# DESIGN AND ANALYSIS OF STAIRCLIMBING WHEELCHAIR

Submitted in partial fulfilment of the requirements
of the degree of

**BACHELOR OF TECHNOLOGY**
**IN**
**MECHANICAL ENGINEERING**

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**GREATER NOIDA**
**2019-2020**

# CERTIFICATE

This is to certify that the Hardware Project (MEE 399) work titled **DESIGN AND ANALYSIS OF STAIRCLIMBING WHEELCHAIR** that is being submitted by **ABHISHEK VYAS, PAVITRA PANDEY, MOHAMMAD WASEEM KHAN, SACHIN PRATAP** is in partial fulfillment of the requirements for the award of **Bachelor of Technology**, is a record of bonafide work done under my guidance. The contents of this project work, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma .

**Supervisor**

**Internal Examiner** **External Examiner**

# APPROVAL SHEET

This thesis/dissertation/project report entitled **DESIGN AND ANALYSIS OF STAIRCLIMBING WHEELCHAIR** by **ABHISHEK VYAS, PAVITRA PANDEY, MOHAMMAD WASEEM KHAN, SACHIN PRATAP** is approved for the degree of bachelor of technology in mechanical engineering.

**Examiners**

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# DECLARATION

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Date: __________

# ACKNOWLEDGEMENT

The contributions of many different people, in their different ways, have made this possible. We would like to extend my gratitude to the following.

We are grateful to our guide **Mr. Arjun Kumar** and co-guide **Mr. Shrikant Vidya** for providing us the proper guidance for this project.

We are grateful to our project coordinator **Dr. Maniraj.M** for granting us permission to work on our project and giving us some important feedback on different occasion which helps us to improve our project idea .

**ABHISHEK VYAS** ______________________

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# ABSTRACT

The basic problems of user on manual wheelchair is overcoming architectural barriers (curbs, stairs etc.) on its way. Even though many research studies have been reported in different fields to increase the independence of wheelchair users, the question of overcoming obstacles by a wheelchair always remains as topic of discussion for many researchers. In our project a manual operated stair climbing wheelchair concept which can overcome the architectural barriers to a considerable extent has been developed. All the design parameters of wheelchair were based on the standard design of the stairs in India. Major part of the project focuses on the proposed design concept and concludes by discussing upon the physical working model developed for the proposed design solution .

# TABLE OF CONTENT

## List of Abbreviation

1. AVR – Automatic voltage Regulator
2. PDS - Production Data Structure
3. LRF – Line Rider Font
4. LIDAR – Light detection and ranging
5. RGBD – Red Green Blue Depth

## List of figures

# 1
# INTRODUCTION

## 1.0 Project background

One-fifth of the estimated global population, i.e. between 110 million and 190 million people, experience significant disabilities. One of the basic problems of user on manual wheelchair is overcoming architectural barriers (curb, stairs etc.) on its way. Even though many research studies have been reported in different fields to increase the independence of wheelchair users, the question of overcoming obstacles by a wheelchair always remains as topic of discussion for many researchers.

## 1.1 WHEELCHAIR

### 1.1.1 HISTORY

The first records of wheeled seats being used for transporting disabled people date to three centuries later in China, the Chinese used early wheelbarrows to move people as well as heavy objects. A distinction between the two functions was not made for another several hundred years around 525 AD, when images of wheeled chairs made specifically to carry people begin to occur in Chinese art.

## 1.1.2 TYPES OF WHEELCHAIR

There are many types of wheelchairs available in the market like manual or powered wheelchair and the choice of wheelchair depends upon the physical and mental ability of the user. General types of wheelchairs are:

### 1.1.2.1 Manual self-propelled wheelchair

A self-propelled manual wheelchair incorporates a frame, seat, one or two footplates (footrests) and four wheels . There will generally also be a separate seat cushion. The larger rear wheels usually have push-rims of slightly smaller diameter projecting just beyond the tyre; these allow the user to manoeuvre the chair by pushing on them without requiring them to grasp the tyres.

Figure 1.0: Manual self-propelled wheelchair

### 1.1.2.2 Manual attendant-propelled wheelchairs

An attendant-propelled wheelchair is generally similar to a self-propelled manual wheelchair, but with small diameter wheels at both front and rear as seen in Figure 1.1. The chair is maneuvered and controlled by a person standing at the rear and pushing on handles incorporated into the frame. Braking is supplied directly by the attendant who will usually also be provided with a foot- or hand-operated parking brake.

Figure 1.1: Manual attendant-propelled wheelchair

### 1.1.2.3 Powered wheelchairs

An electric-powered wheelchair, commonly called a "power chair" is a wheelchair which additionally incorporates batteries and electric motors into the frame and that is controlled by either the user or an attendant, most commonly via a small joystick mounted on the armrest, or on the upper rear of the frame as seen in Figure 1.2.

Figure 1.2: Powered wheelchair

## 1.2 Research Purpose and meaning

There are three purposes of research:

- Exploratory Research
- Descriptive Research
- Explanatory Research

### 1.2.1 Exploratory Research

In this project we have gone through different previous existing systems. Initially, all the previous researches contained study of heavy wheelchair structures with high jerk mechanisms.

The hypothesis of our project is to make a stair climbing wheelchair with an assumption of 60-65 kg mass of human body. The weight of wheelchair will be approximately around 10-14 kg.

### 1.2.2 Descriptive Research

Descriptive research can be conducted by using specific methods like observational method, case study method and survey method. Between these three all major methods of data collection are covered which provides a lot of information.

Since the data we collected is both qualitative and quantitative, it gives a holistic understanding of our research topic.

Descriptive research allows us to understand the research to be conducted in the natural environment of the respondent and this ensures that high-quality and honest data is collected.

## 1.2.3 Explanatory Research

Explanatory Research is the research whose primary purpose is to explain why events occur to build, elaborate, extend or test theory.

All the researches based on the concept of wheelchairs are made for people who are :

- Lower limb disabled people
- Patients at the hospitals
- Elderly people

## 1.3 Objective of study

In our project a stair climbing wheelchair concept is going to be developed which can overcome the architectural barriers to a considerable limit.

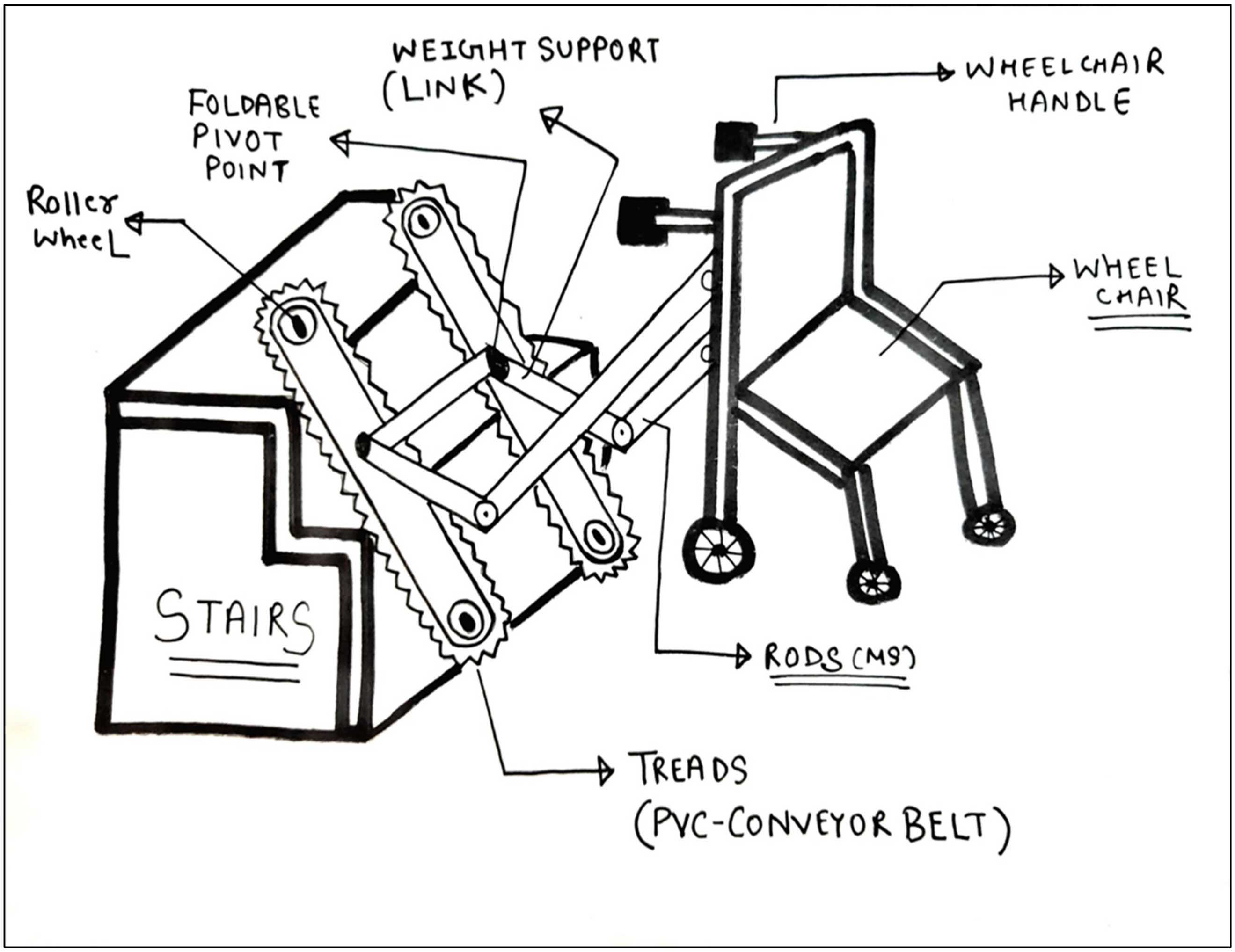



Figure 1.3

# 2
# LITERATURE REVIEW

## 2.1 Introduction

It was found that wheelchairs with stair climbing capacities can be categorized into two types; the battery powered and the manual powered.

Although there are plenty of powered wheelchairs available in the market place, there are limited scholarly reviews published on manual or battery powered wheelchairs. Instead, patent certificates, wheelchair descriptions, and operation manuals are available. Indeed, no peer reviewed literature was found for manual wheelchairs.

Some researchers have built scale models or full size prototypes of their designs but little documentation has been published on this type of wheelchairs.

A Literature Review is "a systematic, explicit, and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners." Hence these are the following researches which are relevant to our project context .

These are the following researches which are relevant to our project context
.

### 2.2.1 AN OPTIMIZATION DESIGN OF STAIRCLIMBING WHEELCHAIR MECHANISM

This research paper is based on design of stair climbing wheelchair which was made for ergonomically conditions .

The author of this research paper is **LIN ZHANG et al [2]** .

In this project the researchers designed a new kind of stair climbing wheelchair , which has flat or Inclined terrain, stairs and obstacles. All parts of the wheelchair were modelled in software Inventor and Rhino, then simulation analysis and the results are as follows.

Design the walking mechanism and transmission system for the stair climbing wheelchair. The optimization for the planetary wheel system changes the torsion acting on the box of the gear instead of acting on the gear , which protect the security and service of the gear. The seat backrest adjusting mechanism adopts manual operation, which is not only energy saving, environment friendly, but also reduces the weight of the wheelchair by not Installing a motor.

Users can adjust the seat backrest system to make sure the seat of the wheelchair is parallel to the level ground when it climbs up and down stairs.

At last , assembling simulation is carried out in Autodesk Inventor in order to avoid Interference between different parts of the wheelchair as shown in (figure 1.4).

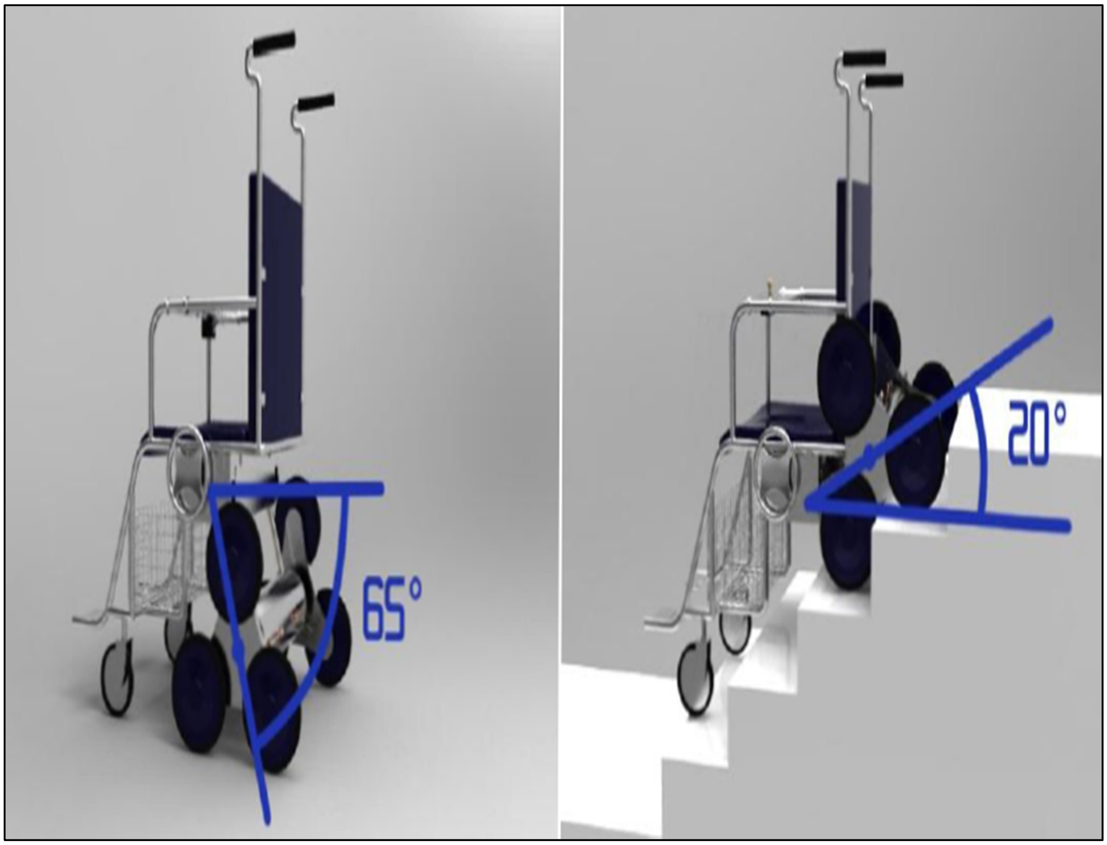



Figure 1.4

## 2.2.2 Home automation by smart wheelchair for the physically handicapped person using Arduino

This research paper is based on sensors using like AVR Microcontroller Atmega 328 circuit and Direct current motor to create the movement of a wheelchair with help of the mobile application.

The author of this research paper is **PROF. SHARDULS.KULKARNI et al [3] .**

The aim of this project is to control wheelchair automatically for moving forward, backward, Left and Right with the help of the mobile application. The result of this design will allow certain people to live a life with less dependence

on others. This project uses AVR microcontroller Atmega 328 circuit and Direct Current Motor to create the movement of a wheelchair with help of the mobile application.

An additional feature is to control basic home appliances with the help of remote device which is very useful for a handicapped person to operate home devices.

### 2.2.3 Design of Multipurpose Wheel Chair for Physically Challenged and Elder People

This research paper is based on design of Stretcher and commode wheelchair for physically abled personalities.

The author of this research paper is **PROF. LOHIT H.S et al [4] .**

The design is generated with the help of the PDS structure implemented on the of wheel chair. The design was developed with improved commode design for ease of defecation for the patients and elder people. Sliding arm rest was provided to increase the comfort for the arms while resting by sliding to the arm rest to comfortable height & for the ease of shifting the patient from chair to the bed or to the vehicle.

Design is provided with a good improved brake system provided to stop the wheel chair when moving down stairs in inclined angle. This shows the wheel chair with foldable x frame design, cushioned seat with head rest that allows the patients to rest the head and back comfortably (Neck injured, back injured, stomach operated, shoulder injured people). The commode is provided with hinge type swinging opening and closing system, commode opens towards back side of the wheel chair.

Cushioned rotatable leg rest to provide cushioning effect for the leg injured patients, adjustable backrest and leg rest with spring operated lock system with angular rotating design as shown in figure 25 provided for rotating the seat and leg rest to inclined angle (from 90° to 180°) as required by the patient while resting. Water tank with flush gun provided for ease of cleaning after defecation. The back rest, commode seat can be dismantled and the chair can be folded which helps in ease of transportation.

Figure 1.5

## 2.2.4 Human-Machine Interface for a Smart Wheelchair

It describes the integration of hardware and software with sensor technology and computer processing to develop the next generation intelligent wheelchair.

The author of this research paper is **PROF.** Vidya K. Nandikolla **et al [5] .** The LabVIEW cluster is developed for real-time autonomous path planning and sensor data processing. Four small form factor computers are connected over a Gigabit Ethernet local area network to form the computer cluster.

Autonomous programs are distributed across the cluster for increased task parallelism to improve processing time performance.

The distributed programs operating frequency for path planning and motion control is 50Hz and 12.3Hz for 0.3 megapixel robot vision system. To monitor the operation and control of the distributed LabVIEW code, network automation is integrated into the cluster software along with a performance monitor.

A link between the computer motion control program and the wheelchair joystick control of the drive train is developed for the computer control interface.

A perception sensor array and control circuitry is integrated with the computer system to detect and respond to the wheelchair environment.

Multiple cameras are used for image processing and scanning laser rangeėnder sensors for obstacle avoidance in the cluster program.

A centralized power system is integrated to power the smart wheelchair along with the cluster and sensor feedback system. The on board computer system is evaluated for cluster processing performance for the smart wheelchair, incorporating camera machine vision and LiDAR perception for terrain obstacle detection, operating in urban scenarios. This modification is likely to achieve the same processing time results across the cluster.

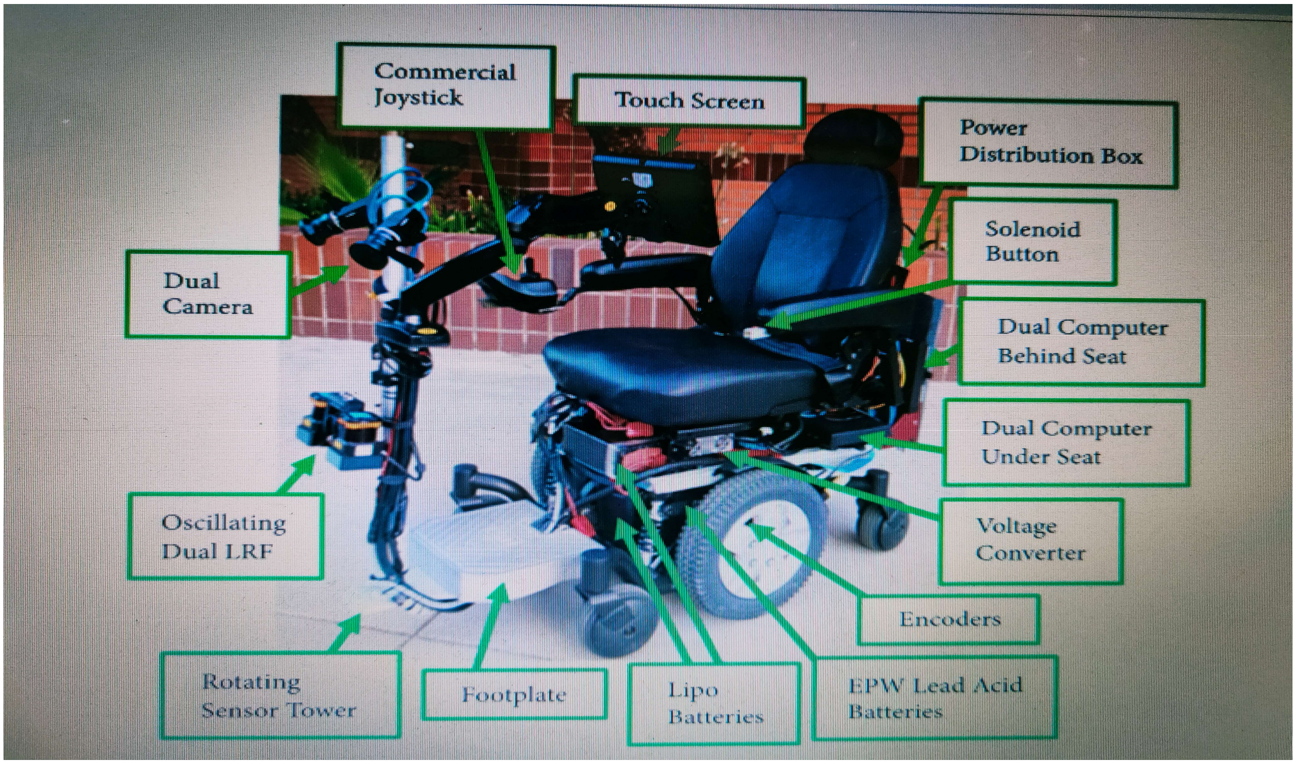



Figure 1.6

### 2.2.5 Smart Electronic Wheelchair Using Arduino and Bluetooth Module

This paper describes the design of a smart, motorized, voice controlled wheelchair using embedded system. The author of this research paper is **Manoj Kumar Pandey et al [6]** .

Proposed design supports voice activation system for physically differently abled persons incorporating manual operation. This paper represents the “Voice-controlled Wheel chair” for the physically differently abled person where the voice command controls the movements of the wheelchair.

For example, when the user says “Go” then chair will move in forward direction and when he says “Back” then the chair will move in backward direction and similarly “Left” and “Right” for rotating it in left and right directions respectively and “Stop” for making it stop. This system was designed and developed to save cost, time and energy of the patient. Ultrasonic sensor is also made a part of the design and it helps to detect obstacles lying ahead in the way of the wheelchair that can hinder the passage of the wheelchair.

This project elaborates the design and construction of Smart Electronic Wheelchair with the help of Bluetooth Module. The circuit works properly to move as the command given by the user. After designing the circuit that enables physically disabled to control their wheel using an android application in their smart phones and it has also been tested and validated. The detection of any obstacle is successfully controlled by the microcontroller.

As the person switches on the circuit and starts moving, any obstacle which is expected to lie within a range of 4 metres will be detected by the Ultrasonic sensor. Designing a simple and efficient automatic speech recognition system for isolated command words to satisfy the

motion control of an electric motorized wheelchair for differently abled persons is the interest of this project. The processing units (the speech kit and the microcontroller) are directly attached to the wheelchair in one package that made the design representing a complete autonomous and smart wheelchair.

The speech recognizer is tested to prove its performance to generate exact movement of the chair. It proved a recognition rate of above 90%.

### 2.2.6 Development of Smart Wheelchair System for a User with Severe Motor Impairment

In this research paper the design is proposed of a smart wheelchair framework.

The author of this research paper is **Yoshinori Kobayashi et al [7] .**

Users with severe motor impairment may find it difficult to operate a wheelchair when they are in tight space (e.g., passing doorway) or when avoiding obstacles since they cannot command the wheelchair by means of a conventional joystick.

Here they propose a framework that can assist users to overcome such circumstances using a hierarchical semi-autonomous control strategy. Initially multimodal user inputs based on momentary switch and yaw head angle are analyzed to decide a maneuvering mode and assign the direction of travel.

Then, environmental information is perceived using the combination of a laser range finder and the Kinect sensor for determining safety map around wheelchair's vicinity. The HCI input device is the switch. It is a single and momentary type in nature that is responsible for triggering several maneuvering modes (i.e., "stop", "semi-auto" and "manual") depending on how long the user lets it "on."

It can be realized by various mediums such as detecting motion of facial parts (e.g. eye blinking or shaking), voice or a button switch. Physiological features will impose much burden to the user when s/he needs to issue a command frequently, especially when s/he navigates in a limited space.

The wheelchair has two control modes: the manual mode and the semi-autonomous mode. The user can change the modes freely by manual switch operation.

### 2.2.7 Simulation and control of multipurpose wheelchair for disabled/elderly mobility

This paper presents investigations into the development of modelling and control strategies for a multipurpose wheelchair as mobile transporter for elderly and disabled people

The author of this research paper is **N.M. Abdul Ghani et al [8] .**

The research is aimed at helping people with physical weakness disabilities in their upper and lower extremities to move independently without human intervention.

A modular fuzzy logic control mechanism with integrated phases is introduced for the overall operations and two-wheeled stabilization of the wheelchair.

It is shown that the proposed modular fuzzy control approach is able to ensure system stability while performing multipurpose tasks such as manoeuvrability on flat surfaces, stairs climbing (ascending and descending), standing in the upright position on two wheels and transformation back to standard four wheels with up to 50% less initial torque in coparison to previous designs . The introduced system is intended for use in small and confided indoor spaces for disabled and elderly mobility to enable them perform daily life activities independently.

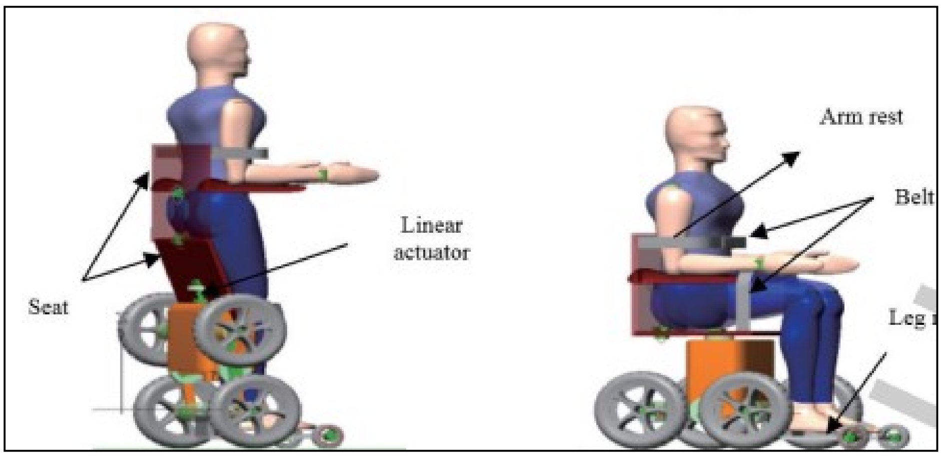



Figure 1.7

### 2.2.8 Smart Navigation and Control System for Electric Wheelchair

The proposed design here is an efficient, safe and simple navigation and control system for driving an electric wheelchair.

The author of this research paper is **K. Prahlad Rao et al [9] .**

In this paper, the development of navigation and control system for an electrically powered wheelchair is reported.

The system requires popularly used Smart phone Arduino UNO board, motor driver, joystick and proximity sensor. For navigation and tracking the destination, mobile application software is developed on Android

platform.

Arduino platform was used as microcontroller for interfacing the sensors and electric motor driver board. The system was tested for the speed, operational skill and safety issues. From the tests it is found that the navigation and control of the wheelchair is efficient, cost-effective and reliable. The mobile App is GPS based and can browse the Google Map in which the destination to travel can be selected. Below the map, two press buttons are created from the software programming.

One button is indicated as “CONNECT” and another as “DISCONNECT”. When the wheelchair user is seated comfortably then the CONNECT button can be activated making the microcontroller initiate the motor driver for electrical supply from the battery to both motors.

The wheelchair can be stopped by using the button DISCONNECT.

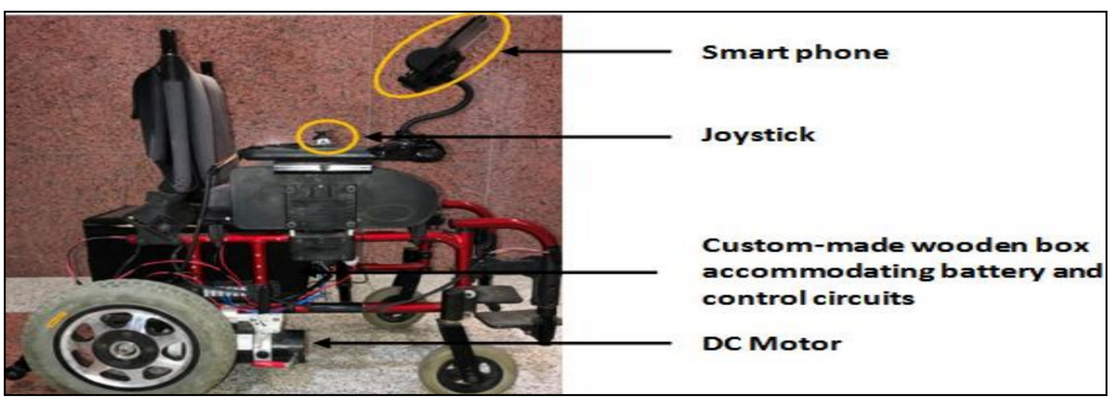



Figure 1.8

### 2.2.9 Developing Intelligent Wheelchairs for the Handicapped

The research paper is based on prototype of autonomous wheelchairs based on commercially available motorized wheelchairs which have been built using behavior-based AI.

The author of this research paper is **Takashi Gomi et al [10] .**

The initial prototyping went very rapidly and the size of the software is significantly smaller than control programs for similar vehicles operating in the real world environment implemented using conventional AI and robotics methodologies. One of the chairs is now capable of travelling to its indoor destinations using landmark-based navigation.

The performance of the prototypes indicates there is a cautious possibility today to build a functional intelligent wheelchair that is practical and helpful to people with certain types and degrees of handicap.

Maintenance would be another issue if we proceed, not to mention various public liability issues that, unfortunately but undoubtedly, will follow. The public liability issue is potentially a problem in introducing an autonomous or semi-autonomous wheelchair to the general public and this can become a hindrance to the effort to bring these technologies to the handicapped.

### 2.2.10 Smart Navigation of Wheelchair using Human Machine Interface

This manuscript deals with smart navigation of wheelchair using human machine interface.

The author of this research paper is **S. Rajapriya et al [11] .**

This project was made especially to handle such problem faced by physically challenged people. To implement the manuscript, microcontroller ATMEGA328 was used to control the motor coupled to the wheel of the wheelchair which was controlled by the voice command from the android mobile phone through a bluetooth module. Apart from moving the motor using voice command, prototype also have ultrasonic sensor which senses the obstacle on the way and will control the direction of the wheel accordingly.

Microcontroller was programmed by Arduino programming. Bluetooth module was first initialized, then voice and distance was read by the controller. If voice command is forward and distance between the object and the wheelchair is greater than 8 cm, motor1 and motor 2 will be turned on by enabling the corresponding pins in the driver IC.

If not , the motors will stop until the distance is greater than 8cm. Procedure will be repeated for other direction by enabling the corresponding pin by using the logic . Motor was operated under the control of microcontroller with the help of voice command whose logic was given.

# 3
# PROBLEM DESCRIPTION

Wheelchair system is one of the common vehicles used by handicap or sick people are limited in its functions, such as it needs human force to move it. It is also can't be use for a long period as the user tired in moving the chair using his or her own energy.

Some of the typical issues that wheelchair users have include are small corridors in older buildings, parking lots that are challenging to get around . Don’t forget uneven surfaces or steep slopes that are impossible to self-propel a manual wheelchair. And then there is public transit.

Hence , how our proposed design is going to be different from the existing systems ?

# 4

# DESIGN METHODOLOGY OF WHEELCHAIR

## 4.1 Wheelchair Parts Dimension

The aim is to produce wheelchairs that perform well. It can provide appropriate seating and postural support without compromising strength, durability and safety. This can be achieved when government authorities, manufacturers, engineers, designers, service providers and users fulfil their respective roles with respect to design.

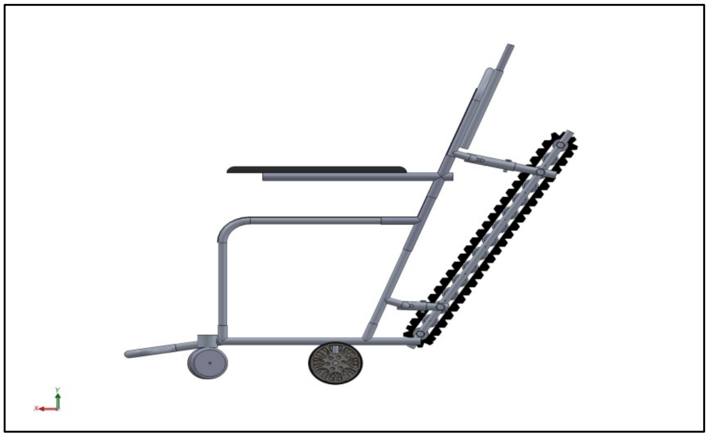
**Parts Dimension Table**

| TOTAL HEIGHT | 1048 mm |
|---|---|
| TOTAL WIDTH | 1136 mm |
| FRAME ROD DIAMETER | 17 mm – 20 mm |
| SEAT DIMENSIONS | 500*500 $mm^2$ |
| SEAT HANDLE DIMENSIONS (L) | 517 mm |
| MAIN HANDLE DIMENSIONS (L) | 577 mm |
| TRACK DIMENSION (L*B) | 800 * 40 |
| WHEEL DIAMETER | 5 inches |
| TRACK ANGLE | 30° |

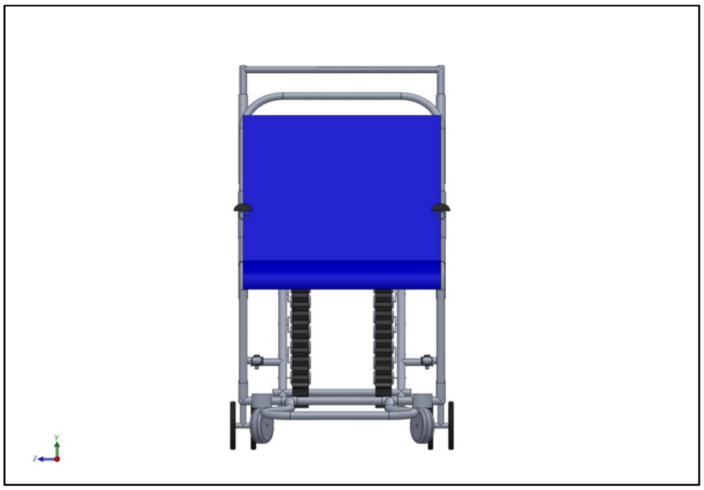
The following considerations needs to be considered are :-

- The user's health and safety
- Strength and Durability
- Suitability for use

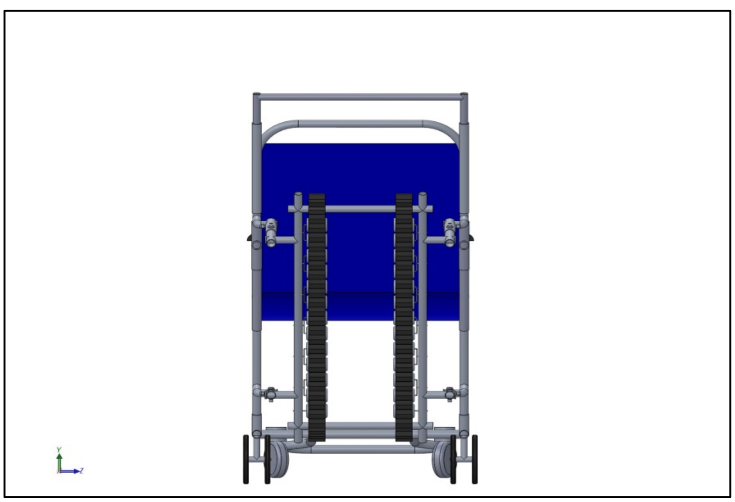
## 4.2 Design Projections and Isometric View



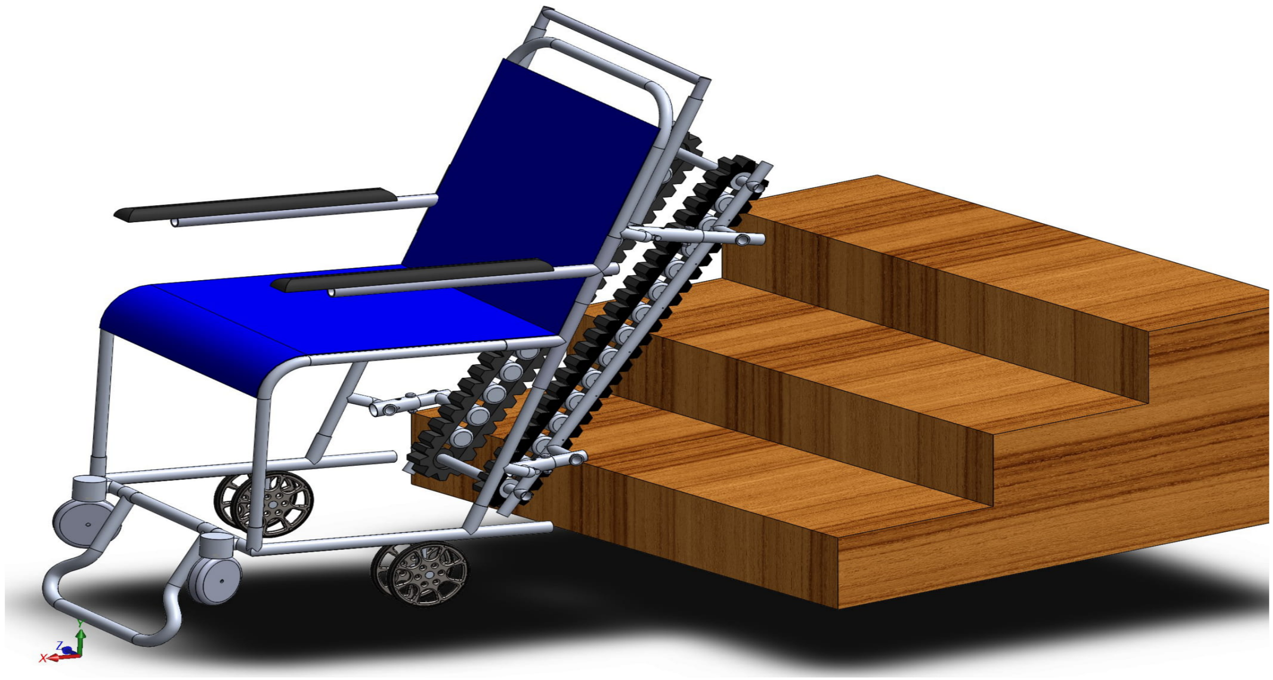
**SIDE VIEW**



**FRONT VIEW**



**BACK VIEW**



**ISOMETRIC VIEW**

## Major Parts of Designing Wheelchair

**FRAME** :- Wheelchair design starts with the frame which plays a crucial role in supporting all components and having provision for user to sit comfortably.

**SEAT AND HANDLE REST :-** Seat is designed as per the ergonomics of the patient sitting and to give comfort to his legs specially . Its equipped with extended hand rest for patient holding it strongly .

**WHEEL SYSTEM :-** To provide strong and rigid support to the body Six wheel system is designed that safely bears load . In front two castor wheels and in rear Four big wheels are installed. In front two castor wheels and in rear Four big wheels are installed.

**TRACK SYSTEM :-** Its design is crucial as it helps in climbing patient smoothly on stairs . Its treadmill kind mechanism equipped with bearings to support the belt and connected with strong rods .

# 5

# ANALYSIS OF DESIGN

## 5.1 Assumptions And Calculations

- Weight of the wheelchair assumed to be = 13kg

  = mg =13*9.81 = 588.6N

- Weight of the user assumed to be = 60kg = mg

  = 60*9.81 = 127.53N

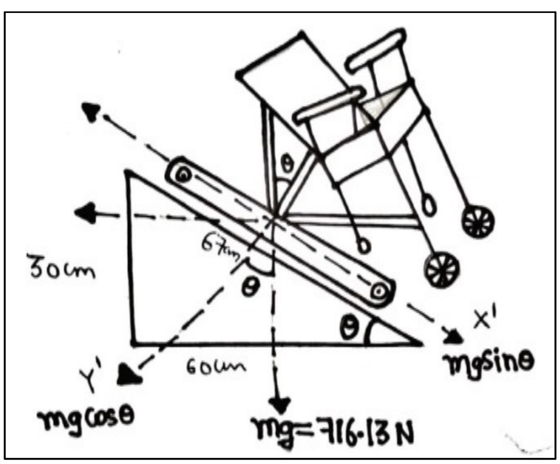
- Net normal force acting on ground (Fn)= 73kg

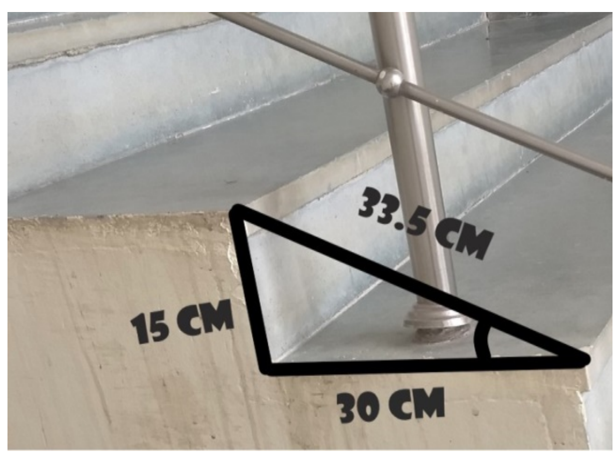
  = mg

  = 73*9.81 = 716.13N

**Stairs Dimensions**

- Land = 300 mm
- Rise = 150 mm
- Slope of the stairs (θ) = $\tan^{-1}(\frac{150}{300})$ = 26.56°




**Free Body Diagram of Wheelchair Motion On Staircase**

**Force Analysis Using Free Body Diagram**

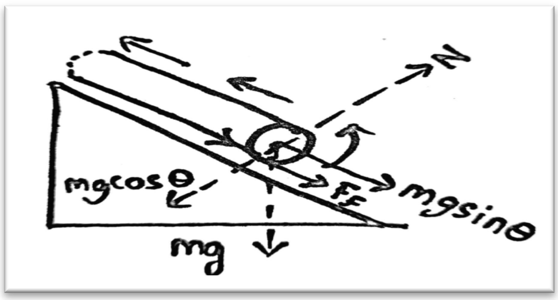
Assuming ,

Friction Coefficient ( μ ) = 0

- Downward force along inclined plane (Fn) = mgcosθ = 640.55 N
- Force acting perpendicular to inclined = mgsinθ = 320.20 N

Considering the friction coefficient ( μ ) = 0.85 [12]

- Friction force = μFn = μmgcosθ = 0.85*640.55= 544.46 N

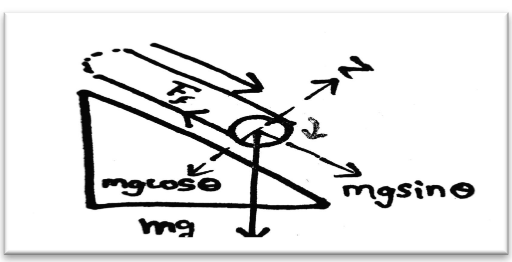



- Net upward force along inclined plane when body moves up stairs

  = mgsinθ + μmgcosθ = 320.20 N+ 544.46 N = **873.16 N**

Considering the friction coefficient **( μ ) = 0.85** [12]

- Friction force = μFn = μmgcosθ = 0.85*640.55= **544.46 N**




- Net downward force along inclined plane when system moves down stair = mgsinθ - μmgcosθ = 320.20 N – 544.46 N = **224.26 N**

## 5.2 Material Selection And Specification

Material selection plays a crucial role in the construction of a wheelchair especially taking care of the strength of a material and how much load it bears. Also, keeping in mind that weight of the wheelchair should not be increased much. Taking all these factors into account, three materials were narrowed down for wheelchair frame that is aluminium, titanium, and steel.

| S.NO. | MATERIAL | DENSITY (g/cm^3) | TENSILE YIELD (MPa) | YOUNG'S MODULUS (GPa) |
|---|---|---|---|---|
| 1. | 6061-T6 Aluminium alloy | 2.70 | 270 | 69 |
| 2. | High Strength Low Alloy Steel (HSLA) | 7.90 | 345 | 205 |
| 3. | Ti-6Al-4V Grade 5 Titanium Alloy | 4.42 | 1100 | 110 |
| 4. | 7075 - T6 Aluminium alloy | 2.81 | 570 | 72 |

As per the requirements, all Four materials are in high demand for industrial applications. Aluminium alloy 6061-T6 having excellent joining characteristics and suitable strength is used extensively in construction material, in the manufacture of automotive components. Ti-6Al-4V titanium alloy is applied in a wide range of applications such as in the aerospace industry, in biomechanical applications, due to its excellent corrosion resistance properties, while HSLA is commonly used in manufacturing oil pipelines.

Also, another aluminium alloy 7075-T6 is used in heavily stressed parts manufacturing such as gears, fuse parts.

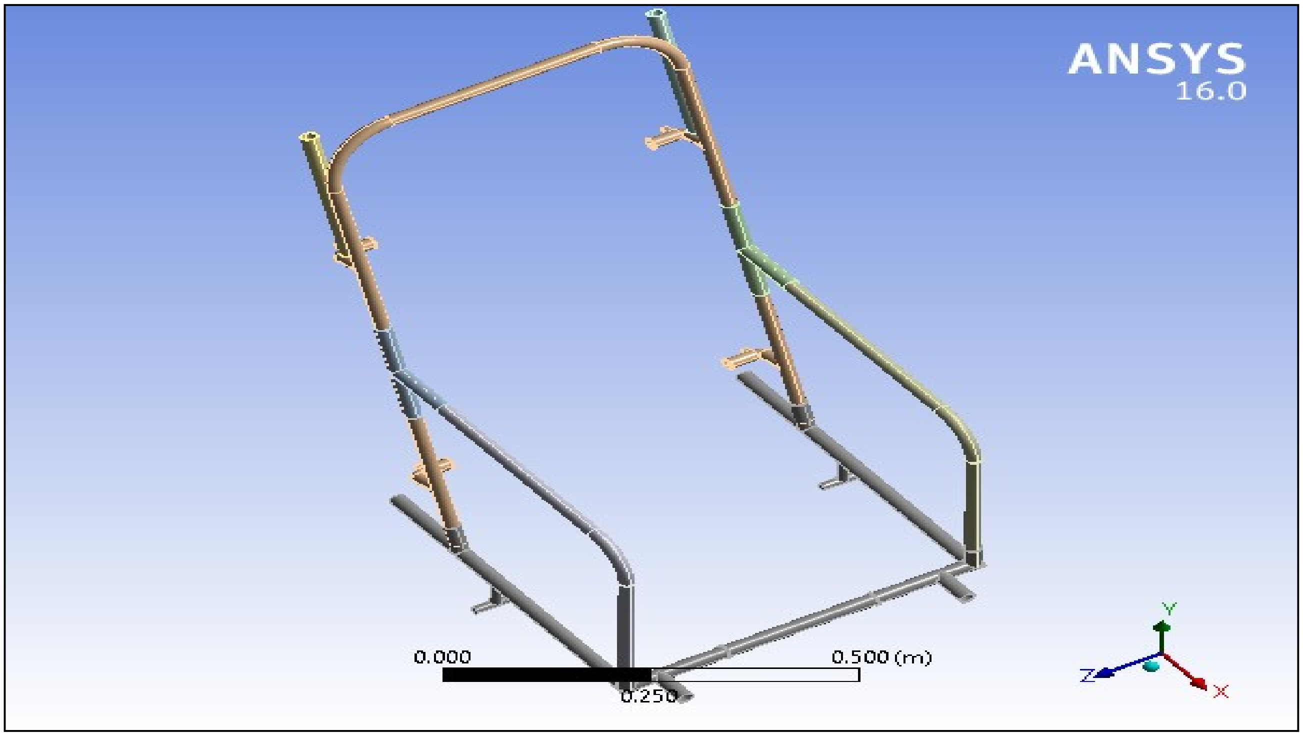
It can be seen from the properties of all four above as HSLA has a higher density compared to Aluminium and Titanium alloy and a minor difference in strength compared to 6061-T6. Also, Ti-6Al-4V has a greater tensile yield and relatively higher density compared to Aluminium alloy.

Another aluminium alloy 7075-T6 also compared with its own family member 6061-T6. It has high tensile strength compared to 6061-T6 and not good corrosion resistance. Such a high strength and higher density material not needed in a wheelchair as it generally bears a load of (700N) that includes the typical weight of wheelchair and adult user. Also, Titanium alloy having a high cost compared to Aluminium, hence it was decided to use Aluminium (6061-T6) for the construction of Frame of wheelchair and other parts.

- Frame - Aluminum Alloy (6061-T6)
- Upper Handle – Plastic
- Footrest Material – Aluminium Alloy
- Handrest - Plastic (Foam)
- Seat - Rigid Plastic , Cotton cover
- Linkage Materials – Aluminium alloy
- Caster Wheels - Nylon

# 5.3 Analysis Result Using 6061-T6 Al Alloy

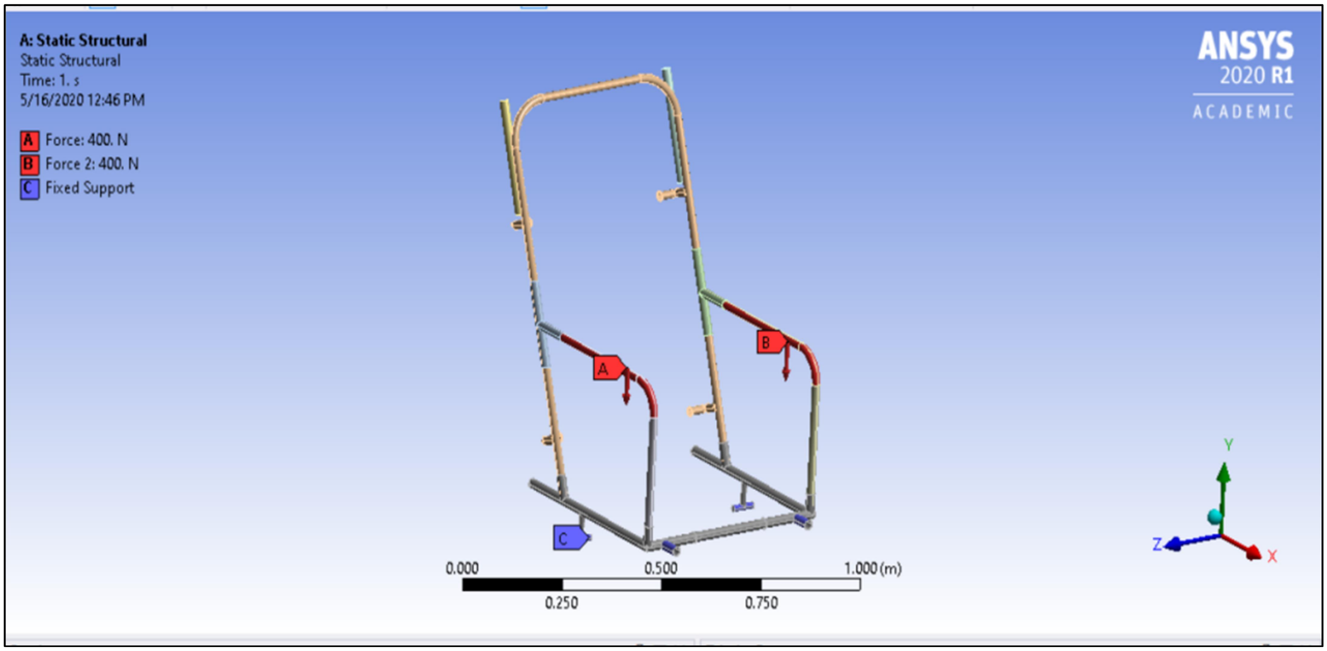
- **<u>Frame Structural Analysis By Applying Downward</u>**

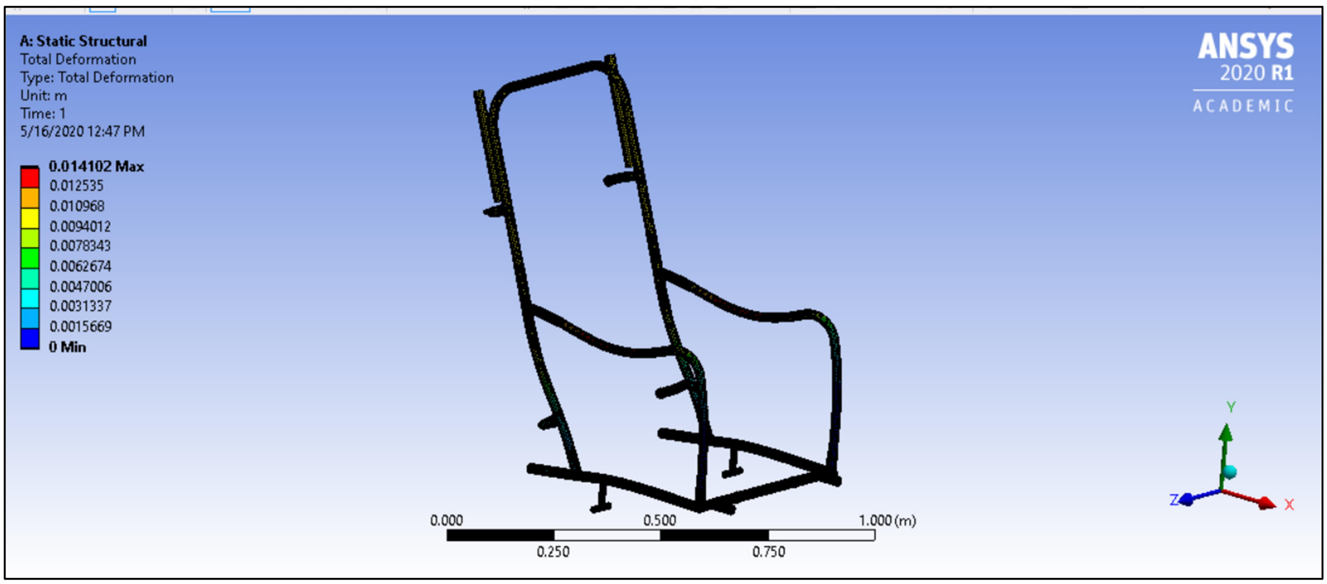


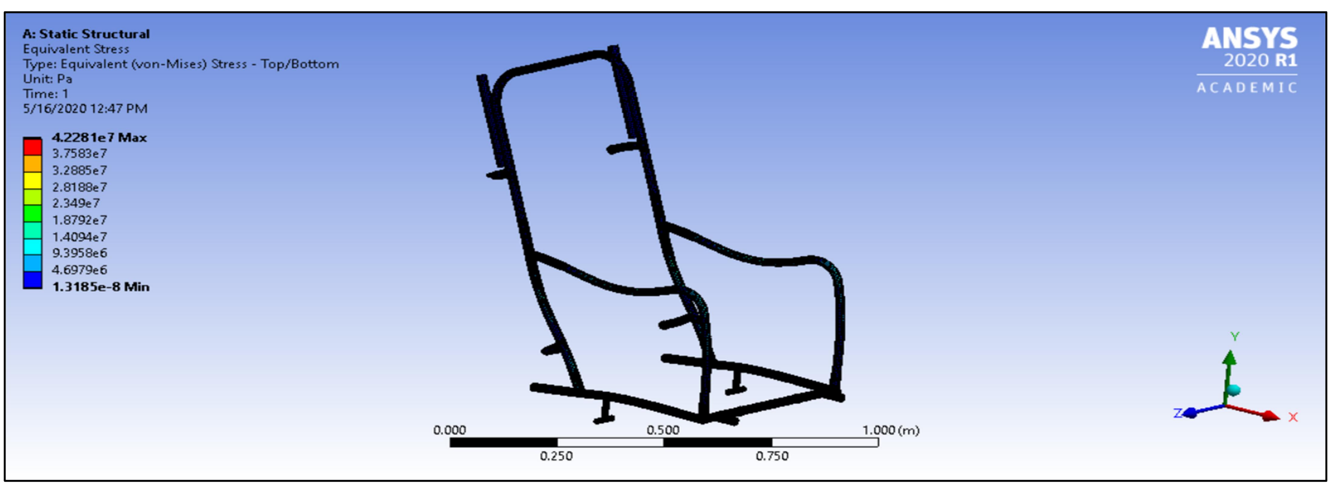

| Object Name | STATIC STRUCTURAL ANALYSIS |
|---|---|
| State | Solved |
| Definition | |
| Physics Type | Structural |
| Analysis Type | Static Structural |
| Solver Target | Mechanical APDL |

| Object Name | *Force* | *Force 2* | Fixed Support |
|---|---|---|---|
| State | Fully Defined | | |
| Scope | | | |
| Scoping Method | Geometry Selection | | |
| Geometry | 4 Faces | | 10 Faces |
| Definition | | | |
| Type | Force | | Fixed Support |
| Define By | Vector | | |
| Magnitude | 400. N (ramped) | | |
| Direction | Defined | | |
| Suppressed | No | | |

**Interpretation :-** Force of about (800 N) acted on the frame in downward direction on Seat frame . No Vertical Deformation or Suppression of frame .


A: Static Structural
Static Structural
Time: 1. s
5/16/2020 12:46 PM
A Force: 400. N
B Force 2: 400. N
C Fixed Support
ANSYS
2020 R1
ACADEMIC
0.000
0.500
1.000 (m)
0.250
0.750


A: Static Structural
Total Deformation
Type: Total Deformation
Unit: m
Time: 1
5/16/2020 12:47 PM
0.014102 Max
0.012535
0.010968
0.0094012
0.0078343
0.0062674
0.0047006
0.0031337
0.0015669
0 Min
ANSYS
2020 R1
ACADEMIC
0.000
0.500
1.000 (m)
0.250
0.750


A: Static Structural
Equivalent Stress
Type: Equivalent (von-Mises) Stress - Top/Bottom
Unit: Pa
Time: 1
5/16/2020 12:47 PM
4.2281e7 Max
3.7583e7
3.2885e7
2.8188e7
2.349e7
1.8792e7
1.4094e7
9.3958e6
4.6979e6
1.3185e-8 Min
ANSYS
2020 R1
ACADEMIC
0.000
0.500
1.000 (m)
0.250
0.750

## Von Mises Equivalent Stress Data

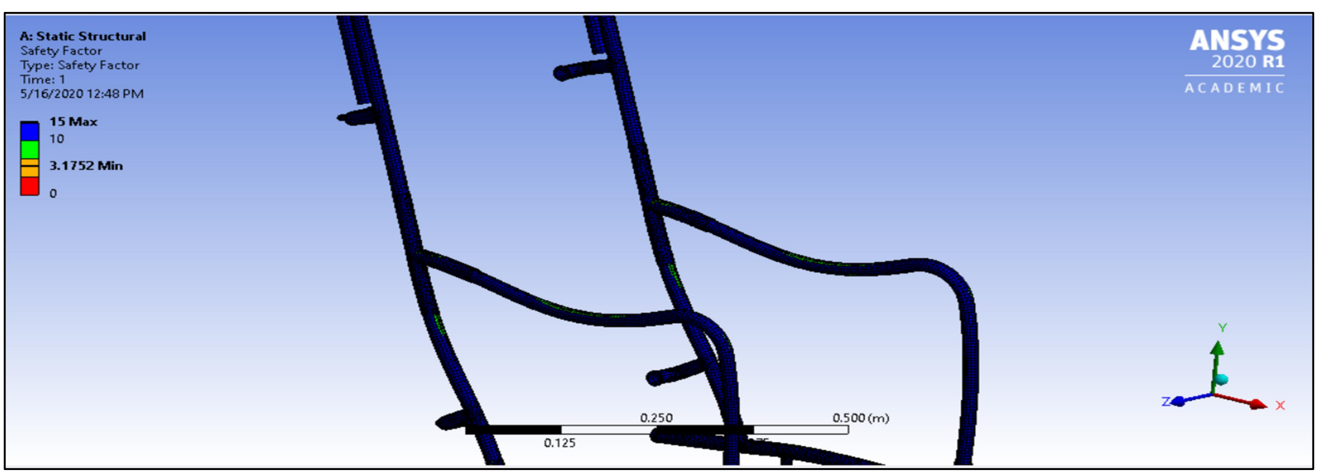
| | | |
|---|---|---|
| Object Name | *Total Deformation* | *Equivalent Stress* |
| State | Solved | |
| **Scope** | | |
| Scoping Method | Geometry Selection | |
| Geometry | All Bodies | |
| Position | | Top/Bottom |
| **Definition** | | |
| Type | Total Deformation | Equivalent (von-Mises) Stress |
| By | Time | |
| Display Time | Last | |
| Calculate Time History | Yes | |
| Identifier | | |
| Suppressed | No | |
| **Results** | | |
| Minimum | 0. m | 1.3185e-008 Pa |
| Maximum | 1.4102e-002 m | 4.2281e+007 Pa |
| Minimum Occurs On | Solid | |
| Maximum Occurs On | Solid | |
| **Information** | | |
| Time | 1. s | |
| Load Step | 1 | |
| Substep | 1 | |
| Iteration Number | 1 | |
| **Integration Point Results** | | |
| Display Option | | Averaged |
| Average Across Bodies | | No |

**Interpretation :- Minimum Deformation =  0** m

**Minimum Deformation =** 1.4102e-002 m

Based on force applied , material selection and Von mises Equivalent stress

**Safety Factor Range** **:-** 3.17 to 15



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# PATENT DETAILS

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2. Patent searchability report
3. Draft of Invention
4. Final filing process

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1. Searchability Report
2. Patent Draft
3. Filing document

IP CURATELABS

# OVERVIEW

## OBJECTIVE

Perform a Patentability search and analysis to uncover Patent /Non-Patent Literature worldwide related to this disclosure.

## SUMMARY OF THE INVENTION

The invention relates to a wheelchair which is meant to move on the stairs easily. The wheelchair comprises a track system is fitted at the back part of the wheelchair, which moves smoothly and supports the wheelchair in moving at forward & reverse direction on the staircase. The track is not battery operated.

## KEY FEATURES

| S. No. | Key Features |
|---|---|
| KEY FEATURE 1 | A stair climbing wheelchair |
| KEY FEATURE 1(a) | a track fitted at the bottom of the wheelchair, |
| KEY FEATURE 1(b) | the track will allow supports the movement of the wheelchair in forward or reverse direction of the stair. |