

# Accelerometer Based Wheelchair for Physically Disable People

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**ABSTRACT:** In our country of 1.3 billion populations, still having more than 1% population of elderly or disabled people, which need support for personal mobility [6]. Our project has a goal to meet their requirement of mobility with smart technology. The problem with them is that their legs bones get weaker or get a break due to an accident and cause pain while moving, so we are using hand or head tilt motions to move a wheelchair. The tilt is sensed by accelerometer and equivalent voltage is developed, that voltage is sensed by Arduino and converts them into an equivalent signal for the relay. Based on Arduino signal, the relay drives the corresponding motor. The motion of motor causes the wheelchair to move in a certain direction. This gives features to the user to control the motion of wheelchair by hand or head tilt. We have used the ultrasonic smart sensor to control the braking of wheelchair based on the distance between the wheelchair and obstacles. If the difference distance is less than 20 cm then Arduino send braking signal to relay and motor halt, this decrease the speed and after 2-3 second the wheelchair finally get stop. This helps the user from major and minor accident on road, with help of smart techniques. LCD shows the difference distance for forward and backward on display for user. This all features make the wheelchair simple, safe and smart for the user.

**KEYWORDS:** Accelerometer; Ultrasonic Sensor; Braking Of Wheelchair; Smart Wheelchair

## I. INTRODUCTION

In today fastest growing technology in the world, still, development in devices for disabled people are less. There is 1% of the population which is facing the problem of personal mobility and there is less manufacturer company for making devices with smart features for them. The personal mobility problem can be solved in a good way by smart wheelchair [2], but still, there is a problem of the cost of the wheelchair. The cost of an automatic wheelchair in the market is around 2-5 lacks based on features. So everyone who needs support cannot prefer such costly wheelchair. So we came with the idea to make a smart wheelchair with innovative features like an automatic seat belt, automatic braking, manual plus accelerometer controller and automatic side light. We have developed a wheelchair, which turns on based on seat belt connectivity; until the user is not wearing a seat belt the wheelchair will not turn on. When the user wears seat belt, the system is on and indicated by LCD glowing and displaying "WELCOME" message and then ask the user for mode selection. Basically, in our wheelchair, there are three modes of operation, the first mode is accelerometer control, second is manual mode [1], third is accelerometer with braking mode. In accelerometer mode Arduino gets input data from adxl 335, for manual mode, Arduino gets input data from gloves based switches and for accelerometer with braking Arduino get input from adxl 335 and ultrasonic sensor. Adxl 335 is an accelerometer sensor and it has 3 axis tilt detection capability, but in our project, we are using 2 axis, x, and y-axis for tilt detection of hands. This tilt is converted into voltage range of 1.4v to 1.8v and the reference voltage of 1.6v [8]. Arduino has been programming in if else statement to detect these voltage change with the axis and convert them into relay signal. Four motors have been interfaced with 4-channel relay. The Arduino send a signal to relay for driving the 4 motor for motion in the corresponding direction. Manual switches are used if a user is not satisfied with accelerometer mode. Each switch corresponds to direction like RIGHT, LEFT, FORWARD and BACKWARD. When a switch is a press then Arduino sense it and correspondingly generate a signal for relay to make a motion in that direction. The ultrasonic sensor is used to measure difference distance between the wheelchair and its nearby obstacles with help of Arduino [9]. These distances are stored in Arduino and displayed on LCD 16\*2 for the user. When the difference distance is less than 20 cm than Arduino generates a braking signal to relay and it stops the motion of motor and finally the wheelchair is

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stopped for the safety of user from the major or minor accident. When the movement of the wheelchair is along a left or right direction, then Arduino generate a signal to the sidelight and it starts glowing and indicating that user wants to turn left or right direction and alert the backsides vehicle that wheelchair wants to turn right or left direction. These features make our wheelchair simple, safe and smart medium for physical mobility on the road or home. This all features in our wheelchair are making a max cost of 15 thousand and all user can use such a smart device with low budget also.

## II. RELATED WORK

### A. LITERATURE SURVEY

Electronics have dramatically altered the world as we know it. One has simply to compare the conveniences and capabilities of today's world with those of the late 1900s. This module documents the advantages of this project over the conventional systems and its importance in miniaturizing the devices.

#### 1] Existing technologies[6]

There is much research are done and, several different solutions have been developed, such as SENARIO, VAHM, Rolland, SIAMO, Wellesley, and Omni-wheeled platform. The prominent companies that develop wheelchairs are Invacare, Permobil AB, and Ottobock.

##### 1.1] Invacare power wheelchair [3]

The high-performance Invacare TDX SP Power Wheelchair boasts superior ride quality, quieter chassis and built-in technologies that make all the difference in challenging conditions. It has TrueTrack motors or G-Trac Technology available to keep wheelchair tracking straight, also quiet stability lock provides stability and shock absorption while in-motion and Traction Control Design for climbing in reverse over obstacles up to 1".

##### 1.2] Permobil F5 VS wheelchair [4]

The F5 Corpus VS is a compact, powerful and stable front wheel drive power wheelchair combined with the best seating system. The active user can get support by seating system for clinical, functional and lifestyle needs. The function of seat plus an innovative new way of standing, allowing you to choose from two positions, Sit-to-stand or Lay-to-stand. It has max. the speed of 10 km/h, max. user weight 136 kg, turning in corridor 1140 mm and obstacle capability 70–100 mm.

Our project has all the advantages of the commercially available wheelchairs at the same time making it portable along with hand based accelerometer at the same time making it cost effective.

#### 2] Conventional method

Electronic systems mainly consist of sensors, signal processing units, software that translates user's commands into medical device actions. These solutions are dubbed robotic wheelchair. The user can control the device via touchscreens and voice commands. Besides these, wheelchair control is also possible by eye movement and electromyography sensors. Such interfaces are Tele thesis and Eagle Eyes.

#### 3] Advanced system

The advanced system that we have developed consists of an Arduino Nano, hand based switch, motor driver circuit and an accelerometer sensor (ADXL335). Power consumption is less as compared to other systems which make it a 'Low Energy' system. Interfacing is very easy and we can connect analog devices directly without any extra circuitry and use them. In this system, an Arduino system that enables standard electric wheelchair control by hand motion and the prototype consists of the digital system (an accelerometer and an Arduino). The accelerometer is used to gather hand motion data. To process the sensor data, an algorithm is implemented using an Arduino IDE software[5]. The output of the digital system is connected to Relay circuit, which is used to position the wheelchair in accordance with the user's command. Sensor data is processed by the algorithm, implemented within the Arduino Nano. Thus, user hand motion is translated into electric wheelchair position.

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## B. BLOCK DIAGRAM

The block diagram consists of the sensor unit, power supply, Arduino, relay, LCD and motors as shown in fig 1. Arduino has inputs from automatic seat belt mechanism for detection of the seat belt is worn by the user or not. When the user wears seat belt, Arduino sense and turns on the system. Then the welcome message is displayed and the user asked to select the mode of operation. There are three modes of operation and are selected by manual switches. Once the mode is selected then it starts sensing the change in the output of accelerometer sensor and correspondingly changes the input signal for relay by Arduino. Based on Arduino signal, the relay drives the motor in particular direction till the Arduino change the relay input [7]. The ultrasonic sensor is used to measure the distance of obstacle near the wheelchair, this information is displayed on LCD and store in Arduino for braking. When the distance is less than 20 cm, Arduino generates braking signal to relay and it stops movement of the wheelchair. There is two power supply used for Arduino and motor supply, Arduino has a supply of 5v and motor has a supply of 24v.

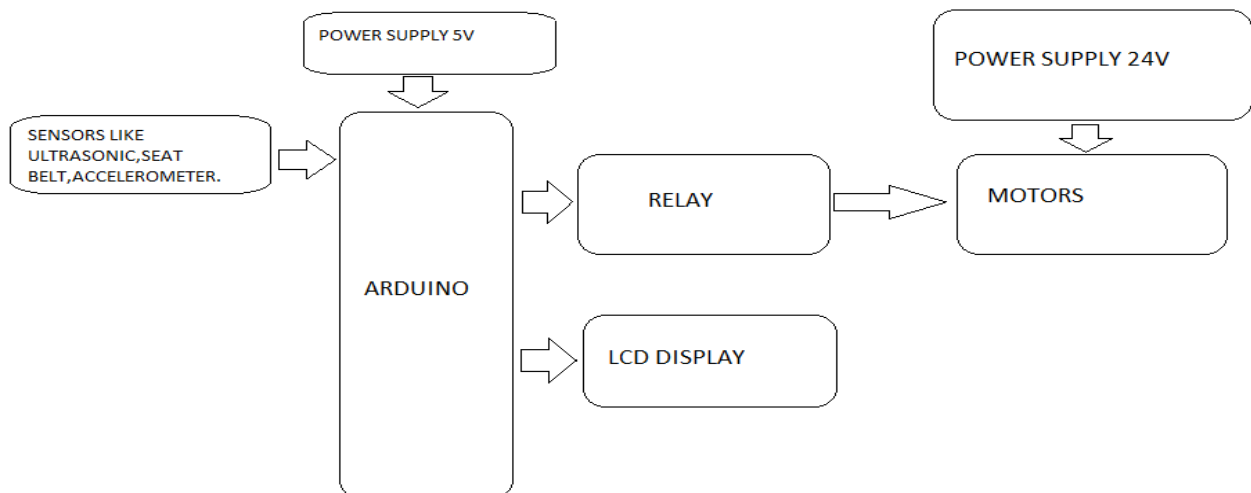


FIG 1. BLOCK DIAGRAM

## III. MECHANICAL WHEELCHAIR ASSEMBLY

### A. BOTTOM FRAME DEVELOPMENT

Development of wheelchair start from mechanical frame assembly. An acrylic or wooden board can be used for the bottom frame of the wheelchair. Then the board is cut in frame size of 24 \* 36 inches, 24 inches is length and 36 inches are the width of the frame as shown in fig 2.

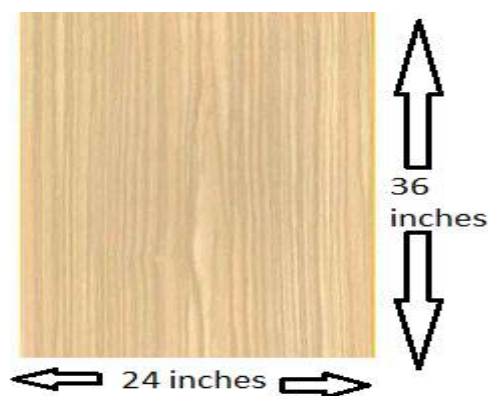


FIG 2.PLY BOARD

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### B. MOUNTING OF MOTOR ON FRAME

Motor are mounted on frame board with help of L bracket. By leaving space of 2 inches on length side and drill hole for mounting the motor. When drilling is over then we place the L bracket and starting putting a screw and then fix the motor by its screw on shaft body. After that wires are extended by joining other extension wire and connecting it to relay output as shown in fig 3.



FIG 3.MOTOR MOUNTING

### C. MOUNTING OF CHAIR ON FRAME

A four leg chair is used to make the system more stable during operating on the road. These legs edge is drilled with hole and place on frame and drilling is also done on the frame. After that chair is fixed on a frame by screw bolt as shown in fig 4.



FIG 4.CHAIR MOUNTING

### D. MOUNTING POWER SWITCH AND LCD ON HAND REST PAD OF CHAIR

A power supply switch is used to provide supply to the motor and if any short circuit happen then turn off the system supply by this switch. These switch and LCD is firstly fixed on wooden board and then fix on rest pad of chair by drilling hole and then fixing it by a screw bolt as shown in fig 5.



FIG 5.MOUNTING OF LCD AND SWITCH



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### E. MOUNTING OF SEAT BELT MECHANISM

For building seat belt mechanism, aluminum handle section is used and bend over an edge. Two handles are used and a nylon belt is used and fixed at Chair shoulder position. The handle is fixed at seating edge of the chair as shown in fig 6.

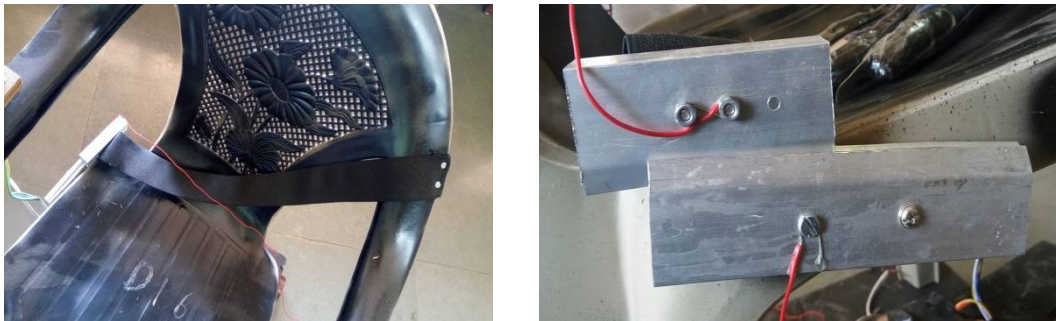


FIG 6. SEAT BELT MECHANISM ASSEMBLY

### F. MOUNTING OF ULTRASONIC SENSOR

Two ultrasonic sensors are used for forward and backward distance measurement with automatic braking, when obstacle is detected in path of travelling. They are fixed at center edge of wheelchair with screw as shown in fig 7.



FIG 7. MOUNTING OF ULTRASONIC SENSOR

### G. MOUNTING OF LEG REST PAD

Two wooden boards of size 2 \* 6 inches are used for leg rest pad. These are fixed on wheelchair edge in v shape position as shown in figure 8. These boards are used for resting of legs, when long distance travelling is done to make comfortable sitting posture.



FIG 8. MOUNTING OF LEG REST PAD

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## IV. WHEELCHAIR HARDWARE IMPLEMENTATION

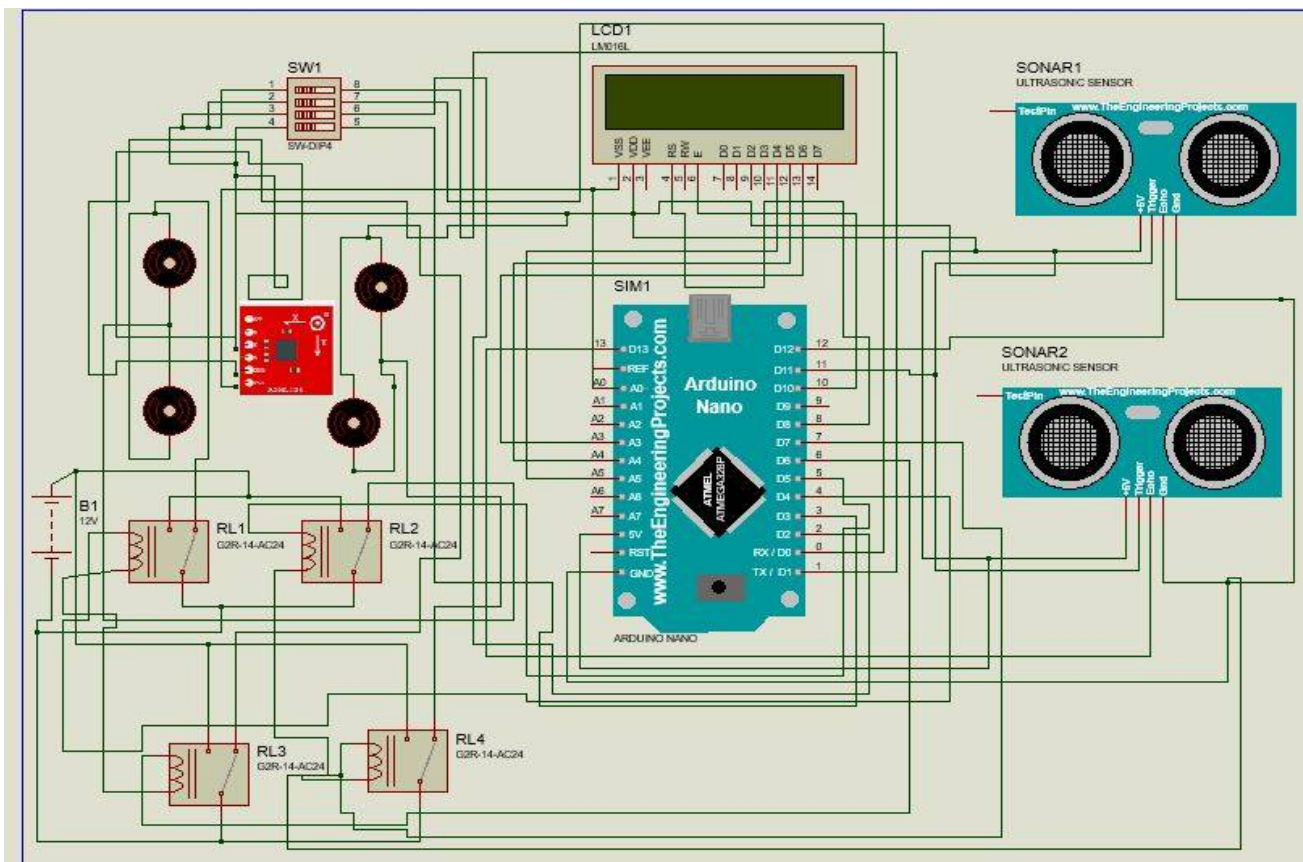
Automatic seat belt and glove based button used short circuit concept and connected to 5v. The LCD is connected to Arduino Nano [5] in 4-bit interfacing mode and it will display a welcome message on start of wheelchair. After that mode selection of wheelchair is done using gloves button. The gloves is connected to 0,1,2,3 pin of Arduino and accelerometer is connected to A0, A1 of Arduino. When accelerometer is tilted, the acceleration is converted to X axis and Y axis voltages. Based on it the movement of wheelchair is done. Direction of acceleration is converted to motion of wheelchair with a help of relay connected to 4,5,6,7 pins of Arduino and it is connected in a manner that the signal is converted into 4 direction motion of wheelchair like forward, backward, left, right. DC motor is connected directly to relay at no connection, open connection, common terminal. Ultrasonic trigger pin is connected to pin no 13 of Arduino and echo is connected to 10,11 pin of Arduino. It is used for automatic braking when obstacle is detected within a range of 20 cm and it displays the distance on LCD. LCD data pins are connected to A2, A3, A4, A5 and enable pin is connected to 9 pin, register select is connected to pin no 10 as shown in fig 9.

FIG 9.CIRCUIT DIAGRAM

## V. ALGORITHM

Algorithm flow operation of wheelchair are done in following manner, as shown in fig 10.

1. Start by connecting power supply of 24 V and 5 V.



2. Connect the Seatbelt, if not connected then go to 16.
3. Check if the accelerometer is in stable condition?
4. Switch on motor supply switch.
5. Select the mode of operation by glove button, the processor execute on 6, 9, 12 and if not selected then go to 16.
6. Mode 1 selected, then

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7. Move the accelerometer in the direction we want to move the wheelchair.
8. Accelerometer moves or tilt his position thus gives the analog signal to Arduino and convert it in appropriate digital level, so as to move the motors of the wheelchair.
9. Mode 2 selected, then
10. Based on glove button is pressed in the direction, we want to move the wheelchair.
11. Arduino senses change in glove switch mode on/off and convert it in appropriate digital level, so as to move the motors of the wheelchair.
12. Mode 3 selected, then
13. Move accelerometer in the direction we want to move the wheelchair.
14. Accelerometer moves or tilt his position thus gives analog signal to Arduino and convert it in appropriate digital level, and check for ultrasonic difference distance.
15. Ultrasonic sensors are used to detect the obstacle. If any obstacle is detected then it gives the signal to Arduino and it apply braking operation and will stop the motors.
16. The wheelchair is in the rest position.
17. Remove the Seatbelt.

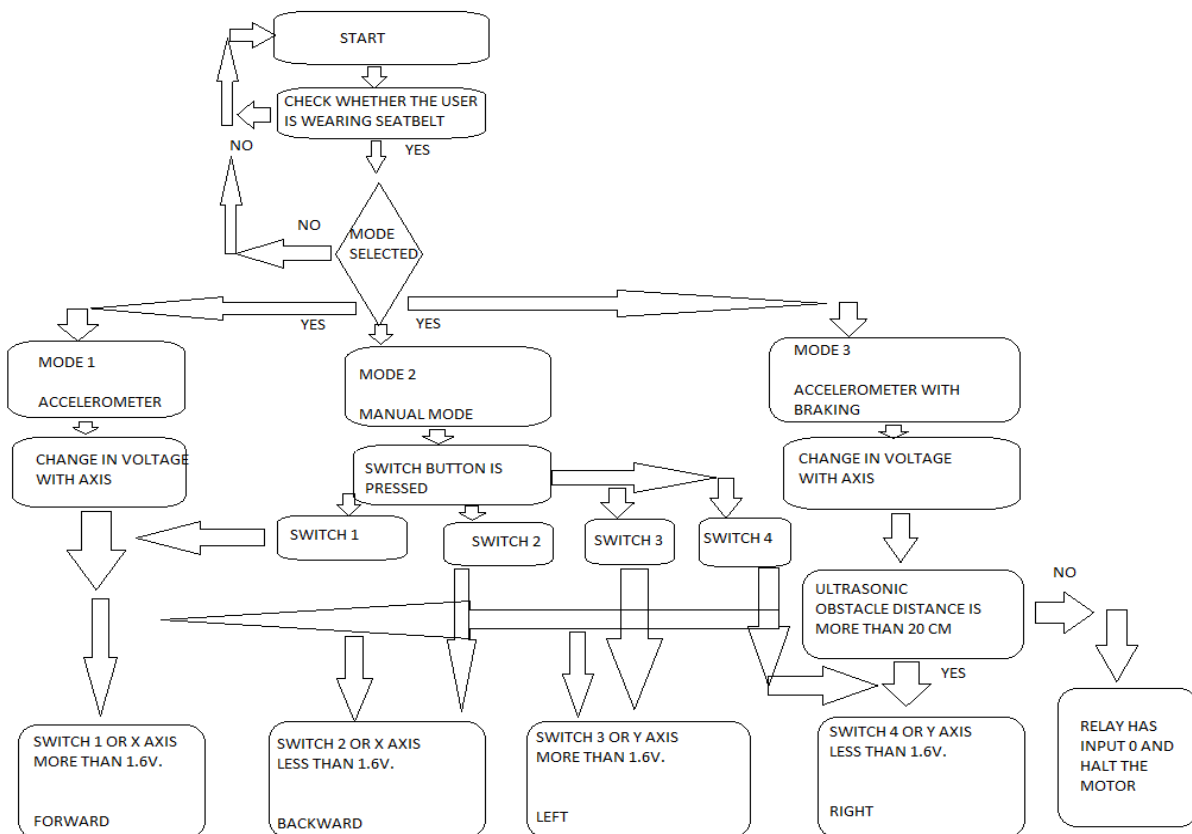


FIG 10. ALGORITHM OF WHEELCHAIR

## VI. RESULT AND DISCUSSION

Efforts were made to make the system compact and wearable. As seen in fig 11, minimum wires have been used and this reduces the system complexity. The Arduino is the heart of the system and therefore needs to be programmed properly. Various gestures were tested and the outputs were studied to check if the right signal is sent to relay. The wheelchair model works on the switching relays & motors with accelerometer sensor placed on patient's hand. Arduino



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with the accelerometer is used to send tilt signal to the wheelchair in term of motion i.e., left or right, front or back. Here relay acts as a switching circuit. According to the relay operation, the wheelchair will move in that corresponding direction.



**FIGURE 11. GLOVE BASED AND ACCELEROMETER MODE**

The proper interfacing of all components according to the circuit diagram gives us hardware circuitry for prototype wheelchair with hand-based gesture and glove based control with automatic braking for the safety of patient's.



**FIGURE 12. PROTOTYPE OF WHEELCHAIR**



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## VII. CONCLUSION

We had implemented automatic wheelchair, which has various advantages. It is operating in three different modes i.e. manual mode, accelerometer and accelerometer with braking mode. Also, there are two ultrasonic sensors which increase accuracy of the wheelchair and provide automatic braking. This Wheelchair is economical and can be affordable to common people. With the development of this project, it can be successfully implemented on a larger scale for the handicapped people. The low cost of the assembly makes it really a bonus for the general public. We can also add new technology in this wheelchair. From the above-obtained results, we conclude that the developed of all three control mode of a wheelchair is tested and works satisfactorily in an indoor environment with minimum assistance to the physically disabled person. It has a good response to accelerometer activating the motors connected to the wheels of the chair. The speed and distance covered by wheelchair can be further improved if the gear system connected to motors are replaced by crank and pinion joint which has less friction and mechanical wear & tear. The running cost of this system is much lower as compared to other systems used for the same purpose.

## VIII. FUTURE ENHANCEMENT

- This system can be extended by including GSM which sends an SMS during an emergency by assigning particular gesture command.
- By including GPS, the wheelchair location, and movement information can be stored and view at the station to know the emergency situation location, if occur.
- For example, if a person is paralyzed and cannot move his body parts, in that case, it can be used. Improvements can be made by using various body gestures such as eye gaze or leg movement accordingly.
- Generally, the pulse rate of an ordinary person is 72 bits/min. If based on increase or decrease of pulse rate, the wheelchair should stop and it activates the alarm to know that he is in the emergency situation.

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