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HAND GESTURE CONTROLLED WHEELCHAIR

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Abstract

Wheelchair allows physically impaired people to move from one position to another. The wheelchair makes the physically impaired people independent. There are varies types of wheelchairs available in market. In this project the manual wheelchair is converted into the electric hand gesture-controlled wheelchair. The different hand gestures are assigned to different motions of the wheelchair. To identify the hand gestures the Accelerometer MPU6050 is used, which measures the angle of tilt in two axis and to read the output of MPU6050 the Arduino Uno is used, which takes the corrective action as per the different hand gestures assigned to each and every motion of wheelchair. To control the motion of wheelchair the relay modules are used which controls the rotation of motor. The operation of relay is controlled using an Arduino Uno and Arduino takes corrective action on the relay as per the sensor output which depends on the hand gesture. This type of chair is useful for handicap people and it makes them independent.

Key words: Wheel chair, Hand Gesture, MPU6050, Arduino Uno, Relay.

I. Introduction

A wheelchair is a mode of mobility that makes it easier for the handicapped to move around. To move it, either the handle or the wheels must be turned. Today's wheelchair industry offers a variety of models, including transport wheelchairs, electric wheelchairs, and manual wheelchairs. The backrest, footrest, wheels, rims, and hand rest are examples of mechanical wheelchair parts. In contrast, the electric motor, battery, controller, and joystick are examples of electrical wheelchair or powered wheelchair parts[1].

Types of Wheelchairs

1. Manual Wheelchair
2. Powered Wheelchair
3. Pediatric Wheelchair
4. Positioning Wheelchair
5. Sports Wheelchair
6. All-Terrain Wheelchair
7. Standing Power Wheelchair [1]

OBJECTIVES -

For physically impaired people the hand gesture controlled electric wheelchair is his/her independency.

It is difficult to handicap people to travel with manual wheel chair because they need to push the wheels of the by their hand only it requires more efforts to move the chair.

The electric wheel chair with joy stick is difficult to operate for those peoples who are not having arm.

1. To study the need of hand gesture-controlled wheel chair.
2. To identify the problem with existing system.

3. To identify the components of wheel chair like motor, battery, sensor, controller, relays, charger etc.
4. To find the type and capacity of motor, battery and charger required for particular application.
5. To control the movement of wheel chair using hand gestures
6. To make the handicap people independent.

II. Motor Selection

As the chair is designed for handicap person the following data is considered for the section of motor [20,26,27]

Mass of human = 100kg
Mass of chair = 10kg
Mass of single motor = 2.5kg
Mass of two motors = 2.5*2 = 5kg
Mass of battery = 10kg
Total mass = mass of (human + 2 motors + battery + chair) = 100+5+5+10 = 125kg
=Force (F) = mass * acceleration
= 150*0.2 = 30 N
Power required to pull the chair =
Power (P) = Force * Velocity
= 30 * 9.5506 = 286 W
Torque requires to push the chair =
Torque (T) = Force*Radius
= 30*0.762 = 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

$$Powere(P) = \frac{2\pi NT}{60}$$

$$250 = \frac{2 * \pi * 120 * T}{60}$$

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 * 2
= 20 * 2
= 40 N-m
[20,26,27]

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) $= \frac{2\pi NT}{60} \frac{2\pi N}{60}$
$= \frac{2*\pi*120}{60}$
$= 12.5663 \frac{rad}{sec}$
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/s^2
But in practical case it is not possible to have acceleration 0 m/s^2 hence we consider the acceleration as = 0.20 m/s^2
Hence the force required to push the chair

III. Battery Selection

As the motor is of rating 24v and 13Aph hence the battery required is of same capacity as motor[20,21,22,23].
The battery selected,

Type – Lead Acid
Output voltage – 24 V
Current Rating – 13Aph

IV. Charger Selection

As the battery selected for motor is of capacity 24V and 13Ah hence the charger required for the battery is of higher capacity than battery rating or specification[20,21,22,23].

V. Components

1. Arduino Uno [18]
2. Wheel Chair [1]
3. Accelerometer MPU6050 [25]
4. Relay Module [19]
5. Motor (250W) [20,21,22,23]

6. Battery (Lead Acid) [24]

7. Charger

VI. Circuit Diagram

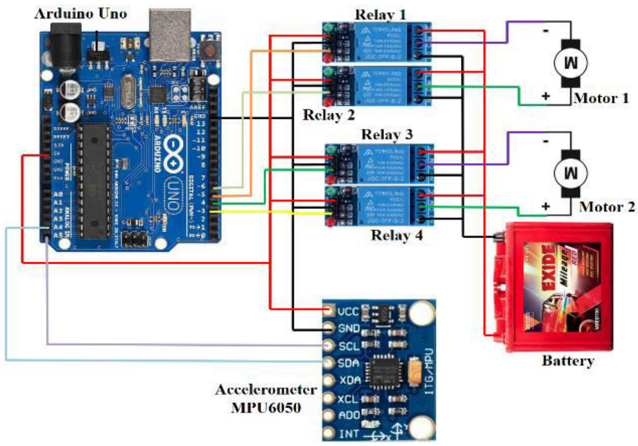


Fig.1 – Circuit diagram

VI. Working

Fig.2 – Hand gesture controlled wheelchair

As discussed, the different hand gestures are assigned to different motions of the wheel chair i.e., forward, backward, left and right. When the hand tilts in forward direction the angle of tilt is sensed by the accelerometer MPU6050 and relay 2 and relay 4 actuates motor then it rotates in clockwise direction and chair moves in forward direction.

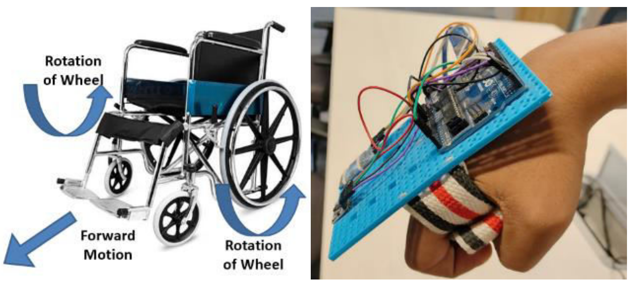


Fig.3 – Forward hand gesture and motion of wheelchair in forward direction

As the hand tilts in backward direction the angle of tilt is sensed by the accelerometer MPU6050 and relay 1 and relay 3 actuates then motor rotates in anticlockwise direction and chair moves in backward direction.

Fig.4 – Backward hand gesture and motion of wheelchair in backward direction

As the hand tilts in left direction the angle of tilt is sensed by the accelerometer MPU6050 and relay 2 and relay 3 actuates motor 1 rotates in clockwise direction and motor 2 rotates in anticlockwise direction due to this chair moves in left direction.

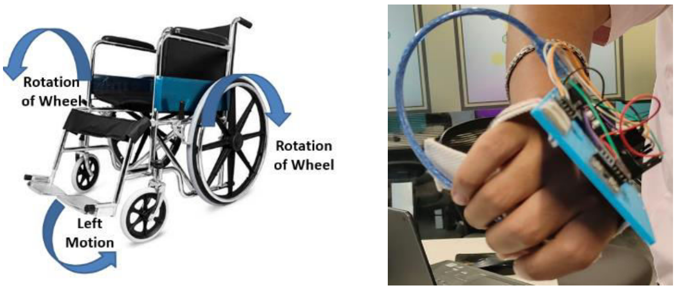


Fig.5 – Left hand gesture and motion of wheelchair in left direction

As the hand tilts in right direction the angle of tilt is sensed by the accelerometer MPU6050 and relay 2 and relay 3 actuates motor 1 rotates in anticlockwise direction and motor 2 rotates in clockwise direction hence, chair moves in right direction.

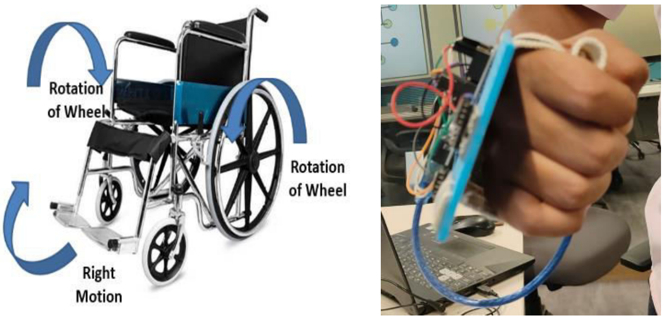


Fig.6– Right hand gesture and motion of wheelchair in right direction

When the hand or palm of hand is parallel to surface at that condition all relays are at off position and both the motors are at rest condition.

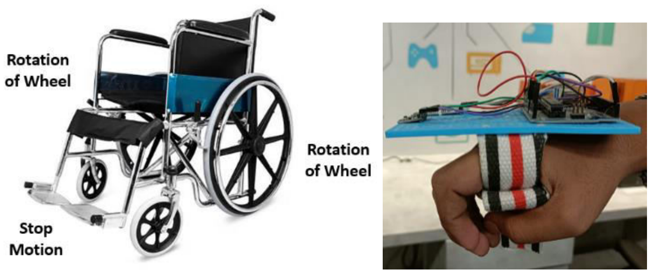


Fig.7 – Stop hand gesture and motion of wheelchair in right direction

VII. Block Diagram

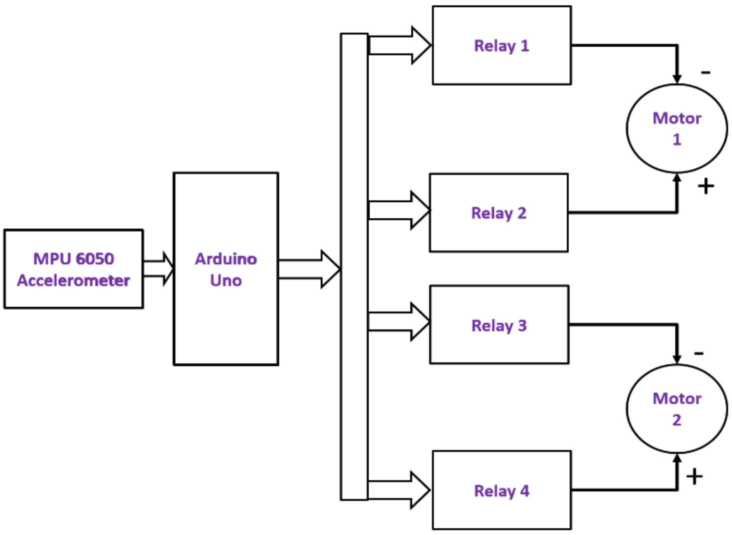


Fig.8 – Block diagram of code

In the above diagram the block diagram required for code and operation or the condition of relay is shown .

Motion	Relay 1	Relay 2	Relay 3	Relay 4
Forward	Off	On	Off	On
Backward	On	Off	On	Off
Left	On	Off	Off	On
Right	Off	On	On	Off
Stop	On/Off	On/Off	On/Off	On/Off

Table. No.1 – Operation of relay for different motion of wheelchair

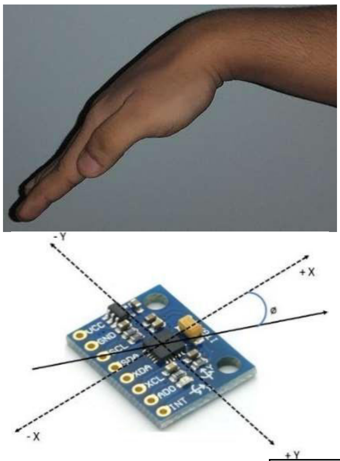
In the above table the condition or the operation of relay is shown as per the different motion of the wheelchair which depends on the hand gesture assigned to each motion of wheelchair.

VIII. Result

As discuss earlier the different hand gestures are assigned for different motions of the wheel chair. The hand gesture assigned for each motion are discussed below –

1. Forward Motion

When the hand is positioned in a forward direction as shown in the figure the accelerometer MPU6050 gives the following values along the x and y-axis.



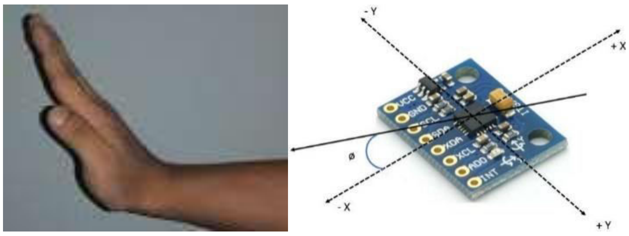
Axis	Output Value
x	50to85
y	100to150

Fig.9– Forward hand gesture

2. Backward Motion

When the hand is positioned in a backward direction as shown in the figure the accelerometer MPU6050 gives the following values along the x and y-axis

.

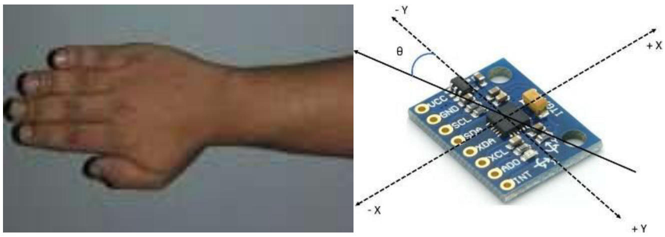


Axis	Output Value
x	180to205
y	100to150

Fig.10 – Backward hand gesture

3. Left Motion

When the hand is positioned in a left direction as shown in the figure the accelerometer MPU6050 gives the following values along the x and y-axis.

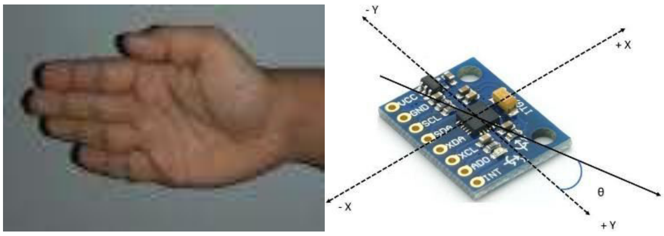


Axis	Output Value
x	100to150
y	50to85

Fig.11 – Left hand gesture

4. Right Motion

When the hand is positioned in the right direction as shown in the figure the accelerometer MPU6050 gives the following values along the x and y-axis.

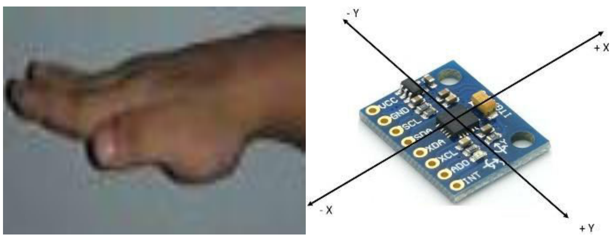


Axis	Output Value
x	100to150
y	180to205

Fig.12 – Right hand gesture

5. Stop Motion

When the hand is at rest condition as shown in the figure the accelerometer MPU6050 gives the following values along the x and y-axis.



Axis	Output Value
x	100to150
y	100to150

Fig.13 – Stop hand gesture

IX. Conclusion

The improvement in assistive technology, the hand gesture operated wheelchair increases freedom and mobility for those with physical limitations. Users may operate the wheelchair, carry out necessary tasks, and interact with their surroundings by using hand gestures.

In conclusion, the hand gesture-controlled wheelchair provides a number of noteworthy advantages:

1. Enhanced mobility
2. Intuitive operation
3. Convenience and comfort
4. Increased social interaction

The hand gesture-controlled wheelchair is a great improvement in assistive technology; however, it may have drawbacks and difficulties when it is put into use. There remains constant room for innovation and optimization in areas like cost, battery consumption, and the precision and reliability of gesture detection. However, the hand gesture-controlled wheelchair offers more mobility, independence, and social integration for people with physical limitations, which has the potential to significantly enhance their quality of life. Authors foresee even more advanced and effective versions of this technology in the future as research and development in this area continue to advance.

X. Future Scope

Speed controller can be added to get 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 more assistance to the user.

GPS module can be used to guide the wheelchair to the specified location.

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REFERENCES

1. REDMAN® Power Chair. Different Types of Wheelchairs. Retrieved from https://www.redmanpowerchair.com/different-types-of-wheelchairs/. (Accessed: 15 May 2023).
2. DeepeshTewari, DeepeshDarmwal, Mudit Gupta and A P Cheema,

"Study of Hand Gesture Recognition Based Controlled Vehicle", International Journal on Emerging Technologies, International Journal of Engineering Research & Technology (IJERT), 2017

3. Ankit Bhagat, Anjali Chandrakar, Neha Sahu, NihalVerma, KusumSahu, Shivani Mishra, "Hand Gesture Controlled Robot",International Journal of Elctrical and Electronics Research, International Journal of Engineering Research & Technology (IJERT), Vol.5, Issue 2, April-June 2017
4. Dr. AmolKasture, Vijay Gaike, AshutoshZagade, VishakhaJamkhedkar, ShreddhaDhakane, VrushaliPatankar, "a Study on Gesture Control Arduino Robot", International Journal of Science Development and Research, International Journal of Engineering Research & Technology (IJERT), Vol. 3, Issue 5, May 2018
5. BenjulaAnbu Malar, Praveen R, KaviPriya, "Hand Gesture Control Robot", International Journal of Innovative Technology and Exploring Engineering, International Journal of Engineering Research & Technology (IJERT), Vol. 9, Issue 2, Dec 2019
6. Priyank Garg, Mansi Patel, HarshitVerma, "Gesture Controlled Robot with Robotic Arm", International Journal for Research in Applied Science and Engineering Technology, International Journal of Engineering Research& Technology (IJERT), Vol. 9, Issue 2, May 2020
7. Nissi Kumar, "Robot Arm with Gesture Control", International Conference on Electronic Circuits and Signaling Technologies, International Journal of Engineering Research & Technology (IJERT), Conference Paper, 2022.
8. SyambabuVadlamudi, D Naresh Kumar, G Sharvan Kumar, "Hand Gesture Controlled Robot Using Arduino and MPU6050", International Journal of Recent Technology and Engineering, International Journal of Engineering Research & Technology (IJERT), Vol. 9, Issue 2, May 2020
9. KathiravanSekar, RamrajanThileebn, VishuramRajkumar, SudharshanBedhuSembian, "Hand Gesture Controlled Robot", International Journal of Engineering Research and Technology, International Journal of Engineering Research & Technology (IJERT), Vol. 9, Issue 11, Nov 2020
10. Valenzuela, Victor L., and Vicente F. de Lucena. "Remote monitoring and control of an electric powered wheelchair in an assisted living environment." IFAC-PapersOnLine 49, no. 30 (2016): 181-185.
11. Chen, Xiaoqi, J. Geoff Chase, Patrick Wolm, Isaac Anstis, John Oldridge, William Hanbury-Webber, Rodney Elliot, and Warren Pettigrew. "System identification and modelling of front wheel drive electric wheelchairs." IFAC Proceedings Volumes 41, no. 2 (2008): 3076-3081.
12. Silva, Yuri MLR, Vinicius da S. Souza, Eduardo LM Naves, F. B. TeodianoFilho, and Vicente F. de Lucena Jr. "Teleoperation training environment for new users of electric powered wheelchairs." Procedia Computer Science 141 (2018): 343-350.
13. Yudhana, Anton, Iqbal CahyaKurniawan, IkhwanAnshori, and IlhamMufandi. "Performance evaluation of communication methods on electric wheelchairs as assistive technology for persons with disabilities." International

Journal on Smart Sensing and Intelligent Systems 15, no. 1 (2022).

14. Elgeme, N. A., Hatem M. Isa Mohamed, and Osama Abdulrahman. "Smart Electric Wheelchair System for Disabled People."
15. Gandepalli, Mohan Krishna, M. Venkata Surya Ajay, N. V. S. Shankar, Archana Acharya, A. Sravani, and P. Chandra Kumar. "Fabrication of Affordable Electric Wheelchair by Retrofitting."
16. Thongpance, Nuntachai, and PhichitphonChotikunnan. "Design and Construction of Electric Wheelchair with Mecanum Wheel." Journal of Robotics and Control (JRC) 4, no. 1 (2023): 71-82.
17. Yang, Laijun, Nan Guo, Ryota Sakamoto, Norihiko Kato, and Ken'ichi Yano. "Electric Wheelchair Hybrid Operating System Coordinated with Working Range of a Robotic Arm." Journal of Robotics and Control (JRC) 3, no. 5 (2022): 679-689.
18. Arduino. What is Arduino and Specification of Arduino. Retrieved from Arduino Uno Rev3 — Arduino Official Store. (Accessed: 24 May 2023).
19. Circuit Digest. How a single channel Relay Module works work. Retrieved from How a Relay Module Works and Interfacing a Single Channel Relay Module with Arduino (circuitdigest.com). (Accessed: 24 May 2023)
20. Theraja, B. L. A textbook of electrical technology. S. Chand Publishing, 2008.
21. Krishnan, Ramu. Electric motor drives: modeling, analysis, and control. Pearson, 2001.
22. Denton, Tom. Electric and hybrid vehicles. Routledge, 2020.
23. Husain, Iqbal. Electric and hybrid vehicles: design fundamentals. CRC press, 2021.
24. Circuit Digest. What is lead acid battery: Types, Working and Application. Retrieved from Lead Acid Battery : Working, Types, Construction, Life and Applications (elprocus.com). (Accessed: 24 May 2023).
25. Circuit Digest. How dose the Accelerometer and Gyroscope MPU6050 works. Retrieved from Arduino MPU6050 Tutorial - How MPU6050 Module Works and Interfacing it with Arduino (circuitdigest.com). (Accessed: 24 May 2023).
26. Khurmi, R. S., and J. K. Gupta. Theory of machines. S. Chand Publishing, 2005.
27. Bhandari, V. B. Design of machine elements. Vol. 1. New Delhi: Tata McGraw-Hill, 2010.