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An Intelligent Control of Wheel Chair by Hand Gesture

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Abstract: *According to a research there are about 6 million populations in the world who are paralysed and needs a wheelchair for their mobility .This Paper is to develop a wheel chair for physically disabled people .The wheel chair is controlled by hand movement/hand gestures.The gestures are recognized by an accelerometer sensor .An ultrasonic sensor is used to detect the obstacles in front of the chair .The signals from the sensors are processed, and the wheel chair is controlled by Arduino micro controller.*

Keywords: Gesture Control, Arduino Nano, Transmitter, Receiver, Encoder, Decoder, Ultrasonic Sensor

I. INTRODUCTION

The wheelchair is one of the most commonly used assistive devices to promote mobility and enhance quality of life for people who have difficulties in walking (e.g. a person with spinal cord injuries resulting in quadriplegia or paraplegia, muscular dystrophy, etc). Wheelchair mobility opens up opportunities for wheelchair users to study, work, and engage in social activities and access services such as healthcare. In addition to providing mobility, an appropriate wheelchair benefits the physical health and quality of life of the users by helping in reducing common problems such as pressure sores, progression of deformities and improves respiration and digestion.

To ensure effective mobility, wheelchair users need a wheelchair which fits them correctly and meets their specific needs. However statistics show that about 10% of the global population, i.e. about 650 million people have disabilities and of these, some 10% require a wheelchair. It is thus estimated that about 1% of a total population, or 10% of a people with a disability, need a wheelchair, i.e. about 65 million people worldwide.

In addition, it was estimated that in 2003, 20 million of those requiring a wheelchair for mobility did not have one. There are indications that only a minority of those in need of wheelchairs has access to them, and of these very few have access to an appropriate wheelchair. Mobility devices are appropriate for people who experience a wide range of mobility difficulties as a result of a broad spectrum of health conditions and impairments, including amputation, arthritis, cerebral palsy, poliomyelitis, muscular dystrophy, spinal-cord injury, spine bifida, and stroke and are also relevant for older people who experience mobility difficulties. Assistive technologies such as wheelchairs have been shown that, when appropriate to the user and the user's environment, they have a significant impact on the level of independence and participation which people with disabilities are able to achieve. This also reduces the burden of care and has been reported to reduce the overall need for formal support services.

Wheelchair provision is not only about the wheelchair, which is just a product, rather it is about enabling people with disabilities to become mobile, remain healthy and participate fully in community life. We often take the ability to move in our home and community for granted, but for individuals with a disability with mobility impairments even the smallest step can prevent them from accessing all parts of their life. Being mobile enhances a person's ability to learn, interact with others, earn a living and participate in the community. A wheelchair is the catalyst to increased independence and social integration, but it is not an end in itself. Studies have shown that assistive technologies including wheelchairs, when appropriate to the user and the user's environment, have a significant impact on the level of participation which people with disabilities are able to achieve and when provided through a supportive service have been reported to reduce the time and physical burden for caregivers. The use of mobility devices, in particular, creates opportunities for education and work, and contributes to improved health and quality of life but may also have an impact on the prevention of falls, injuries, further impairments and premature death

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Fig 1.Commercial Wheel Chair

Investment in provision of mobility devices can reduce health-care costs and economic vulnerability, and increase productivity and quality of life. An active lifestyle has been proven to have both physical and mental health benefits with individuals participating in physical activity shown to have a reduced risk of cardiovascular disease, non-insulin-dependent diabetes mellitus, osteoporosis, osteoarthritis, and several cancers. An appropriate wheelchair provides the user the freedom to move around, allowing the user to access day to day physical activity as they push around conducting activities of daily living increasing overall physical activity levels and day to day mobility. It also provides the greatest possible opportunity for independence and do the things they want to do, allowing individuals to move within their home more easily, provides increased comfort and a more active lifestyle.

Difficulty with ambulation need to frequently lean on someone or hold onto their arm as they walk next to you, decreased balance fear of falling can cause individuals to become isolated from friends and family. A wheelchair that is functional, comfortable and can be propelled efficiently can result in increased levels of activity. Independent mobility and increased physical function can reduce dependence on others. Thus, wheelchair users can be more independent and more in control of their own life. Individuals who experience the least discomfort when sitting are often more productive. Users who are able to spend more time in their wheelchair will have more opportunities for participating in day-to-day life along with others in the household, greatly improving their quality of life.

A wheelchair can improve the user's health in many ways. A wheelchair that is functional, comfortable and can be propelled efficiently can result in increased levels of physical activity, thus improving both physical and mental health. A well fitting wheelchair with cushion combined with adequate user training can reduce common problems, such as pressure sores, the progression of deformities or contractures, and other secondary conditions associated with poor postures. Other benefits, such as improved respiration and digestion, increased head, trunk and upper extremity control and overall stability, can be achieved with proper postural support. Maintenance of health is an important factor in measuring quality of life. These factors combined serve to increase access to opportunities for education, employment and participation within the family and the community.

Self-esteem is described as a general evaluation of one’s self- concept or sense of personal worth and adequacy with high self-esteem linked to many positive health outcomes in persons with a disability including reduced depression and higher life satisfaction and well-being. Wheelchairs have been shown to have a profound influence on quality of life and participation. Wheelchair users may become more confident and have more self esteem when they have a wheelchair, often viewed as an extension of the users body, that fits them and which they can use well, therefore the chair’s weight and dimensions affect the person’s ability to negotiate through the home and in the community. Research has shown that wheelchair users with higher self-esteem displayed increased participation levels independent of gender, age and disability type.

Access to community life including community participation, involving both being active in family and community life with engagement in typical roles and responsibilities in society plays a key role in the health and wellbeing of wheelchair users and has been shown to be a key factor in preventing health deterioration in individuals with spinal cord injury. Being able to access the community, move outside the home is important for social participation and engagement and many positive health indicators as well. Having an appropriate wheelchair improves access to the

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community and enables wheelchair users to be more involved in community life i.e. it enables the user to go to the work or school, visit friends, attend places of worship or other community activities. Additionally, appropriate wheelchairs influence individual autonomy because they facilitate both mobility and activities of daily living both in the home and in the community.

In many developing countries, only 3% of people with disabilities who require rehabilitation services have access to them. According to a report of the United Nations Special Reporter, 62 countries have no national rehabilitation services available to people with disabilities. This means that many wheelchair users are at risk of developing secondary complications and premature death that could be avoided with proper rehabilitation services.

Old citizens or disabled persons become dependent on other members of the family to navigate through their habitat or within residence. A smart wheel chair can be a useful assistant for them. It can be controlled wirelessly adopting proper communication system. The chair can be controlled by head gesture as well as hand gesture method with directions as needed. The previous development of this kind of wheel chair is using a laptop or PC on the wheel chair. Now-a-days most of the electronic wheelchairs are joystick controlled. But the limitations of this kind of technologies are that the wheel chair is getting too bulky and it is to be controlled only by sitting on it. That's why these types of wheel chairs are not giving satisfactory feedback from the users. The proposed model makes the wheel chair a lot easier to assemble and simple in the use, in addition the cost of manufacturing also gets reduced.

II. HARDWARE COMPONENT

2.1 ARDUINO UNO Development Board

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based

Fig 2 Arduino UNO

Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.

Arduino was born at Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for I0T applications, wearable, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open-source, and it is growing through the contributions of users worldwide.

2.2 Arduino

Arduino has been used in thousands of different projects and applications. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and

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robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step by step instructions of a kit, or sharing ideas online with other members of the Arduino community.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Net media's BX-24, Phi gets, MIT's Handy board, and many others offer similar functionality. The Arduino Uno is one kind of microcontroller board based on ATmega328, and Uno is an Italian term which means one. Arduino Uno is named for marking the upcoming release of microcontroller board namely Arduino Uno Board 1.0**.** This board includes digital I/O pins-14, a power jack, analog i/ps-6, ceramic resonator-A16 MHz, a USB connection, an RST button, and an ICSP header. All these can support the microcontroller for further operation by connecting this board to the computer. The power supply of this board can be done with the help of an AC to DC adapter, a USB cable, otherwise a battery.The ATmega328 is one kind of single-chip microcontroller formed with Atmel within the megaAVR family. The architecture of this Arduino Uno is a customized Harvard architecture with 8 bit RISC processor core. Other boards of Arduino Uno include Arduino Pro Mini, Arduino Nano, Arduino Due, Arduino Mega, and Arduino Leonardo.

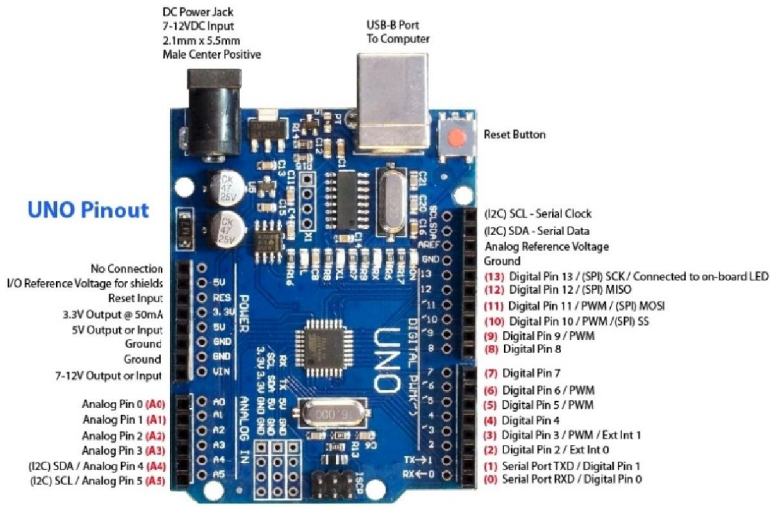

Fig 3 Arduino uno pinout

2.3 MHz RF Transmitter Receiver Wireless Module

Fig 4 Rx and Tx modules

This hybrid RF Transceiver Module provides a complete RF transmitter and receiver module solution which can be used to transmit data at up to 3KHz from any standard CMOS/TTL source.The transmitter module is very simple to operate and offers low current consumption (typical. 11mA). Data can be supplied directly from a microprocessor or encoding device, thus keeping the component count down and ensuring a low hardware cost.The RX – ASK is an ASK Hybrid receiver module. The RF Transmitter Receiver Module is an effective low-cost solution for using 433MHz. The TX-ASK is an ASK hybrid transmitter module. TX-ASK is designed by the saw resonator, with an effective low cost, small size and simple to use for designing.

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2.4 ASK – Amplitude Shift Keying

These modules use a technique called Amplitude Shift Keying or ASK. In Amplitude Shift Keying the amplitude (i.e. the level) of the carrier wave (in our case it's a 433MHz signal) is changed in response to the incoming data signal an ON/OFF switch.This is very similar to the analog technique of amplitude modulation which you might be familiar with if you're familiar with AM radio. It's sometimes called binary amplitude shift keying because there are only two levels we are concerned with. You can think of it as

- For Digital 1 – This drives the carrier at full strength.
- For Digital 0 – This cuts the carrier off completely.

This is how the Amplitude modulation looks like:

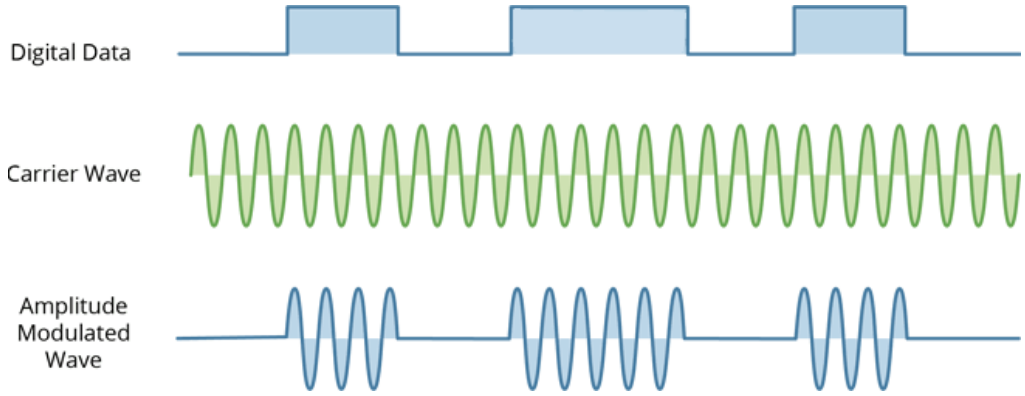

Fig 5 Amplitude Modulation

Amplitude Shift keying has the advantage of being very simple to implement. It is quite simple to design the decoder circuitry. Also ASK needs less bandwidth than other modulation techniques like FSK (Frequency Shift Keying). This is one of the reasons for being inexpensive. The disadvantage however is that ASK is susceptible to interference from other radio devices and background noise. But as long as you keep your data transmission to a relatively slow speed it can work reliably in most environments.

2.5 MPU6050 Sensor Module

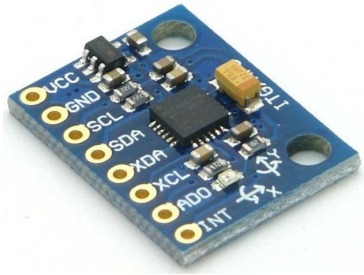

Fig 5 MPU6050

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.

IMU sensors like the MPU 6050 are used in self-balancing robots, UAVs, smart phones, and more. IMU sensors help us get the position of an object attached to the sensor in three-dimensional space. These values are usually in angles to help us to determine its position. They are used to detect the orientation of smart phones, or in wearable gadgets like the Fit bit, which uses IMU sensors to track movement.

At the heart of the module is a low power, inexpensive 6-axis Motion Tracking chip that combines a 3-axis gyroscope, 3-axis accelerometer, and a Digital Motion Processor (DMP) all in a small 4mm x 4mm package.

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2.6 MPU6050 Pin Description

The pin descriptions of the MPU6050 module are as follows:

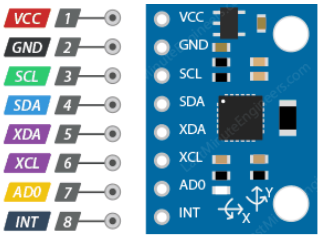

Fig 6 Pin out

VCC is the power supply for the module. Connect it to the 5V output of the Arduino.GND should be connected to the ground of Arduino.SCL is a I2C Clock pin. This is a timing signal supplied by the Bus Master device. Connect to the SCL pin on the Arduino.SDA is a I2C Data pin. This line is used for both transmit and receive. Connect to the SDA pin on the Arduino.XDA is the external I2C data line. The external I2C bus is for connecting external sensors.XCL is the external I2C clock line.AD0 allows you to change the internal I2C address of the MPU6050 module. It can be used if the module is conflicting with another I2C device.INT is the Interrupt Output. MPU6050 can be programmed to raise interrupt on gesture detection, panning, zooming, scrolling, tap detection, and shake detection.

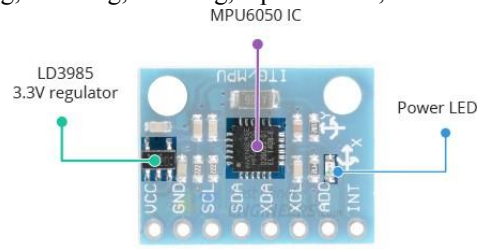

Fig 7 MPU6050 PARTS

The module comes with an on-board LD3985 3.3V regulator, so you can use it with a 5V logic microcontroller like Arduino without worry. The MPU6050 consumes less than 3.6mA during measurements and only 5µA during idle. This low power consumption allows the implementation in battery driven devices.

2.7 Measuring Acceleration

The MPU6050 can measure acceleration using its on-chip accelerometer with four programmable full scale ranges of ±2g, ±4g, ±8g and ±16g.

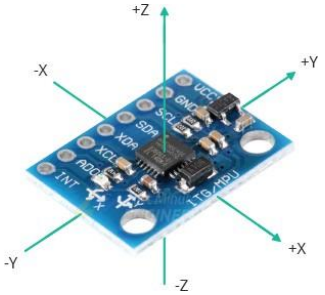

Fig 8 MPU6050 Parts

The MPU6050 has three 16-bit analog-to-digital converters that simultaneously sample the 3 axis of movement (along X, Y and Z axis).

2.8 Measuring Rotation

The MPU6050 can measure angular rotation using its on-chip gyroscope with four programmable full scale ranges of ±250°/s, ±500°/s, ±1000°/s and ±2000°/s.

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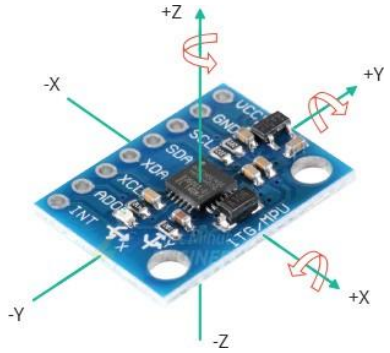

Fig 9 Rotation

2.9 The I2C Interface

The module uses the I2C interface for communication with the Arduino. It supports two separate I2C addresses: $0x68_{HEX}$ and $0x69_{HEX}$. This allows two MPU6050s to be used on the same bus or to avoid address conflicts with another device on the bus.

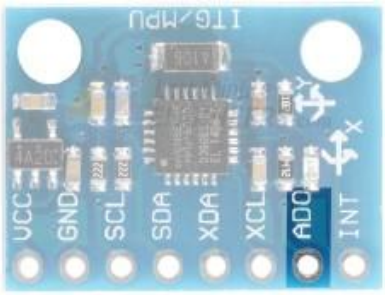

Fig 10 I2C interface

The ADO pin determines the I2C address of the module. This pin has a built-in 4.7K pull-down resistor. Therefore, when you leave the ADO pin unconnected, the default I2C address is $0x68_{HEX}$ and when you connect it to 3.3V, the line is pulled HIGH and the I2C address becomes $0x69_{HEX}$.

2.10 Adding External Sensors

To increase the level of accuracy even further, the MPU6050 module provides a feature for connecting external sensors. These external sensors are connected to the MPU6050 via a second I2C bus (XDA and XCL), which is completely independent of the main I2C bus.

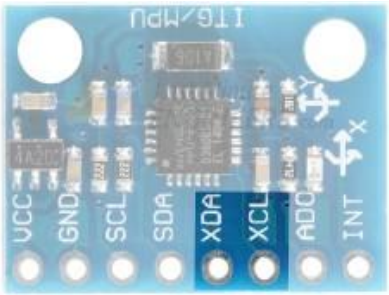

Fig 11 External sensor attachment

This external connection is usually used to attach a magnetometer, which can measure magnetic fields on three axes. By itself, the MPU6050 has 6 Degrees of Freedom (DOF), three each for the accelerometer and the gyroscope. Adding a magnetometer adds an extra three DOF to the sensor, making it 9 DOF.DMP stands for Digital Motion Processing. The MPU 6050 has a built-in motion processor. It processes the values from the accelerometer and gyroscope to give us accurate 3D values

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2.11 L293D Motor Driver Module

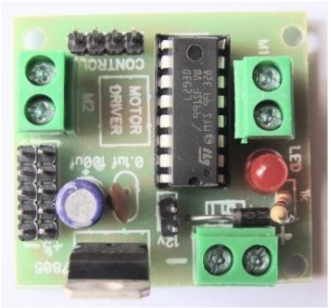

Fig 11 L293D module

This L293D driver module is a medium power motor driver perfect for driving DC Motors and Stepper Motors. It uses the popular L293D motor driver IC. It can drive 4 DC motors in one direction, or drive 2 DC motors in both the directions. The L293D is a popular 16-Pin Motor Driver IC**.** As the name suggests it is mainly used to drive motors.

A single L293DIC is capable of running two DC motors at the same time; also the direction of these two motors can be controlled independently. So if you have motors which has operating voltage less than 36V and operating current less than 600mA, which are to be controlled by digital circuits like Op-Amp, 555 timers, digital gates or even Micron rollers like Arduino, PIC, ARM etc..

Every AC and DC motor havet he ability to rotate in both directions. AC motor has its own rules and usage, but DC motor could rotate in another direction just by changing the polarity of the current. Now a day mostly DC Motors are used to produce rotatory motion due to its high efficiency. But in some cases, we need to rotate the motor in both directions like robots, cars, etc.

2.12 Rechargeable Batteries

A rechargeable battery is an energy storage device that can be charged again after being discharged by applying DC current to its terminals. Rechargeable batteries allow for multiple usages from a cell, reducing waste and generally providing a better long-term investment in terms of dollars spent for usable device time. This is true even factoring in the higher purchase price of rechargeable and the requirement for a charger. A rechargeable battery is generally a more sensible and sustainable replacement to one-time use batteries, which generate current through a chemical reaction in which a reactive anode is consumed. The anode in a rechargeable battery gets consumed as well but at a slower rate, allowing for many charges and discharges.

In use, rechargeable batteries are the same as conventional ones. However, after discharge the batteries are placed in a charger or, in the case of built-in batteries, an AC/DC adapter is connected. While rechargeable batteries offer better long term cost and reduce waste, they do have a few cons. Many types of rechargeable cells created for consumer devices, including AA and AAA, C and D batteries, produce a lower voltage of 1.2v in contrast to the 1.5v of alkaline batteries. Though this lower voltage doesn't prevent correct operation in properly-designed electronics, it can mean a single charge does not last as long or offer the same power in a session. This is not the case, however, with lithium polymer and lithium ion batteries.

Some types of batteries such as nickel cadmium and nickel-metal hydride can develop a battery memory effect when only partially discharged, reducing performance of subsequent charges and thus battery life in a given device. Rechargeable batteries are used in many applications such as cars, all manner of consumer electronics and even off-grid and supplemental facility power storage.

2.13 TP4056 Battery Charging Module

This TP4056 1A Li-ion Lithium Battery Charging Module with Current Protection – Mini USB is a tiny module, perfect for charging single cell 3.7V 1 Ah or higher lithium ion (Li-Ion) cells such as 16550s that don’t have their own protection circuit. Based on the TP4056 charger IC and DW01 battery protection IC this module will offer 1A charge current then cut off when finished.

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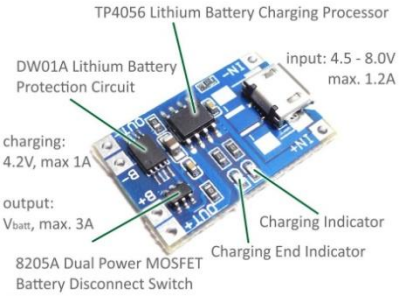

Fig 12 TP4056

The TP4056 is a complete constant-current/constant-voltage linear charger for single cell lithium-ion batteries. Its SOP package and low external component count make the TP4056 ideally suited for portable applications. Furthermore, the TP4056 can work within USB and wall adapter. No blocking diode is required due to the internal PMOSFET architecture and have prevent TO negative Charge Current Circuit. Thermal feedback regulates the charge current to limit the die temperature during high power operation or high ambient temperature.

The charge voltage is fixed at 4.2V, and the charge current can be programmed externally with a single resistor. The TP4056 automatically terminates the charge cycle when the charge current drops to 1/10th the programmed value after the final float voltage is reached. TP4056 Other features include current monitor, under voltage lockout, automatic recharge and two status pin to indicate charge termination and the presence of an input voltage.

2.14 D.C Motor

A dc motor uses electrical energy to produce mechanical energy, very typically through interaction of magnetic fields and current-carrying conductors. The reverse process, producing electrical energy from mechanical energy, is accomplished by an alternator, generator or dynamo. Many types of electric motors can be run as generators, and vice versa. The input of a DC motor is current/voltage and its output is torque (speed). The DC motor has two basic parts: the rotating part that is called the armature and the stationary part that includes coils of wire called the field coils. The stationary part is also called the stator.

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.

III. PROPOSED SYSTEM DESIGN

3.1 Proposed system

Our proposed project is an advance approach of changing the physical gesture of hand into the electrical signal and then to process that signal into digital signal of appropriate magnitude and to be transmitted through the transmitter. This project provides an instrumental solution to the people who have difficulty in moving or their body part has paralyzed, or they have lost their limb in an accident. This wheelchair is going to bring a paradigm shift between man and machine. Where this machine will be working on the user commands, we can also say its 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 had proved their metal in bringing the comfort to the people who are in need with the help of technology. Bringing the technology and economy parallel to each other is paramount aim of this paper. Also to build a Hand Gesture Wheelchair which has sound technology but low in cost is the primary concern. Today in this modern era around world's 10 percents, around 650 million people are suffering from physical disability.

In order to make their life bit easier we decided to make a hand gesture controlled wheel chair which will be working on the gesture of their hand. The wheel chair is wireless and has a range of 200 yards. It means a person can control his wheelchair from 200 yards away. He can call his chair while sitting from one place irrespective of weather conditions. The disabled people always find difficulties in moving from one room to another and even to do that the handicapped person was dependent on someone else who will push the wheelchair manually and take the handicapped person from

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one place to another. Now with the Hand Gesture Controlled Wheelchair the handicapped person is independent and he need not to ask for help from any other person to move his wheelchair. Just with the movement of his hand the handicapped person is able to move from one place to another without needing anyone's assistance which also makes him self-dependent.

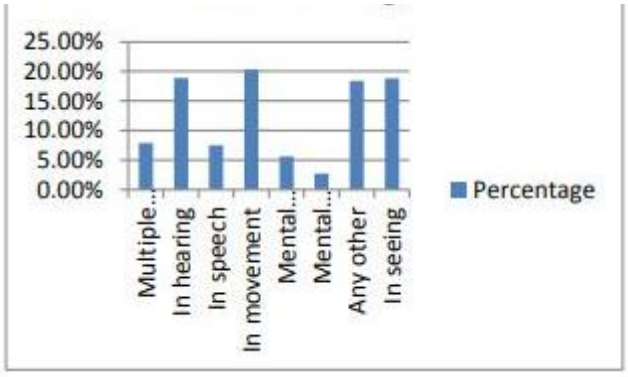

Fig 13 Percentage of disabled people

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; there are people whose lower half of the body is paralyzed. This Wheelchair will add on to the comfort and make the life of people bit easier. Around 5436604 people are affected from movement disability. Percentage of population which suffers from different disabilities is shown in graph below. Out of total disability maximum people suffers from disability in movement.

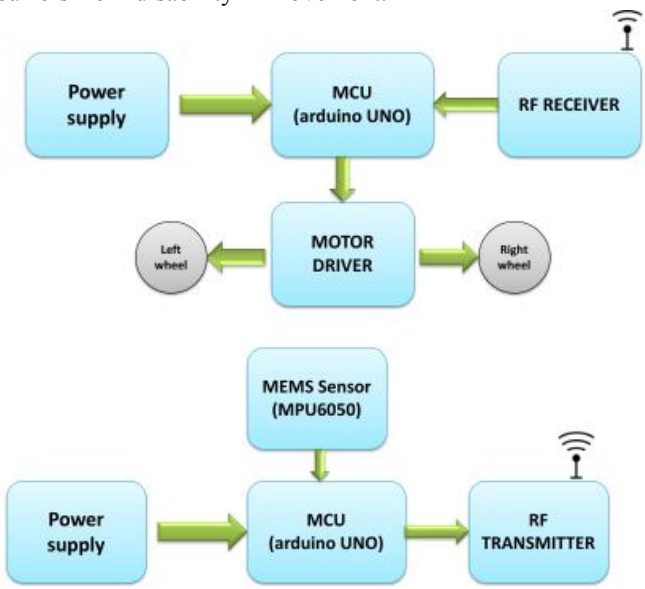

Fig 14 hand gesture device block diagram

IV. WORKING METHODLOGY

4.1 Hand Gestures

This fig so the operation of hand gesture control using wheel chair by operating the working module we can operate using our hand to go one place to another place without others help by programming in arduino we can operate the motor in our own direction the accelerometer is used to sense the motion of hand to give instruction to the recivier part we can move forward, backword ,right, left in different direction

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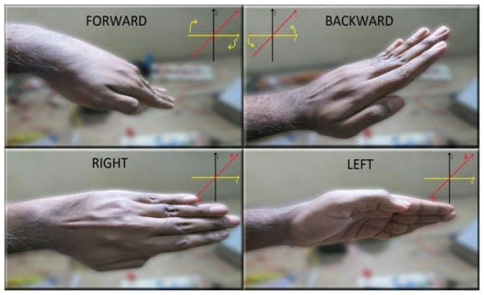

Fig 6.5 hand gestures

Table 1 Direction of wheelchair

Direction of hand gesture	Movement of left motor	Movement of right motor
Up(backward)	BACKWARD	BACKWARD
Down(forward)	FORWARD	FORWARD
Left	BACKWARD	FORWARD
Right	FORWARD	BACKWARD

V. CONCLUSION

The proposed system will serve as an active system for the disables persons. It facilitates the disable peoples to move the wheelchair in front, back, left and right direction through the hand gestures. By the hardware modules such as Arduino and mpu6050 accelerometer sensor. Since the system uses the hand gestures movement to activate the wheelchair it helps the disabled persons to move in different directions. The wheelchair has integrated with smart fall detection alarm, and moving in accordance to the gesture given by the person who is using the wheel chair. Certain improvisation and improvement can be done to make the wheelchair more reachable to those whose whole body is paralyzed. Certain eyes gesture or brain signals reader can be imparted on the wheelchair system so as to make it better. The hand gesture wheelchair has the ability to bridge the gap between man and machine. Further this hand gesture can be changed to speech and brain signal recognition which will be a battle winning factor for all those people whose whole body is paralyzed. We can further improve wheelchairs by making it with low cost and high accuracy which are operating by a wireless remote with various different sensors. An array of sensors can be used and integrating the inputs of multiple sensors and then processing them. Further safety features can be added into the wheelchair like implementation of ultrasonic sensor for the object detection. GPS system can also be implemented to know the exact location of the person who is in wheelchair and by using GSM module an SMS can be sent to pre defined number in case of emergency.

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