# Direction Control of Wheelchair Based on Hand Gesture Recognition Utilizing AVR Microcontroller

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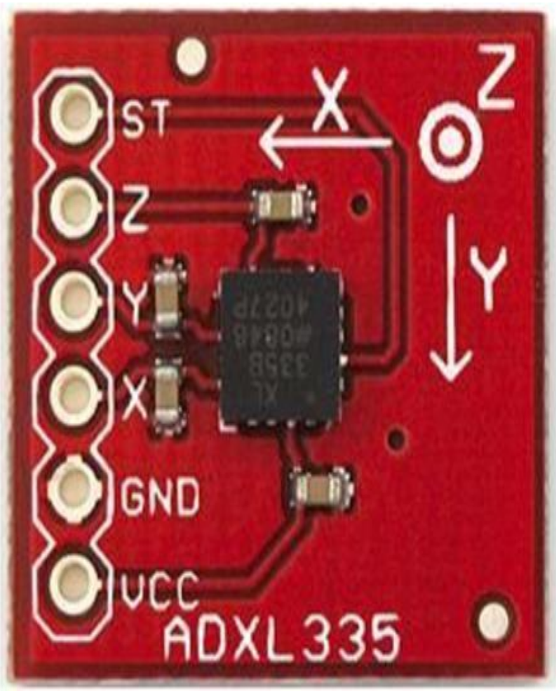
***Abstract*- In the modern world, individuals with physical disabilities and the elderly often rely on others for assistance. However, as society becomes increasingly fast-paced, many people find it difficult to dedicate time to caregiving. Automated wheelchairs offer a solution for easy transportation for those with physical impairments. This study aims to design and develop a wheelchair controlled by hand gestures using a Gesture Control System. Wheelchairs are essential for individuals unable to walk due to physical limitations, injuries, or disabilities. Recent advancements show significant potential in creating hand gesture-based or smart wheelchairs. This paper introduces a gesture-based wheelchair using an accelerometer sensor, which allows the user to control the wheelchair's direction through hand movements. We present a model for a hand gesture-controlled user interface, highlighting current technology trends, applications, and usability. Our integrated approach for real-time detection employs a hand gesture-based data glove technique, utilizing an accelerometer sensor to control the wheelchair with hand movements. This study proposes a low-voltage, low-cost, and compact 3-axis wireless system to manage the wheelchair via an AVR microcontroller.**

***Keywords:* microcontroller, accelerometer sensor, wheel chair control, hand gesture recognition, RF module**.

## INTRODUCTION

The goal of this project is to design and develop a smart wheelchair that can be easily controlled through a hand gesture recognition system. This innovative solution is particularly beneficial for the mobility of physically disabled and elderly individuals, allowing them to navigate using hand movements alone. The project employs an accelerometer module for gesture recognition, which is a critical component. The hand's movements are detected by the accelerometer sensor. The wheelchair control system is built using a MEMS accelerometer sensor, an AVR microcontroller, a motor driver IC, and an RF module. Specifically, the L293D IC is used as the motor driver to control the wheelchair's motors. This hand gesture-based wheelchair minimizes the effort required by physically disabled individuals and the elderly, enabling them to live more independently in today's fast-paced world. It is user-friendly and designed to be operated by those in need.



The primary aim of this project is to create a wheelchair that can be controlled by physically disabled individuals through simple hand movements, allowing the wheelchair to move forward, backward, left, and right with ease.

This project seeks to support individuals with physical challenges who require assistance to move. The wheelchair incorporates a MEMS accelerometer sensor for detecting hand movements, an AVR microcontroller unit for decision-making, and motors for navigation controlled by the L293D motor driver IC. By tilting the accelerometer sensor through hand movements, users can quickly and easily direct the wheelchair in four directions. The use of a small MEMS accelerometer sensor, which can be conveniently placed on the patient's fingertips, reduces the complexity of previous systems. Gesture control wheel chairs are extensive employed in human for non-verbal communication, in which the accelerometer is used control the gesture controls using the movements of the hand and hand gesture also making the system very less complex and The MEMS accelerometer sensor used for gesture recognition and movement control is a lightweight, highly sensitive microelectromechanical sensor capable of quickly detecting tilt. This sensor identifies tilt and uses this information to change the direction of the wheelchair based on hand movements. With this highly sensitive sensor, the wheelchair's direction can be easily controlled by hand movements alone. The MEMS accelerometer sensor allows for precise control of the wheelchair in left, right, forward, and reverse directions. It is one of the best sensors available for motion and hand gesture detection. .

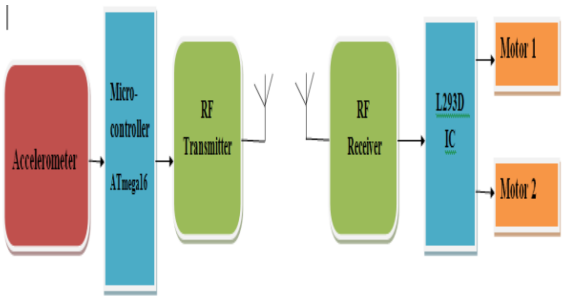



Figure 2: Basic block diagram of hand gesture basedwheel chair direction control

The entire device is portable and can be operated wirelessly, making it suitable for use anywhere. This system employs an AVR microcontroller, programmed with embedded C instructions using WinAVR or Notepad++ software. The AVR microcontroller facilitates communication with the transmitter and receiver modules designed for this project. The MEMS sensor detects tilt and provides this information to the microcontroller, which then issues movement instructions—left, right, forward, and backward.

The controller interfaces with two DC motors through a motor driver IC, which manages the wheelchair's direction. The device operates wirelessly, using hand movements detected by the highly sensitive accelerometer sensor. The microcontroller is loaded with a program written in embedded C. This program generates a .hex file, which is then used to load the instructions into the microcontroller.

****Technology****

This project utilizes MEMS accelerometer-based hand gesture technology. An accelerometer measures changes in speed (acceleration) of the object it is mounted on. It is a crucial sensor in many applications due to its ability to quickly detect a wide range of motions. The accelerometer is an electromechanical device that measures acceleration forces in three directions relative to gravity.

The accelerometer's ability to quickly measure speed changes makes it ideal for controlling the wheelchair's direction. It is an integrated circuit (IC) that measures motion and intensity in all three axes, generating analog signals proportional to acceleration. These analog signals, corresponding to movements in the X, Y, and Z directions, are captured by the highly sensitive accelerometer sensor.

The primary goal of gesture control recognition research is to develop a system that can identify specific human gestures and use them to convey information or control devices. Various types of gesture recognition sensors exist, including those for hand, face (emotion), and body gestures.

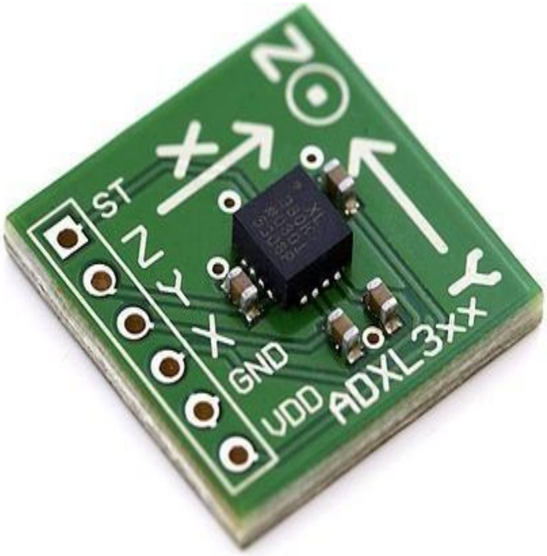



Figure 3: An Accelerometer sensor IC (ADXL3x)

**Table I: How to connect the pins of AccelerometerSensor**

| Pin No. | Use of pin |
|---|---|
| 1- VDD | On this pin we will give the +5volt supply. |
| 2- GND | We connect its pin no. 2 to the groundfor biasing. |
| 3- X | This pin is used receive the analog data for x direction movement. |
| 4- Y | This pin is used to receive the analog data for y direction movement. |
| 5- Z | This pin is used to receive the analog data for z direction movement. |
| 6- ST | This pin is used to set the sensitivity of accelerometer 1.5g/2g/3g/4g. |

In this project, we utilize a hand gesture recognition system to control the wheelchair through hand movements detected by an accelerometer sensor. Hand gesture recognition offers an intuitive and highly adaptive interface between machines and users. This technology enables the operation of complex machines using simple hand movements, making it an excellent choice for our application.

****Design Proposed****

The proposed design for this real-time embedded system is based on hand gestures interfaced with an AVR ATmega16 microcontroller. The MEMS accelerometer sensor is used to control the wheelchair's direction through hand movements. This design significantly reduces the effort required by elderly or physically challenged individuals who rely on others for mobility. With this system, these individuals can move independently from one place to another. help of the hand gesture based wheel chair that is control by their hand movements easily. It is the portable.

To implement this design, the key components include the accelerometer module, AVR microcontroller module, transmitter module, receiver module, and the L293D IC for driving the DC motors, forming the motor driver module. The transmitter module sends signals detected by the accelerometer sensor, which is attached to the user's hand. The receiver module receives these signals and, through the microcontroller, controls the wheelchair's movement according to the instructions provided. The receiver module is connected to the L293D motor driver module to manage the wheelchair's direction.

Before implementing the hardware, we verify the design and programming using Proteus software. This software allows us to simulate the design and check its functionality using the program's hex file. By creating a virtual version of the hardware design in Proteus, we ensure that the system works correctly before actual hardware implementation. The Proteus simulation of the project is shown in the accompanying figure..

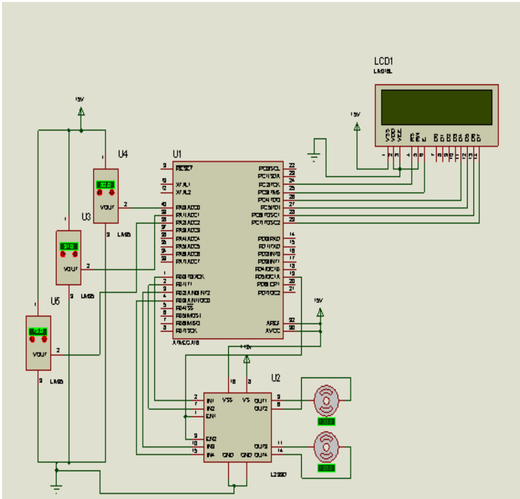


Figure 4: protues design

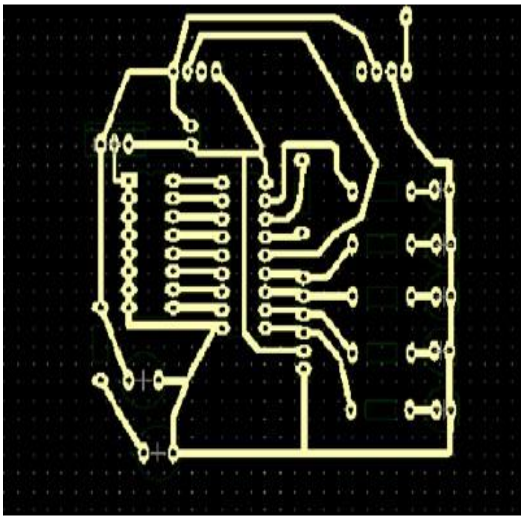


Figure 5: PCB Layout of RF Receiver

After completing the PCB, we drill holes and mount the components onto it. Once the components are mounted, we solder them to finalize the design. Prior to soldering, we ensure each component functions correctly. After assembling the components on the PCB, we thoroughly check all connections and component ratings.

With the hardware design fully implemented, we load the program's .hex file into the microcontroller and verify the device's performance. After these checks, our hardware implementation is complete, and the device is operational.

**PROGRAMMING**

The programming of this design is written in the embedded-C language using Win AVR or notepad++ software. After properly run this programme, the .hex file of this programme is generated. This .hex file of programming is used to load in the microcontroller IC, which is AVR microcontroller in this project. After load this .hex file or programming the microcontroller is work properly with the given instruction of the programme.

```
#include <avr/io.h> #include <util/delay.h>#include <stdio.h> #include<inttypes.h> #define RS PC2 #define E  PC3
#define D4 PC4#define D5 PC5#define D6 PC6#define D7 PC7
#define output_low(port,pin) port &= ~(1<<pin) #define output_high(port,pin) port |= (1<<pin) #define
set_input(portdir,pin) portdir &= ~(1<<pin)#define set_output(portdir,pin) portdir |= (1<<pin) #include<lcd.h>
int channelselect(char);unsigned int l;
```

```
char n[5],m[5],p[5];int temp=0; unsigned int l;
char n[5];
int x,y,z;
int main(void)
{
DDRC=0XFF; InitLCD(); DDRA=0X00; DDRD=0XFF; PORTD=0x00;DDRB=0XFF; PORTB=0X00;
ADCSRA=0X87;//10000111 ADMUX=0xC0;
TCCR1A=(1<<WGM10)|(1<<COM1A1)|(1<<COM1A0);
//enable fast pwm in inverting mode, 8 bit pwm
TCCR1B=(1<<CS11)|(1<<WGM12);
int x,y,z; WriteStringToLCD("Welcome");
//ShiftLCDLeft(16);
_delay_ms(100); ClearLCDScreen(); GoTo(0,0);
WriteStringToLCD("X:"); GoTo(6,0);
WriteStringToLCD("Y:"); GoTo(11,0);
WriteStringToLCD("Z:"); while(1)
{
//ClearLCDScreen();x=channelselect(0);
_delay_ms(1); y=channelselect(1);
_delay_ms(1); z=channelselect(2);
_delay_ms(1); GoTo(0,1);
sprintf(m,"%d",x); WriteStringToLCD(m); GoTo(6,1);
sprintf(n,"%d",y); WriteStringToLCD(n); GoTo(11,1);
sprintf(p,"%d",z); WriteStringToLCD(p);
if(x>340 && x<350 && y>330 && y<350)
{
PORTB=0X00;
_delay_ms(100);
}
if(x>350)
{
PORTB=0X01;
temp=((x-350)*255)/63; OCR1AL= 255-temp;
}
if(x<340)
{
PORTB=0X04;
temp= ((255/63)*(340-x)); OCR1AL= 255-temp;
}
if(y>350)
{
PORTB=0X05;
//output_low(PINB,7); temp=((y-350)*255)/65; OCR1AL= 255-temp;
}

/*if(y>370 && y<381)
{
OCR1AL=0;
_delay_ms(10);
}
if(y>381 && y<392)
{
OCR1AL=64;
_delay_ms(10);
}
if(y>392 && y<403)
{
OCR1AL=128;
```

```
_delay_ms(10);
}
if(y>403 && y<415)
{ OCR1AL=192;
_delay_ms(10);
} */
//} if(y<330)
{
PORTB=0X0A;
//output_low(PINB,7); temp= ((255/53)*(330-y));
OCR1AL= 255-temp;
/*if(y>317 && y<330)
{
OCR1AL=0;
_delay_ms(10);
}
if(y>304 && y<317)
{
OCR1AL=64;
_delay_ms(10);
}
if(y>291 && y<304)
{
OCR1AL=128;
_delay_ms(10);
}
if(y>277 && y<291)
{
OCR1AL=192;
_delay_ms(10);
}  */
}
_delay_ms(100);
}
return 0;
}
int channelselect(char a)
{
ADMUX=0b11000000; ADMUX=ADMUX+a;
ADCSRA|=(1<<ADSC);
//ADCSRA&=(0<<ADIF);
//ADCSRA|=(1<<ADATE); while((ADCSRA&(1<<ADIF))==0);
/*PORTD=ADCH;PORTB=ADCL; l=ADCH;
_delay_ms(100);sprintf(n,"%d",l);

ClearLCDScreen(); WriteStringToLCD(n);*/ return(ADCL+(ADCH*256));
```

**Conclusion**

The accelerometer is an ideal sensor for implementing a hand gesture-based control system due to its high sensitivity and ability to quickly detect a wide range of motions. In this project, we selected the accelerometer because it is compact, requires low supply voltage, is cost-effective, and excels in detecting precise movements. These attributes make it perfect for our goal of controlling a wheelchair's direction through hand gestures, making the device practical and efficient.

This design primarily benefits physically challenged or elderly individuals who rely on others for mobility. With this system, they can move independently by simply using hand movements to operate the wheelchair.

The device is user-friendly and consumes very little power while functioning effectively. Additionally, it allows for control over the wheelchair's speed and direction, enhancing the user's overall experience.

Designed to be easily operable by physically challenged or elderly individuals, this system is also cost-effective and energy-efficient, ensuring accessibility and convenience for its users.it is also designed at the low cost and low supply.

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