HAND GESTURE CONTROLLED WHEELCHAIR

The project report submitted to

Veermata Jijabai Technological Institute, Mumbai

For the award of

DIPLOMA IN ELECTRONICS ENGINEERING

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Department of Electronics Engineering

Veermata Jijabai Technological Institute, Mumbai

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Veermata Jijabai Technological Institute, Mumbai

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Department of Electronics Engineering

Approval of the Guide and the External Examiner

Certified on 20/06/2022, that the project titled "Hand Gesture controlled Wheelchair" has been submitted by the following Project group:

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to the Veermata Jijabai Technological Institute, Mumbai for the award of DIPLOMA IN ELECTRONICS ENGINEERING and that the students have successfully examine in the viva voce examination held today.

Signature:

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CERTIFICATE

ACKNOWLEDGEMENT

The success and final outcome of this project required a lot of guidance and assistance from many people and we are extremely privileged to have got this all along the completion of the project. All we have done is only due to such supervision and assistance and we would not forget to thank them.

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Thank You Again!

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DECLARATION

We certify that,

- The work contained in this report is original and has been done by me under the guidance of my guide.
- The work has not been submitted to any other Institute for the award of my diploma, or certificate.
- We have followed the guidelines of the Institute in preparing the thesis.
- Whenever we have used materials (data, theoretical analysis, figures, text, etc.) from other sources, we have given due credit to them by citing them in the text of the thesis and giving their details in the references necessary.

Sr No	Name of Student	Signature
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LIST OF ABBREVIATIONS

In alphanumeric order

₹	Rupees
A	Ampere
cm	Centimetre
CRPD	Convention on the rights of person with disabilities
DC	Direct Current
EEPROM	Electrically Erasable Programmable Read Only Memory
GND	Ground
I2C	Inter Integrated Circuit
IDE	Integrated Development Environment
KB	Kilo Bytes
Kg	Kilograms
LED	Light Emitting Diode
Li-Po	Lithium Polymer
mA	Milli Amperes
MHz	Mega Hertz
MISO	Master Input Slave Output
MOSI	Master Output Slave Input
PCB	Printed Circuit Board
PWM	Pulse Width Modulation
RPM	Revolutions per minute
SCL	Serial Clock
SDA	Serial Data
SRAM	Static Random Access Memory
SS	Slave Select
UART	Universal Asynchronous Receiver Transmitter
UN	United Nations
UNICEF	United Nations Children's Emergency Fund
USB	Universal Serial Bus
Vin	Voltage Input
WHO	World Health Organisation

CHAPTER 1

INTRODUCTION

This chapter consists of objective and motivation behind the project. It aims to broadly explain the need of an alternative solution in the market for the physically disabled people. Wheelchair - Device which we have been seeing from quite a long period of time, it has developed several folds but the solution to make one's life easier cost more than what an average disabled person can afford.

1.1 Objective

This project is an advanced approach of changing the physical gesture of hand into the electrical signal and then to process that signal into a digital signal of appropriate magnitude to be transmitted through the transmitter. This project provides an instrumental solution to the people who have difficulty in moving or their body parts have paralysed, or they have lost their limb in an accident. This wheelchair concept can bring a paradigm shift between man and machines much like many other machines have earlier succeeded in doing. This machine will be working on the user commands, we can also say it is a human machine interface. With the growth of technology there has always been an effort to use the technology for the betterment of mankind. Time and again the technocrats of the world have proved their metal in bringing comfort to the people who are in need of help of technology. Bringing the technology and economy parallel to each other is the major aim of this project. This project (Hand Gesture Controlled Wheelchair) is also aimed to provide a sound technology but low in cost. Today in this modern era around the world's 10%, around 650 million people are suffering from some or the other physical disability. In order to make their life better and easier, we decided to make this hand gesture-controlled wheelchair which also aligns with our group's primary aim, i.e., to make the physically disabled and special people with the help of technology whilst keeping economy factor in consideration. The disabled people always find it difficult to move from one place to other and in some situations even need the help of another person to push them/wheelchair. Now with the help of this wheelchair concept, the person can traverse from one point to another without a need to ask someone. Therefore, making the person self-dependent and confident in carrying out some of the basic tasks which were not possible earlier.

Fig 1.1 Ordinary Wheelchair

1.2 Motivation

The percentage of disabled people has increased in both rural and urban part of India. The Disability could be by birth or due to some medical or accidental reason. The motivation behind this project is these people themselves, the hardships faced by them every day, at almost every circumstance. We cannot really understand their pain but we can do our part by helping the people who actually need help. And this can be done by the help of technology and affordability. Today in India many people are suffering from disability, there are people whose lower half of the body is paralysed. Approximately 1 out of every 6 person is disabled in some or the other way.

For disabled people, a wheelchair is a vital piece of equipment. Majority of Wheelchairs are operated manually, which is extremely difficult for disabled person. To alleviate this difficulty, we designed a prototype of an automated wheelchair that can be operated with simple hand gestures. This wheelchair can also be controlled remotely, by another person or by the same which is an added benefit. The Project's main components are 3 Axis Gyro sensors and Accelerometer and Bluetooth module. Gyro sensors are utilised to detect hand gestures while maintaining the I2C Protocol. The Bluetooth Module is utilised to keep the wheelchair and the hand gesture controller connected wirelessly and communicate with each other. The Master is the Transmitting Gesture Controller and the Receiving unit is the wheelchair which also serves as the Slave. The fundamental end goal of this project was to develop new medical equipment that was cutting-edge in technology, simple to use, and cost-effective.

Fig 1.2 Disabled People

CHAPTER 2

LITERATURE SURVEY

This chapter consists of a Literature survey done by our group. This survey mainly focuses on the Disabilities prevailing in the world, its various causes and its effects. This chapter also highlights the percentage of Inclusion of Physical disability in the Health Sector. Thus, this chapter gives an overall view of statistics of disabled people and their various other complexes.

2.1 Disability

A disability is any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions).
Conditions such as **cerebral vascular accident, spinal cord injury, traumatic brain injury (TBI), cancer, amputation, musculoskeletal injury, or neuromuscular diseases** may result in impaired lower limb function and lead to considerable temporary or permanent disability.

Types of people who are Disabled:

a. Paralytic person.
b. Those who crawl.
c. Those who walk with the help of aid.
d. Those have acute and permanent problems of joints/muscles.
e. Those who have stiffness or tightness in movement or have loose, involuntary movements or tremors of the body or have fragile bones.
f. Those who have difficulty in motor cell and neurons coordination.

Fig 2.1 Group of Disabled Children

2.2 Symptoms and Causes

A physical disability is a limitation on a person's **Physical functioning, mobility, dexterity or stamina**. Other physical disabilities include impairments which limit other facets of daily living, such as respiratory disorders, blindness, epilepsy and sleep disorders. **Strictly speaking Locomotor Disability means problem in moving from one place to another** i.e., disability in legs. But, in general, it is taken as a disability related with bones, joints and Page 3 muscles. It causes problems in person's movements (like walking, picking or holding things in hand, etc.).

It is very important in the field of health-related research to study the causes of mortality and disability. The pattern of causes provides a clear and in-depth idea about the situation of the disease and injury prevalence in the population under study. There are numerous studies available worldwide (developed as well as developing countries) for causes of death, but very few such studies are available on the causes of disability in developing countries like India. Most often International agencies, governmental and non-governmental sources, mentioned the causes of disability are heredity, birth defects, lack of care during pregnancy and child birth, insalubrious housing, natural disasters, illiteracy and the resulting lack of information available on health services, poor sanitation and hygiene, congenital diseases, malnutrition, traffic accidents, work-related accidents and illness, sports accidents, the so-called diseases of ‘civilization' (cardiovascular disease, mental and nervous disorders, the use of certain chemicals, change of diet and life style etc.), marriage between close relatives, accidents at home, respiratory diseases, metabolic diseases (diabetes, kidney failure etc.), drugs, alcohol, smoking, high blood pressure, old age, chagus disease, poliomyelitis, measles etc.

What are the most common causes of disability?

- Illnesses like cancer, heart attack or diabetes cause the majority of long-term disabilities. Back pain, injuries, and arthritis are also significant causes.
- Lifestyle choices and personal behaviour that led to obesity are becoming major contributing factors.
- Musculoskeletal disorders are the #1 cause of disabilities. Examples include; arthritis, back pain, spine/joint disorders, fibro myositis, etc.

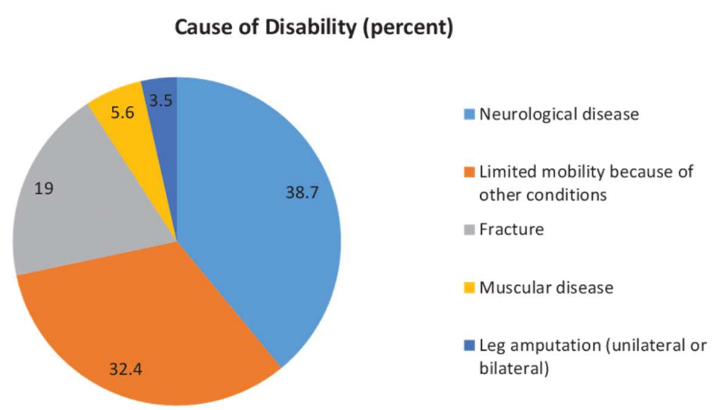


Fig 2.2 Pie Chart of Causes of Disability

2.3 Disability inclusion in the health sector

Disability is often not perceived as a health issue. Therefore, action is not taken towards disability inclusion in the health sector, which is also often overlooked in national disability strategies and action plans to implement and monitor the CRPD. Attaining the highest possible standard of health and well-being for all will only be possible if governments understand the need for a paradigm shift, recognizing that the global health goals can only be achieved when disability inclusion is intrinsic to health sector priorities, including:

- universal health coverage without financial hardship
- protection during health emergencies
- access to cross-sectorial public health interventions, such as water, sanitation and hygiene services.

Disability inclusion is critical to achieving universal health coverage without financial hardship, because persons with disabilities are:

- three times more likely to be denied health care
- four times more likely to be treated badly in the health care system
- 50% more likely to suffer catastrophic health expenditure.

Disability inclusion is critical to achieving better protection from health emergencies, because persons with disabilities are disproportionately affected by COVID-19, including:

- directly due to increased risk of infection and barriers in accessing healthcare
- indirectly due to restrictions to reduce spread of virus (e.g., disruptions in support services).

Disability inclusion is critical to achieving better health and well-being, because persons with disabilities are:

- 4–10 times more likely to experience violence
- at higher risk of nonfatal injury from road traffic crashes.

Children with disabilities are:

- three times more likely to experience sexual abuse
- two times more likely to be malnourished

Fig 2.3 Health Sector Icon

2.4 Statistical Overview on Disabilities

Around 15 per cent of the world's population, or estimated 1 billion people, live with disabilities. They are the world's largest minority. (WHO) This figure is increasing through population growth, medical advances and the ageing process, says the World Health Organization. (WHO) In countries with life expectancies over 70 years, individuals spend on average about 8 years, or 11.5 per cent of their life span, living with disabilities. (Disabled World) Eighty per cent of persons with disabilities live in developing countries, according to the UN Development Programme. (WHO) Disability rates are significantly higher among groups with lower educational attainment in the countries of the Organisation for Economic Co-operation and Development (OECD), says the OECD Secretariat. On average, 19 per cent of less educated people have disabilities, compared to 11 per cent among the better educated. In most OECD countries, women report higher incidents of disability than men. The World Bank estimates that 20 per cent of the world's poorest people have some kind of disability, and tend to be regarded in their own communities as the most disadvantaged. (World Bank) Women with disabilities are recognized to be multiply disadvantaged, experiencing exclusion on account of their gender and their disability. (Disabled World) Women and girls with disabilities are particularly vulnerable to abuse. A small 2004 survey in Orissa, India, found that virtually all of the women and girls with disabilities were beaten at home, 25 per cent of women with intellectual disabilities had been raped and 6 per cent of women with disabilities had been forcibly sterilized. According to UNICEF, 30 per cent of street youths have some kind of disability. (UNICEF) Mortality for children with disabilities may be as high as 80 per cent in countries where under-five mortality as a whole has decreased below 20 per cent, says the United Kingdom's Department for International Development, adding that in some cases it seems as if children are being "weeded out". (World Bank) Comparative studies on disability legislation shows that only 45 countries have anti-discrimination and other disability-specific laws.

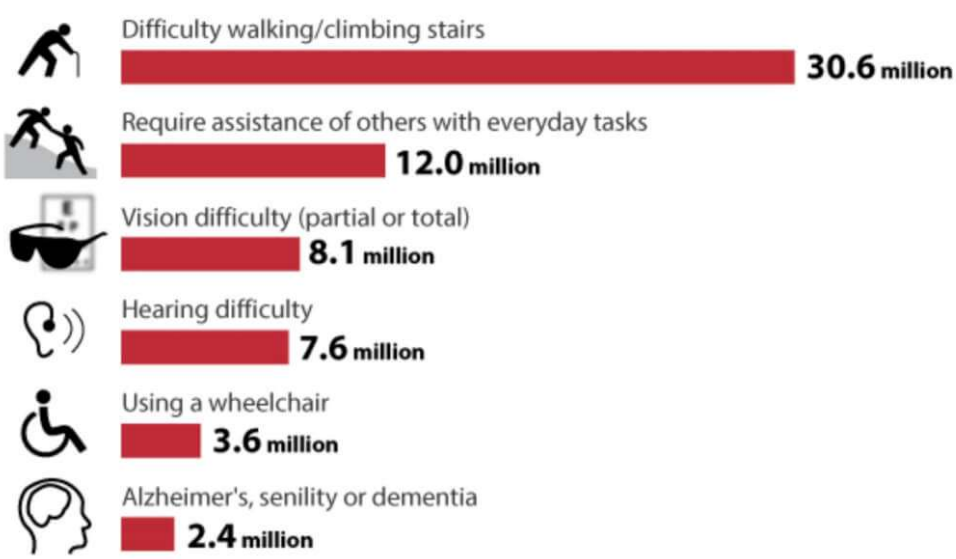


Fig 2.4 Statistical overview of Disabilities

CHAPTER 3

MARKET SURVEY

The following chapter is a Market Survey conducted by our group. The aim of this survey was to find out the prevailing solutions in the market to the problem we are addressing, i.e., physical disability. We found out that there are various alternatives available in the market which are much more advanced than the project we built but the economy factor loses in this situation. And that is exactly where our solution kicks in. The best alternatives we found are displayed below.

3.1 Frido GO Self Propelled Wheelchair

Fig 3.1 Frido GO Self Propelled Wheelchair

Frido GO SP, a rolling shower commode chair with a total width of 25 Inches for the narrow version and 27 inches for the wide version. Frido Go is designed and manufactured to the highest standards of assisted living mobility devices, specifically to cater to the daily common and traveling needs of individuals with spinal cord injury and physical movement related to mobility limitations. To cater to the daily or occasional travel needs of our users, The Frido GO SP has a quick and Easy Folding Mechanism and fits in a bag/suitcase which not only saves space while traveling but also can be carried with you at places. With the ease of our user & his/her family in mind, this rolling shower commode chair equips a swing-away armrest for easy wheelchair transfers and is also made up of stainless steel 304 for maximum protection against rust. With a Keyhole shaped cushion and the proven ability to roll over the commode directly, the Frido GO SP is designed to access toilets in a safe and dignified manner. The Frido GO SP also comes with a 2 level of height adjustments.

Estimated market price ₹ 41,999.00 per unit.

3.2 Kosmo Care Rider Wheelchair

Fig 3.2 Kosmo Care Rider Wheelchair

A reclining automatic wheelchair, it has an Aluminium frame and added features for comfort.

Features:

- Variable speed from 1 to 6 Km/hr. and extra power to take a 12-degree slope in its stride.
- Larger capacity Battery which helps It to travel up to 20 Km on a full charge.
- It has a reclining high back rest and comes with detachable and height adjustable armrests. The leg rests are detachable with calf support.
- Wider seats of 18" width, which are comfortably cushioned and added head rest.
- Extra strong frame can carry a load up to 125 Kg.

Estimated market price ₹ 1,01,400.00 per unit**.**

3.3 Kosmo Care Recliner Junior

Fig 3.3 Kosmo Care Recliner Junior

A fine quality wheelchair, it comes with reclining high back and extra cushioned upholstery. It is specially designed for children with cerebral palsy.

Features:

- Folding wheelchair with detachable; height adjustable desk jet armrest for easy transfer to/from bed & detachable footrest.
- Lightweight aluminium alloy anodized frame.
- Elevating footrests to rest legs at various levels and calf supports. Height adjustable and detachable head rest.
- A hydraulic reclining high back for a comfortable posture. Detachable back and seat cushion and an anti-tripping mechanism to prevent it from tipping when tilted.
- Hard cushioned seat and back. The smaller seat width of 15" (38 cm) with cloth look like water proof upholstery and a safety belt for added safety.
- Load carrying Capacity: 100 Kg/220 lb.
- Net Weight (approx.): 18.5 Kg/ 41 lb.

Estimated market price ₹ 28,405.00 per unit.

3.4 Freedom Power Wheelchair A08L

Fig 3.4 Freedom Power Wheelchair A08L

The Freedom Electric power wheelchair is a heavy-duty lightweight foldable automatic wheelchair with a lithium battery. This electric wheelchair has brushless motors, controlled by the joystick and joystick can be fixed on either armrest. Freedom Automatic wheelchair makes light work cobbled streets and rougher terrains. Height of the backrest is adjustable for the optimal comfort of the power wheelchair user. The electromagnetic brakes are automatically applied when the joystick is in the neutral position, preventing accidental rolling. The Joystick can be detached and keep safely when travelling.

FEATURES:

- This Electric Wheelchair Has Flip back armrests
- Detachable Joystick for extra safety of Electric wheelchair user
- Height Adjustable backrest for the optimal comfort of the wheelchair user
- Removable and tension adjustable backrest
- Detachable spacious storage bag
- Interchangeable joystick (left or right side)
- Brushless motors
- Extra space for 2 spare batteries
- Four suspensions for a smooth ride on rough terrain
- Seat Belt
- Speed controller

Estimated market price ₹ 1,20,952.00 per unit.

3.5 Our Wheelchair Model

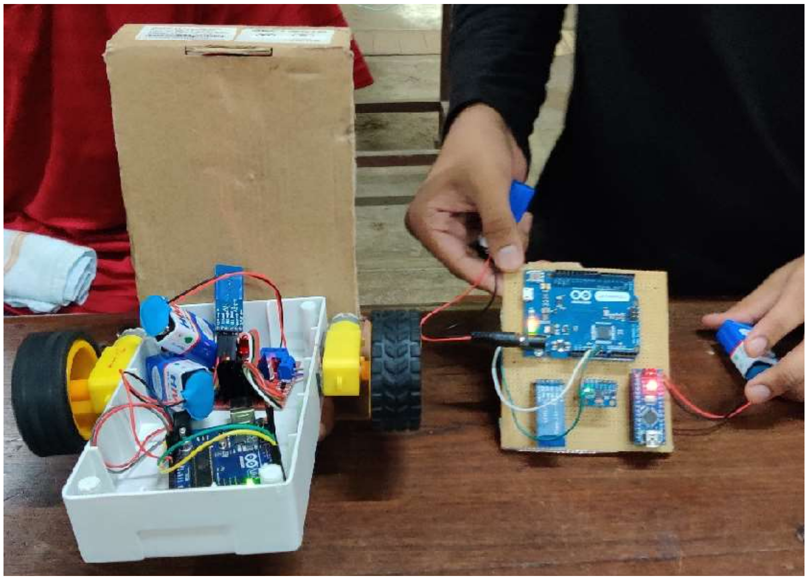


Fig 3.5 Wheelchair Model

Our project combines a hand controller and a wheelchair model to make a wireless system for controlling movement of a wheelchair through hand gestures. In addition to this, the use of low-cost Bluetooth Module and Arduino microcontrollers (Uno and Nano) bring down the cost to ₹ 1925. As we can see this is quite a low-cost device and also user friendly one. The components raw picture can be seen above, this was taken before covering the plastic case and putting on a Velcro band.

COMPONENTS	UNITS	COST (in ₹)	TOTAL COST (in ₹)
Arduino Nano	1	300	300
MPU6050 Module	1	100	100
HC-05 Bluetooth Module	2	250	500
Arduino Uno	1	500	500
L298N Motor Driver	1	100	100
150 RPM Single Shaft BO Motor	2	40	80
9v Battery	3	15	45
Li-Po Battery (3.7v)	1	200	200
Plastic Casing	1	60	60
Wheels	2	20	40
		TOTAL	₹ 1925

Table 3.5 Costing

CHAPTER 4
DESIGN OF PROJECT SETUP

This chapter shows us the Design of the Experimental Setup through 2 separate block diagrams and circuit diagram, one for the transmitter and other for the receiver. The Diagrams are shown separately for the ease of understanding. The power supply to the Transmitter is given by a 9v Battery and a Li-Po Battery. The receiver similarly is powered by two 9v Batteries. Further working of each block is explained in the following sections.

4.1 Block Diagram

1. **Transmitter Section**

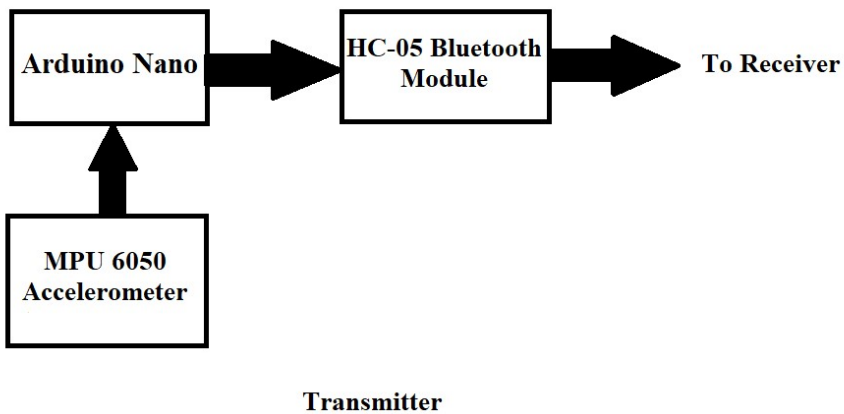


Fig 4.1.1 Transmitter Block Diagram

2. **Receiver Section**

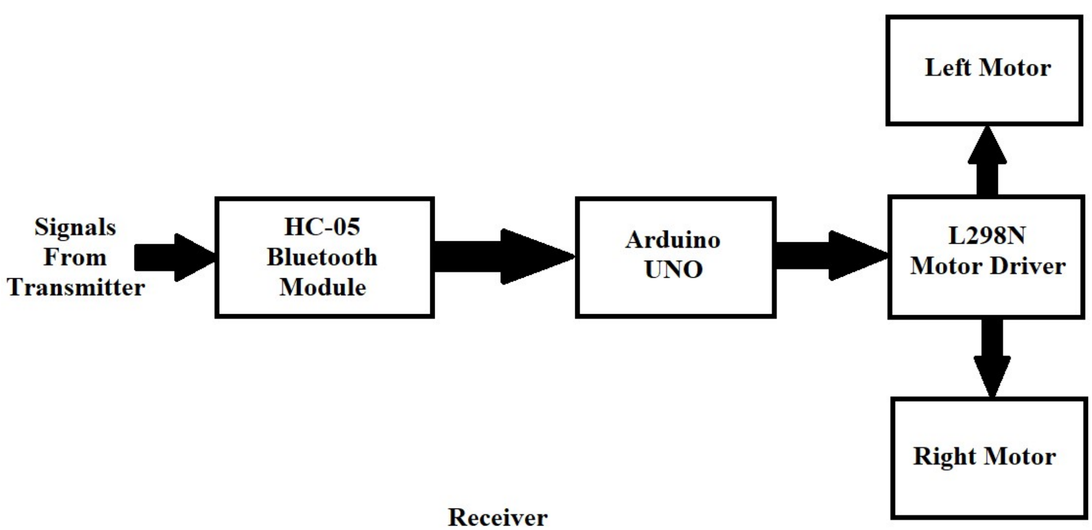


Fig 4.1.2 Receiver Block Diagram

4.2 Approach/Proposed Flow of Techniques

We have divided this project into two major segments i.e., the transmitter and receiver with each side containing 3-4 minor parts/segments.

Transmitter:

The transmitter side is basically made up of three main blocks namely the Arduino Nano, MPU 6050 accelerometer and the HC-05 Bluetooth module.

The MPU 6050 accelerometer is placed on the glove worn by the user and it provides its readings to Arduino Nano depending on the hand position.

The second block is the Arduino Nano which acts like the brain of the entire system controlling and using all other devices interfaced with it. The readings from the accelerometer are processed by the Arduino. Also, the Bluetooth module is connected to the Arduino so that it can send data wirelessly.

The third block is the HC-05 Bluetooth module which transmits the data from the Arduino wirelessly to another HC05 module and Arduino connected on the receiver side of the circuit.

The Arduino Nano is here is powered using a 9v battery and rest of the devices connected take power either from the native or a spare Arduino (Here Arduino Leonardo).

Receiver:

The receiver here consists of HC-05 Bluetooth module, Arduino Uno, L298N motor driver and Two DC motors connected to the driver.

The HC-05 module does the work of receiving the signals which are wirelessly transmitted by the HC05 module on the transmitter side.

The Arduino Uno processes the signals coming from the transmitter and sends control signals to the motor driver which in turn drives the dc motors.

The direction of rotation of dc motors is decided depending upon the signals received from the transmitter side.

For example, both the motors would rotate in clockwise direction if the letter ‘F’ is received at the receiver end from the transmitter side.

The Arduino powers the HC-05 Bluetooth module through its 5v output pin. The Arduino along with the L298N motor driver and the motors use two separate 9v batteries for their power.

4.3 Circuit Diagrams

1. Transmitter

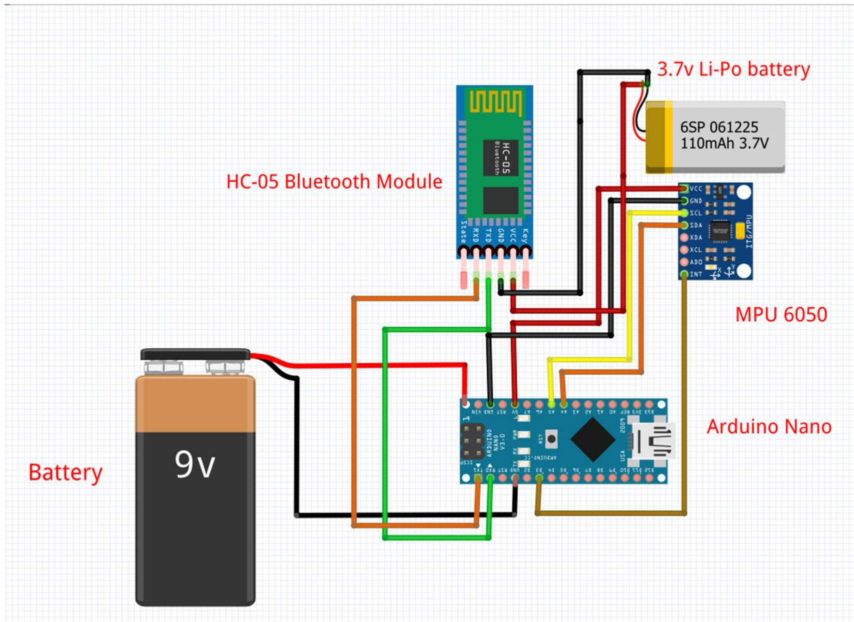


Fig 4.3.1 Transmitter Circuit Diagram

2. Receiver

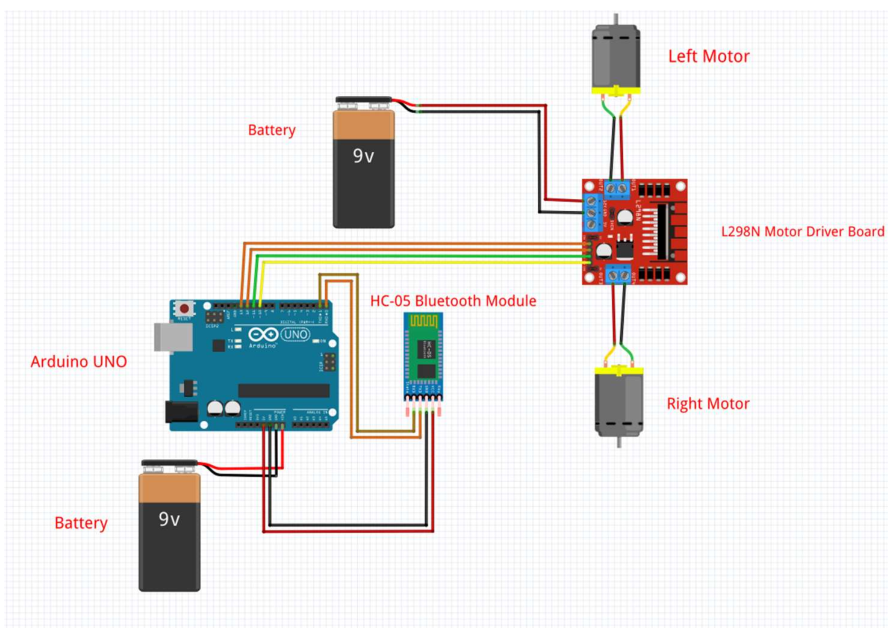


Fig 4.3.2 Receiver Circuit Diagram

4.4 Circuit Components and Assembly

Transmitter

For the transmitter circuit we have used a Dot PCB board with dimensions 10cm x 10cm. All the transmitter components are mounted on the Dot PCB board. The Dot PCB board is attached to a strap made of Velcro bands. All the connections are made with the help of normal wires of proper length. MPU 6050 is placed in such a way that its x,y,z axis will determine the direction of movement of the wheelchair, this is achieved by the use of Gyro sensors and the Accelerometer of the MPU 6050 is used to detect the angle of tilt or inclination along the x,y,z axis. A 9v battery is connected to the Arduino nano with the help of a battery connector which provides power supply to the transmitter circuit, also a Li-Po Battery can be connected to power the HC-05 Bluetooth module, although here we have used an Arduino Leonardo for the same purpose.

Receiver

The receiver circuit is made by placing all the components in a plastic case. We further made a hole on top of the switch box to place the Bluetooth module HC-05 outside of the case. Placing the HC-05 outside of the case will let us know if both the transmitter and receiver are connected or not, also the range and connectivity will be strengthened. Two more holes are carved on the back end of the case to place the tip of the motor facing outside the case, two wheels are connected to these motor tips outside the case. Two 9v batteries are connected to Arduino Uno and L298N motor driver respectively and are also placed inside the case.

CHAPTER 5
EXPERIMENTAL OBSERVATIONS

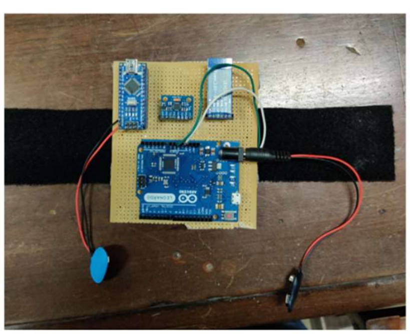
5.1 Circuit Output

Two 9v batteries are connected to the controller band (transmitter). One 9v battery is connected to Arduino Nano and the other battery is connected to charge the Bluetooth module through Arduino Leonardo. Here, in the transmitter the Bluetooth module acts as the master and goes into Data mode. Similarly, the wheelchair which is the receiver is powered ON by a 9v battery. The Bluetooth module here acts as the 'slave' and goes into Data mode.

So, both Transmitter i.e., the controller band and the Receiver i.e., the wheelchair is now ON but not connected or communicating with each other. After a few seconds, the Master Bluetooth module detects the Slave and now the Transmitter and the Receiver are connected to each other wirelessly.

The Wheelchair is now paired with the controller band on the Subject's hand but the wheels won't move until the subject tilts the controller band in any direction. Depending on the inclination of the controller band, the wheelchair will move in 4 different directions:

1. When the controller band is tilted in the forward direction, the slave receives the signal 'F' and both the wheels of the wheelchair move in forward direction.
2. When the controller band is tilted in the backward direction, the slave receives the signal 'B' and both the wheels of the wheelchair move in the backward direction.
3. When the controller band is tilted left, the slave receives the signal 'L' and left wheel moves forward and the right wheel moves backward.
4. When the controller band is tilted right, the slave receives the signal 'R' and the right wheel moves forward and the left wheel moves backward.



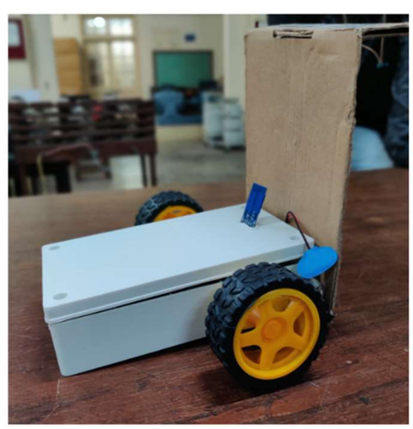


Fig 5.1 Transmitter and Wheelchair in OFF State

5.2 Code

1. Transmitter Code

```
#include<SoftwareSerial.h>
#include <SPI.h>
#include<Wire.h>
//SoftwareSerial mybt(0,1);
int16_t AcX,AcY,AcZ,Tmp,GyX,GyY,GyZ;
int m=0,n=0;
const int MPU_addr=0x68;
int dupa=0;
int joystick[2];

void setup() {
  // put your setup code here, to run once:
//  mybt.begin(38400);
  Serial.begin(38400);
  Wire.begin();
  Wire.beginTransmission(MPU_addr);
  Wire.write(0x6B);  // PWR_MGMT_1 register
  Wire.write(0);     // set to zero (wakes up the MPU-6050)
  Wire.endTransmission(true);
}

void loop() {
  // put your main code here, to run repeatedly:
  Wire.beginTransmission(MPU_addr);
  Wire.write(0x3B);  // starting with register 0x3B (ACCEL_XOUT_H)
  Wire.endTransmission(false);
  Wire.requestFrom(MPU_addr,14,true);  // request a total of 14 registers
  joystick[0]=Wire.read()<<8|Wire.read();  // 0x3B (ACCEL_XOUT_H) & 0x3C (ACCEL_XOUT_L)
  joystick[1]=Wire.read()<<8|Wire.read();  // 0x3D (ACCEL_YOUT_H) & 0x3E (ACCEL_YOUT_L)
  joystick[2]=Wire.read()<<8|Wire.read();  // 0x3F (ACCEL_ZOUT_H) & 0x40 (ACCEL_ZOUT_L)
```

```
    AcX = joystick[0];
    AcY = joystick[1];
    if(AcX<-6000){      //Forward
//    mybt.write("F");
    Serial.println('F');
    }
    else if(AcX>6000){
//    mybt.write("F");
    Serial.println('B');
    }
    else if(AcY>6000){
//    mybt.write("R");
    Serial.println('R');
    }
    else if(AcY<-6000){
//    mybt.write("L");
    Serial.println('L');
    }
    else if(AcX<6000 && AcX>-6000 && AcX<6000 && AcX>-6000){
//    mybt.write("S");
    Serial.println('S');
    }
    delay(1000);


}
```

2. Receiver

```
#include<SoftwareSerial.h>
//SoftwareSerial mybt(2,3);
char m;

void setup() {
pinMode(10, OUTPUT);
pinMode(11, OUTPUT);
pinMode(12, OUTPUT);
pinMode(13, OUTPUT);
Serial.begin(38400);
//S.begin(9600);
}

void loop() {
if(Serial.available()>0)
{
m= Serial.read();
Serial.println(m);
delay(100);

if(m=='F')


{
digitalWrite(10, HIGH);
digitalWrite(11, LOW);
digitalWrite(12, HIGH);
digitalWrite(13, LOW);

}

else if(m=='B')

{
digitalWrite(10, LOW);
digitalWrite(11, HIGH);
digitalWrite(12, LOW);
digitalWrite(13, HIGH);

}

else if(m=='R')

{
digitalWrite(10, LOW);
digitalWrite(11, HIGH);
digitalWrite(12, HIGH);
```

```
digitalWrite(13, LOW);

}
else if(m=='L')

{
digitalWrite(10, HIGH);
digitalWrite(11, LOW);
digitalWrite(12, LOW);
digitalWrite(13, HIGH);

}

else if(m=='S')

{
digitalWrite(10, LOW);
digitalWrite(11, LOW);
digitalWrite(12, LOW);
digitalWrite(13, LOW);

}
}}
```

CHAPTER 6
SUMMARY AND CONCLUSIONS

6.1 Summary

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 project shows how such a wheelchair model benefits from the use of different wireless technologies. The proposed system "Hand Gesture Controlled 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.

While promoting this system we would like to emphasize on the following 3 points:

• The first is to encourage people to treat the limbless and disabled people normally or at least make them feel normal.

• The second is to help the specially abled, i.e. not only limbless but all kinds of abled people like blind, mute, mentally challenged, etc.

• The third is to make the disabled people aware of the governmental help they can get, like scholarships, medical benefits, etc. Without all three of these behaviours occurring, the service will not achieve its intended individual objective and the aim which we created the project.

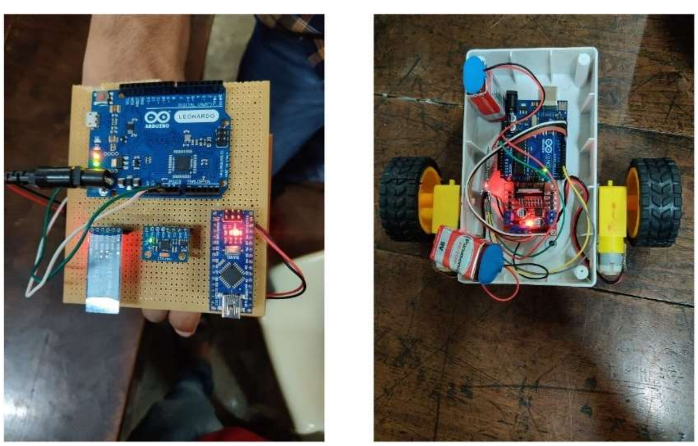


Fig 6.1 Transmitter and Wheelchair in ON State

6.2 Advantages

1. It is easy to design and manufacture as all the components are easily available
2. It is portable and hence can be operated from anywhere
3. It has low cost of manufacturing
4. The microcontroller can be programmed if any modification is required
5. Due to wireless communication data rate is faster.
6. Wireless makes ease of operation
7. No need of lengthy wires
8. Power consumption is less

6.3 Disadvantages

1. If power supply fails system won't work
2. Failure of device/components may have dire consequences, fatal accidents can occur
3. Can be uncomfortable for some people (for example – small children as their hand are small to fit the band)
4. Prototype Stage
5. Unreliable

CHAPTER 7
SCOPE FOR FUTURE WORK

In future, we can integrate various elements to the existing system to make the project more advanced and a complete product. The modifications/updates can be as follows:

1. **Speech and Brain Signal Controlled Wheelchair**
   The existing system can be upgraded to wheelchair which would be controlled by detecting the changes in electroencephalogram (EEG) produced by the brain. This system would be a battle winning factor for all those people with a partially or totally paralyzed body, enabling them to move around without the help of others and help them to become more self-dependent.

2. **Wheelchair with Automatic Obstacle Detection and Avoidance**
   The existing wheelchair can be fitted with an array of sensors which would help in obstacle detection. In addition to this, various artificial intelligence algorithms can be implemented in order to avoid the various obstacles coming in its way of the wheelchair.

3. **Wheelchair with location tracking and SMS support**
   GPS system can be also implemented to know the exact location of the person who is in the wheelchair. Further this GPS system along with some kind of mobile network can be used to keep a track of location of the person using the wheelchair and also can save the person in case of any mis happenings.

4. **IOT wheelchair**
   The wheelchair can be integrated with the various IOT devices present indoors. This would help in performing various operations inside a house with ease. IOT operations include controlling lights, opening/closing doors, turning on/off various devices. All these operations can just be controlled by a click of button present on the controller band.

7.1 Scalable Model

The project that we have built is a conceptual model of what we originally intend to build, i.e., a proper wheelchair – a real model with the technology and instruments that we have used. However, the cost for this real-life model is far more than what we as a group can come up with. Nonetheless the cost does not compromise the economy factor of the project because the other alternatives available in the market and far more costly than the solution we provide. By doing some research and survey we found out that the real-life wheelchair will require a large motor as well as high power motor driver to drive them.

The transmitter section remains exactly the same with no changes otherwise. This is also an advantage of the project since one communicator goes unchanged. The Receiver section here changes its components with the suitable ones, hence adding the overall cost. The costing table is listed below for the same:

COMPONENTS	UNITS	COST (in ₹)	TOTAL COST (in ₹)
Arduino Nano	1	300	300
MPU6050 Module	1	100	100
HC-05 Bluetooth Module	2	250	500
Arduino Mega	1	2500	2500
BTS7960 43A Motor Driver	1	900	900
Ebike 250W Motor	2	2300	4600
Lead acid Battery (12v)	1	800	800
		TOTAL	₹ 9700

Table 7.1 Scalable Model Costing

The Normal Wheelchair adds this system cost by ₹ 5000. Therefore, this brings the scalable model cost to ₹ 14,700 which is again low compared to the cheapest alternative available in the market.

APPENDIX

Main Components and Software Specifications:

1. **Arduino Nano**
2. **MPU6050 3 Axis Gyro Sensor and Accelerometer**
3. **Arduino Uno**
4. **HC-05 Bluetooth Module**
5. **L298N Motor Driver**
6. **150 RPM Single Shaft BO Motor**
7. **Arduino IDE**

A.1 Arduino Nano

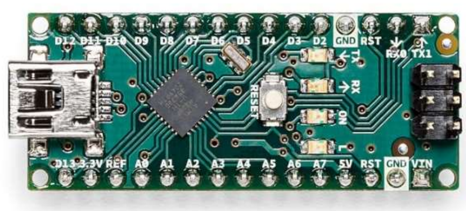


Fig A.1.1 Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package. It lacks only a DC power jack, and works with a Mini-B USB cable instead of a standard one.

Power: The Arduino Nano can be powered via the Mini-B USB connection, 6-20V unregulated external power supply (pin 30), or 5V regulated external power supply (pin 27). The power source is automatically selected to the highest voltage source.

Memory: The ATmega328 has 32 KB, (also with 2 KB used for the bootloader. The ATmega328 has 2 KB of SRAM and 1 KB of EEPROM.

The Nano has 8 analog inputs, each of which provide 10 bits of resolution (i.e., 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the analogReference() function. Analog pins 6 and 7 cannot be used as digital pins. Additionally, some pins have specialized functionality:

- I2C: A4 (SDA) and A5 (SCL). Support I2C (TWI) communication using the Wire library (documentation on the Wiring website).

Programming: The Arduino Nano can be programmed with the Arduino software. Select "Arduino Duemilanove or Nano w/ ATmega328" from the Tools > Board menu (according to the microcontroller on your board). The ATmega328 on the Arduino Nano comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. You can also bypass the bootloader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar.

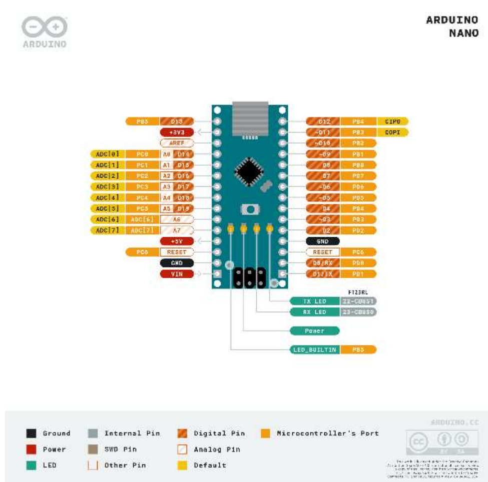


Fig A.1.2 Pin Diagram of Arduino Nano

Input and Output: Each of the 14 digital pins on the Nano can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.
- External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the attachInterrupt() function for details.
- PWM: 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the analogWrite() function.

- SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

There are a couple of other pins on the board:

- AREF. Reference voltage for the analog inputs. Used with analogReference().
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication: The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

Table A.1 Arduino Nano Features

MICROCONTROLLER	ATmega328
ARCHITECTURE	AVR
OPERATING VOLTAGE	5 V
FLASH MEMORY	32 KB of which 2 KB used by bootloader
SRAM	2 KB
CLOCK SPEED	16 MHz
ANALOG IN PINS	8
EEPROM	1 KB
DC CURRENT PER I/O PINS	40 mA (I/O Pins)
INPUT VOLTAGE	7-12V
DIGITAL I/O PINS	22 (6 of which are PWM)
PWM OUTPUT	6
POWER CONSUMPTION	19 Ma
WEIGHT	7 g
PRODUCT CODE	A000005

A.2 MPU6050 3 Axis Gyro Sensor and Accelerometer Module

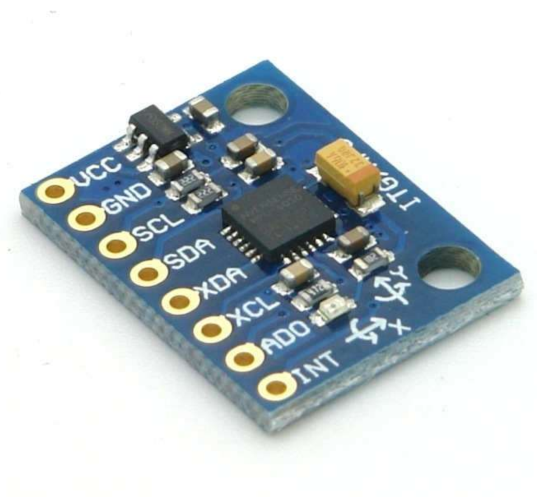


Fig A.2.1 MPU6050 3 Axis Gyro Sensor and Accelerometer

MPU6050 sensor module is complete 6-axis Motion Tracking Device. It combines 3-axis Gyroscope, 3-axis Accelerometer and Digital Motion Processor all in small package. Also, it has additional feature of on-chip Temperature sensor. It has I2C bus interface to communicate with the microcontrollers.It has Auxiliary I2C bus to communicate with other sensor devices like 3-axis Magnetometer, Pressure sensor etc.If 3-axis Magnetometer is connected to auxiliary I2C bus, then MPU6050 can provide complete 9-axis Motion Fusion output.

MPU6050 inside sensors:

- **3-Axis Gyroscope**

The MPU6050 consist of 3-axis Gyroscope with Micro Electro Mechanical System (MEMS) technology. It is used to detect rotational velocity along the X, Y, Z axes as shown in below figure. When the gyros are rotated about any of the sense axes, the Coriolis Effect causes a vibration that is detected by a MEM inside MPU6050.

- The resulting signal is amplified, demodulated, and filtered to produce a voltage that is proportional to the angular rate.

- This voltage is digitized using 16-bit ADC to sample each axis.

- The full-scale range of output are +/- 250, +/- 500, +/- 1000, +/- 2000.

- It measures the angular velocity along each axis in degree per second unit.

- **3-Axis Accelerometer**

The MPU6050 consist 3-axis Accelerometer with Micro Electro Mechanical (MEMs) technology. It used to detect angle of tilt or inclination along the X, Y and Z axes as shown in below figure. Acceleration along the axes deflects the movable mass.

- This displacement of moving plate (mass) unbalances the differential capacitor which results in sensor output. Output amplitude is proportional to acceleration.

- 16-bit ADC is used to get digitized output.

- The full-scale range of acceleration are +/- 2g, +/- 4g, +/- 8g, +/- 16g.

- It measured in g (gravity force) unit.

- When device placed on flat surface it will measure 0g on X and Y axis and +1g on Z axis.

- **DMP (Digital Motion Processor)**

The embedded Digital Motion Processor (DMP) is used to compute motion processing algorithms. It takes data from gyroscope, accelerometer and additional 3rd party sensor such as magnetometer and processes the data. It provides motion data like roll, pitch, yaw angles, landscape and portrait sense etc. It minimizes the processes of host in computing motion data. The resulting data can be read from DMP registers.

- **On-chip Temperature Sensor**

On-chip temperature sensor output is digitized using ADC. The reading from temperature sensor can be read from sensor data register.

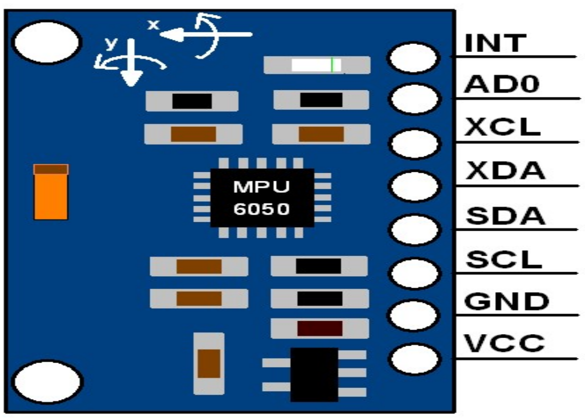


Fig A.2.2 MPU6050 Pin Diagram

The MPU-6050 module has 8 pins,

INT: Interrupt digital output pin.

AD0: I2C Slave Address LSB pin. This is 0th bit in 7-bit slave address of device. If connected to VCC then it is read as logic one and slave address changes.

XCL: Auxiliary Serial Clock pin. This pin is used to connect other I2C interface enabled sensors SCL pin to MPU-6050.

XDA: Auxiliary Serial Data pin. This pin is used to connect other I2C interface enabled sensors SDA pin to MPU-6050.

SCL: Serial Clock pin. Connect this pin to microcontrollers SCL pin.

SDA: Serial Data pin. Connect this pin to microcontrollers SDA pin.

GND: Ground pin. Connect this pin to ground connection.

VCC: Power supply pin. Connect this pin to +5V DC supply.

A.3 Bluetooth Module HC-05

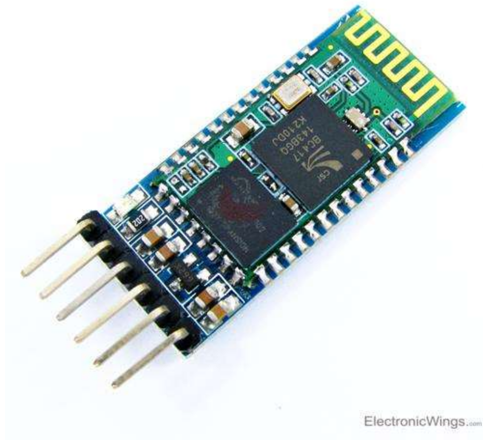


Fig A.3.1 HC-05 Bluetooth Module

- It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard and many more consumer applications.
- It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.
- It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN).
- It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

Fig 6.3.2 HC-05 Pin Diagram

1. **Key/EN:** It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

2. **VCC:** Connect 5 V or 3.3 V to this Pin.

3. **GND:** Ground Pin of module.

4. **TXD:** Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)

5. **RXD:** Receive data serially (received data will be transmitted wirelessly by Bluetooth module).

6. **State:** It tells whether module is connected or not.

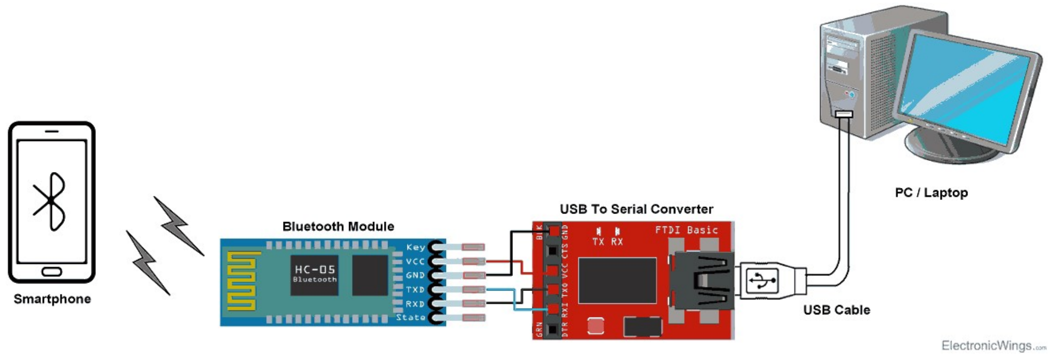


Fig A.3.3 Interfacing Bluetooth

Command Mode

- When we want to change settings of HC-05 Bluetooth module like change password for connection, baud rate, Bluetooth device's name etc.
- To do this, HC-05 has AT commands.
- To use HC-05 Bluetooth module in AT command mode, connect "Key" pin to High (VCC).
- Default Baud rate of HC-05 in command mode is 38400bps.
- Following are some AT command generally used to change setting of Bluetooth module.
- To send these commands, we have to connect HC-05 Bluetooth module to the PC via serial to USB converter and transmit these commands through serial terminal of PC.

Table A.3 HC-05 Command Modes

Command	**Description**	**Response**
AT	Checking communication	OK
AT+PSWD=XXXX	Set Password e.g., AT+PSWD=4567	OK
AT+NAME=XXXX	Set Bluetooth Device Name e.g., AT+NAME=MyHC-05	OK
AT+UART=Baud rate, stop bit, parity bit	Change Baud rate e.g., AT+UART=9600,1,0	OK
AT+VERSION?	Respond version no. of Bluetooth module	+Version: XX OK e.g., +Version: 2.0 20130107 OK
AT+ORGL	Send detail of setting done by manufacturer	Parameters: device type, module mode, serial parameter, passkey, etc.

A.4 Arduino Uno

Fig A.4.1 Arduino Uno

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst-case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

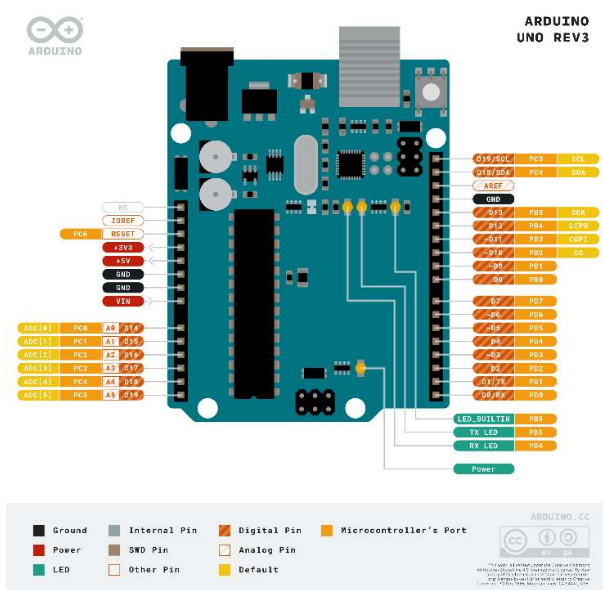


Fig A.4.2 Arduino Uno Pin Diagram

Table A.4 Arduino Uno Features

MICROCONTROLLER	ATmega328P
OPERATING VOLTAGE	5V
INPUT VOLTAGE (RECOMMENDED)	7-12V
INPUT VOLTAGE (LIMIT)	6-20V
DIGITAL I/O PINS	14 (of which 6 provide PWM output)
PWM DIGITAL I/O PINS	6
ANALOG INPUT PINS	6
DC CURRENT PER I/O PIN	20 mA
DC CURRENT FOR 3.3V PIN	50 mA
FLASH MEMORY	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
CLOCK SPEED	16 MHz
LED_BUILTIN	13
LENGTH	68.6 mm
WIDTH	53.4 mm
WEIGHT	25 g

The Arduino Uno has a resettable polyfuse that protects your computer's USB ports from shorts and overcurrent. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

A.5 L298N Motor Driver Module

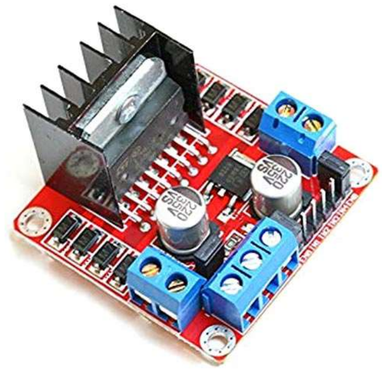


Fig A.5.1 L298N Motor Driver

This **L298N Motor Driver Module** is a high-power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. L298N Module can control up to 4 DC motors, or 2 DC motors with directional and speed control.

Features & Specifications

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V
- Driver Voltage: 5-35V
- Driver Current:2A
- Logical Current:0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heatsink for better performance
- Power-On LED indicator

Applications

- Drive DC motors.
- Drive stepping motors
- In Robotics

L298N Module Pinout Configuration

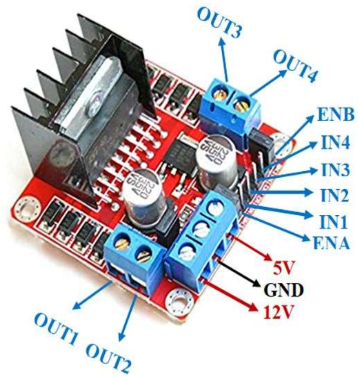


Fig A.5.2 L298N Pin Diagram

Table A.5 L298N Pin Description

Pin Name	**Description**
IN1 & IN2	Motor A input pins. Used to control the spinning direction of Motor A
IN3 & IN4	Motor B input pins. Used to control the spinning direction of Motor B
ENA	Enables PWM signal for Motor A
ENB	Enables PWM signal for Motor B
OUT1 & OUT2	Output pins of Motor A
OUT3 & OUT4	Output pins of Motor B
12V	12V input from DC power Source
5V	Supplies power for the switching logic circuitry inside L298N IC
GND	Ground pin

A.6 150 RPM Single Shaft BO Motor - Straight

Fig A.6 Single Shaft BO Motor

The 150 RPM Single Shaft BO Motor - Straight motor gives good torque and rpm at lower operating voltages, which is the biggest advantage of these motors. Small shaft with matching wheels gives an optimized design for your application or robot. Mounting holes on the body & light weight makes it suitable for in-circuit placement. This motor can be used with 69mm Diameter Wheel for Plastic Gear Motors. It is an alternative to our metal gear DC motors. It comes with an operating voltage of 3-12V and is perfect for building small and medium robots.

The motor is ideal for DIY enthusiasts. This motor set is inexpensive, small, easy to install, and ideally suited for use in a mobile robot car. They are commonly used in our 2WD platforms.

Specifications of 150 RPM Single Shaft BO Motor - Straight: -

- Shaft length: 7 mm
- Shaft Diameter: 5.5 mm
- Size: 55 x 48 x 23 mm.
- Operating Voltage: 3 to 12V.
- Current (without loading): 40-180mA.
- RPM: 150 rpm.
- Output Torque: 0.8 kg cm.

Features of 150 RPM Single Shaft BO Motor - Straight: -

- Cost-effectiveness of the injection-molding process.
- Elimination of machining operations.
- Low density: lightweight, low inertia.
- Uniformity of parts.

A.7 Arduino IDE

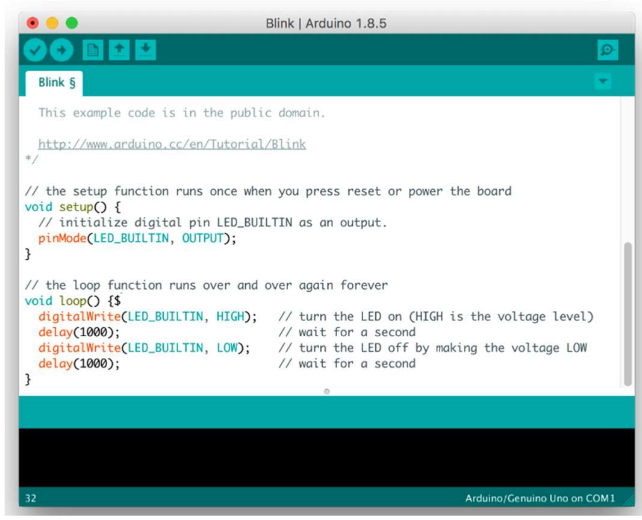


Fig A.7.1 Arduino IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them. The Arduino integrated development environment (IDE) is a cross-platform application (for Microsoft Windows, macOS, and Linux) that is written in the Java programming language. It originated from the IDE for the languages Processing and Wiring. It includes a code editor with features such as text cutting and pasting, searching and replacing text, automatic indenting, brace matching, and syntax highlighting, and provides simple one-click mechanisms to compile and upload programs to an Arduino board. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures.

Blink Example:

Most Arduino boards contain a light-emitting diode (LED) and a current limiting resistor connected between pin 13 and ground, which is a convenient feature for many tests and program functions. A typical program used by beginners, akin to Hello, World! is "blink", which repeatedly blinks the on-board LED integrated into the Arduino board. This program uses the functions pinMode(), digitalWrite(), and delay(), which are provided by the internal libraries included in the IDE environment. This program is usually loaded into a new Arduino board by the manufacturer.

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