Wireless Gesture Control Wheelchair

Shanelle Fernandes, Rushia Fernandes, Jessica Kakkanad

Abstract: ***Wheelchairs have been used by patients who suffer from various physical disabilities to help them with locomotion and cater their day to day needs with ease. But there are some cases where the movement of a wheelchair is dependent on another individual as is the case with patients who lack the required arm strength and movement to properly push the wheels forward such as quadriplegics, paraplegics, stroke patients, elders etc. Joystick oriented wheelchairs, thought to be a solution to those kinds of patients, can pose different problems as it requires basic shoulder movement. It is not always possible for the aforementioned types of patients. In addition, our solution doesn't have the positional constraints that a joystick wheelchair might have as it is wireless and can be worn on either hand which allows the patient to sit in their preferred position for minimum discomfort. This project is an attempt to help the disabled move around independently. Thus, in this research work, we present a prototype of a wireless gesture-based wheelchair which can be controlled via hand gestures. The framework consists of a transmitter and a receiver that communicate with each other wirelessly. For wireless transmission, 433Mhz RF Transmitter and Receiver Unit has been used as it transmits data through an antenna at the speed of 1Kbps - 10Kbps and the range can be adjusted as required. The transmitter unit consists of an Arduino LilyPad microcontroller and an accelerometer that has been attached to a hand glove. The accelerometer sensor has been used to register the position of the hand while creating a gesture. This glove is supposed to be worn by the patient allowing them to move their hand conveniently, sending signals to the receiver unit connected to the wheelchair leading to the movement of the wheels in the desired direction. The receiver unit consist of motor drivers that convert the voltage as needed by the wheels. This paper presents an alternative to the commercial wheelchairs as it is cost effective, easy to control and efficient. The working and assembly of the system has been explained in the paper.***

Keywords: Accelerometer, Gesture Recognition, Handicapped Assistance, Radio-Frequency Transceiver, Wheelchair

I. INTRODUCTION

With the growth of technology there has always been an effort to use the technology for the betterment of mankind in various domains. One such feature which is beneficial for the disabled and the elderly is a wheelchair as it helps to ease their movements. As per the studies done by the WHO (World Health Organization), it is estimated that out of 650 million people with disabilities 10 percent of them need wheelchairs for their day to day locomotion [2]. The popular wheelchairs in today's market are mainly joystick-controlled that expects a patient to grip onto the joystick and move it, with a certain amount of force.

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Due to varied strengths in hands all users including elders, physically challenged, partially paralyzed patients, quadriplegics, stroke patients, spinal cord injury patients etc. cannot use the joystick as they lack physical strength. Although alternative control methods are available, they are very expensive and might not be affordable by all.

The wheelchairs that are being used in the present time are controlled by the persons sitting on. The person sitting on the chair has to exert a force by his hands in order to move the chair and get to the desired location. Thus, taking into consideration the lack of force applied to maneuver the wheelchair by the handicapped, a new implementation could be made on the wheelchair which requires the application of minimal force. There are various options to modernize the traditional joystick-controlled wheelchair that can operate by touch, eye movement, voice recognition and body gestures. Under gesture control, there are a number of options available which include movement of the head, arm, palm, etc. This research paper focuses on wheelchairs operating on hand gestures. The advantage of using hand gestures is that it supports wireless technology that can help improve the movement of the wheelchair by increasing the range of transmission in which they operate. The communication occurs between the glove worn by the patient and the wheelchair unit. Data transmission among these takes place with the help of Radio Frequency. This application will be done by using microcontrollers and an accelerometer sensor and will give patients the independence of using the wheelchair without the help of any other person.

II. THEORY

A. Motivation

The physically disabled or partially paralyzed often find it difficult to navigate themselves in and around their house without the assistance of someone. Generally, after paralysis or other physical disorders the usage of a wheelchair is highly recommended for the locomotion of such people. But to navigate through one's own house with the help of someone every time can be demoralizing for the person as well.

B. Related Works

In the paper by Ababneh, M., et al. [1], some approaches to assist elderly and wheelchair people are accomplished by employing Socially Assistive Robots (SAR). Few of which are used as assistants while performing specific exercises that improve human health. These robots are used in assisting the elderly people to walk. However, in many cases these robots are expensive choice for the kind of the service they provide.

Other approaches include wearable data gloves to provide communication with caregiver or attached inertial sensor for fall detection of elderly people. In many cases, these sensing devices might be annoying to the elderly and wheelchair people as they must be attached or fixed to them. The authors of the paper [2], show the statistics of India i.e. 20.3% of the differently abled people have mobility issues. They have used Android's open platform to develop a mobile application which can pair with the wheelchair's wireless module via the app's Bluetooth so that the caretaker can make use of this technology to help the patient with locomotion. Also, the pairing of the master and the slave requires a password which makes it difficult for unauthorized people with the app to control the wheelchair. Although, they use specific finger movements which could be a task for the disabled to move the fingers in an appropriate angle to have accurate movement of the wheelchair. In another paper by Khadilkar, Shraddha Uddhav, et al. [3], a wheelchair is fitted with sensors like the obstacle, temperature, gas and smoke along with a smart phone to help driver achieve independent mobility. The wheelchair user can navigate himself around in 4 directions by just tilting his smart phone. This approach allows the user to synchronize the movement of his wheelchair with the smart phone's human voice or gesture recognition capabilities. The complexity decreases by using smart phones in order to obtain a compact system. The research paper [4], has emphasized on creating a gesture interaction method which is developed to control the mobile service robot. A new detecting method was proposed in this paper which fused skin colour method and deep information. The whole system can identify the user's intention by the gesture interaction system and adjust the speed and direction of the robot according to the result of gesture recognition in real time. They have made use of kinetic cameras for hand gesture recognition. The authors of the research paper [5], have worked on making the movement of Quadriplegic better with the help of hand gestures as they use the wheelchair. The movement of their hands in the forward, backward, left and right direction will accordingly move the wheels of the wheelchair which use DC motors for the movement of the wheels. Also, the use of RF transmitting unit is used instead of IR because of the accuracy provided by the RF sensors is measured to be better. Megalingam, Rajesh Kannan, et al. [6], have created an HanGes application which uses the patient's entire palm for movement in any direction. The system HanGes, comprises of a gesture tab that includes sensors like the IR and MCU and a management circuit that are specifically designed to identify and recognize gestures. They have also implemented a controller for driving motors. Placing the hand on the Gesture pad and changing the direction of the palm horizontally moves the wheelchair. The drawback of this system would be the absence of an external mobile application and also lack of obstacle detection capability. The paper by Tao Lu [7] is related to develop a motion control system of intelligent wheelchair based on hand gesture recognition for those with physical accessibility problem. This paper depicts the accelerations of a hand in motion in three directions detected by a MEMS accelerometer and are transmitted to a computer via a wireless Bluetooth protocol. They developed automatic gesture segmentation algorithm to identify individual gestures in a sequence and the Hidden Markov Model (HMM) is used for the hand gesture model training. Then they combined the trained gesture model and Bayes method to recognize the gestures from the sensing data sequences. As the gestures got transferred into corresponding directions for the wheelchair's movement, S-Curve function was adopted to connect the velocities of the neighbouring directions. This helped them ensure the wheelchair's motion to be smoother. The simulations carried out by them showed the effectiveness of recognition method and smoothed motion of intelligent wheelchair under control.

III. SYSTEM DESIGN

The accelerometer at the transmitter end will be controlled by the patient and will sense the hand movement of the patient which will then transmit data in form of radio signals to the microcontroller at the receiver end via the radio unit called RF-433Mhz transmitter receiver module which uses IEEE 802.15.4 protocol for wireless transmission.

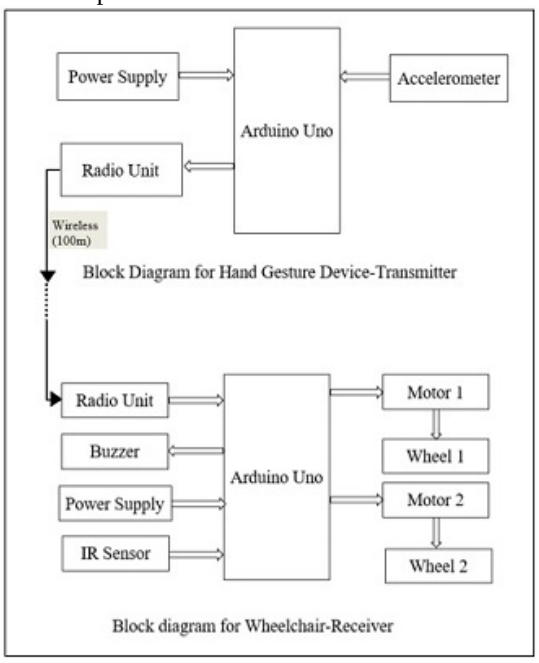

Fig. 1.System Design

The receiver end consists of the microcontroller which analyses the signals and accordingly directs the motion of the motor leading to the movement of the wheels. An IR sensor is used as an obstacle detection facility which takes input from the surrounding and alerts the patient via buzzer if any obstacle or object is detected on the path of motion.

IV. RESULTS

Accelerometer with Arduino:

An accelerometer sensor is used to detect any change in movement or slight vibrations. These outputs display the XYZ coordinates which display the direction and the position of the device at which the acceleration occurred.

- Roll is the rotation about the X-axis.
- Pitch is rotation about the Y-axis.

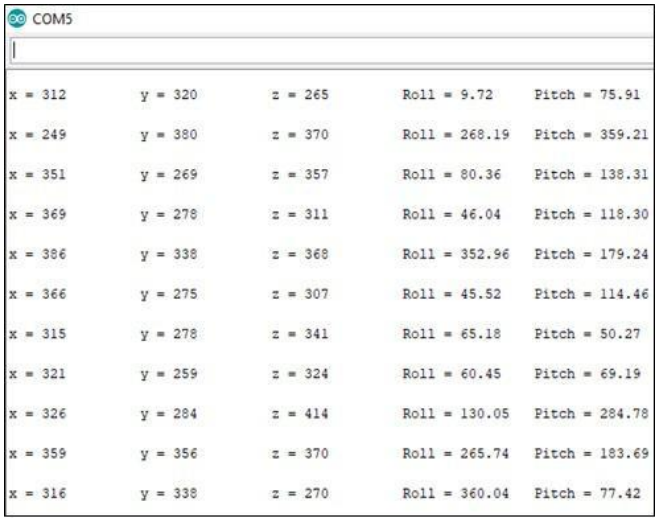

Fig. 2.Output on serial monitor

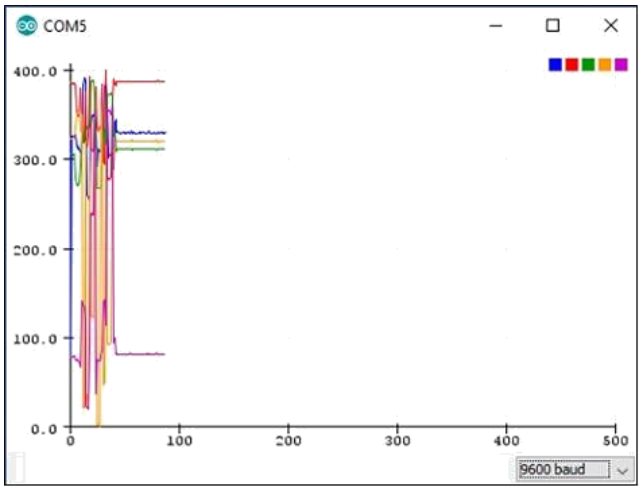

Fig. 3.Output on serial plotter

Every value of the accelerometer is displayed using the serial plotter in Arduino IDE. This feature helps to see a visual display and comparison of the three sets of inputs.
Ultrasound with Arduino

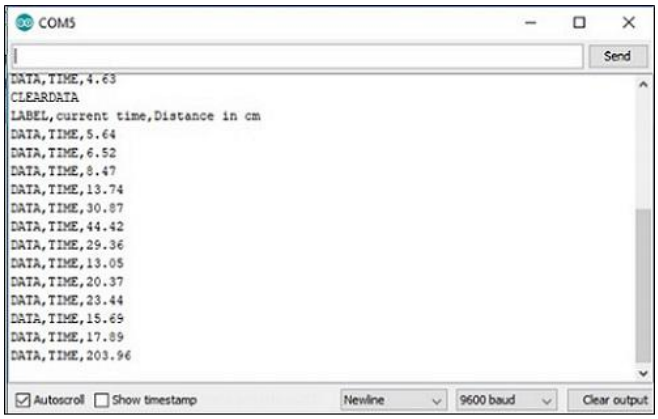

Fig. 4.Output on serial plotter of Ultrasonic sensor

The above image is used to show the data displayed on the serial monitor. It contains the values of distance in cm. This is the distance between the ultrasonic sensor and an obstacle.

The screen below is an added feature in Arduino IDE which allows visualisation of the data collected from the sensors in the form of a plot.

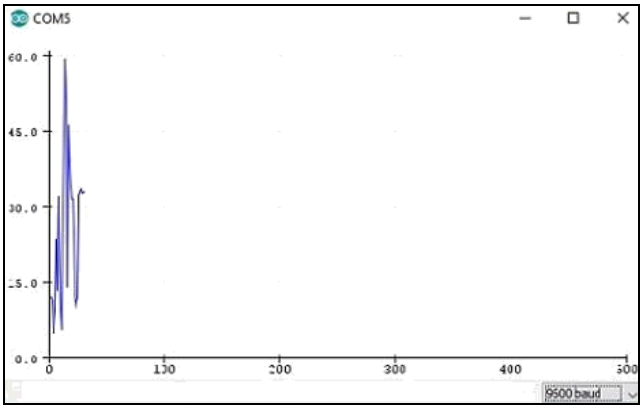

Fig. 5.Output on serial plotter

The following image shows the integration of the transmitter module of the wheelchair which consists of the Arduino Lilypad and the accelerometer which detects the motion of the hand in the specific direction. The transmitter module will be fixed on the hand glove for the patient to wear it and move it with ease.

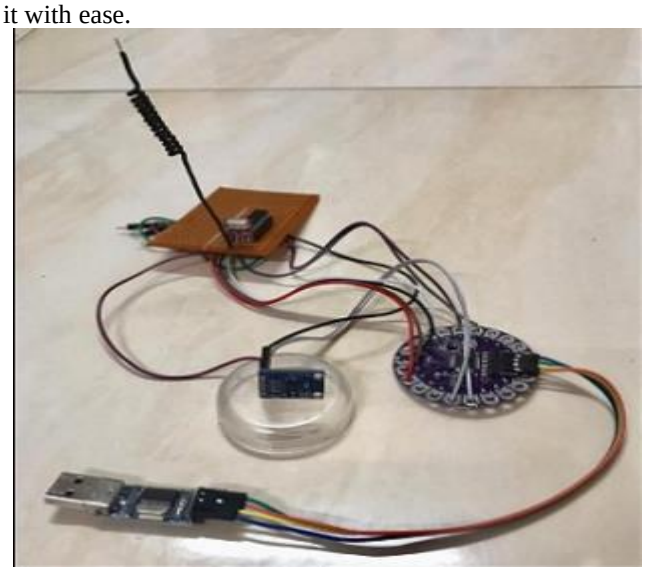

Fig. 6.Transmitter Module

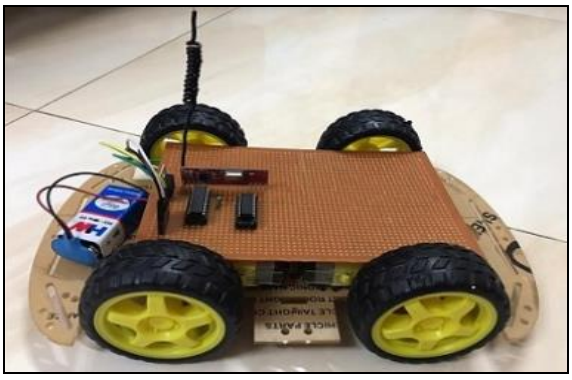

Fig. 7. Receiver Module

The Receiver Module is fixed on the wheelchair where in its connected to the wheels which detects the signals passed through the transmitter module and accordingly moves the wheels of the wheelchair in the required direction.

Fig. 8.Corresponding gestures to move the wheelchair

The pictures above represent the hand gestures required to move the wheelchair. The direction of the wheelchair is completely dependent on the gestures made by the patient sitting on it. The table below tells us how the hand gestures decide the direction of both the motors.

Table-I: Hand Gestures to direct the motor

Direction of hand gesture	Right motor movements	Left motor movements
Forward	Forward	Forward
Right	Stop	Forward
Left	Forward	Stop
Backward	Backward	Backward

We can hence say, that when both the wheels of wheelchair rotate in forward or backward direction then the wheelchair moves in the same direction. When the left motor rotates and the right motor shaft is at rest then the wheelchair turns right. Similarly, when the right motor rotates and the left motor shaft is at rest then the wheelchair turns left.

V. CONCLUSION

The goal of this project was to find an alternative solution for the wheelchairs present in the market and to do so by creating an affordable model. This empirical study shows how such a wheelchair model benefits from the use of different wireless technologies. The proposed system "Wireless Gesture Control Wheelchair" was designed to cater patients with various kinds of physical disabilities. Since the wheelchair moves according to specific hand gestures each corresponding to its own direction; complete ease of the patient has been kept in mind while making the system. We envisioned this system can be a better alternative to the joy-stick wheelchair model. As for future work, a statistical analysis of the prototype and its abilities to detect deviations in hand movements in multiple environmental settings is planned.

ACKNOWLEDGMENT

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Shanelle Fernandes is currently a final year B.E student of Information Technology affiliated with Mumbai University. She will be completing her undergraduate degree in 2020 and is focused on being a professional in the IT sector. She was drawn to subjects that helped her with this focus, some of those subjects are Database Management System, Internet of Things, Computer Networks, Website Designing, Cyber Security and Project Management. The various projects she has completed during her bachelor's degree are Smart Irrigation System related to Wireless Networks, Online Cleaning Service Website in the field of Web Development and an Automated Pill Dispenser in the IoT domain.

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