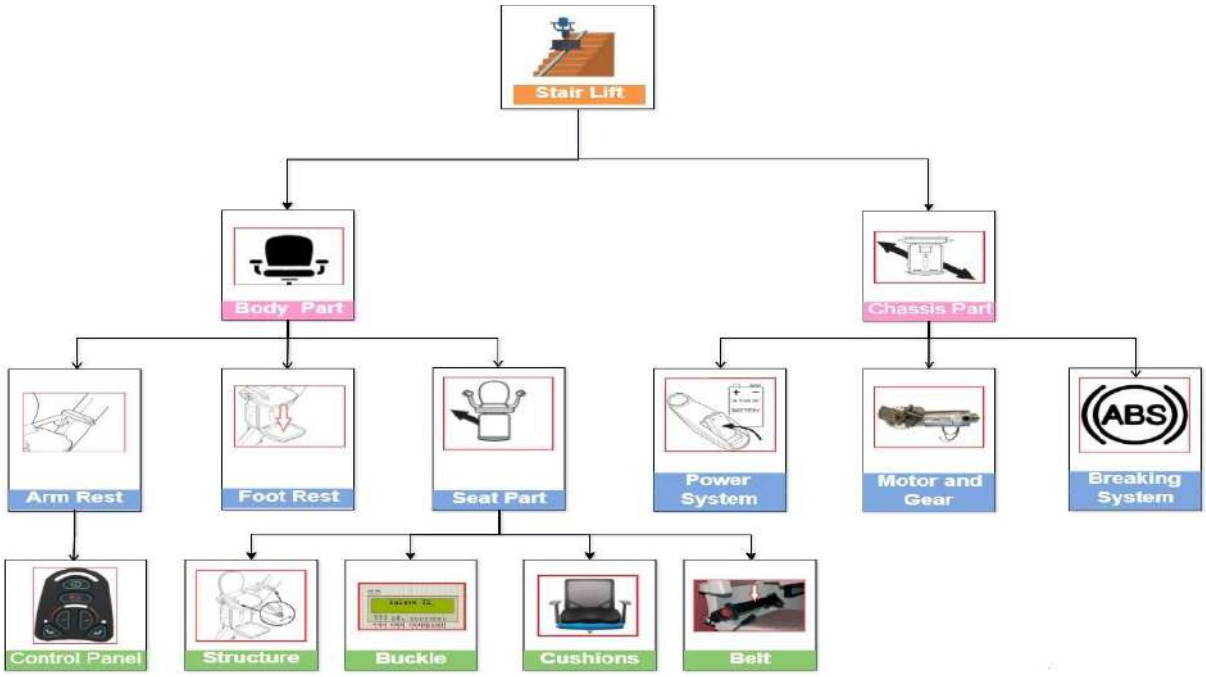


Figure 3.23: Conceptual flow diagram

3.3 WORKING

After completing the mechanical assembly, the electronic sensors and actuators assembly is designed and integrated with the system as shown in Figure 3.24.

When the system is first turned on, it prompts the user to enter a password via a mounted keypad or mobile application. Once the correct password is entered, the "up" button moves the chair upward (if pressed) and the "down" button moves the chair downward, while the "Stop" button stops the chair and the "Lock" button locks the system. Simultaneously, information such as the status, direction, remaining steps, and remaining time are displayed on the TFT display mounted on the armrest as well as the mobile application (if connected).

When the "Up" button on the keypad/mobile application is pressed, the Arduino sends a command to the relay board to turn on the respective relay to move the chair up. Once the relay is turned on, the servo driver (i.e. MR J2s-40A) moves the servo motor to the respective direction(clockwise or anti-clockwise), and the chair moves upward. At the same time ultrasonic measures the changing distance by using the treads of the stairs(count goes -1 from

total number of stairs every time while distance variable comes in specified range)When the chair reaches its destination, the limit switches make contact with iron strip at the end of track and automatically stops the stairlift to avoid the crash.

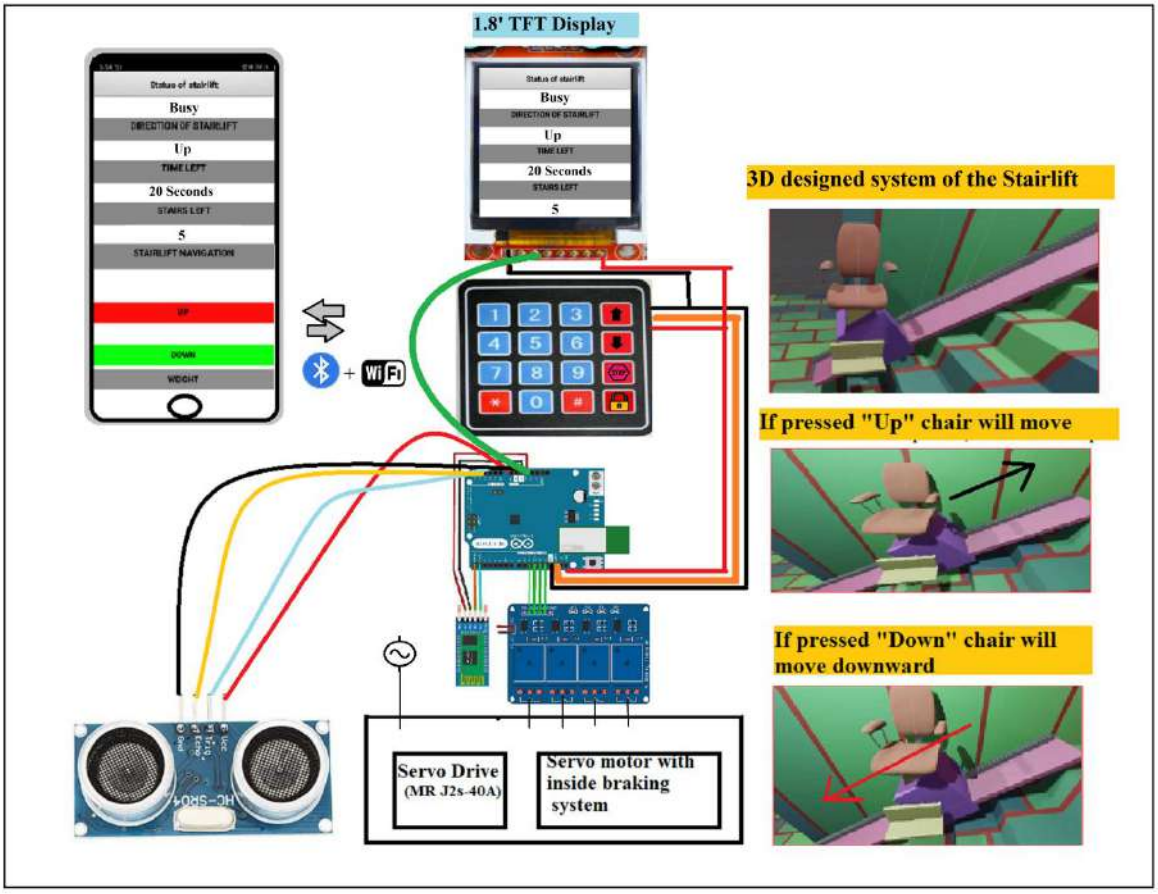


Figure 3.24:The general circuit diagram of whole system

The complete working of stairlift i.e how is it travel onto track, is shown in video[13]

3.4 CONCLUSION:

Hence, the description describes how the project has been designed and developed through different software and hardware based phases along with the steps and processes.

CHAPTER 04
RESULTS AND DISCUSSION

We have designed, constructed, installed and tested a low cost stairlift having luggage carrier at the stairs of Electronics (new building) department of Mehran UET Jamshoro and has integrated several electronic features in it .

4.1 EXPECTED OUTPUT

A hardware system of low cost electronics Stairlift along with mobile app to control remotely.The designed stairlift measures the steps(Tread) remaining as well time required to complete those steps .

After design and installation, a moveable stairlift is ready to carry disabled people to up story building, the prototype as designed in 3D is shown in Figure 4.1.

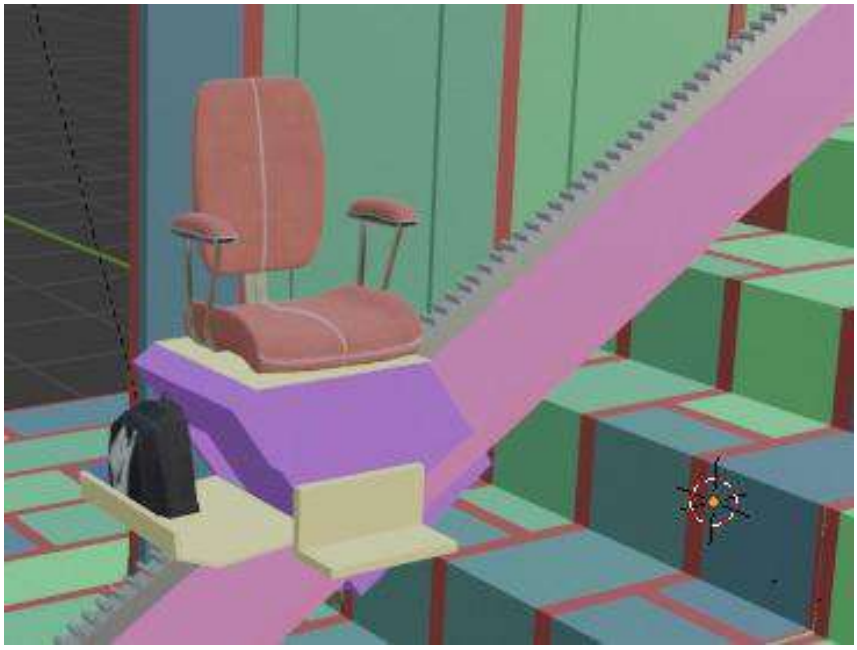


Figure 4.1: Final deliverable product i.e "stairlift" in 3D environment

The hardware system is installed at the stairs of (new building) Electronic Engineering Department of MUET Jamshoro as shown in Figure 4.2.

Figure 4.2: "Stairlift" installed at the stairs (new building) Electronic Engineering department of MUET Jamshoro .

4.2 TESTING OF THE STAIRLIFT:

After designing the stairlift we tested on different weights, different speed, and in different directions (up and down), and found that the system was working properly.

Figure 4.3 shows testing of the stairlift.

Figure 4.3: Testing of the stairlift

4.3 WEIGHT TESTING

The system has been tested care fully on different weighs to see the whether it can bear and work properly or not, the results shown in table 4.1 defines that the system is working properly.

S.No	Weight(in Kg)	Status
1	45	Satisfactory
2	50	Satisfactory
3	55	Satisfactory
4	60	Satisfactory
5	70	Satisfactory
6	90	Satisfactory

Table 4.1: Weight bearing capacity on different weighs

4.4 TECHNICAL DETAILS OF FINAL DELIVERABLE:

The final product is a moveable chair called "Stairlift", that glides up and moves down on a pre-installed Rail/track and carries the disabled and old age person to the up-story building, some of the specifications of the project are given in table 4.2.

S.No	Name	Value
1	Weight capacity	100Kg to 150Kg
2	Voltage required	220 volt AC
3	The total length of Track	10 Feet
4	Speed	87mm/s
	Tread of step size	300mm
	Rise of step size	180mm
	Slope of the stair	35°
5	Total Steps	9

Table 4.2:The specifications of the system

4.5 SALIENT FEATURES:

The system have features like:

- Digital display on the armrest.
- Speed(RPM) control
- Remote control feature through mobile app.
- Indication for the improperly locked safety belt.
- Sustainable and secure (Password + to operate for authentication in order to keep maintenance cost low)
- Remaining steps counting feature.
- Remaining time display to reach destination display
- Foot rest for easy sitting
- Luggage carrier space
- Weight limit checking feature

CHAPTER 05
CONCLUSION AND FUTURE RECOMMENDATIONS

A low-cost stair lift has been designed in the proposed project idea for disabled people whose mobility is impaired by various diseases. Just so they can travel through any low-rise (multistory) building, stairlifts are used to carry those people to any low-rise building. There are a number of solutions such as (elevators and escalators) to help them, but they are expensive and have structural limitations, so in order to fill this cost-based product gap, a low-cost stairlift have been manufactured by utilising easily/locally available materials with a few additional features that are rarely available in exist.

5.1 BENEFITS OF THE PROJECT:

- People, with locomotive disabilities, can travel through any low-rise building by using this stairlift.
- They can get it on Low cost.
- The system overcomes the structural limitations of elevators and escalators.
- The proposed idea will help to follow a law mentioned in "The Accessibility Code of Pakistan 2006"[1]. which states “it’s necessary requirement of HEC to have access facilities(say ramps, elevators, or stairlifts)for differently abled persons in the multistory public places which the universities have to follow, but as the lifts are quite expensive they are not in common use.”.

5.2 FUTURE RECOMMENDATIONS:

Bellow are some recoomendations:

- As the designed stairlift can be only installed at straight stairs, while one cannot install this stairlift on curved stairs, so the design can be updated in future to make it applicable for curved stairs as well by using any alternative method instead rack and pinion mechanism or by using the rack and pinion by any other method.
- Similarly few extensions at Electronics side can be done also, like we can add weight measuring feature to measure the weight of sitting person in order to avoid disturbance in assembly due to over weight.
- Feature to estimate the posture, detect.
- Face detection and fall detection feature.
- The remote control feature is based on Bluetooth communications which is distance limited, instead Bluetooth we can use WiFi or GSM module to control remotely.
- The designed system is powered by 120v AC supply, though instead AC, DC batteries cab be used as power bank.
- Mechanical design can be changed in a way so that the stairlift can work as dual function, I.e, travelling on surface like ordinary wheelchair and climb on stairs same as stairlift.

REFERENCES

1. Ministry of Social Welfare and Special Education Government of Pakistan. (2006). "Accessibility_Code_of_Pakistan_2006" pp.42,2006

2. M. Hirata, A. Setoyama, S. Adachi, and H. Sakaniwa, "Attitude Control System Design of a Seated Stair Lift on a Single Rail by Using Two-Degrees-of-Freedom Control," Japan Soc. Mechabical Eng., vol. 13, no. 1, pp. 1–11, 2007.

3. T. Choban Khidir, A. Mohammed Ismael, and A. Aydin Abduljabbar, "Designing and Analysing Stair Case Lift System," Eur. J. Eng. Technol., vol. 5, no. 4, pp. 3–10, 2017, [Online]. Available: www.idpublications.org.

4. W. Sulistiyo, D. A. Sumarsono, and R. Setiawan, "Development of a stairlift for the elderly patients in the hospitals," AIP Conf. Proc., vol. 2344, no. 1,pp.050005, 2021

5. K. Navya, B. P. Kumar, G. H. Mounika, B. Vineeth, P. Rao, and P. Electronics, "Smart Stair Lift for Disabled and Elderly," Int. J. Pure Appl. Math., vol. 120, no. 6, pp. 4647–4660, 2018.

6. J. L. Mattie, J. F. Borisoff, D. Leland, and W. C. Miller, "Development of an integrated staircase lift for home access," J. Rehabil. Assist. Technol. Eng., vol. 2, p. 12-14, 2015.

7. M. U. Masood et al., "Design and Development of a Semi-Autonomous Stair Climbing Robotic Platform For Rough Terrains," 2017 17th Int. Conf. Control. Autom. Syst., pp. 212–217, 2017.
8. P. K. Behera and A. Gupta, "Novel design of stair climbing wheelchair," J. Mech. Sci. Technol., vol. 32, no. 10, pp. 4903–4908, 2018.

9. J. Sun, "A novel design of the intelligent stair-climbing wheelchair," Proc. - 2020 6th Int. Conf. Mech. Eng. Autom. Sci. ICMEAS 2020, pp. 217–221, 2020.

10. M. M. B. Peters, Ethan, “Portable Stair Lift System: Designing a Modular and Mobile Assistive Lift Apparatus.”, WORCESTER POLYTECHNIC INSTITUTE, pp. 5-7, 2020.

11. L. Duntzee, K. Mantyla, M. Dunn, Y. Sun, and A. S. Implementation, “An Automated Scaled-Down Model of a Smart Home for Independent Living,” pp. 3–4, Feb 2020.

12. O. Convenience, “SUMMIT SL350OD Stairlift” , HARMAR, Sarasota, 2020, [Online]. Available: https://bit.ly/3lwfdcU
13. "Design and development of #SGK STAIRLIFTS for the people with locomotor disabilities - YouTube</i>. (n.d.). Retrieved October 27, 2022, from https://www.youtube.com/watch?v=si0NgY1KGMc