

Embedded System Based Smart Wheelchair For Physically Challenged People

A. Sanjana¹, K. Sree Amrutha Valli¹, Ch. Adarsh¹, M. Sai Hrithik Reddy¹, V. Usha Rani², J Sridevi²

¹UG student, EEE Department, GRIET, Hyderabad, Telangana

²Assistant Professor, EEE Department, GRIET, Hyderabad, Telangana

²Professor, EEE Department, GRIET, Hyderabad, Telangana

Abstract: The degradation of mobility is an important concern that affects the independent living ability of physically Challenged people. Therefore, mobility assistive devices require improvements to uplift the living standards of the people. This paper sets out a design of a smart wheelchair using an embedded system. This paper sets out a design and development of a smart wheelchair using an embedded system. The proposed design of the wheelchair can be controlled through bluetooth which enables the user to control the wheelchair with less effort. Touch commands are deployed to the system in addition to the virtual joystick-controlling interface to enhance the interaction with the user. This aids the disabled in carrying out daily activities independently within indoor environments. Experiments are conducted to verify the functionality of the developed smart wheelchair.

1 Introduction

This paper focuses on the problems faced by specially-abled people who wish to commute on their own, but they cannot drive because of natural causes. In this proposed project, the emphasis is on Bluetooth control of the wheelchair with automatic movement in the directions like forward, backward, left, right and diagonal directions through Bluetooth command. In this model, we will use an Android app to pass on the Bluetooth commands to the Raspberry PI 3 through Bluetooth communication using the Bluetooth module.

When a person becomes physically disabled then he/she faces a lot of problems while moving from one place to another. Most of the physically disabled people use traditional wheelchairs. Previously wheelchairs were manual controlled. They are operated by hands or by a second person if the patient is unable to drive it. For that kind of wheelchairs the person should be strong enough to control that, otherwise another person should be there to monitor the movement of the chair. Some patients who cannot manipulate the direction of the wheelchair with their arms due to a lack of force face major problems such as orientation, mobility etc. This is very difficult for that person if another person is not there for support. In that case there is always a requirement of a second person [1]. So if a person who's minor part of the body is working he or she can use it with the least efforts and maximum precision and speed control. This device is loaded with many additional features which make it smart. Therefore this wheelchair is developed to overcome the above problems allowing the end-user to just perform safe movements and accomplish some daily life important tasks. Taking all this in consideration we have decided to work on a bluetooth operated wheelchair.

The paper describes a simple, smart, affordable, key, motor controlled device which is friendly and customized commands are given and it will make the wheel chair move independently. Smartphones are used as the brain of the robot for giving instructions. Bluetooth has made communication easier from wired to wireless. IR sensors are also used for sensing and giving notification if it finds an obstacle in the passage.

In this design, we need to control the movement of the wheelchair using bluetooth commands by the user. These commands are received by an Android application on the user's phone, which is connected to the wheelchair using the Bluetooth module. The commands issued will be related over, and RS channel and will be received by the module. The goal of a Bluetooth-controlled wheelchair is to listen and act on the commands received from the user. This application is nothing but an artificial intelligence application. Here, the system requires training from the user, after which the device will start grasping the commands issued. This is done by appending comments to the controller through a code[2].

2 Working Methodology

The Smart Wheelchair consists of a Wheelchair-controlled Bluetooth Module. To construct the system cost-effective for observing, a Raspberry PI 3 UNO is permitted to approach the system without showing units. The movement of Wheelchair can be directed manually by Bluetooth. The command is implemented utilizing a mobile bluetooth app and then the command is sent to Raspberry PI 3 UNO where the command is processed.[3,4] After processing, the command is sent in the structure of a digital signal to the motor driving IC then it controls the movement of the Wheelchair. The

system was also designed for controlling the Wheelchair by using an android device. Users can select specific directions shown within the four quadrants on the Android Smartphone screen for controlling the Wheelchair. Raspberry PI 3 UNO exerted to execute all commands. The Motor Driver and Bluetooth Module are operated in this system. In this way, we have obtained an automatic Wheelchair that can be driven using an android device.

The project uses a Bluetooth module i.e the HC-05. When the button on the Bluetooth app is pressed, then the Bluetooth module detects the respective button pressed in the Bluetooth. The Android smartphone app you are using is running in the smartphone, uses character commands which are detected by the Bluetooth in the phone.

Command is processed, each button pressed to character conversion is done within the Bluetooth module, it's then sent to the receiver side which is a Raspberry PI 3 via Bluetooth app. This project is with the control of Raspberry PI 3 here; the Raspberry PI 3 used is Raspberry PI 3 UNO.

Raspberry PI 3 UNO is a ATmega328 Microcontroller root development board that has six analog input means and 14 digital I/O pins. It has 32kb flash memory(ISP), 2 kb ram, and 1 kb EPROM. This Board provides the capability of serial communication via UART, SPI. It can be operated at a clock frequency of 16MHz. In this project, 2, 3, 4, and 65 are the digital input-output pins that of Raspberry PI 3 are configured as output pins. Serial communication uses 0's and 1's with the HC 05 module. Texts received via Bluetooth are transferred to the Raspberry PI 3 Uno board using UART serial communication protocol. Raspberry PI 3 UNO program controller checks the character received, if it is matching character order, no control of the movement of the wheelchair at the start.

Table 1. Bluetooth-Controlled Wheelchair Directions

Character	Direction	Function
N	North	Moves Forward
E	East	Moves Right
W	West	Moves Left
S	South	Moves Backward
0	Stop	Motor Stops
1	North-West	Moves Forward Left
3	North-East	Moves Forward Right
7	South-West	Moves Backward Left
9	South-East	Moves Backward Right

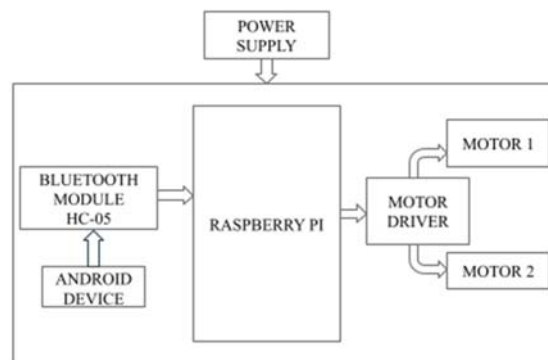


Fig. 1. Block Diagram of Bluetooth controlled Wheelchair

The power supply of this entire system is given through a battery. This system's hardware consists of an embedded-system based on the Raspberry Pi 3b, Bluetooth module(HC-05), Motor driver(L298N), Android device and dc motors. Bluetooth Module is the communication medium between the user interface through the android device and the system by means of character commands given to the android device.

All the software application program is installed in the Raspberry Pi and android device. When the user opts for the desired character command through the bluetooth app through android device, then this is transferred to the Raspberry Pi using bluetooth module which is the transmission unit to the receiving unit. According to the desired character opted by the user, the Raspberry Pi gives the signal to the Motor driver as per the algorithm used in the software program. Motor driver gets signal using serial communication and moves the wheelchair either forward, backward or stop. The Android application is connected to the Bluetooth module HC-05 and is installed on the wheelchair by Bluetooth. The commands are sent to the wheelchair using Bluetooth commands present on the Android application. The transmitter of the Bluetooth can take Bluetooth commands which are converted to encoded digital data for the advantage of the adequate 100 meters range from the wheelchair. The receiver part will decode the data via motor driver IC for the necessary commands.

2.1 Algorithm of interfacing the bluetooth module and motor driver with the raspberry pi

1. Declare the variables that act as inputs to the motors: motorRightA, motorRightB, motorLeftA, motorLeftB (2 inputs for each motor/ 2 inputs on each side of motor driver)
2. Initialise a variable bt that represents bluetooth control to zero.
3. Create the setup function so that the initial values can be set.
4. Use The pinMode() function to configure the above declared variable pins to behave as outputs.
5. Start the serial communication(at baud rate), so

- that the Arduino can send out commands.
6. Set the corresponding output values of the output pins as LOW.
 7. End setup.
 8. Start loop function which checks the button pin each time and will send serial if it is active or pressed.
 9. Call the control function which can be declared as follows.
 10. Exit loop function.
 11. Declare control Function.
 12. If the number of bytes are available for reading from the serial port, read the incoming serial data and assign it to the variable bt assigned earlier.
 13. Check for the input variable in bt and assign the output values respectively.
 - a. If bt is N, then both the motors move in forward direction, so assign HIGH to motorRightA, motorLeftA and LOW to motorRightB, motorLeftB.
 - b. If bt is S, then both the motors move in backward direction, so assign LOW to motorRightA, motorLeftA and HIGH to motorRightB, motorLeftB.
 - c. If bt is E, then the wheelchair moves right, so assign HIGH to motorLeftA and LOW to the other three.
 - d. If bt is W, then the wheelchair moves left, so assign HIGH to motorRightA and LOW to the other three.
 - e. If bt is 1, then the wheelchair moves NorthWest, so assign HIGH to motorRightA and LOW to motorRightB and after a few seconds delay, assign HIGH to motorLeftA and LOW to motorLeftB.
 - f. If bt is 3, then the wheelchair moves NorthEast, so assign HIGH to motorLeftA and LOW to motorLeftB and after a few seconds delay, assign HIGH to motorRightA and LOW to motorRightB.
 - g. If bt is 9, then the wheelchair moves SouthEast, so assign HIGH to motorLeftB and LOW to motorLeftA and after a few seconds delay, assign HIGH to motorRightB and LOW to motorRightA.
 - h. If bt is 7, then the wheelchair moves SouthWest, so assign HIGH to motorRightB and LOW to motorRightA and after a few seconds delay, assign HIGH to motorLeftB and LOW to motorLeftA.
 - i. If bt is 0, then set all values to 0.
 14. End control function.

2.2 Flowchart of interfacing the bluetooth module and motor driver with the raspberry pi

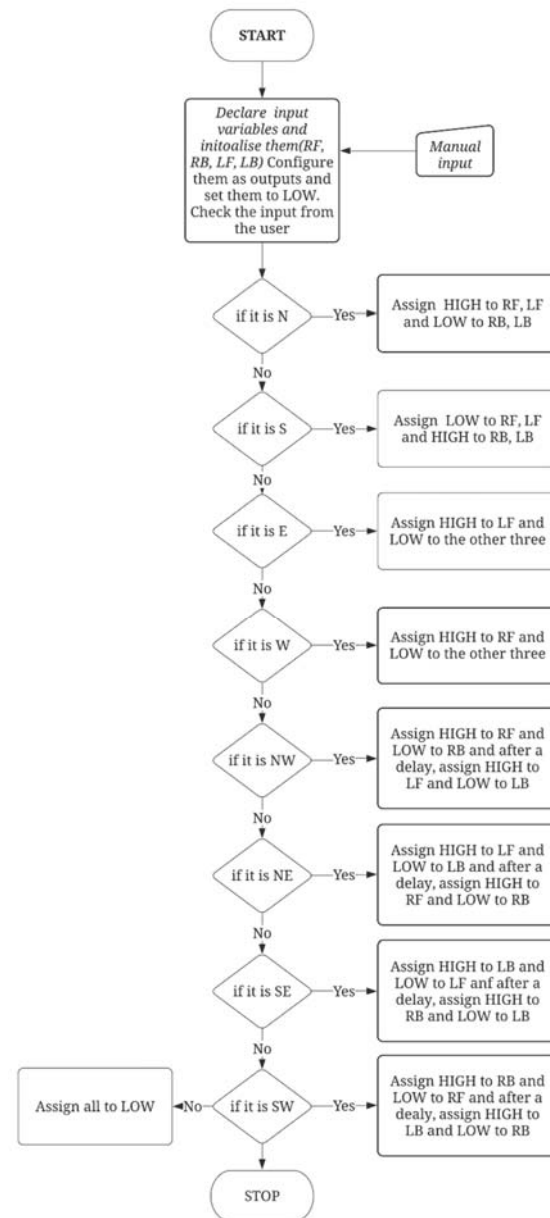


Fig. 2. Flowchart of Smart WheelChair

3 Results and Discussions

The Raspberry PI 3 program checks the code received by the Bluetooth module and if it is a matching character with a given program, then with each respective character the Raspberry PI 3 sends a signal to the motor driver. Depending on the received character the Motor. This Bluetooth-module is simple to interface the wireless-connection devices.

Now the main crucial component of the wheelchair is the L293D Motor Driver. It is a dual H Bridge high current motor driver IC. This is used because digital pins of Raspberry PI 3 can't source enough current to run the motor of a wheelchair.[5] H-bridges are useful in controlling the direction of rotation of the motor enable

pins of the IC being actively high are connected to the 5 volts. 4 output pins of I293d IC are connected to Motors A and B at the receiver end.

3.1 Simulation Results

Used Software and application: Proteus 8 Professional Simulation Software, Bluetooth Joystick App.

Fig. 3. Motors moves in forward direction as the joystick is in forward direction

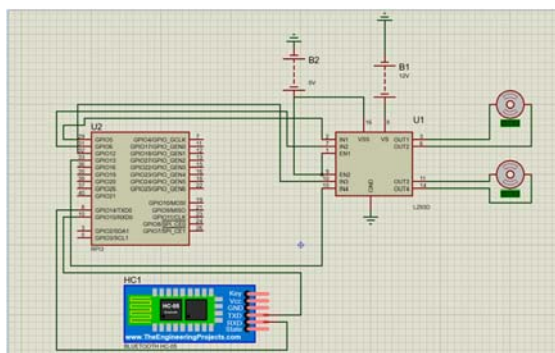


Table 2. Rotation of motors with inputs.

Inputs	Rotation of motors with inputs according to user commands
Input 1 = HIGH	Motor 1 rotates in clockwise direction
Input 2 = LOW	
Input 3 = HIGH	Motor 2 rotates in clockwise direction
Input 4 = LOW	
Input 1 = LOW	Motor 1 rotates in anti-clockwise direction
Input 2 = HIGH	
Input 3 = LOW	Motor 2 rotates in anti-clockwise direction
Input 4 = HIGH	
Input 1 = HIGH	Motor 1 stays still
Input 2 = HIGH	
Input 3 = HIGH	Motor 2 stays still
Input 4 = HIGH	

The wheelchair moves forward when it is instructed to do so by the movement of both the wheels in clockwise direction. It moves backward when both the wheels are given input to move in an anti-clockwise direction. It turns right when the left wheel only turns clockwise and moves left when the right wheel turns clockwise. It moves diagonally forward to the right when the left wheel initially turns clockwise and after a delay, the right wheel also starts turning clockwise. It moves diagonally forward to the left when the right wheel initially turns clockwise and after a delay, the left wheel also starts turning clockwise. It moves diagonally backward to the right when the left wheel initially turns anticlockwise followed by the right wheel after a delay. It moves diagonally backward to the left when the right wheel initially turns anticlockwise followed by the left wheel after a delay.

4 Conclusion

The Present Bluetooth-controlled wheelchair gives a safety and staunch system. It provides a comfortably get-at-able and different varieties of functions. In this, we developed a wheelchair that includes ultrasonic sensors to smart track the paths and can detect the objects in the middle of the path along with an ability of maintaining good care to refrain from tragedy, good results are obtained. Hence, parietic peoples can be reliable-self, safely, and ease controlling with this wheelchair. Future changes can improve the wheelchair more. The presented wheelchair will be done by appending new advanced sensors, in order to make the wheelchair increased friendliness and to refrain from tragedy by learning-self. Security will be integrated for retrieval with the assistance.

5 References

- Asakawa T., Nishihara K., Yoshidome T.: IEEE International Conference on Robotics and Biomimetics, pp. 1260-1265, China (2007).
- Krishnamoorthy A, International Journal of Reconfigurable and Embedded Systems (IJRES), Vol. 6, No., pp. 82~87 ISSN: 2089-4864, DOI: 10.11591/ijres.v6.i2.pp82-87. (2, July 2017).
- Deepak Kumar Lodhi et al, International Journal of Computer Science and Mobile Computing, Vol. 5 Issue.5, May- 2016, pg. 433-438 ©, IJCSMC.(2016).
- Simpson RC, LoPresti EF, Hayashi S, Guo S, Ding D,Cooper RA. Technology and Disability: Research, Design, Practice and Policy: 26th International Annual Conference on Assistive Technology for People with Disabilities (RESNA) [CD-ROM]; 2003 Jun 19–23; Atlanta, GA. Arlington (VA): RESNA Press;(2003).
- Shaiju Paul, Ashlin Antony, Aswathy B., International. Journal of Computing and Technology (IJCAT). Volume 1, (1, February 2014).

6. Pithon, T., Weiss, T., Richir, S., and Klinger, E., volume **21**, pp. 1-10.(2009)
7. Rani V. U., Sridevi J., Sai, P.M., 2021 International Conference on Sustainable Energy and Future Electric Transportation, IEEE (March 2021).
8. Iromini Nurudeen Ajibola, Keshinro Kazeem Kolawole, Alimi Teslim Adekunle. Imanager Publications, Vol **8**, Issue 2, (2020).
9. Ayush Wattal, Ashutosh Ojha, Manoj Kumar. National Conference on Product Design NCPD 2016, (July 2016).
10. Gurjashan Singh Pannu, Mohammad Dawud Ansari, Pritha Gupta. International Journal of Computer Applications Volume 113-No. **9**, (March 2015)
11. S. A. Sheikh and D. R. Rotake, Proceedings of the 2015 International Conference on Communications and Signal Processing (ICCSPP), pp. 1811–1815, Melmaruvathur, India, (April 2015).
12. Bhavini M. Chaudhari, Nehal G. chitaliya. International Journal of Innovative Research in Computer and Communication Engineering. An ISO 3297: 2007 Certified Organization) Vol. **4**, Issue (2 February 2016.)
13. N.bt Aripin and M.B.Othman, Electrical Power, Electronics, Communications, Control and Informatics Seminar.(2014)
14. C. Huang, Z. Wang, G. Chen, and C. Yang, Proceedings of the 2017 2nd International Conference on Control and Robotics Engineering (ICCRE), pp. 73–76, Bangkok, Thailand,(April 2017).
15. Pajkanovic, A. & Dokic, B., Serbian Journal of Electrical Engineering, **10(1)**, pp.135–151, (2013)
16. Cerejo, R., Correia, V. & Pereira, N., **3(6)**, pp.94–98, (2015).
17. Nutakki, M., Palakaluri, S.V.D. Vijaya Santhi, R., International Journal of Innovative Technology and Exploring Engineering, **8(11)**, pp. 2325–2329, (2019).
18. Sai, V.A., Srikanth, B., Devi, P.S., Rajamahanthi, V.; International Conference on Sustainable Energy and Future Electric Transportation, SeFet 2021, (2021).
19. Jayahari, L., Hussaini, S.M., Varmaa, D., ; Advances in Materials and Processing Technologies, **6(2)**, pp. 285–295, (2020).
20. Srividya Devi.P, R Vijaya Santhi; International Journal of Electrical and Computer Engineering **9(2)**:861(2019)
21. DSNMRAO, Ch. Pushpa Latha, N. Bharath kumar and PM Venkatesh, Journal Européen des Systèmes Automatisés (JESA), Vol. **52**, no. 5, pp. 535-540, (2019).
22. Adapa, R.R., Nawaz, S.S., Padhan, D.G. Proceedings - 2020 IEEE India Council International Subsections Conference, INDISCON 2020, pp. 1–7, 9344573, (2020).
23. Reddy, K.L.P.K., Padhan, D.G. E3S Web of Conferences, **184**, 01043, (2020).