



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 5, May 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

9940 572 462

6381 907 438

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Gesture Controlled Assisting Chair with Fire Extinguishing System for Paraplegics

Surender S¹, Boopathirajan M², Jesslin Francis³, Yogul Kishore N⁴

Assistant Professor, Department of Medical Electronics, Velalar College of Engineering and Technology, Thindal, Erode, India¹

U. G. Student, Department of Medical Electronics, Velalar College of Engineering and Technology, Thindal, Erode, India²

U. G. Student, Department of Medical Electronics, Velalar College of Engineering and Technology, Thindal, Erode, India³

U. G. Student, Department of Medical Electronics, Velalar College of Engineering and Technology, Thindal, Erode, India⁴

ABSTRACT: Paraplegia refers to paralysis that occurs in the lower half of the body. Paraplegics will have mobility issues and may require the use of a wheelchair. This project presents a prototype of wireless gesture based assisting chair which can be controlled by hand gestures. The proposed system consists of a RF transmitter and receiver module for wireless transmission. The transmitter unit is made of NodeMCU and an accelerometer that has been attached to a hand glove. The accelerometer sensor identifies the movement of the hand in a specific direction which results in the motion of the wheelchair in the respective directions. The receiver unit consists of motor drivers that convert the voltage as needed by the wheels. Considering the safety of the user, a fire extinguishing system is added using flame sensor and dc pump.

KEYWORDS: Accelerometer, NodeMCU, RF Module, Flame sensor, Hand gestures, Paraplegics.

I. INTRODUCTION

The wheelchair is a means of transport used by people who have difficulty walking due to illness or disability. Today there are many options and many types of wheelchairs such as manual wheelchairs, electric wheelchairs and transport wheelchairs. Paraplegia is a form of paralysis that primarily affects lower body movement. People with paraplegia may not be able to voluntarily move their legs, feet, and sometimes their abdomen. They will have mobility problems and devices to support mobility, such as a wheelchair or a mobility scooter, are usually necessary. There are a wide variety of wheelchair types, which differ in the method of propulsion, control mechanisms and technology used. A motorized wheelchair, powerchair, electric wheelchair or electric powered wheelchair (EPW) is a wheelchair that is propelled by means of an electric motor rather than manual power [10]. Advances in smart wheelchair technology are at their peak. Wheelchair technology has evolved from manual wheelchairs to electric wheelchairs and then finally to robotic wheelchairs [6]. Wheelchairs come in a wide variety of formats to meet the specific needs of their users.

II. RELATED WORK

Chitte. P. P et al. (2016) have developed a hand gesture based wheelchair for physically handicapped person with emergency alert system. The system is classified into gesture units and wheelchair units. Accelerometer sensor control the movement of wheelchair based on user's hand gesture values which are given to lpc2138 microcontroller. ARM7 controller controls the wheelchair ways like left, right, forward & backward depending on the direction of acceleration [2].

Kalpana Lamb et al. (2016) have proposed an automatic bed position control system for disabled patients based on hand gesture recognition. Gesture input is given to microcontroller via RS-232 communication cable. The AVR ATMEGA-16 microcontroller processes this input and changes the position of the bed with the help of DC motors. Accelerometer is used as a sensor to detect and display patient fall [9].



Fahd N. Al-Wesabiet al. (2019) have proposed a smart cordless wheelchair using hand movements to help people with partial quadriplegia carry out their daily activities. The accumulator sensor is used to acquire hand movements and convert them to analog signals by using encoder and decoder protocols, and send them to other connected devices by using an RF transmitter and receiver. AT89C51 microcontroller analyses the encoded signals and translates them to useful commands. Arduino microcontroller (ATMEGA328P-PU) is directly connected to the wheelchair and moves it [5].

V. Sridevi et al. (2019) have developed a wireless wheelchair control based on automated gesture. This has been implemented using Arduino UNO and NANO processors. ATmega328 recognizes and decodes different gestures of the hand sensed by the accelerometer. In this system wheelchair is tracked through laptop for security of paralysed persons. The direction of the wheelchair is observed with the help of Arduino board. The wheelchair basically takes input from person hand gestures and values are displayed on laptop monitor [15].

J. Jalani et al. (2019) have developed an automatic firefighting robot. It uses 3 flame sensors to detect the fire. It is also equipped with 3 ultrasonic sensors for obstacle avoidance. Each sensor on the robot is controlled by the Arduino. Apart from the sensors, the robot is also equipped with the water tank that provides water once the fire is detected. When the flame sensors detected the fire, the robot will move to the fire source and send a warning message to the user. Once the robot reached the burning area, it will stop at a certain distance and extinguish the fire by using water [7].

The current solutions as far as aids for locomotion are concerned, have a variety of control systems based on the degree of disabilities being addressed. The common among these are mouth stick based control, keypad based control, joystick based control and brain actuated wheelchair control. In severe cases of paralysis direct neural control, pupil tracking control, head movement based control and tongue based control are used. They include ARM7 controller, Arduino UNO and NANO processors, IR-led and TSOP pairs, MEMS sensor, Bluetooth based control, joystick based control, and image processing. The main shortcomings are that they are far too expensive and suitable only for niche use. Such solutions are difficult to use because movements such as pressing buttons or controlling a joystick are impossible for those who lack fine motor control. These technologies are not comfortable enough that they had to put a significant amount of force in order to operate the wheelchair.

III. METHODOLOGY

Proposed Method:

The proposed system is based on gesture recognition which consists of NodeMCU, accelerometer, RF module and flame sensor. The objective of the project is to make a gesture controlled assisting chair to help paraplegics in moving from one place to another by giving direction from the hand. This system helps paraplegics in moving to the desired location with the help of hand gestures which controls the movement of the chair.

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 microcontroller and an accelerometer sensor which calculates the hand motion, and will give patients the independence of using the wheelchair without the help of any other person. It is also easy to control and user friendly. The system will be effective in reducing the physical effort the user has to apply for locomotion. This system also protects the user from fire by detecting and extinguishing it.

i. Transmitter:

An RF transmitter module is a small PCB i.e., printed circuit board sub-assembly capable of transmitting a radio wave and modulating that wave to carry data. Transmitter modules are usually implemented alongside a micro controller which will provide data to the module which is transmitted. RF transmitters are usually subject to regulatory requirements which dictate the maximum allowable transmitter power output, harmonics and band edge requirement. When powered on, the transmitter part, which consists of Microcontroller, Encoder and RF Transmitter, will continuously monitor the accelerometer sensor. This data is captured by the NodeMCU, which then transmits a corresponding data to the Encoder, based on the orientation of the Accelerometer Sensor. The parallel data received by the encoder is converted into serial data and this serial data is transmitted by the RF Transmitter.

ii. Receiver:

An RF Receiver module is a 433 MHz radio receiver receives the modulated RF signal, and then it demodulates. Based on the input codes master will give command to slave microcontroller and rotation of wheels is controlled. L293D is a dual H-bridge motor driver integrated circuit (IC). Motor drivers act as current amplifiers as they take a low-current control signal and provide a higher-current signal. This higher current signal is used to drive the motors. L293D contains two inbuilt H-bridge driver circuits. The motor operations of two motors can be controlled by input logic. When an enable input is high, the associated driver gets enabled. As a result, the outputs become active and work in phase with their inputs. Similarly, when the enable input is low, that driver is disabled, and their outputs are off and in the high-impedance state. The RF Receiver receives the serial data and transmits it to the Decoder. The Decoder will convert the serial data to parallel data and this parallel data is given to the motor driver. Based on the data, the movement of the motors, and hence the movement of the chair is defined.

Block Diagram:

The accelerometer at the transmitter end will be controlled by the patient and will sense the hand movement of the patient, and is given to the microcontroller. The data is transmitted via the RF433 MHz transmitter and receiver module for wireless transmission. Based on the input given the direction of rotation of motor is controlled by the motor driver. The block diagram of the wheelchair control and fire extinguishing Circuits is shown in Fig. 1 and Fig. 2. If fire occurs, the flame sensor detects it and extinguishes (sprinkles water) with the help of dc pump.

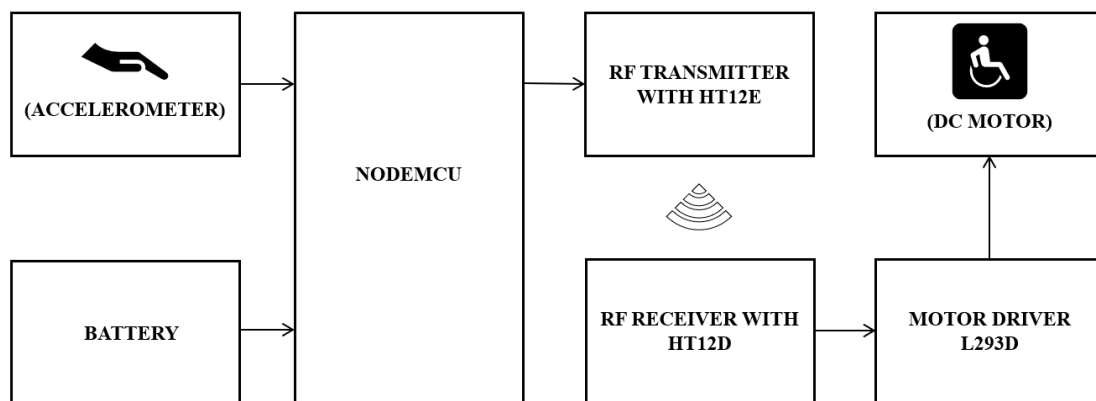


Fig. 1. Wheelchair Control System

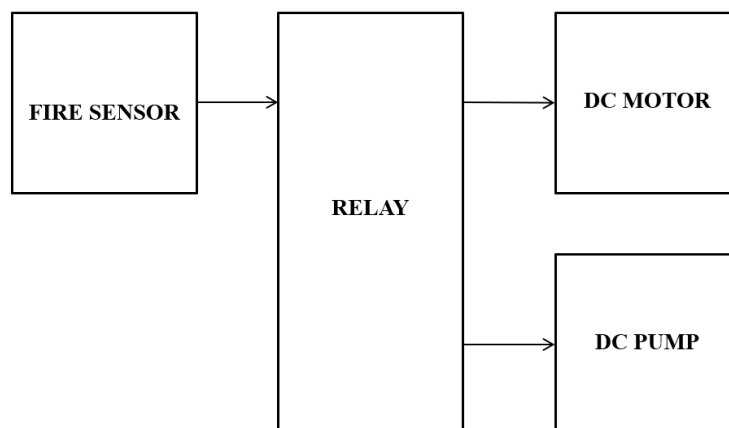


Fig. 2. Fire Extinguishing System

System Requirements:

- **Accelerometer:** An accelerometer is a tool that measures the vibration, or acceleration of movement of a structure. The pressure resulting from vibration or a extrude in movement (acceleration) reasons the mass to "squeeze" the piezoelectric fabric which produces an electrical rate this is proportional to the pressure exerted upon it. When acceleration is skilled through this device, the mass receives displaced until the spring can effortlessly circulate the mass, with the equal charge identical to the acceleration it sensed. Then this displacement price is used to degree the acceleration. Accelerometers are to be had as virtual gadgets and analog gadgets. Accelerometers are designed for the use of distinct methods. Piezoelectric, piezoresistive and capacitive additives are usually used to transform the mechanical movement induced in accelerometer into an electrical signal.

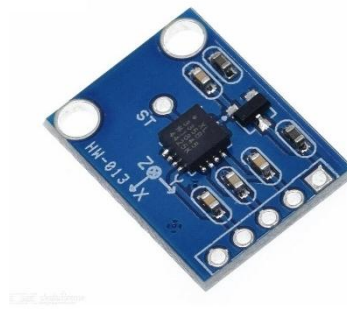


Fig 3. 3-axis accelerometer

- **NodeMCU:** NodeMCU is a fully open Lua-based firmware and enhancement board specially designed for fully IoT-based applications. It consists of firmware that runs on the Espressif Systems ESP8266 WiFi SoC and hardware based primarily on the ESP12 module. The NodeMCU ESP8266 improvement board comes with the ESP-12E module containing the ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. This microprocessor assists RTOS and operates at an adjustable clock frequency of 80 MHz to one hundred and sixty MHz. NodeMCU has 128 KB RAM, 4MB of Flash reminiscence to save facts and programs. Its excessive processing electricity with in-constructed Wi-Fi / Bluetooth and Deep Sleep Operating functions make it best for IoT projects. NodeMCU can be powered via Micro USB, VIN (External Supply Pin) socket. Supports UART, SPI and I2C interfaces.



Fig 4. NodeMCU

- **RF Module:** The 433 MHz Module is a pair of transmitter and receiver electronic modules. It sends and receives radio signals between two devices. This module uses a serial data input and transmits it to the 3-meter range but the range is extendable upto 100 meters. In general, the wi-fi structures has overriding constraints. It should function over a positive distance and switch a positive quantity of statistics inside a records rate. The RF modules are very small in measurement and feature, a huge running voltage variety i.e., 3V to 12V. Basically, RF modules are 433 MHz transmitter and receiver modules. The transmitter attracts no energy whilst transmitting, at the same time as completely suppressing service frequency as a consequence notably low energy in battery operation. When good judgment one is dispatched service is completely directed to approximately 4.5 mA with a 3volt supply. The records are dispatched serially from the transmitter that is

acquired through tuned receiver. Transmitter and receiver are interfaced with 2 microcontrollers for record change.

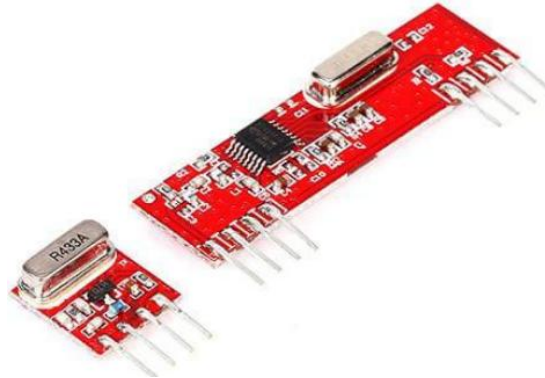


Fig 5. 433 MHz RF transmitter and receiver

- *Motor Driver:* The L293D IC is a well-known motor motive force IC that permits the DC motor to exercising in any direction. This IC consists of 16-pins which is probably used to control a tough and speedy of DC vehicles right away in any direction. This means that by using an L293D IC, we would be able to control two DC motors. In addition, it can drive small and large motors. It works on the basic principle of H-bridge, this motor driver circuit allows the voltage to flow in any direction. We know that voltage must change direction for the DC motor to spin in both directions. H-bridge circuit using L293D ICs is best for driving a motor. L293D single IC consists of two H-bridge circuits, which can run two DC motors. Generally they are used in robotics due to its size to control DC motors.



Fig 6. L293D motor driver IC

- *Fire Sensor:* It detects as well as responds to the occurrence of a fire or flame. It works based on the concept that when a flame or fire is burning it emits IR signals. It includes an alarm system, a natural gas line, propane, fire extinguishing system. It is used in industrial boilers.



Fig 7. Flame Sensor



Circuit Diagram:

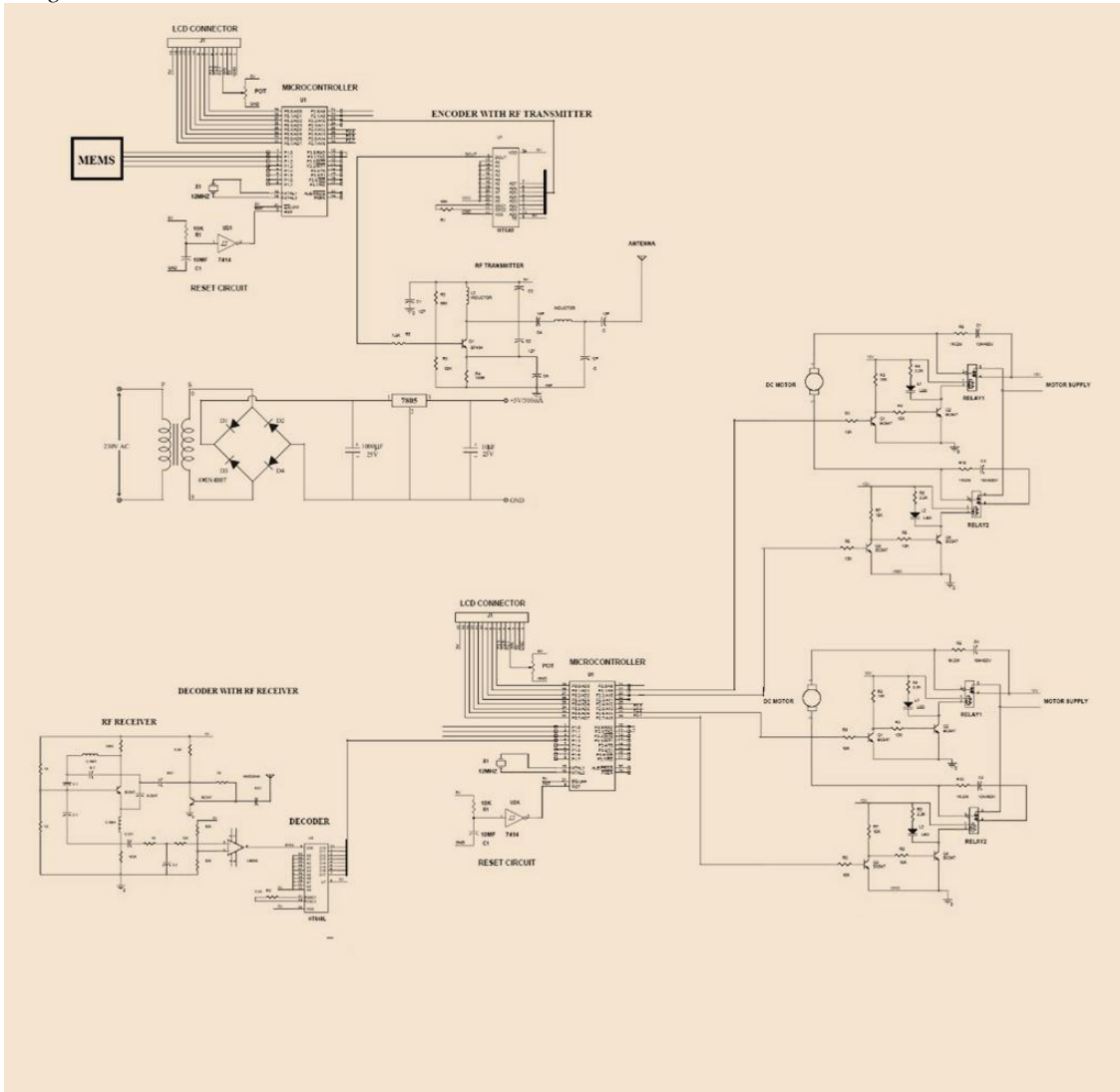


Fig 8. Wheelchair Control Circuit

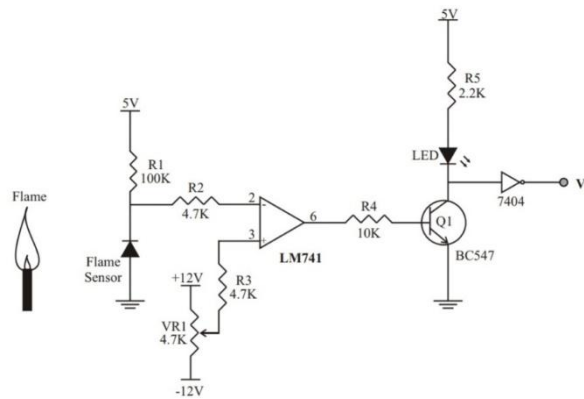


Fig 9. Fire Extinguishing Circuit

IV. EXPERIMENTAL RESULTS

The “Table 1” indicates how the hand gestures determine the path of each the motors.

Table 1 Hand Gestures to direct the motor

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

Hence 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.

The system also detected the fire and extinguisher was released (sprinkled water) with the help of dc pump.

In future the proposed system may be designed to identify a greater number of gestures for higher level performance. Multiple control options can be provided for safety and for use in different environments. GSM can be embedded in the present work to extend features like sending messages during an emergency. To increase the speed of the wheelchair, DC motors can be replaced by servo motors. It can also be designed to control household devices. Speed control and autonomous control feature can be added. Self-power generating from the rotation of the wheel can be done in the future. The device can be made more flexible by placing solar power supply so the anxiety about charging the battery can be reduced.

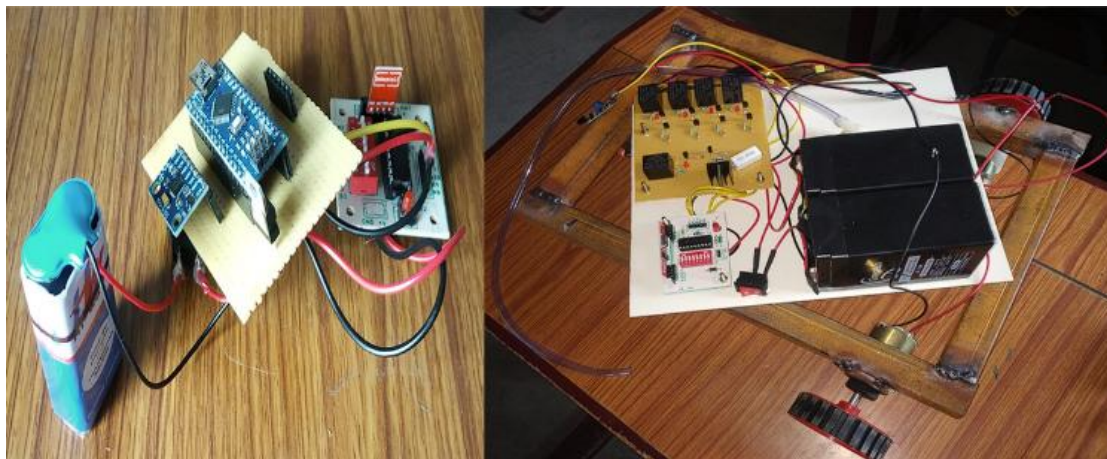


Fig .3. Wheelchair Control and Fire Extinguishing Modules

V. CONCLUSION

A prototype for gesture based wheelchair control to assist paraplegics has been developed in this project. The complete ease of the patient has been kept in mind while making the system and is designed such that, the command to navigate in specific direction in the environment is based on the hand gestures provided by the user. Hand Gesture Controlled System gives a more natural way of controlling devices. Since the system has a wireless transmission, it can be worn on either hand for convenience and smooth navigation. This system is cost effective, easy to control, user friendly and ensures flexibility and mobility for the users. The system assures the safety of the user from fire by extinguishing it. It also eliminates the aid of an external person, and reduces the physical effort the user has to apply for locomotion.



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