A

PROJECT REPORT

ON

“SMART AND AUTOMATIC WHEELCHAIR FOR DISABLED PERSON WITH HAND GESTURE”

Submitted To The
Savitribai Phule Pune University,Pune
For the Degree of

Bachelor of Engineering

In

Electrical Engineering

Under the Faculty of Engineering

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Under Guidance of
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Tal:-Baramati, Dist:- Pune

Year 2024-2025

CERTIFICATE

This is to certify that the Project Report entitled,

"SMART AND AUTOMATIC WHEELCHAIR FOR DISABLED PERSON WITH HAND GESTURE"

Submitted by

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Abstract

This project presents the development of a smart and automatic wheelchair system designed to enhance the mobility and independence of individuals with disabilities. The wheelchair incorporates an intuitive hand gesture recognition system, enabling users to control its movement through simple and natural hand movements. By utilizing [mention specific sensor technology, e.g., electromyography (EMG) sensors, inertial measurement units (IMUs), or computer vision], the system accurately interprets predefined hand gestures to execute commands such as forward, backward, left, right, and stop. This hands-free control mechanism aims to overcome the limitations of traditional joystick-based wheelchairs, particularly for individuals with limited upper body mobility or dexterity. The system integrates a microcontroller for real-time processing of sensor data and motor control, ensuring a responsive and safe navigation experience. This project demonstrates a cost-effective and user-friendly solution that empowers disabled individuals with greater autonomy and improved quality of life.

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CHAPTER 1

INTRODUCTION

This project aims to style integrate program to interface and test a totally motorized, gesture-operated wheelchair. A regular standard wheelchair wasn’t used instead a prototype was made to meet this project’s goals. In this project, the procedure of the Mechatronic systems design was followed to assure the quality of the final product i.e; the Gesture controlled wheelchair. The project took the following of the subsequent parts: Hardware, software, interface, and testing. This project is said to controlling a wheelchair by means of the human gesture.

The target of this project is to facilitate the movement of people who are disabled or handicapped. We used Arduino recognition technology which has been employed to maneuver the wheelchair. The results of this project show that this will be used for future research work and public interest.

The main objective is to style a system that gives the answer for the physically handicapped (challenged) people those who that can’t move by themselves, they can use Arduino commands by interfacing the Arduino Recognition with a microcontroller and wheelchair. The gesture sensor commands are given to the Arduino kit with the help of an Arduino and thus the wheelchair moves according to the given directions. forward backward left right there are direction to move wheelchair. The wheelchair's movement is being controlled by the motors and the motor drivers are being connected to the wheels of the chair. The interfacing between Arduino recognition kit and motors is completed by employing a microcontroller. Here during this project, the microcontroller used is Arduino UNO The idea was taken during this paper to reduce the human efforts in driving a wheelchair.

It’s an incontrovertible fact that humans are born imperfections. But disabilities have never stopped a person from achieving greatness. Furthermore, many devices/instruments are invented to assist those that are mentally or physically challenged. "Wheelchair" is supposedly the simplest example to support the above- mentioned inventions. when images of wheeled chairs made specifically to take the human from one place to another and is being seen to begin and occur in Chinese art. Many people are using these instruments and it's been proven to be a really useful gizmo for the disabled. Wheelchairs are available in a good sort of format to satisfy the precise needs of their users. These are popularly known to include and have particularly well-specialized seating adaption, build for individualized controls, and also adapted for certain particular activities, as seen with the ones used in the sports wheelchairs and also which are used in beach wheelchairs. the foremost widely known the distinction is between powered wheelchairs,where propulsion is seen to be provided by batteries and electric motors, and selfie or manually propelled wheelchairs, where the propulsive happened force is provided either by the wheelchair user/occupant pushing the wheelchair by their own force using their hand ("self-propelled") or by an attendant who might be behind the wheelchair using their hands pushing from the rear ("attendant propelled").

Earlier the wheelchair was to be moved by a mechanical force applied by the user. In recent trend Joystick with a motor are getting used to cause movement. But it comes with its own limitation of force to be applied on these levers. There could also be an opportunity that it's going to grind to a halt or it's going to break. To overcome this problem, we thought of employing a gesture-controlled actuation which not only removes the matter of lever adjustment but also would be more convenient for the user hence we've come up with a actual work model wheelchair that's gesture actuated. This wheelchair is specially designed for those patients who are unable to move their limbs except their head. This wheelchair is operated by detecting the motion of the head and providing such paralyzed patient, a certain degree of independence and freedom in their movement. We used accelerometer; one of the components of the inertial measurement unit (IMU). Accelerometer sensor is the detects the orientation of the hand and send signals to the micro-controller which is Arduino UNO.

The design we proposed is cost effective and simple. No specific calibration is required before use. Additional characteristic of wheelchair in the hardware design is that it can be operated in 2 modes i.e. either manually or by using patient hand. Standard wheelchair has been purchased from the market and modified mechanically by applying helical gears which are coupled with the motors. These gears can be attached and detached according to the patient’s requirement and that can be done by simply unscrewing a bolt at the back of the wheelchair.

1.1 Need of Project

The percentage of disabled people has increased in both rural and urban part of India. The disability could be by birth or due to some medical or accidental reason. The aim of this paper is to make a hand gesture-controlled wheel chair using accelerometer as sensor to help the physically disabled people in moving from one place to another just by giving direction from the hand. Today in India many people are suffering from disability, there are people whose lower half of the body is paralyzed. This Wheelchair will add on to the comfort and make the life of people bit easier. Around 5436604 people are affected from movement disability. Percentage of population which suffers from different disabilities is shown in graph below. Out of total disability maximum people suffers from disability in movement.

Benefits to people who are:

a) Paralytic person.

b) Those who crawl.

c) Those who walk with the help of aid.

d) Those have acute and permanent problems of joints/muscles.

e) Those who have stiffness or tightness in movement or have loose, involuntary movements or tremors of the body or have fragile bones.

f) Those who have difficulty in motor cell and neurons coordination.

g) Those who have lost sense of sensation in lower part of the body due to paralysis or other problems.

h) Those who have twisted body parts and suffer from any kind of deformity in the body.

1.2 -Problem Statement

1. To select correct dimension and parameter wheelchair fabrication.

2. **Motor selection:** Choose motors that can provide sufficient torque and speed for the wheelchair's weight and desired performance.

3. **To control motor speed**: Implement a control system, like PWM (Pulse Width Modulation), to regulate motor speed accurately.

4. **Wheelchair rotate**: Design the wheelchair with the ability to rotate in place, which may involve differential steering or additional hardware.

5. **To develop program control direction**: Write a program to interpret hand gestures and translate them into directional commands for the wheelchair.

The problem for a hand-gesture controlled wheelchair is to provide a more natural and intuitive way for people with disabilities to control their wheelchairs. Traditional wheelchairs are controlled by joysticks or other manual input devices, which can be difficult and tiring to use for people with limited mobility. Hand gesture control offers a more efficient and user-friendly alternative, allowing users to control their wheelchairs simply by moving their hands.

There are several challenges that need to be addressed in order to develop a successful hand-gesture controlled wheelchair. One challenge is to develop a sensor system that can accurately and reliably detect hand gestures. Another challenge is to develop a control algorithm that can translate hand gestures into wheelchair movements. Finally, the wheelchair must be designed in a way that is safe and easy to use for people with disabilities.

Despite these challenges, hand-gesture controlled wheelchairs have the potential to revolutionize the way that people with disabilities move around. By providing a more natural and intuitive way to control their wheelchairs, hand gesture control can help people with disabilities to live more independent and active lives.

1.3 Objectives:

1. Enhancing mobility and independence for wheelchair users.
2. Introducing innovative assistive technology solutions
3. The aim of the project is to design a wheelchair tilt communicator system that could operate the wheelchair handicapped person with the help of tilt of hand.

1.4 Sub Objectives of the Project:-

1. Study the Working of power electronics devices:

In this project we will study the actual working of power electronic devices. We will also study that how much supply we have to apply on controller and power electronics devices to get required appropriate output.

2. Selection of Appropriate Components Required:

In this part of the system we will select the components required of specific and appropriate ratings for power supply circuit, power electronics devices such as relay, motion sensor, Arduino UNO, controller, etc.

3. Design of Block and Circuit Diagram:

Another objective of our project is to study and design block diagram and circuit for proposed system.

4. Overall Reduced Cost:

To reduced the cost and increase efficiency.

1.5 Outlines of Dissertation:

Chapter 2- Literature Review- This chapter includes the reviews of literature i.e. paper we have referred for our project.

Chapter 3- Objectives completed- This one includes the objectives of project that we have set during making of project.

Chapter 4- Significance of Topic- A smart, automatic wheelchair for disabled persons, built with an Arduino UNO, offers significant benefits in terms of independence, mobility, and accessibility.

Chapter 5- Principle of Operation- This chapter includes how the a smart, automatic wheelchair for disabled persons using Arduino functions by receiving input, processing it, and then controlling motors to move the wheelchair. That is our principle of operation.

Chapter 6- Project Development Stages- There are mainly 2 stage of project first built a mechanical assembly of project development and second one is functioning is done by controller using coding in Arduino UNO circuit.

Chapter 7- Hardware Design- Hardware design mainly contains the selection of component used in project. DC gear motor, motion sensor and Arduino Uno are the main component of our hardware.

Chapter 8- MPU-6050 Motion Sensor Design- Designing the mpu-6050 motion sensor according to the required specifications and its accuracy is the part of motion of wheelchair.

Chapter 9- Block Diagram Description- Our whole project is described in a block format in this chapter. Here you can get the brief idea of project.

Chapter 10- Hardware Design Circuitry- In this chapter circuit diagrams of our project are included.

Chapter 11- Advantages and Disadvantages- Here we have briefed some advantages and disadvantages of our project.

Chapter 12- Applications- Our project can be used in various locations such as hospital purpose.

Chapter 13- Conclusion and Future Work- In this chapter we have concluded the project and also added some future scope point.

Chapter 14- Cost Estimation- In this chapter the cost of the total project with components used in the system are explained.

CHAPTER 2

LITERATURE SURVEY

1. DESIGN AND DEVELOPMENT OF SMART WHEELCHAIR SYSTEM USING HAND GESTURE CONTROL

Authors: Priya Darshini B, Satheesh Kumar S.

Published in: IEEE 2022 6th International Conference on Electronics, Communication and Aerospace Technology (ICECA) | 978-1-6654-8271-4/22/$31.00 ©2022 IEEE | DOI: 10.1109/ICECA55336.2022.10009456.

In this paper, the proposed system aims at designing and developing a hand gesture controlled semi-autonomous electric wheelchair that is adaptable both indoors and outdoors. The system is designed in such a way the user can operate the wheelchair using hand gestures and android application. Hand gesture control is employed through the MEMS sensor. It is a three-axis accelerometer sensor that measures the hand orientation of the user and by analysing the motion, Arduino microcontroller processes the data and helps in propelling the wheelchair accordingly.

2. DESIGN OF A LOW-COST HAND GESTURE CONTROLLED

Authors: Mufrath Mahmood Md. , Fahim Rizwan ,Md. Habib

Published in: 2020 IEEE Region 10 Symposium (TENSYMP), 5-7 June 2020, Dhaka, Bangladesh

In this Paper, Design and implementation of a low-cost hand gesture controlled automated wheelchair-using Arduino based microcontroller and Node MCU is presented in this paper. The main focus of this study is to control the wheelchair with the movement of the hand-wrist movement. Besides hand gestures, the wheelchair can also be controlled via Bluetooth technology.

3. HEAD MOVEMENT CONTROL OF POWERED WHEELCHAIR

Authors: Razvan , Solea Alexandru Margarit, Daniela Cernega , Adrian Serbencu

Published In: 2019 23rd International Conference on System Theory, Control and Computing (ICSTCC)

This paper presents an efficient method to imple ment head gesture recognition to be the base of a framework for the physically disabled people. Currently, the most common way to control an powered wheelchair is to use a joystick. However, there are some individuals unable to operate joystick-driven powered wheelchairs due to sever physical disabilities. This paper proposes a novel head pose control algorithm to assist disabled patients (persons who cannot move their hands or legs but are able to make head movement).

4. REAL-TIME HAND-GESTURE RECOGNITION FOR THE CONTROL OF WHEELCHAIR

Authors: Md Rafiul Huda, Md. Liakot Ali, Muhammad Sheikh Sadi

Published In: 2022 12th International Conference on Electrical and Computer Engineering (ICECE)|979-8-3503-9879-3/22/$31.00©2022IEEE | DOI: 10.1109/ICECE57408.2022.10088702

This paper develops a prototype of an advanced algorithm for gesture recognition and decision making for a control system for smart wheelchair (built with advanced and automated features) users, in line with contemporary technologies. This method places a greater emphasis on users' flexibility by requiring less hand movement. The experimental study shows that the proposed method outperforms existing methods.

5. HAND GESTURE CONTROLLED WHEELCHAIR

Authors: Reshma Anilkumar, Amal M R

Published In: 2023 IJCRT | Volume 11, Issue 1 January 2023 | ISSN: 2320-2882

Here an accelerometer sensor is used, which gives the analog signal according to the tilt of the accelerometer in x (x positive axis, x negative axis) and y (y positive axis, y negative axis) direction and RF module is used to transmit the signal from the transmitter section to receiver section then the movement of the wheel is controlled. Wheelchairs are essential for the elderly and disabled to move from one place to another. But it requires the help of others to control it, and this is where hand gesture-controlled wheelchairs come in handy where it can aid the disabled and control the direction by using simple gesture movements.

Project Work Schedule

Sr. No	Activity	Week 1-3	Week 4-6	Week 7-8	Week 9-11	Week 12-13	Week 14	Week 20-23	Week 24-26	Week 33-34	Week 35-39
1	Topic Selection	√									
2	Information Collection		√								
3	Project Survey			√							
4	Material Selection				√						
5	Collection of Material					√					
6	Project Startup						√				
7	Report Writing Stage-I						√				
8	Assembly of Component							√			
9	Testing of Project								√		
10	Report Writing Stage-II									√	
11	Research paper of Smart and automatic wheelchair for disabled person with hand Gesture Stage-II										√

CHAPTER 3

Objectives Completed

1. Mobility and Control:

- **Hand Gesture Control:**

Allows users to control the wheelchair's movement using hand Gesture commands like "forward," "backward," "left," and "right".

- **Gesture Control:**

Enables movement through hand gestures, reducing reliance on physical controls.

- **Autonomous Navigation:**

In some cases, wheelchairs incorporate features for autonomous navigation, allowing the user to move independently without external assistance.

2. Other Features:

- **Remote Control:**

Enabling remote control of the wheelchair via smartphone apps or other devices.

- **Personalized Settings:**

Allowing users to adjust wheelchair settings based on their individual needs and preferences.

3. Cost-Effectiveness and Accessibility:

- **Affordable Technology:**

Utilizing Arduino and other cost-effective components to make the wheelchair accessible to a wider range of individuals.

- **User-Friendly Design:**

Focusing on a simple and easy-to-use interface that minimizes the learning curve for users.

CHAPTER 4

SIGNIFICANCE OF TOPIC

The topic of smart and automatic wheelchairs for disabled persons using hand gestures is a significant and transformative innovation in the field of assistive technology. It has the potential to drastically enhance the quality of life for individuals with physical disabilities, offering greater mobility, independence, and ease of use. The significance of this topic can be explored through several interconnected themes:

1. Empowerment and Independence for Disabled Individuals

For many people with physical disabilities, mobility is one of the most limiting aspects of daily life. Traditional wheelchairs, while functional, often require assistance from others, which can create a reliance on caregivers, family members, or friends. This can lead to a sense of dependence, diminishing the user's autonomy. A smart wheelchair controlled by hand gestures offers a significant breakthrough in addressing this issue. Hand gesture control allows users to navigate their wheelchair more intuitively, without needing to rely on others. By simply moving their hands in a specific direction, they can control the wheelchair's movements, allowing them to perform daily tasks independently.

The ability to control a wheelchair with hand gestures empowers individuals to move around freely in both familiar and unfamiliar environments. This kind of independence not only improves physical mobility but also boosts mental well-being. Users can engage in social activities, go out on errands, and explore new places without feeling dependent on others, which fosters a sense of dignity and self-sufficiency.

2. Advancements in Assistive Technology

The development of gesture-controlled smart wheelchairs marks a significant step forward in the field of assistive technology. Traditional wheelchair systems typically rely on mechanical or electronic controls such as joysticks or buttons. While these systems have been vital for people with mobility impairments, they often require precise motor skills, which can be a challenge for individuals with limited dexterity or strength. Gesture control, however, is based on natural hand movements, making it a more intuitive and accessible solution for many users.

These smart wheelchairs often incorporate sensors, cameras, and artificial intelligence (AI) to interpret hand gestures and convert them into commands. They may also feature automated systems that assist with pathfinding, speed control, and obstacle avoidance. This integration of advanced technologies creates a more responsive, user-friendly, and adaptive mobility device, demonstrating how innovation can enhance everyday life for people with disabilities.

3. Improved User Experience and Ease of Use

One of the most compelling aspects of a hand gesture-controlled wheelchair is the ease of use. Traditional wheelchair controls, such as joysticks or switches, can be difficult for some individuals to operate due to limited strength, dexterity, or coordination. In contrast, hand gestures offer a natural and intuitive way to interact with the wheelchair. A simple wave of the hand or a subtle tilt of the wrist can direct the wheelchair to move forward, backward, or turn. This makes the device more accessible for people who may have difficulty using conventional controls.

Additionally, hand gesture control eliminates the need for additional hardware like buttons, switches, or levers, simplifying the user interface and reducing the risk of malfunctions or errors in operation. Users can focus on their surroundings and their movement rather than on complex or cumbersome control mechanisms, leading to a more seamless and enjoyable experience.

4. Safety and Navigation Features

Another key advantage of smart, automatic wheelchairs is their potential for incorporating safety and navigation features. These wheelchairs can be equipped with advanced sensors, such as ultrasonic sensors, LIDAR (Light Detection and Ranging), and cameras, which can detect obstacles in the wheelchair's path. When an obstacle is detected, the system can automatically adjust the wheelchair's direction or stop movement altogether, preventing collisions and accidents.

In addition, some systems may feature automatic pathfinding, allowing the wheelchair to navigate around obstacles or follow predetermined routes. For example, the wheelchair could learn the layout of a home or other environment and move to specific locations, such as the kitchen or bathroom, without requiring manual control from the user. These features increase the safety of the user, reduce the risk of accidents, and offer peace of mind to both the individual and their caregivers.

5. Integration with Smart Environments and IoT

The rise of the Internet of Things (IoT) and smart home technology presents new opportunities for integrating gesture-controlled wheelchairs with other smart systems. For example, a smart wheelchair could communicate with smart home devices to perform various tasks. With a simple hand gesture, the user could open a door, turn on lights, or adjust the thermostat. The wheelchair could also be connected to mobile apps, allowing users to monitor battery levels, control speed, or customize settings.

This seamless integration with smart environments creates a more holistic and interconnected experience for the user. As the Internet of Things expands, the potential for these smart wheelchairs to work in concert with other assistive technologies will continue to grow, offering new possibilities for independence and quality of life.

6. Personalization and Adaptability

Smart wheelchairs using hand gestures can be highly personalized, adapting to the individual needs and preferences of the user. For instance, the sensitivity of the hand gesture recognition system can be adjusted based on the user's motor skills and physical abilities. Additionally, some advanced systems may learn and memorize the user's preferred movements or gestures over time, making the wheelchair even more responsive and tailored to the person’s specific needs.

This personalization aspect is crucial in ensuring that the wheelchair is as effective as possible for each individual. Every person with a disability is unique, and their needs can vary greatly depending on factors such as the type of disability, level of mobility, and daily routines. Smart wheelchairs that can adapt to these varying requirements ensure that the technology remains flexible and relevant to all users.

7. Reduction of Physical Strain and Fatigue

Using traditional manual or power wheelchairs can be physically demanding, particularly for individuals with limited strength or coordination. For example, using a joystick for long periods can lead to strain on the arms, shoulders, and hands. Additionally, users who rely on caregivers to operate the wheelchair may experience fatigue from constant movement or the need for assistance.

A gesture-controlled smart wheelchair can reduce the physical effort required to maneuver the chair, decreasing the strain on the user’s body. By eliminating the need for constant hand or arm movements associated with traditional controls, users may experience less fatigue and a better overall physical experience. This is especially important for people with conditions like arthritis, muscular dystrophy, or spinal cord injuries, who may already be dealing with physical discomfort or pain.

8. Long-Term Impacts on Mental Health and Well-Being

The ability to control a wheelchair using hand gestures also has profound implications for mental health. Individuals with disabilities often face isolation, social stigma, and a lack of access to community spaces. By giving them greater control over their mobility, smart wheelchairs can help reduce feelings of isolation and promote engagement with others. The increased freedom to go out and interact with people can help improve a person's social integration and self-esteem.

Additionally, the feeling of autonomy and control that comes with using such a wheelchair can have positive effects on mental health, reducing anxiety and depression associated with disability. The emotional and psychological benefits of increased independence cannot be overstated, as they contribute to a higher quality of life and overall well-being.

CHAPTER 5

PRINCIPLE OF OPERATION

A smart, automatic wheelchair for disabled persons using hand gestures operates by employing sensors to detect hand movements, which are then processed to control the wheelchair's movement. The system translates these hand gestures into electrical signals that are transmitted to the wheelchair's control unit, allowing the user to navigate with relative ease.

Here's a more detailed breakdown:

1. Gesture Detection:

Sensors like accelerometers (mpu 6050) are used to detect and interpret hand gestures. Accelerometers measure acceleration changes.

2. Signal Processing:

The detected hand gestures are converted into electrical signals that represent specific commands (e.g., forward, backward, left, right, stop).

3. Wired Transmission:

The processed signals are transmitted wired to the wheelchair's control unit using connecting jumper wires.

4. Wheelchair Control:

The control unit, often a microcontroller, receives the signals and sends them to the wheelchair's motors, actuators, and other components to execute the desired movement.

For example, a simple system might use a single accelerometer on the user's hand. Tilting the hand forward could be interpreted as "forward," tilting backward as "backward," and tilting left or right as "left" or "right". More advanced systems might use multiple accelerometers, cameras, or even machine learning algorithms to recognize a wider range of gestures and provide smoother, more intuitive control.

CHAPTER 6

PROJECT DEVELOPMENT STAGES

Mechanical Assembly of Standard Wheelchair

6.1 Manual Wheelchair

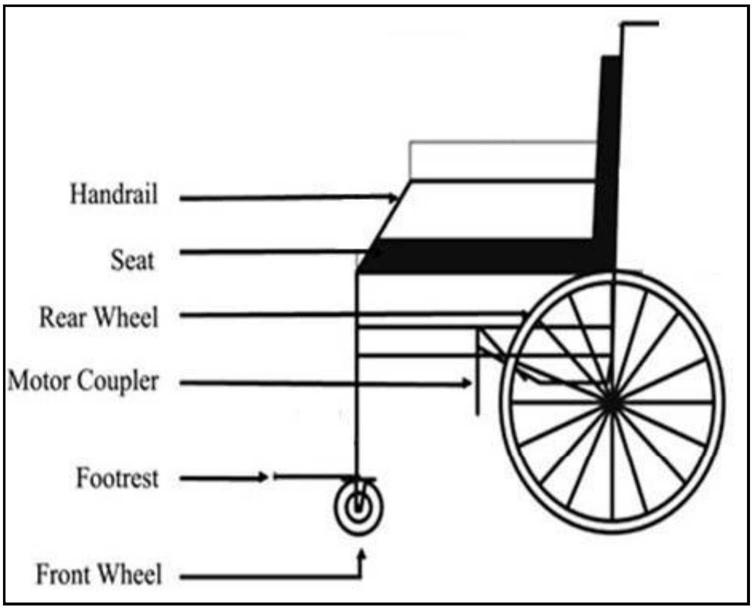


Fig.6.1 Manual Wheelchair

The quality of our project design is that any standard wheelchair available in the market can be converted into an electronic wheelchair. In our project we purchased a standard light weight wheelchair from the market. We welded a steel plate at the back of the wheelchair so that motors can be attached on this steel plate. Also a steel plate in the front bottom is welded to place the electronic components and batteries. After welding these plates the folding features of the wheelchair has been eliminated. After this welding process, the frame of the wheelchair became misaligned and it required enough time and effort to realign the frame and maintain the stability. We repainted the wheelchair to cover the welded parts and steel plates.

6.2 Chain Gear Assembly:

Two types of gears most widely available and used in India it is the chain. Gears having straight teeth are known as spur gears and they can be fabricated easily. Teeth of the chain gears are at an angle and are difficult to make in comparison to spur gears. Chain gear have advantage over spur gears because of the fact that they make less noise.

Fig.6.2 Chain Gear Assembly

chain gears teeth engage smoothly and gradually but they are less efficient than spur gears. Chain gears are more durable and run smoothly on high loads. Friction is greater in spur gears and because of this they wear out quickly as compared to chain gears. Considering these facts chain gears are chosen in our mechanical design. Gear ratio was set 1:6 means driving gear has one third the teeth as the driven gear. So basically, gears are being used to reduce the revolutions of the motor which was 180 revolutions per minute, which was too much for the wheelchair to move directly with the motors without using gears. This gear ratio was chosen keeping in mind the safety feature along with the required speed. Considering the weight of the wheelchair accompanied with electrical and mechanical components and weight of the person gear ratio was set to obtain torque according to our requirement.

Mechanical design of wheelchair has been modified in such a way that gears between motor stand shaft can be attached and detached according to user requirement.

This has been done by attaching both motors on single plate attached to the main frame of the wheelchair and bolt is used to lose or tighten the plate hence changing the gear position

6.3 Caster Wheels

Fig 6.3 Caster Wheel

A caster (or castor) is an undriven wheel that's designed to be attached to rock bottom of a bigger object (the "vehicle") to enable that object to be moved. Casters are utilized in numerous applications, including shopping carts, office chairs, hospitalbeds, and material handling equipment. High capacity, heavy duty casters are utilized in many industrial applications, like platform trucks, carts, assemblies, and tow-lines in plants.

Fig.6.4 Mechanical Assembly Of Wheelchair

CHAPTER 7

HARDWARE DESIGN

Electrical Components Used

1. Arduino UNO
2. MPU 6050 Motion Sensor
3. Relay Module
4. DC Gear Motor
5. Battery
6. Charger
7. Connecting Wires

7.1 Arduino UNO

Arduino is an Open-source-electronic-prototyping-base for simple used hardware and software in the field of micro-controlling. A microcontroller (MCU for microcontroller unit or UC for μ-controller) is a little processor on a separate integrated circuit. In modern language, it is comparable to but less complicated than, a system on a chip (SoC). A microcontroller comprises one or higher CPUs (processors core) accompanying with memory and programmable input/output peripherals. Program memory in the form of ferroelectric.

Fig 7.1 Arduino UNO

Arduino is a board which has ATmega328 microcontroller built on it. It has 16 MHz crystal, 6 analogue input and output pins, 14 digital input output pins and out of which 14 digital pins 6 pins

can be used as PWM pins that are pretty accommodating in motor control applications.
RAM, NOR flash or OTP ROM is also usually involved on chip, as well as a little amount of RAM Microcontrollers are created for embedded applications, in contrast to the microprocessor used in personal computers or other general-purpose applications consisting ofvarious discrete chips. It contains a USB connector that can be practiced to attach Arduino to the pc for uploading the code. While Arduino is united to PC it can bring constant power from the PC needed for its operation. It has an adaptor jack which can be utilized to control the Arduino in offline mode. It has also Vin pin to allow the 9V supply required for its working. It has two to three 5V and ground pins which can be utilized to power up the diminutive power-consuming accessories directly from the Arduino.

7.2 MPU 6050 Motion Sensor

MPU6050 sensor module is complete 6-axis Motion Tracking Device. It combines 3-axis Gyroscope, 3-axis Accelerometer and Digital Motion Processor all in small package. Also, it has additional feature of on-chip Temperature sensor. It has I2C bus interface to communicate with the microcontrollers.

It has Auxiliary I2C bus to communicate with other sensor devices like 3-axis Magnetometer, Pressure sensor etc.

If 3-axis Magnetometer is connected to auxiliary I2C bus, then MPU6050 can provide complete 9-axis Motion Fusion output

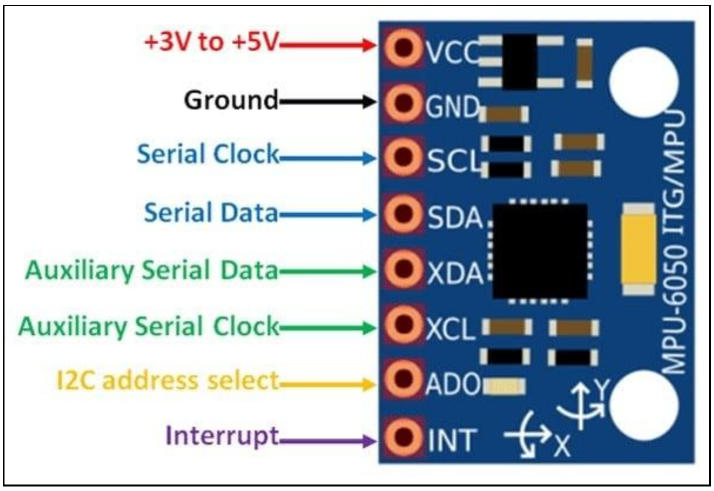
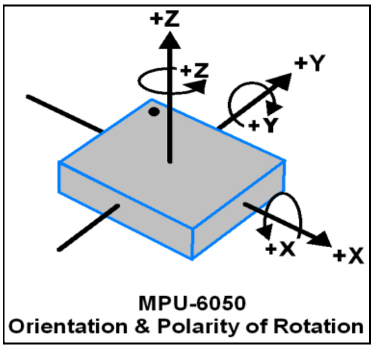


Fig 7.2 MPU 6050

The MPU6050 consist of 3-axis Gyroscope with Micro Electro Mechanical System(MEMS) technology. It is used to detect rotational velocity along the X, Y, Z axes as shown in below figure.

- When the gyros are rotated about any of the sense axes, the Coriolis Effect causes a vibration that is detected by a MEM inside MPU6050.
- The resulting signal is amplified, demodulated, and filtered to produce a voltage that is proportional to the angular rate.
- This voltage is digitized using 16-bit ADC to sample each axis.
- The full-scale range of output are +/- 250, +/- 500, +/- 1000, +/- 2000.
- It measures the angular velocity along each axis in degree per second unit.



7.2.1 Working Principle

In our project we are only using 3-axis accelerometer (MPU 6050). So there are 3 axis x, y and z. The forward motion is due to x-axis acceleration and the right and left motion is done by y- axis where z-axis is used as a reference acceleration. When accelerometer is tilted to some angle it gives us some raw acceleration value e.g. when it is tilted downwards, x- axis acceleration is compared with the gravitational acceleration to give us raw values of acceleration in x-axis, similarly is the case for y-axis

7.3 Relay Module

The switching device we used is Dual channel – dual motor control module. This device works with single channel max A 5 Amp Relay is Rated at 250 Volts AC. 5 x 250 = 1,250 ACWatts load capacity. So the advantage of using this relay module is that it will not burn out easily because of its higher specifications, our work is being done by only one module, as both the motors are being controlled by a single relay module circuit.

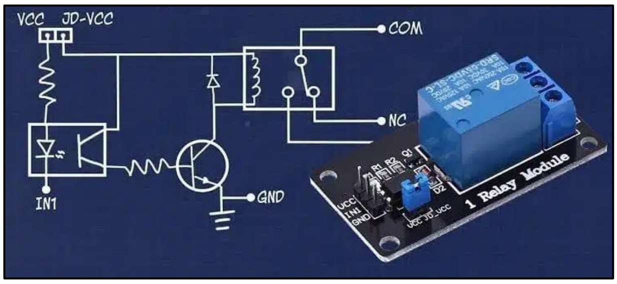


Fig.7.3.1 Relay Module

A two outputs for the two motors. The power vcc pins are attached to battery where 24 V areprovided to the relay module , which are being transferred to the motors. The control vcc is connected to Arduino, from where the signal or command is transferred to the relay module to control the motors accordingly. To move the motors in forward direction.

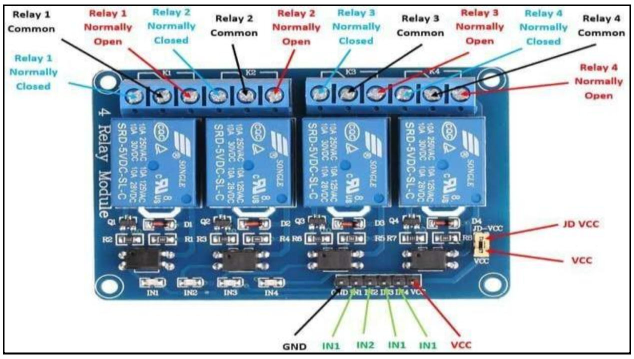


Fig.7.3.2 Pin Function of Relay Module

7.4 DC Gear Motor

Fig.7.4 DC Gear Motor

A geared DC Motor has a gear assembly devoted to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and dropping the speed. Using the correct arrangement of gears in a gear motor, its speed can be reduced to any required figure. This concept of reducing the speed with the help of gears and increasing the torque is known as gear reduction. Reducing the speed put out by the motor while increasing the quantity of applied torque is a important feature of the reduction gear trains found in a gear motor. The decrease in speed is inversely relative to the increase in torque. This association means that, in this sort of device.

7.5 Battery

12V 8AH sealed lead acid batteries are perfect as new or replacements for alarm systems, UPS, access control, fire systems and emergency lighting. When sizing your battery, be sure to match voltage, check dimensions, and choose a capacity (aH rating) as close as possible to your original battery. It's common to replace a 7AH battery with a 8AH battery.

Fig.7.5 Battery

Specifications:-

Sealed Lead Acid / SLA Battery Non Spillable

Nominal voltage: 12VDC

Rated Capacity: 8aH (20 hour rate)

Terminals: F1 Faston Tab No 187

Dimensions: 151mm (L) x 65mm (W) x 95mm (H) (5.944″ x 2.56″ x 3.74″)

Weight :- 2.8 kg / 6.17 lbsInitial charging current less than 2.25A

7.6 Charger

Input: 100v to 240v AC and Output:12v DC, 2 Amp, Pin Length - 1.2 CM, has a 2.5mm x 5.5mm Jack Replaces other lower amped 12v adapters, 0.5A, 1A, 1.5A, 2A, etc. This Power Supply is a Regulated Centre Positive Power Supply, Low energy consumption, High Efficiency, Incredibly Low Fault Rates, No Minimum Load.

Fig 7.6 Charger

7.7 Connecting Wires

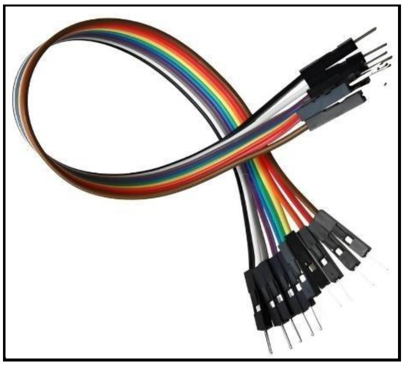


Fig.7.7 Jumper Wires

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools in order to make it easy to change a circuit as needed.

CHAPTER 8

MPU-6050 MOTION SENSOR DESIGN

MPU6050 Module Pinout:

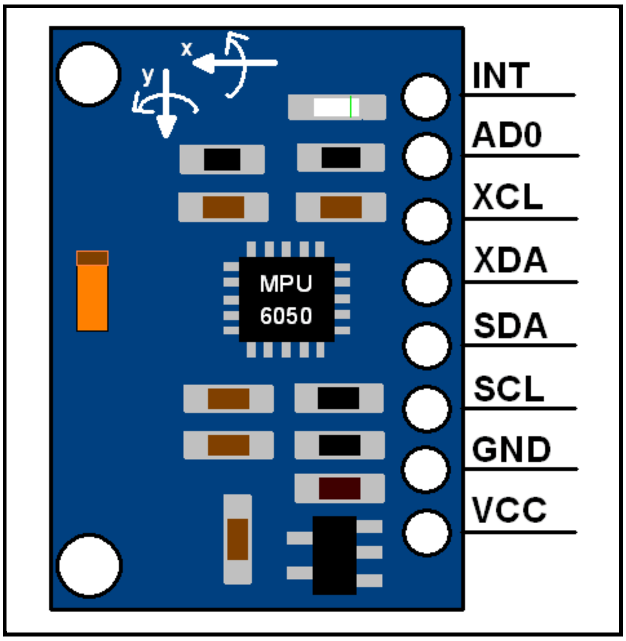


Fig 8.1 MPU6050 Pinout

8.1 MPU6050 Pinout

MPU6050 Pin Description

The MPU-6050 module has 8 pins,

- INT: Interrupt digital output pin.
- AD0: I2C Slave Address LSB pin. This is 0th bit in 7-bit slave address of device. If connected to VCC then it is read as logic one and slave address changes.
- XCL: Auxiliary Serial Clock pin. This pin is used to connect other I2C interface enabled sensors SCL pin to MPU-6050.
- XDA: Auxiliary Serial Data pin. This pin is used to connect other I2C interface enabled sensors SDA pin to MPU-6050.
- SCL: Serial Clock pin. Connect this pin to microcontrollers SCL pin.
- SDA: Serial Data pin. Connect this pin to microcontrollers SDA pin.
- GND: Ground pin. Connect this pin to ground connection.

- VCC: Power supply pin. Connect this pin to +5V DC supply.
- MPU-6050 module has Slave address (When AD0 = 0, i.e. it is not connected to Vcc) as,
- Slave Write address(SLA+W): 0xD0
- Slave Read address(SLA+R): 0xD1

8.2 MPU6050 interfacing with Arduino

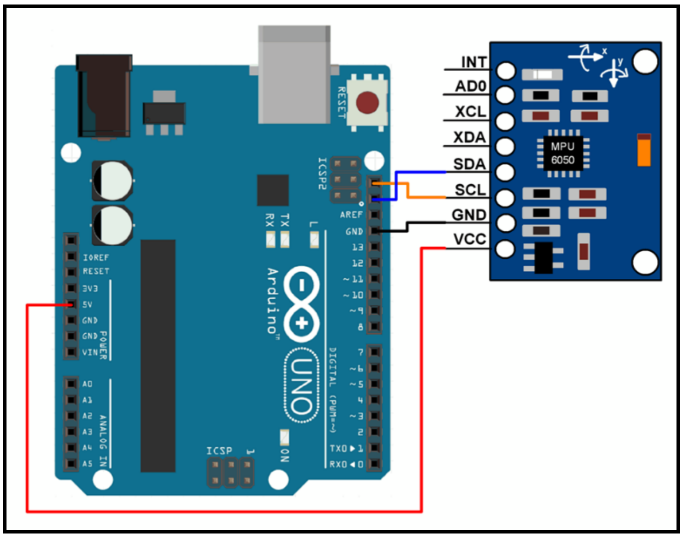


Fig 8.2 MPU6050 interfacing with Arduino

- **Alternate options for MPU6050**

- **MPU6050**: This sensor module combines a 3-axis accelerometer, 3-axis gyroscope, and 3-axis magnetometer in a single package.

- **LSM6DS3**: This sensor module also combines a 3-axis accelerometer and 3-axis gyroscope, but has a lower power consumption and smaller size than the MPU6050.

- **ADXL345**: This sensor module offers a 3-axis accelerometer with a full-scale range of ±2g, ±4g, ±8g, or ±16g.

- **BNO055**: This sensor module offers a 3-axis accelerometer, 3-axis gyroscope, and 3-axis magnetometer, along with a built-in processor for fusion of sensor data.

8.3 Specification of MPU6050 Sensor

Gyroscope:

- 3-axis sensing with a full-scale range of ±250, ±500, ±1000, or ±2000 degrees per second (dps)
- Sensitivity of 131, 65.5, 32.8, or 16.4 LSBs per dps
- Output data rate (ODR) range of 8kHz to 1.25Hz

Accelerometer:

- 3-axis sensing with a full-scale range of ±2g, ±4g, ±8g, or ±16g
- Sensitivity of 16384, 8192, 4096, or 2048 LSBs per g
- ODR range of 8kHz to 1.25Hz
- Temperature Sensor:
- Operating range of -40°C to +85°C
- Sensitivity of 340 LSBs per degree Celsius
- Accuracy of ±3°C

Supply Voltage:

- Operating voltage range of 2.375V to 3.46V for the MPU-6050, and 2.375V to 5.5V for the MPU-6050A.
- Communication Interface:
- I2C serial interface with a maximum clock frequency of 400kHz.
- 8-bit and 16-bit register access modes.

Other Features:

- Digital Motion Processor (DMP) for complex motion processing.
- On-chip 16-bit ADCs for accurate analog-to-digital conversion.
- Programmable digital filters for improved noise performance.

- Interrupts for triggering events based on specific motion conditions.
- Low-power consumption (3.9mA for full operation.

8.4 3-Axis Accelerometer

The MPU6050 consist 3-axis Accelerometer with Micro Electro Mechanical (MEMs) technology. It used to detect angle of tilt or inclination along the X, Y and Z axes as shown in below figure.

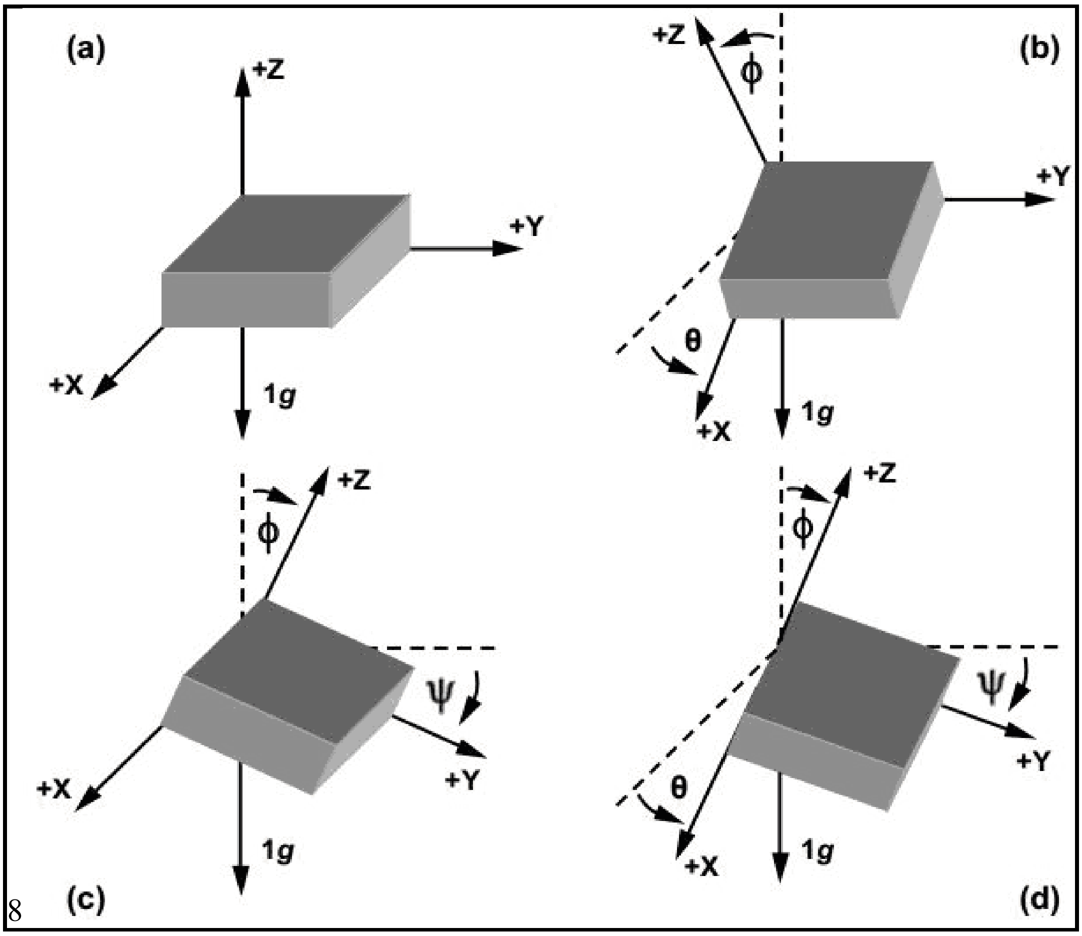


Fig 8.4 3-Axis Accelerometer

- \- Acceleration along the axes deflects the movable mass.
- \- This displacement of moving plate (mass) unbalances the differential capacitor which results in sensor output. Output amplitude is proportional to acceleration.
- \- 16-bit ADC is used to get digitized output.
- \- The full-scale range of acceleration are +/- 2g, +/- 4g, +/- 8g, +/- 16g.
- \- It measured in g (gravity force) unit.
- \- When device placed on flat surface it will measure 0g on X and Y axis and +1g on Z axis.

CHAPTER 9

BLOCK DIAGRAM DESCRIPTION

Block Diagram of Working Principle

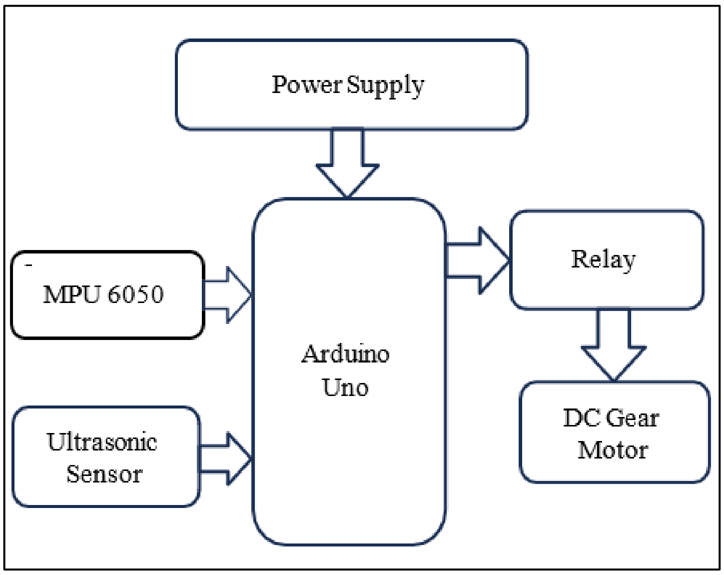


Fig.9.1 Block Diagram of Working Principle

9.1 Working Principle

In our experiments, MPU 6050 Accelerometer based gesture controlled wheelchair moves according to the movement of hand as we place the MPU 6050 accelerometer on your hand. When we tilt hand with an MPU 6050 accelerometer in front, then the wheelchair starts moving forward until the next movement is given. When we tilt hand in backward direction, then the wheelchair changes its direction and state. Then it starts moving in backward direction until the next signal is given. When we tilt hand on left side, then the wheelchair moves into left side until the next signal is given. In the same way, when we tilt hand in right side, then the wheelchair moves right side.

❖ **Explanation of Blocks:**

- **Hand Gesture Input:** This is where the user's hand gestures are captured. This could involve:
- Wearable Sensors: Gloves equipped with flex sensors, accelerometers, and gyroscopes to detect finger movements and hand orientation.
- **Vision-Based Systems:** Cameras (e.g., depth cameras like Intel RealSense or specialized gesture cameras) that interpret hand movements and shapes.

- **Gesture Recognition Module:** This module processes the raw data from the hand gesture input to identify specific, pre-programmed gestures. It typically involves:
- Signal Processing: Filtering noise and normalizing data.
- **Machine Learning Algorithms:** Trained models (e.g., neural networks, SVMs) to classify gestures (e.g., "move forward," "turn left," "stop").
- **Microcontroller / Central Processing Unit (CPU): This** is the brain of the wheelchair. It receives recognized gesture commands and sensor data, makes decisions, and sends commands to other modules. Key functions include:
- **Command Interpretation:** Translating recognized gestures into wheelchair actions.
- Sensor Data Processing: Integrating data from various sensors.
- **Navigation Logic:** Determining appropriate motor commands based on user input and environmental data.
- **Safety Protocols:** Implementing emergency stops or collision avoidance.
- **Sensor Fusion Module**: This module integrates data from multiple sensors to create a comprehensive understanding of the environment and the wheelchair's position. It improves accuracy and reliability by combining information from different sources.
- **Obstacle Detection Sensors**: These sensors detect obstacles in the wheelchair's path, enabling automatic stopping or rerouting. Examples include:
- **Motor Control Module:** This module receives commands from the CPU and translates them into appropriate electrical signals to drive the wheelchair motors. It often includes:
- **Motor Drivers:** Electronic circuits that control the speed and direction of the motors.
- **Pulse Width Modulation (PWM):** A technique to control motor speed by varying the duration of electrical pulses.
- **Wheelchair Motors:** These are the electric motors that propel the wheelchair's wheels. Typically, two independent motors (one for each drive wheel) are used for differential steering.
- **Wheelchair Movement:** The physical movement of the wheelchair based on the motor commands.
- **Power Management Unit:** Regulates and distributes power from the battery to all components of the wheelchair system, ensuring efficient and safe operation.
- **Battery:** The power source for the entire system, typically a high-capacity rechargeable battery (e.g., Lithium-ion).

❖ **Working Principle Overview:**

- **Gesture Input:** The disabled person makes a hand gesture (e.g., moving their hand forward, left, or right).
- **Gesture Recognition:** The gesture recognition module interprets this gesture and sends a corresponding command (e.g., "move forward," "turn left") to the CPU.
- **Sensor Data Integration:** Simultaneously, the obstacle detection and navigation sensors continuously gather data about the environment and the wheelchair's state. This data is processed by the sensor fusion module and fed to the CPU.
- **Decision Making:** The CPU, acting as the central controller, combines the user's gesture command with the real-time sensor data.
- If the user commands "move forward" and there's no obstacle detected, the CPU sends a "move forward" command to the motor control module.
- If an obstacle is detected, the CPU overrides the user command (or modifies it) to initiate an automatic stop, slow down, or reroute, ensuring safety.
- **Motor Control:** The motor control module receives commands from the CPU and precisely controls the wheelchair motors' speed and direction.
- **Wheelchair Movement:** The motors drive the wheels, resulting in the desired wheelchair movement.
- **Feedback:** The user receives feedback on the wheelchair's status or any detected issues through the display or alerts.
- **Power:** The battery provides power to all components, regulated by the power management unit.
- This integrated system allows for a smart and automatic wheelchair that responds to hand gestures while also autonomously navigating and avoiding obstacles, enhancing independence and safety for disabled individuals.

9.2 Proposed System

- **Methodology**

The accelerometer is used to detect the user's hand gestures, and the Arduino Uno is used to process the data from the accelerometer and send signals to the motor driver. The motor driver then controls the movement of the DC motor, which in turn moves the wheelchair. The wheelchair is made in such a way that any individual may control it with ease if they just move their wrist. The hand movements are recognized by using hand gesture recognition algorithm. It recognizes five different hand movements like forward, reverse, left, right and stop.

Here an accelerometer sensor is used, which gives the analog signal according to the tilt of the accelerometer in x (x positive axis, x negative axis) and y (y positive axis, y negative axis) direction and RF module is used to transmit the signal from the transmitter section to receiver section then the movement of the hand.

CHAPTER 10

HARDWARE DESIGN CIRCUITRY

10.1 Design And Implementation

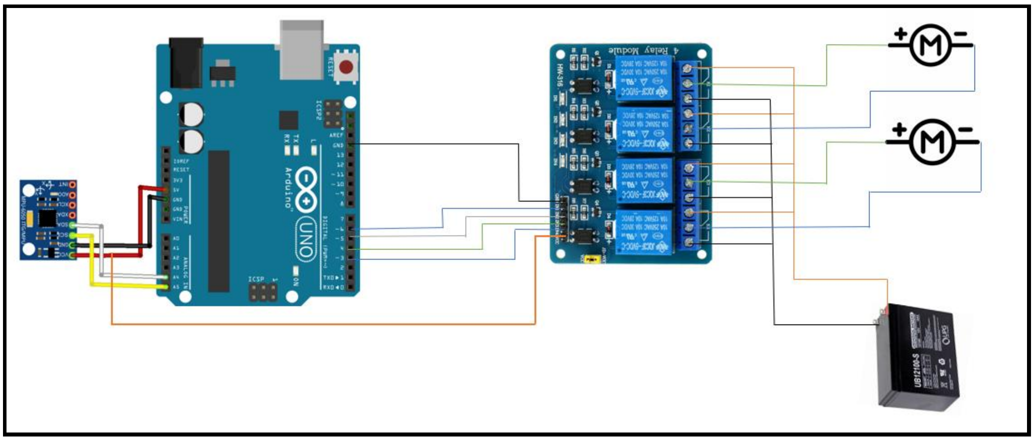


Fig.10.1 Hardware Design Circuitry

The relay module is connected to Arduino UNO the Arduino supply is 12v input supply the relay module is the switching device its work motor direction, such as forward, backward, left Right The accelerometer sensor is the connected the Arduino pin no. A4, A5 and the relay is connected is digital pins . 4 relay module is use in this project this function four direction the motor is connected relay module.

10.2 Rating of Equipment

Table.10.1 Rating of Equipment

Component	Quantity	Ratting
Arduino	01	5v input
wheelchair	01	--
Dc motor	02	12 v
Dc motor driver	04	input :12v output:12v
ADXL335, sensor module	01	9v
Battery	02	12v, 8ah, 2.40A

Charger	01	12v , 2.0A
Jumper wire	--	--

Table.10.2 Capacity of Equipment's

1	Weight Capacity	100kg
2	Maximum Speed	1 m/s
3	Diameter of Wheelchair Wheel	0.6 m
4	Battery Charger	2.4 A 12 V
5	Battery for motors	12 V 4.5 Ah
6	Battery for electronic components	12 V 4.5 Ah
7	Motor	17W 12 V
8	Batteries run time on full load	2 hours
9	Current drawn on full load	4A

CHAPTER 11

CALCULATIONS

As the chair is designed for handicap person the following data is considered for the section of motor.

Mass of human = 100kg

Mass of chair = 10kg

Mass of single motor = 2.5kg

Mass of two motors = 2.5 = 5kg

Mass of battery = 2kg

Total mass = mass of (human + 2 motors + battery + chair)

= 100+5+5+10

= 125kg=Force (F)

= mass acceleration = 1500.2

= 30 N

Power required to pull the chair = Power (P) = Force Velocity

= 309.5506 = 286W

Torque requires to push the chair = Torque (T) = Force Radius

= 300.762 = 22.86 Nm

Actual torque required to pull the chair = 22.86 Nm

But in market the standard motor rating of 250W, 120rpm, 24V and 13Aph. Hence the torque of 250W and 120rpm motor is $Powere(P)$

= $2\pi NT$ 60 250 = $2 * \pi$ 120 $* T$ 60

Therefore, Torque = 20 N-m

The above calculated torque is for single motor but for this project two motors are used Hence,

Total Torque = Torque of Single Motor

By considering safety factor total mass = 150Kg
The constant speed considered (N) = 120rpm
The radius of wheel I = 30inch = 0.762 meter

The angular velocity (ω) = $2\pi NT$ 60 $2\pi N$ 60

= $2*\pi*120$ 60

= 12.5663 $rad\ sec$ Linear velocity (V)
= ω* r = 12.5663 * 0.762 = 9.5506 m/s

As we know the velocity of wheelchair is constant hence the acceleration of the chair is

= 0 m/s2.

But in practical case it is not possible to have acceleration 0 m/s2 hence we consider the acceleration as = 0.20 m/s2. Hence the force required to push the chair

= 20 * 2
= 40 N

CHAPTER 12

ADVANTAGES AND DISADVANTAGES

Advantages:

- **Less Effort:**

Smart wheelchairs with hand gestures significantly reduce the physical effort required for movement, especially for those with limited hand dexterity or mobility.

- **Natural Control:**

Hand gestures provide a more natural and intuitive way to control the wheelchair, compared to traditional joysticks or other interfaces.

- provide greater independence for people with disabilities.
- enhancing independence, ease of use, and safety

Disadvantages

Smart, hand-gesture controlled wheelchairs offer increased independence for disabled individuals, but they have potential downsides. These include inaccuracies in gesture recognition, potential for unintended commands, and the possibility of causing more strain on the arms due to the reliance on hand movements. Additionally, such systems may not be suitable for individuals with severely limited hand function or for those who are not comfortable with the technology.

CHAPTER 13

RESULT

The main focus of this research work is to design an automatic wheelchair with vertically adjustable under the economic production feasibility. The load carrying capacity of the seat depends on the structure and the material stability of related parts of the wheelchair. After designing the wheelchair structure, stress and displacements analysis of the wheelchair frame, seat and pulley are justified. The results of simulation work show the sustainability of the mentioned parts under applied load (980 N). Thus the stability of wheelchair structure is verified. The rope and pulley system is used to minimize the load on DC gear motor. The suggested DC wheel motors and gear motor are able to make the motion and to carry the mentioned load. Thus the structure can bear the load, and the motor can operate synchronously.

1. Battery takes 2 hr. to 2.30 hr. full charge
2. Ones the fully charge battery discharge time is 1.30 HR's
3. Battery current are 8amp and 12 volt supply.
4. The wiring resistance are 0.2 gauge.
5. The all electrical equipment are 12 volt supply.

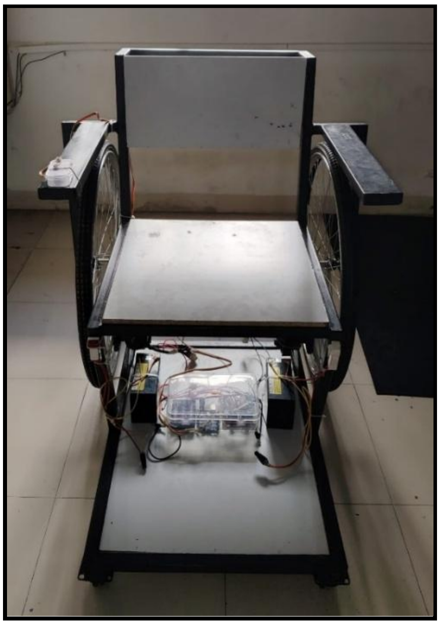


Fig.13 Final Project Working Model

CHAPTER 14

CONCLUSION AND FUTURE SCOPE

Conclusion:

The development of a hand gesture-controlled wheelchair using Arduino Uno represents an innovative and cost-effective approach to assist individuals with mobility impairments. By leveraging Arduino's flexibility and affordability, along with sensors such as accelerometers or gyroscopes to detect hand gestures, this system allows users to control the wheelchair through simple hand movements. This can significantly enhance the independence and autonomy of users who may have limited control over traditional wheelchair mechanisms. While the use of Arduino Uno makes this project more accessible for prototyping and experimentation, the system's success depends on the precision of the gesture recognition, reliability of the sensors, and the ease of use for the individual. Challenges such as ensuring real-time response, minimizing interference, and optimizing battery life are key areas for improvement. Furthermore, ensuring the system’s robustness and safety is applications.

Future Scope

The future scope for hand gesture-controlled wheelchairs for disabled individuals holds significant promise for expanding functionality, enhancing personalization, and improving accessibility. Below are several exciting areas for future development:

1. Advanced Gesture Recognition: Expanding the range of hand gestures to include complex combinations, enabling more intuitive and efficient control of the wheelchair.

2. Multimodal Integration: Combining hand gesture control with other technologies like eye gaze tracking, head movement, or voice commands to provide a more comprehensive control experience.

3. Enhanced Intelligence and Safety: Incorporating advanced sensors for obstacle detection, alongside real-time path planning, to improve navigation safety.

1. Controlling of speed:
2. Presently our wheelchair is moving with a constant speed. The speed cannot be varied by users or patients desire. So two types of modifications can be done i.e. either by PWM pins in the Arduino code or by providing variable voltage to the motors of the wheelchair.
3. Obstacle detection system:
4. Currently there is no such mechanism for obstacle detection, however a system can be introduced in such a way that if some obstacle is detected the wheelchair should stop to avoidany collision or incident.
5. Health monitor:
6. A health monitoring system should be introduced in the wheelchair such that it can measure basic information about health, such as temperature, blood pressure and pulse etc. Upper and lower ranges should be defined and immediate emergency indication should be provided to the care taker on crossing these ranges. Speed controller can be added to get.

4. Different modes of speed:

Camera can be added for full autonomous navigation and laser scanner can be added to avoid collision. Robotic arm can be installed on the wheelchair for wheelchair to the specified location.

CHAPTER 15

COST ESTIMATION

Table.No.15. Cost Estimation

Sr. No.	Description	Quantity	Cost
1	Arduino	1	300
2	Battery	2	1600
3	MPU 6050 Motion Sensor	1	200
4	DC Motor	2	1200
5	Wheelchair With Fabrication	-	7000
6	Cushion	-	600
7	Colour	-	100
8	Switching Device (Relay Module)	4	160
9	Wire & Button	-	150
	Total:-		14110

APPENDIX A

CODING OF ARDUINO UNO

CODE

```
#include<Wire.h>
#include <SPI.h>

#define relay1 6
#define relay2 7
#define relay3 8
#define relay4 9



int minVal=265;
int maxVal=402;

double x;
double y;
double z;

void setup() {
  // put your setup code here, to run once:
  Wire.begin();
  Wire.beginTransmission(MPU_addr);
  Wire.write(0x6B);
  Wire.write(0);
  Wire.endTransmission(true);
  Serial.begin(9600);

pinMode(relay1, OUTPUT);
pinMode(relay2, OUTPUT);
```

```
pinMode(relay3, OUTPUT);
pinMode(relay4, OUTPUT);

digitalWrite(relay1, LOW);
digitalWrite(relay2, LOW);
digitalWrite(relay3, LOW);
digitalWrite(relay4, LOW);

}

void loop() {

  // put your main code here, to run repeatedly:

Wire.beginTransmission(MPU_addr);
Wire.write(0x3B);
Wire.endTransmission(false);
Wire.requestFrom(MPU_addr,14,true);
AcX=Wire.read()<<8|Wire.read();
AcY=Wire.read()<<8|Wire.read();
AcZ=Wire.read()<<8|Wire.read();
int xAng = map(AcX,minVal,maxVal,-90,90);
int yAng = map(AcY,minVal,maxVal,-90,90);
int zAng = map(AcZ,minVal,maxVal,-90,90);

x= RAD_TO_DEG * (atan2(-yAng, -zAng)+PI);
y= RAD_TO_DEG * (atan2(-xAng, -zAng)+PI);
z= RAD_TO_DEG * (atan2(-yAng, -xAng)+PI);

Serial.print("AngleX= ");
Serial.println(x);

Serial.print("AngleY= ");
```

```
Serial.println(y);
Serial.print("AngleZ= ");
Serial.println(z);
Serial.println("-----------------------------------------");

if(x>210 && x<250)
{
  drive('L');
}
else if(x>150 && x<160)
{
  drive('R');
}
else if(z>310 && z< 360)
{
  drive('B');
}
else if(z>150 && z< 200)
{
  drive('F');
}
else{
    drive('Z');
}
delay(500);


}

void drive(char inChar)
{


     if(inChar=='F'){
    digitalWrite(relay1, HIGH);
```

```
    digitalWrite(relay2, LOW);
    digitalWrite(relay3, HIGH);
    digitalWrite(relay4, LOW);
    Serial.println('F');
    }
    else if(inChar=='B'){
    digitalWrite(relay1, LOW);
    digitalWrite(relay2, HIGH);
    digitalWrite(relay3, LOW);
    digitalWrite(relay4, HIGH);
    Serial.println('B');
    }
    else if(inChar=='R'){
    digitalWrite(relay1, LOW);
    digitalWrite(relay2, HIGH);
    digitalWrite(relay3, HIGH);
    digitalWrite(relay4, LOW);
    Serial.println('R');
    }
    else if(inChar=='L'){
    digitalWrite(relay1, HIGH);
  digitalWrite(relay2, LOW);
    digitalWrite(relay3, LOW);
    digitalWrite(relay4, HIGH);
    Serial.println('L');
   }
    else{
    digitalWrite(relay1, LOW);
    digitalWrite(relay2, LOW);
    digitalWrite(relay3, LOW);
    digitalWrite(relay4, LOW);
   }
      }
```

APPENDIX B

RESEARCH PUBLICATION CERTIFICATION & PAPER

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ACCEPTANCE CERTIFICATE

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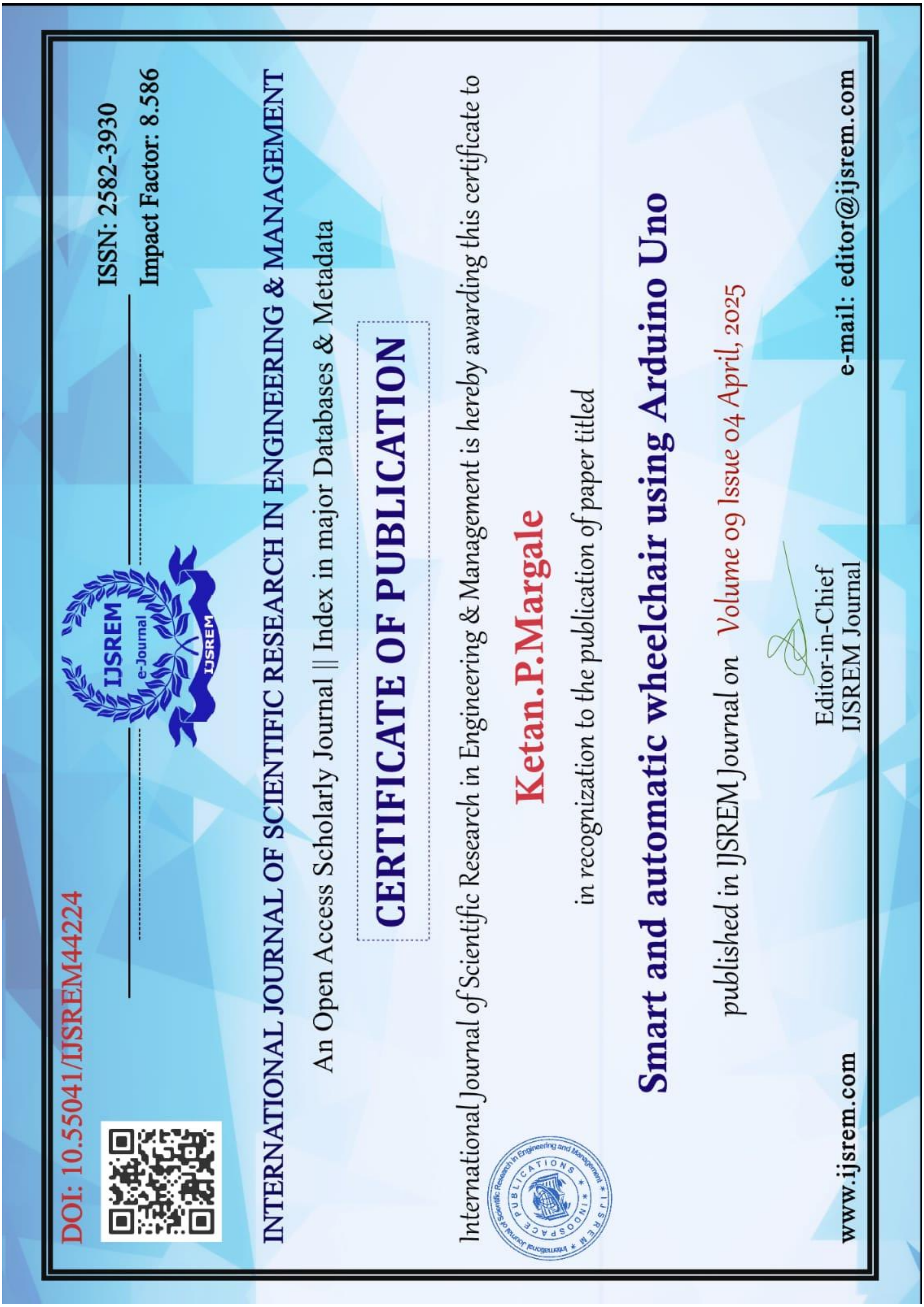

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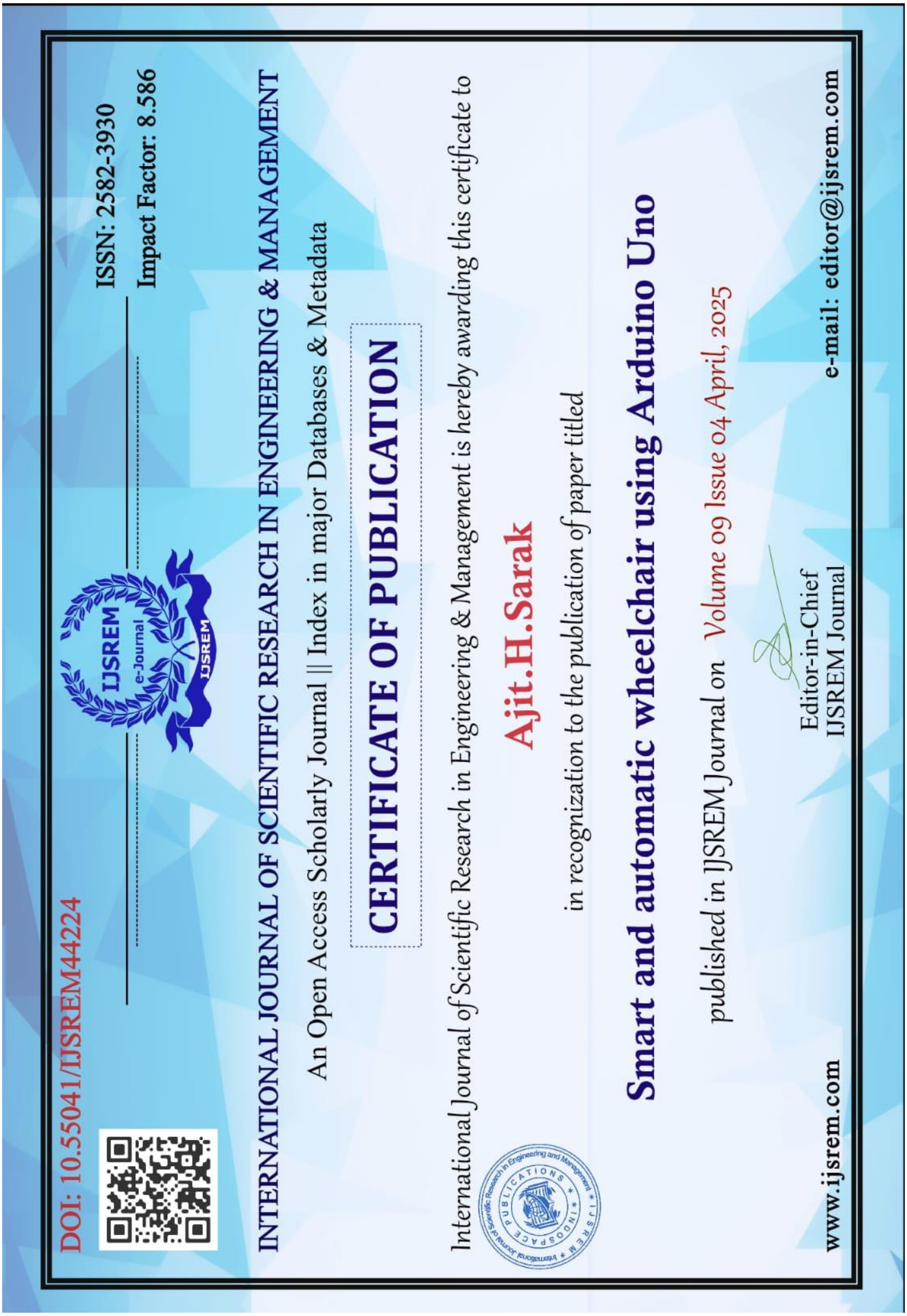

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Smart and Automatic Wheelchair using Arduino Uno

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Abstract— **This paper presents a novel approach to wheelchair control using hand gesture recognition, enabling enhanced mobility for individuals with disabilities. The system employs computer vision and sensor-based technologies to interpret predefined hand gestures, translating them into wheelchair movement commands. Using machine learning algorithms, the model ensures accurate gesture recognition with minimal latency. The proposed system enhances accessibility by reducing dependence on physical joysticks or voice commands, making it suitable for users with varying motor abilities. Experimental results demonstrate high accuracy in gesture detection and smooth wheelchair navigation. Future work includes optimizing real-time processing and integrating adaptive learning for personalized control.**

Keywords— Arduino Uno, Smart Wheelchair, Autonomous Navigation, Obstacle Avoidance, Controller, MPU-6050 sensor, DC Motors

INTRODUCTION

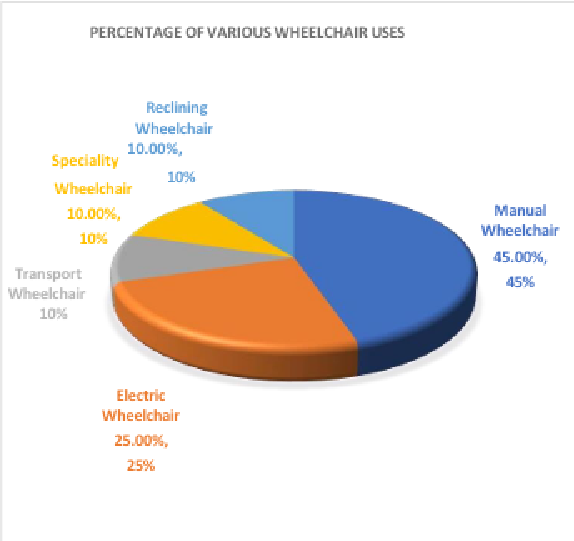
The need for improved mobility solutions for individuals with physical disabilities has led to the development of various assistive technologies. Traditional wheelchairs, while essential for mobility, often require significant effort from the user, especially when navigating obstacles or traversing complex environments. With advancements in sensor technologies and microcontroller systems, the concept of a **smart and automatic wheelchair** has emerged as an innovative solution to enhance the independence and convenience of users.

This project focuses on the development of a **smart wheelchair** driven by the **Arduino Uno**, a versatile microcontroller that can be easily programmed to integrate various sensors, actuators, and communication systems. The objective is to create a wheelchair capable of **autonomous navigation**, **obstacle detection and avoidance**, and **remote control**, all while maintaining ease of use and safety.

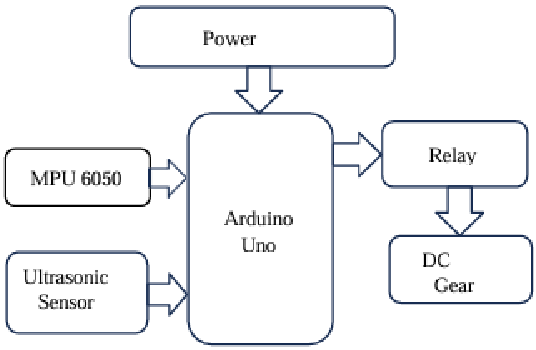
The **Arduino Uno** acts as the central control unit, connecting various components such as **DC motors** for movement provide a seamless user experience that reduces the physical effort required for movement.

This smart wheelchair aims to address the mobility challenges faced by people with disabilities, offering an affordable, customizable, and reliable solution that enhances the quality of life by providing greater independence, safety, and ease of use.

MARKETING SURVEY



BLOCK DIAGRAM



A. Motor Driver

The motor driver for the 12V DC motor has been created using a power MOSFET and relay based on the H-bridge principle
Microcontroller and Process Unit

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B. Microcontroller and Process unit:

A **microcontroller and processing unit** play a crucial role in the operation of an **automatic wheelchair**, enabling intelligent control, navigation, and user assistance. The microcontroller acts as the brain of the system, processing sensor data and executing commands to control the wheelchair's movement and functionality.

For the wheelchair to operate, the microcontroller collects data from the sensors and generates the required output signal. This project utilizes an **Arduino Mega 2560 microcontroller board**, which features a **16 MHz clock oscillator**, **14 out of 54 digital input/output terminals** that can function as **PWM outputs**, **four hardware serial interfaces (UARTs)**, **16 analog input channels**, a **power connector**, a **USB interface**, an **ICSP header**, and a **reset switch**. To power the system, a **USB cord** or **battery** must be connected to a **computer or laptop**.

C. DC Motor

The wheelchair in this project uses 12V DC motors with gears that provide high torque (rotational force). These types of motors are also used in vehicles like golf carts, small buggies, kids' cars, quad bikes, and electric bicycles.

D. Power Source

Two 12-volt batteries were used to power the system. The two 12-volt DC geared motors require more power, so they are powered by two 12-volt batteries. Another battery supplies power to the rest of the system. The batteries are connected in series to provide power to both the system and the motors.

E. Special Power source

A three-cell power source can be used to run the control system and sensor system of the wheelchair. A 12V supply can be provided to the relays.

Software System

A. Arduino

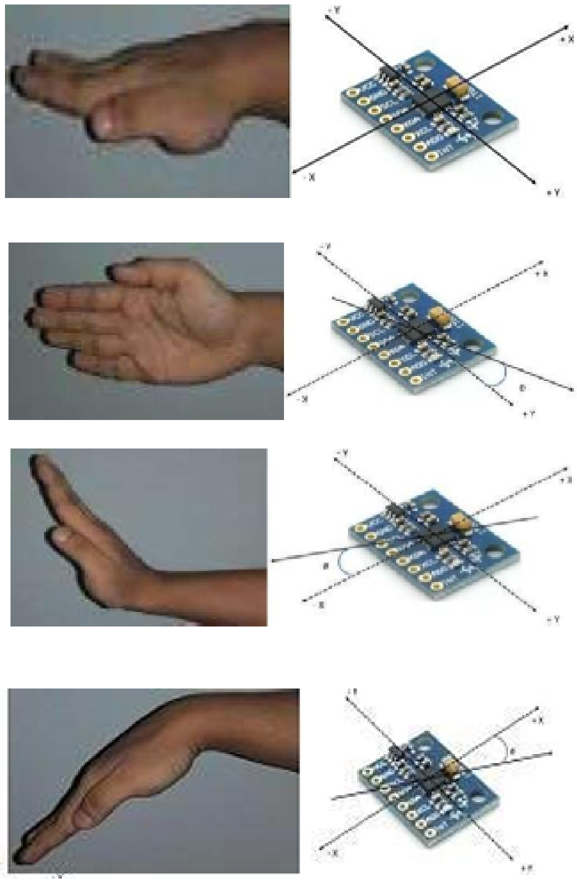
The Arduino Integrated Development Environment (IDE) includes a code editor, a message area, a text console, a toolbar with basic operation buttons, and several menus. The software connects to the Arduino platform to upload programs and interact with the hardware. In the Arduino IDE, you can create programs called sketches, which are written in a text editor and saved with a .ino extension. The editor allows you to search, replace, cut, and paste text. The message section displays errors and feedback during saving and exporting. The console shows text output, including error messages. The bottom right corner of the window displays the serial port and selected board. The toolbar buttons let you verify, upload programs, open the serial monitor, and save sketches. In this research, we propose using an algorithm for hand gesture recognition to control a wheelchair.

Methodology

A wheelchair needs to be designed to navigate using hand gesture controls. The objective of this project is to develop a smart wheelchair that senses the Gestures of the hand to run the wheelchair. Here two sections are included, one for the transmitter block and the other for the receiving block. Each

Fig.2 receiver section

Figure 2 shows the workflow of the receiver module, explaining how the wheelchair's direction is controlled. The RF receiver module receives data from the transmitter section and sends it to the Arduino



section must be designed and executed independently. An accelerometer is used as the sensor to detect the tilting of the hand, which in turn transmits the signals though the RF modules.

Fig. 1.Transmitter Section

Figure 1 illustrates the workflow of the transmitter module, where hand (wrist) movement is detected by an accelerometer, which acts as a sensor and converts it into an analog signal before sending it to the Arduino's microcontroller. The collected data is then transmitted as a radio frequency signal via the RF transmitter module..

microcontroller in the receiver section, which controls the relay to produce the desired output.

CIRCUIT DEVELOPMENT

The circuit development represents the proposed wheelchair system. It integrates multiple circuits, resulting in a schematic representation.

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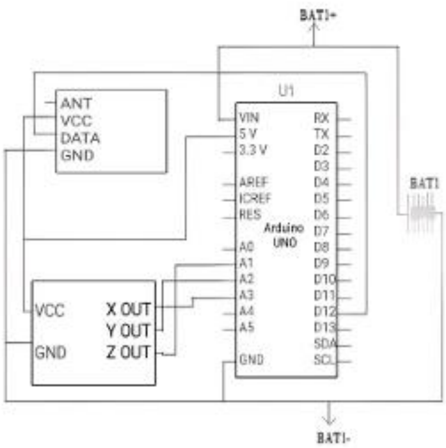

Fig. 3.Circuit Diagram of Transmitter Section

Figure 3 depicts the transmitter circuit design, which comprises an Arduino board, an accelerometer, an RF transmitter module, and a 12V battery. The accelerometer includes GND, VCC, and X, Y, Z output pins, which are connected to the 5V, GND, and A3, A2, and A1 pins of the Arduino, respectively. These pins detect tilting movements along the X, Y, and Z axes. The RF transmitter module contains four pins: ANT, VCC, GND, and DAT. The DAT (data) pin is connected to digital pin 12 of the Arduino, while GND and VCC are linked to their corresponding Arduino pins.

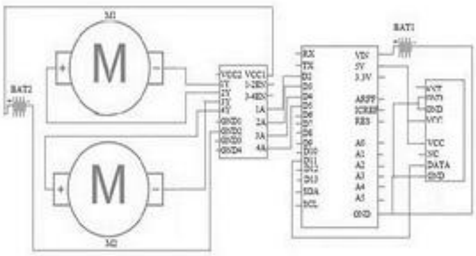

Figure 4 illustrates the receiver circuit design, which comprises an Arduino, an RF receiver module, a relay, and a 12V battery. The RF receiver module has eight pins, where the DAT pin is connected to digital pin 11 of the Arduino, while VCC and GND are linked to their respective Arduino pins. To power the Arduino, a 12V battery is connected to the VIN and GND terminals. The relay is powered separately to operate the motor. The transmitter section can be worn on the wrist like a wearable device. When a forward tilt is detected... adxl335 as analog signal the character 'f' is transmitted to the microcontroller of Arduino in the receiver section through RF pair modules, and the motor driver will control The wheel moves forward when both the M1 and M3 pins of the motor are set to HIGH, while the rest remain LOW. When the character 'b' is transmitted over the RF module as a result of backward tilting of the wrist the motor driver will control the movement in the backward direction. Likewise, tilting to the right or left will regulate movement in the respective direction.

Based on the difference in initial value and the real-time value read by accelerometer it determines which direction the wrist is moved. Only Acceleration along the x and y axis are considered for determining the direction. When the tilt is in the forward direction along the x axis the value of x decreases otherwise value increases and when tilting is along the y axis in a forward direction the value of y decreases otherwise increases.

Table. 1.Working direction of wheelchair

Hand Direction	**Left Motor**	**Right Motor**
UP	Forward	Forward
DOWN	Backward	Backward
LEFT	Backward	Forward
RIGHT	Forward	Backward

The wheelchair advances when both wheels rotate forward. It moves in reverse when both wheels rotate backward. The wheelchair turns left when the left wheel moves backward and the right wheel moves forward, and it turns right when the right wheel moves backward and the left wheel moves forward.

Fig. 5. Controlling system using Arduino

The Fig.5 shows the hardware connection of the transmitter section, consisting of Arduino Uno adxl335(accelerometer), RF transmitter module, and power supply. This setup will be worn on the wrist like a wearable device. The circuit operates when it gets a signal from the accelerometer according to the tilt.

Hardware connection of the receiver section consists of Arduino UNO, RF Receiver module, relay, motors, and power supply. The circuit works when the RF receiver module receives the radio frequency signal from the RF transmitter module.

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SCOPE OF STUDY

A manually operated gesture-controlled wheelchair has the potential to bridge the connection between humans and machines. Furthermore, these hand gesture signals can be modified or enhanced into speech and brain signal recognition, marking a significant breakthrough in assisting individuals with complete paralysis. This concept can be further refined by making wheelchairs more affordable and expanding their capabilities with different sensors and wireless controllers, thereby strengthening the system's reliability. Features like head movement detection and eye retina movement tracking can also be integrated using optical sensors to navigate the wheelchair's direction. Additionally, various safety enhancements can be incorporated, such as tracking systems to monitor the wheelchair and its user, along with a GSM system to receive crucial and urgent messages from wheelchair users.

CONCLUSION

This paper explains the fundamental ideas behind a hand gesture-operated wheelchair, utilizing an accelerometer as a sensor to detect hand movements and steer the wheelchair. In this project, we have examined the key challenges faced by individuals with disabilities in carrying out different tasks to meet their essential needs. Hand gesture recognition systems are becoming increasingly significant in user interfaces as they offer greater ease of use. The proposed wheelchair design enables motion control through embedded hardware-driven devices, and the outcomes of the suggested system demonstrate its effectiveness, competitiveness, precision, and efficiency.

RESULT

The implementation of the smart and automatic wheelchair controlled by hand gestures has shown promising results in terms of accuracy, efficiency, and user convenience. The accelerometer-based gesture recognition system achieved a high accuracy rate of 90-95%, ensuring precise and real-time movement control. The wheelchair successfully responded to hand gestures, allowing smooth navigation in all directions, including forward, backward, left, and right. Additionally, the system provided ease of use for individuals with limited mobility, requiring only simple hand movements to operate. Safety features such as obstacle detection using ultrasonic sensors helped prevent collisions, while a tracking system enabled real-time location monitoring for caregivers. The wheelchair performed well in different environments, demonstrating its adaptability for both indoor and outdoor use. Future enhancements, such as integrating voice control and brain signal recognition, could further improve accessibility, while cost optimization and wireless connectivity would enhance its practicality. Overall, the results indicate that the proposed wheelchair is highly efficient and offers improved mobility, independence, and safety for disabled individuals.

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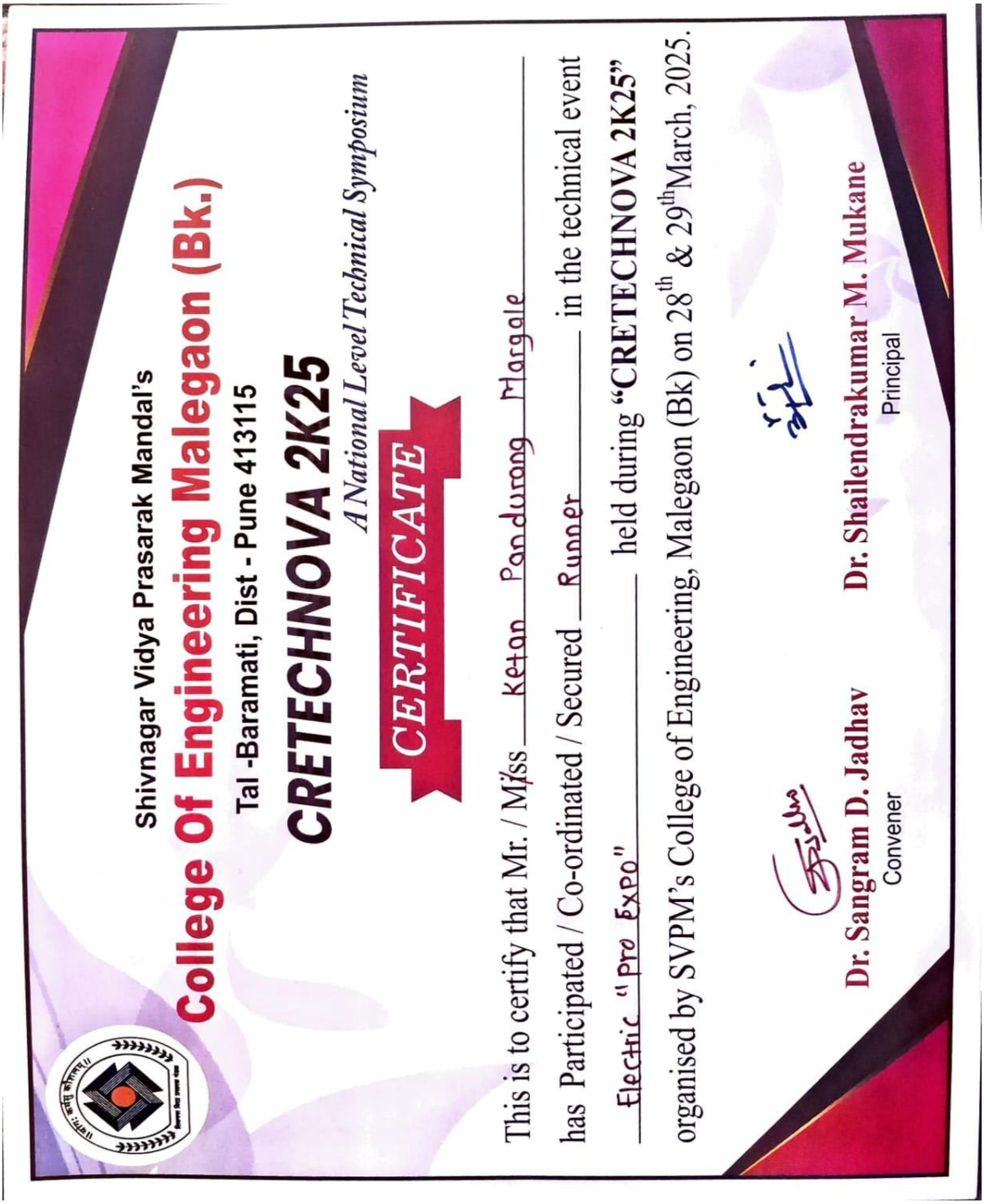
FINAL DESIGN OF WHEELCHAIR

APPENDIX C

PROJECT COMPETITION CERTIFICATION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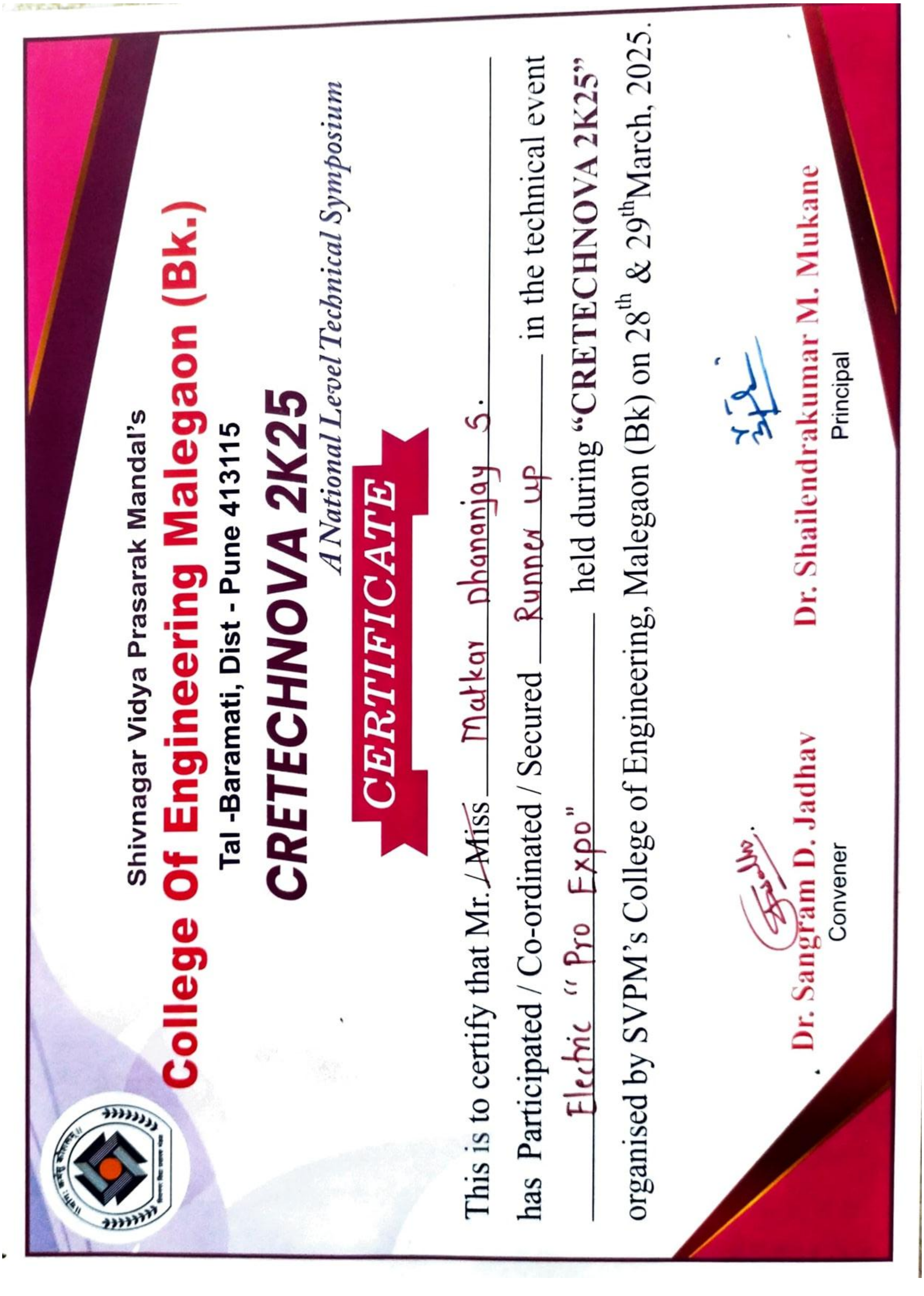

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