International Scientific Journal of Engineering and Management
Volume: 02 Issue: 05 | May – 2023 DOI: 10.55041/ISJEM00847
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata
ISSN: 2583-6129
www.isjem.com

Hand Gesture Controlled Wheelchair with Obstacle Detection for Physically Disabled People

Aavesh Bagwan
Dept. of ENTC
VPKBIET Baramati, Pune
aavesh.bagwan.entc.2019@vpkbiet.org

Rutik Andhalkar
Dept. of ENTC
VPKBIET Baramati, Pune
rutik.andhalkar.entc.2019@vpkbiet.org

Dheeraj Shinde
Dept. of ENTC
VPKBIET Baramati, Pune
dheeraj.shinde.entc.2019@vpkbiet.org

Prathamesh Shinde
Dept. of ENTC
VPKBIET Baramati, Pune
prathamesh.shinde.entc.2019@vpkbiet.org

Assistant Prof. Rohit Piske
Dept. of ENTC
VPKBIET Baramati, Pune
rohit.piske@vpkbiet.org

***Abstract*—This paper demonstrate that how can we design and implement the hand gesture controlled wheelchair for the physically challenged person who cannot move by himself. The main focus of this project is to detect the motion of the wrist of the hand and control the motors accordingly to move in desired direction along with some additional features such as, obstacle detection and emergency massaging system for the help of operator/patient if needed. Previously we needed some other person to move the wheelchair in desired direction but later, we developed the "joystick controlled wheelchair" which are good in its own ways but most of the times it becomes difficult for the physically challenged person to use it efficiently to overcome this situations we have developed this "gesture controlled wheelchair" and among all the available gestures we found that this hand gesture controlled wheelchair will be the best suited for the physically challenged person. For this demonstration of the project we have used ESP32, Accelerometer sensor, motors and motor driver, ultrasonic sensor for obstacle detection.**

***Index Terms*—ESP32 board, Gesture controlled, accelerometer sensor, obstacle detection, ultrasonic sensor, ESP-NOW, Wheelchair navigation, Motor control.**

I. INTRODUCTION

In present in the world there are around 650 million people who are physically challenged and suffering from varies challenges in the daily life, some of them are by birth due to certain neural issues are physically challenged and some of them are physically challenged due any accidents and due to increased rate of accidents there is high incremental rate of increase of physically challenged people. Hence it is extremely essential to build a system for them so that they can move by themselves without need of any other persons intervention and live more independently, flexibly and be self dependent for physical movement.The need for a Hand Gesture Controlled Wheelchair with Obstacle Detection for physically challenged individuals arises from the desire to enhance their mobility, independence, and overall quality of life. Traditional wheelchair controls often require manual dexterity and physical strength, which can be challenging or impossible for individuals with severe physical disabilities. By incorporating hand gesture recognition technology, this innovative wheelchair offers an intuitive and alternative control mechanism. It enables users to operate the wheelchair effortlessly by simply gesturing with their hands, eliminating the need for complex joystick controls or manual pushing. Moreover, obstacle detection plays a crucial role in ensuring the safety and well-being of wheelchair users. By integrating obstacle detection sensors, the wheelchair can detect potential barriers in its path, such as furniture, uneven surfaces, or unexpected obstacles. Previously a concept of controlling the wheelchair by the help of the motion or gesture of body developed during world war II to assist the injured veterans it was developed by the George Klein in 1953 but this has no any major security intelligent system which will help the operator. Since then many research has been done in this area. There are varies motion controlled wheelchairs present such as eye movement controlled wheelchair, joystick controlled wheelchair, voice controlled wheel chair, head motion controlled wheelchair, or even wheelchairs which are controlled by brain. But most of them have certain issues such as eye movement controlled wheelchair will require a screen in front of eyes of operator all the time which is cumbersome and also if operator is away from the wheelchair, operator cannot use eye controlled wheelchair because he or she does not have that screen which detects eye motion in front of him, the voice controlled wheelchair has issue of understanding different voices around it which will cause a disturbance in an noisy environment and if operator is away from the wheelchair voice will also not be able to reach to the wheelchair. Joy stick controlled wheelchair is also not a proper solution because it is also not a convenient to move that joystick all the time, and if operator is away from the wheelchair, operator does not have joystick to control it, even head motion controlled wheelchair become cumbersome most of the time its not a convenient to move head all the time, and brain reading wheelchairs are also under development but they are very expensive that's why most of the people simply cannot afford it. To overcome all above mentioned important issues we found that using hand gesture controlled wheelchair can be very useful and convenient in all the condition for

ISSN: 2583-6129
www.isjem.com

the operator. In this method by moving wrist of the hand of patient to the right, left, top, down, wheelchair can be moved to the right, left, backward, and forward respectively. In this we have two circuits one which is transmitter circuit which is set on the hand of the operator which detects the gesture of the hand by accelerometer sensor and then transfers the data through wireless communication to the receiver circuit which is present at the wheelchair and then receiver circuit controls the motors using motor driver accordingly and for the obstacle detection we have used ultrasonic sensor at the receiver which detects the obstacle and reports to the receiver circuit to stop the wheelchair.

II. Literature Review

The literature review for hand gesture-controlled wheelchair reveals that there has been significant research conducted on this topic. The main objective of this research is to develop a user-friendly and efficient means of mobility for individuals with disabilities. The following review explores some of the key findings from various research papers on this topic.

Shayban Nasif and Muhammed Abdul Goffar Khan (2017) proposed a wireless head gesture-controlled wheelchair for disabled persons. The system is based on an Arduino microcontroller, and a RF transmitter and Receiver is used for wireless communication. The user's head gestures are captured by an accelerometer and gyroscope, and the wheelchair is controlled accordingly. The authors claimed that this system can be a cost-effective and efficient solution for individuals with physical disabilities.

Pushpendra Jha (2016) developed a hand gesture-controlled wheelchair.In this an ADXL335 accelerometer is used as a sensor which will be giving analog signal on moving it in X, Y, Z axis respectively. An LM324 operational amplifier is used as a comparator to convert the analog signal into the digital signal. Radio Frequency transmitter of 434 MHz frequency is used to transmit the signal wirelessly. Before sending, the data is encoded with an encoder IC HT12E. If the input data matches the preinstalled data then the signal is given to L293D IC on receiving the signal the L293D IC gives the signal to relays and then the wheelchair starts moving.

Prof. Vishal V. Pande, Nikita S.Ubale, Darshana P. Masurkar, Nikita R. Ingole, Pragati P. Mane developed Hand Gesture Based Wheelchair Movement Control for Disabled Person Using MEMS(Micro Electro-Mechanical Systems).Here they have used ADXL202E for gesture detection at the transmitter,TheADXL202E can measure both dynamic acceleration (e.g., vibration)and static acceleration (e.g., gravity). for the wireless transmission they have used RF ASK Module It is an effective low cost solution to receiving data at 315/433MHz.

Krunal Bansod, Kushal Asarkar, Mandar Topre, Vikrant Raj (2020) proposed a hand gesture-controlled wheelchair that uses arduino nano to process the signals produced by the accelerometer sensor and then used RF transmitter to transmit the signals then at the receiver they have used arduino uno for processing at the receiver section where RF receiver will receive the signals and command to the arduino for the desired movement, here they have used proximity sensor for obstacle detection and here they have used buzzer as well for beep sound to convey the presence of obstacle.

Mufrath Mahmood, Md.Fahim Rizwan, Masuma Sultana, Md.Habib, Mohammad Hasan Imam "Design of a low cost hand gesture controlled automated wheelchair." IEEE Region 10 Symposium, june 2020. here they have developed a low-cost hand gesture-controlled automated wheelchair.In this system Arduino nano is used to read data from the accelerometer sensor and then trasnmit it via rf transmitter, arduino mega is used to control the motors depending upon the signals coming from the transmitter and arduino mega along with the GSM module helps in emergency messaging system. arduino nano and an ultrasonic sensor is used for the obsctacle detection at receiver end and here they have implemented GPS location tracker using NodeMCU.

Overall, the literature review highlights that hand gesture-controlled wheelchair technology has evolved significantly over the years. The systems proposed in various research papers have the potential to provide better mobility and user experience for individuals with disabilities. However, there is a need for further research to improve the accuracy and reliability of gesture recognition and to develop more affordable and user-friendly solutions.

III. Working Of Proposed System

For the implementation of the concept mentioned above which is hand gesture controlled wheelchair we need to make two circuits one for the capturing gesture of the hand made by operator and other for the movement of the wheelchair according to that gestures and we need to establish a wireless communication between these two circuit for transferring signals form hand gesture capturing circuits to wheelchair moving circuit.

A. Transmitter section

This circuit deals with the detecting gestures of the hand as mentioned above and then this circuit commands to the receiver circuit, here we need a sensor or a mechanism which can detect the gestures of the hand for that purpose we are using accelerometer sensor which deals with the measurments of the acceleration due to gravity done by itself. so if we put this on the hand of the operator we can easily detect the hand motion by measuring acceleration due to gravity made by itself. Here we are using MPU6050 sensor as accelerometer sensor and we are communicating with this via inter-integrated communication protocol, then we need a processing unit which can process the data and then transfer the data coming from sensor unit to the receiver section for that purpose we use ESP WROOM 32 board which contains ESP32 SoC for the wireless communication we are using ESP-NOW protocol developed by espressif which is a fast communication protocol that can be used to exchange small messages (up to 250 bytes) between ESP32 boards. ESP-NOW is very versatile and we can have one-way or two-way communication in different setups.

International Scientific Journal of Engineering and Management
Volume: 02 Issue: 05 | May – 2023 DOI: 10.55041/ISJEM00847 ISSN: 2583-6129
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata www.isjem.com

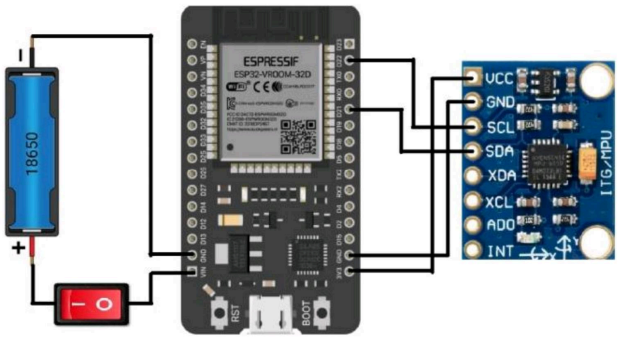

Fig. 1. Transmitter circuit.

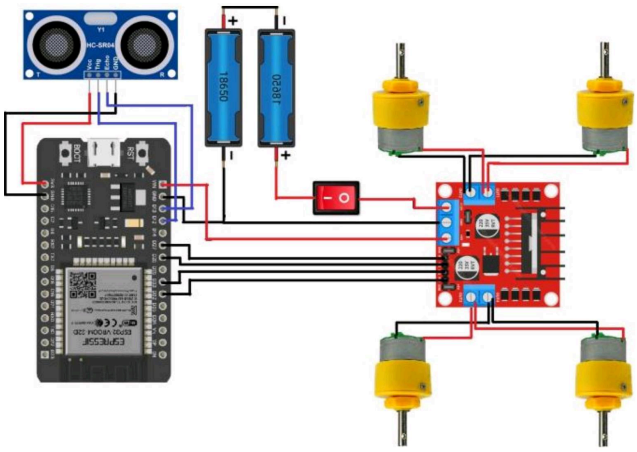

Fig. 2. Receiver circuit.

B. Receiver section

This section is dealing with movement of the wheelchair, obstacle detection. for receiving data by receiver section and transmitting data by transmitter section we are using ESP-NOW protocol as mentioned in the above section as well. then for the further processing of the data which is received we need a processing unit and for that purpose we are using ESP-WROOM-32 board.

we need to move wheelchair to the right, left, forward, backward for this purpose we will be using four motors (we can use two motors as well) and a motor driver to control the direction and speed of these motors and above fig. 3 explains how a wheelchair is moving to the right, left, forward, backward, using two motors. In order to move a chair we are using differential steering mechanism where turning of the chair can be accomplished by changing the direction of the rotation of the motors, if we need to move wheelchair forward then we are going to rotate both side motors in forward direction, if we need the move wheelchair backward then we will move both motors to the backward, if we need to move the wheelchair to the right side then we are going to rotate left motors forward and right motors backward and if we need to move left side then we a going to move right

Movement of motors according to hand gesture		
Direction of hand gesture	**Movement of left Motor**	**Movement of right Motor**
Downward	Forward	Forward
Upward	Backward	Backward
Right	Forward	Backward
Left	Backward	Forward

Fig. 3. Movement Mechanism For Wheelchair

motors to the forward and left motors to the backward.

In order to implement obstacle detection we are using ultrasonic sensor which uses ultrasonic waves for the detection of the obstacle, ultrasonic waves are a type of sound wave that has a frequency greater than the upper limit of human hearing, typically above 20,000 Hz and The approximate speed in air is 330 m/s. the sensor sends the ultrasonic waves and then it measures the time taken by the signals to reflect back from the obstacle and then by using time speed and distance formula it calculates the exact distance between obstacle and the sensor and if the distance is less than a specific threshold then we can say obstacle is detected and we need to stop the wheelchair.

C. Technology used

- ***ESP32 Board :*** The ESP32 is a series of low-cost and low-power System on a Chip (SoC) microcontrollers developed by Espressif that include Wi-Fi and Bluetooth, Bluetooth low energy wireless capabilities and dual-core processor, it can be programmed with arduino IDE as well. it has Tensilica Xtensa Dual-Core 32-bit LX6 micro-processor, running at 160 or 240 MHz clock frequency. It also has a rich set of peripherals, including GPIO, UART, SPI, I2C, and ADC, making it ideal for a wide range of IoT applications. It includes numerous built-in sensors such as temperature, hall effect, and capacitive touch sensors.
- ***Accelerometer sensor :*** We are using MPU6050 as a accelerometer sensor, The MPU-6050 IMU (Inertial Measurement Unit) is a 3-axis accelerometer and 3-axis gyroscope sensor. The accelerometer measures the gravitational acceleration and the gyroscope measures the rotational velocity. Additionally, this module also measures temperature. This sensor is ideal to determine the orientation of a moving object. we can interface this sensor with the board using I2C communication.
- ***ESP-NOW Protocol :*** ESP-NOW is a connection-less communication protocol developed by Espressif Systems for low-power, peer-to-peer communication between ESP8266 and ESP32 devices without the need for a Wi-Fi network or Internet connection. It uses a lightweight

ISSN: 2583-6129
www.isjem.com

message format, strong security features. ESP-NOW supports Encrypted and unencrypted unicast communication, it can transfer data upto 250 bytes at a time. this protocol has a limitation it supports maximum of 20 encrypted and unencrypted peers.

- ***Ultrasonic sensor :*** Here we use HC SR-04 ultrasonic sensor it consists of two main components: an ultrasonic transmitter and an ultrasonic receiver. The transmitter emits a high-frequency sound wave, typically at 40 kHz. The range of this sensor available between 2cm to 400cm. The HC-SR04 Ultrasonic sensor comes with four pins namely Vcc pin, Trigger pin, Echo pin, and Ground pin. Vcc pin can be connected to 3v3 pin of esp32 board and trig and echo pin can be connected to the any digital pin of the esp32 board.
- ***Motors and Motor driver :*** we are using 12v DC geared motor to achieve high torque and decent speed for a wheelchair movement and here we are using L298N dual H-Bridge motor driver which allows speed and direction control of two DC motors at the same time. The module can drive DC motors that have voltages between 5 and 35V, with a peak current up to 2A. it has two independent motor driver channels, labeled as Channel A and Channel B, each capable of driving one motor. it has four logic inputs, two for each motor channel this inputs can be used to control the direction of the motor rotation.Each motor channel of the L298N motor driver has an enable input that can be used to control a speed of motor.it has built-in protection against overheating, overvoltage, and under-voltage conditions.

CONCLUSION

In conclusion, the hand gesture controlled wheelchair with obstacle detection is an innovative and practical solution for individuals with mobility impairments. The system provides a simple and intuitive way to control the movement of the wheelchair using hand gestures, while also detecting and avoiding obstacles in the environment. the main purpose of this paper is to demonstrate a a system which can show case the idea of the hand gesture controlled wheelchair With obstacle detection, and this research paper successfully demonstrate the way of implementing a solution for above mentioned problem and the results show that the system is reliable, accurate and it is believed that the proposed system can reduce the complexities of other automated wheelchairs, further by improving the motors and motor driver we can make this capable of carrying a person and commercial production of the presented wheel chair could be a good replacement of imported one and could be a great help to the disabled patients in our country.

REFERENCES

[1] Shayban Nasif, Muhammed Abdul Goffar khan “Wireless head gesture controlled wheelchair for disabled person.” IEEE humanitarian technology conference December 2017.
[2] Pushpendra jha “Hand gesture controlled wheelchair” international journal of scientific and technology research volume 5, issue 04, April 2016.
[3] Prof. Vishal V. Pande, Nikita S.Ubale, Darshana P. Masurkar, Nikita R. Ingole, Pragati P. Mane “Hand Gesture Based Wheelchair Movement Control for Disabled person Using MEMS”. Et al int. Journal of Engineering Research and application Vol4, issue 4(Version 4). April 2014.
[4] Kunal Bansod, kushal Asarkar, Mandar topre, vikrant raj “Hand Gesture Controlled Wheelchair” IRJET International Research Journal of Engineeirng and technology Volume -07 Issue- 07 July 2020.
[5] Mufrath Mahmood, Md.Fahim Rizwan, Masuma Sultana, Md. Habib, Mohammad Hasan Imam “Design of a low cost hand gesture controlled automated wheelchair.” IEEE Region 10 Symposium, june 2020.
[6] Chowdhury, SM Mazharul Hoque. Smart wheelchair for disable people. Diss. jahangirnagar university, 2019.
[7] Speech and flex sensor-controlled wheelchair for physically disabled people presented by 1 Shruti Warad, 2 Vijayalaxmi Hiremath, 3 Preeti Dhandargi, 4 Vishwanath Bharath, 5 P.B. Bhagavati.

RESULT

Fig. 4. Final Prototype

