A

PROJECT REPORT

ON

HUMAN ASSISTED GESTURE DOMINATED SELF BALANCING SCOOTER

Submitted in The Partial Fulfilment of The Requirement of The Degree In

Bachelor of Technology

In

Mechanical Engineering

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In Pursuit of Excellence

DEPARTMENT OF MECHANICAL ENGINEERING

MORADABAD INSTITUTE OF TECHNOLOGY

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Session 2018-19

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DECLARATION

We certify that the work embodied in this Project Report is our own Bonafede work carried out by us under the supervision of **Mr. Ganesh Kumar Sharma** in session 2018-2019 at **Moradabad Institute of Technology, Moradabad**. The matter embodied in this report has not been submitted elsewhere for the award of any other degree/diploma. We declare that we have faithfully acknowledged, given credit to and referred to the researchers work wherever their works have been cited in the text and the body of the report. We further certify that we have not willfully lifted up some other's work, para, text, data, results, etc. reported in the journals, books, magazines, reports, dissertations, theses, etc., or available at web-sites and have included them in this report and cited as our own work.

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Students of B.Tech. Final year, Mechanical Engineering branch, Moradabad Institute of Technology, Moradabad have successfully completed their project entitled **"Human Assisted Gesture Dominated Self Balancing Scooter"** under our guidance and supervision.

While gleaming the required information and styling the report they were found pretty sincere and devoted. The report produced them is completely authentic proof of their dedicated efforts. The assistance and help taken during the course of the work has been duly acknowledged and the source of literature amply recorded.

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ABSTRACT

A **Human Assisted Gesture Dominated Self Balancing Scooter** Or a **HOVER-TROLLEY**, which can be used as a vehicle and as a trolley for transportation work inside the industry. It resembles personal transportation like a skate board but has magnetic induction usage instead of the mainstream wheel usage alone. The board levitates to provide the transport. The main purpose of the device is the motion in the forward direction and movement of the wheel in both the directions. There are many secondary objectives associated with it such as it can be used for security purpose by using camera in it etc.

It is typically known as a Hover Board or self-balancing scooter or a Hover-Trolley which works on a rechargeable battery and has a platform above its wheels where the rider stands or sit. The scooter has different techniques that can be mastered and must be known to enjoy the ride safely. There are more than dozens of brands and companies that offer their self-balancing scooters with attractive features, designs and enhancements.

These portable self-balancing scooters provide great pleasurable experiences. They are the most popular gifts for the year too. They are made of several components that help it to work. The technical parts include the logic board with circuit and a couple of sensors, microprocessors and microcontrollers. There are also two electric motors under the wheels and two gyroscopes with two speed sensors that are also present inside the wheels.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Across the world, Engineering has the common Moto is - "Improving the Quality of Life" of mankind without any restrictions. To achieve this transformation in science and technology is needed. The term levitation refers to a class of technology that uses electromagnetic levitation to propel vehicles with electromagnets rather than with wheels axels and bearings. Hover board is a personal transportation device which lifts person, where person can experience more smoothness while moving. Hover boards are generally depicted as resembling a skateboard, initially boards were based on wheels but after modifications and applying electromagnetic concepts boards are made without wheels. First type of hover board is similar to helicopter which weights a single person. Next board is based on concept of magnetic levitation. Last one is based on super conduction. Hover board contains electromagnets so that conductivity is made possible due to repulsion it floats and moves forward. Basic concept can be applied for further future transportations also to reduce real time problems such as vehicle traffic etc. Major applications fall in the fields of medical and self-transportation. Now a day's jet-based hover board is invented which is having amazing speed. These concepts of hover boards will help in future to make amazing transportation.

1.2 Objective

The device was to move using motorized wheels and would be able to turn using swivel caster wheels. It was important for the user to have good balance while standing on the device. The batteries were to be mounted on the device underneath the device next to the wheels and off the ground, or otherwise concealed from the audience. The device was to be controlled via either remote control by another person or hand gesture by the user. The device must allow the user to move forward and turn in both directions all while balancing. It must also be considerably quiet, as the audience is only a few feet away from the performers

and loud motor noise would give away the "magic" of the device's smooth and eerie movement.

The other secondary objectives associated with it as: -

- Carrying heavy loads.
- Contains camera for recording and security purposes.
- Used for transportation of loads inside industries.
- Low cost.
- Portable.
- Stability.
- Safety.

1.3 Design methodology

I. Product Development

1. Outline project

a. Identify all project constraints

b. Assess new possible technologies (research)

2. Concept Generation

a. The final product would involve motorized wheels and at least one surface for the user to stand and balance on.

b. The device must also be powered by batteries due to power being aesthetically displeasing.

3. Concept Selection

a. Establish target specifications

b. Screen for best concepts - Decision Matrices

c. Concept recombination

d. Final concept selection

4. Detail Design

a. Structure: One design concept involved two separate motorized devices, one for each rear wheel. This design was inspired by Heelys.

b. Assign tolerances.

c. Produce solid model.

II. Product Manufacturing

1. Planning

a. Identify production constraints

b. Estimate production costs

c. Evaluate production feasibility

d. Produce dimensioned drawings for manufacturing

2. Machining

a. Order desired materials.

b. Order pre-made products from manufacturers.

c. Set up area task leaders.

d. Acquire proper tooling.

e. Machine project.

3. Assembly and Finishing

a. Select proper fasteners

b. Paint frame and desired parts

c. Assemble all parts (motor, Arduino kit, wheel)

d. Lube moving parts

III. Product Testing and Refinement

1. Initial Testing

a. Test HOVER-TROLLEY on simulated rated load and uneven track

b. Repair or modify any non-working parts

c. Continue a and b until product performs as desired

2. Final Testing

a. Test HOVER-TROLLEY on an actual course under actual conditions.

b. Perform any final modifications or adjustments.

CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

In 2006 Chinese developers unveiled the world's first full-permanent magnetic levitation (Maglev)" wind power generator at the Wind Power" Asia Exhibition 2006 held June 28 in Beijing, according to Xinhua News. September 22, an elevated Trans rapid train collided with a maintenance vehicle on a test run in Lathan (Lower Saxony / north-western Germany). Twenty-three people were killed and ten were injured. Back in the 1950s, an aircraft manufacturing company, Hiller aircraft, produced the "Flying Platform" which had many similarities to the modern concept of a hover board. Information that got in circulation in 2001 confirmed that Ginger, an invention by Dean Kamen of Hiller Aircraft, was a real Segway human transporter; hence, this invention was a self-balancing two-wheeled electric transportation device. In 2004, an attempt by Jamie Hyneman and his team to build a makeshift hovercraft was successful. The attempt led to invention and production Hyneman Hoverboard. This hover board was made from a surfboard and leaf blower. However, despite the success, Jamie's hover board was not very effective. In 2005, a hover board was made by Jason Bradbury for The Gadget Show. He did his production using a wooden board that was levitated using a leaf blower. The initial design was not propelled and could not be steered too. In 2009, the second version by Jason was made which. This was an improvement of the first one as it was propelled/steered by a small jet engine and also contained two more powerful leaf blowers.

In October 2011, The University Paris Diderot in France was observed. The University presented the "Mag Surf", a superconducting device that can levitate 3 cm above two magnetized repulsing floor rails. As compared to Nil Guadagnini's earlier production, this was an improvement since the board could carry up to 100 kg. In May 2015, announced that the Romania-born Canadian inventor Catalin Alexandru Duru He continuously travelled as a controlling pilot on an autonomously powered hover board, travelling over a distance of 200.

There are mainly three types of hover boards based on concept of working and working principle is given.

2.2 Omni Hoverboard

All hoverboards, need some upward force to push against the gravitational force. For the Omni hoverboard, this upward force is from the air. The props push air downward resulting in an upward force on the rotors. Just like a helicopter, it can move both up and down as well as side to side. This Omni hoverboard can fly over water or land. It doesn't really matter what is below it. The Omni hoverboard has two major flaws. First is the flight time. Since this is essentially like an electric powered quadcopter, it needs a battery. Batteries are heavy, fig 1.so it can only power the propellers for a couple of minutes of flight time. Second, is the risk of human life due to instability in it.

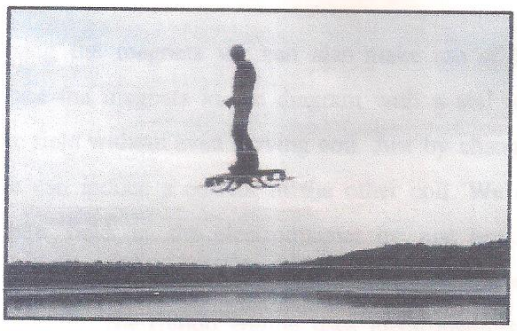


Fig 2.1 Omni Hoverboard

2.3 Hendo Hoverboard

Working principle is based on farads laws. A changing magnetic field induces a current in a wire that is conducting. This principle is applicable for most of the electric generators. The magnitude of the induced electric current depends on the intensity of changing magnetic fields. If the magnet is moved faster, more current is generated. If the magnet is kept stationary, the magnetic field doesn't change at all resulting into zero current. But if there is an electric current in loop of wire, that induced current also makes a magnetic field. It turns out that this induced current makes a magnetic field that is in the opposite direction as the change in magnetic field due to the magnet.

If the magnet was moving to the right, the magnetic field due to the magnet (which I labelled *B*m) would still be pointing to left, but it would be decreasing in magnitude at the location of the coil. This means that the induced current (and thus the magnetic field due to the loop) would be in the opposite direction.

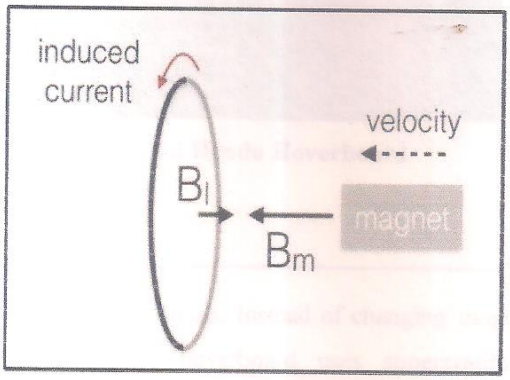


Fig. 2.2 Magnetic Field

Now instead of using the magnets we can also make use of Electromagnets. That is, if we replace the magnets in the diagram with a coil of wire, we can change the magnetic field without even moving coil. Just by changing the current in the one coil, we can induce a current in the other coil. We can continually change the magnetic field in the electromagnet by just having the current oscillate back and forth. So here in the Hoverboard we are making use of Electromagnetic levitation. The Hendo engine uses electromagnets that produce changing magnetic fields to interact with a conducting surface. Basically, when these electromagnets change the magnetic field that produces an electric current in the metallic surface underneath the hoverboard. This electric current then produces its own magnetic field to repel the hoverboard electromagnets. It's clearly a skateboard that hovers. Major flaws are the primary problem with this hoverboard is that it only hovers over a conducting surface. If you put this over water, the electromagnets would still make changing magnetic fields but without an electric conductor below it there would be no repulsion. The other small problem is that it doesn't ride like a skateboard.

Fig. 2.3 Hendo Hoverboard

2.4 Lexus Hoverboard

This hoverboard uses magnetic fields. Instead of changing magnetic fields from an electromagnet, the Lexus hoverboard uses superconductors. When a superconductor is placed near a magnet, you can get a levitation effect. The magnets are in the ground and the superconductor is inside the board. It is awesome because this board is much smaller than either the Hendo or the Omni hoverboard. Just like the Hendo, this board also requires a special surface to ride it on. But it doesn't work over water or any other surface that doesn't already have magnets embedded in the ground. Another drawback is the superconducting magnets. Superconductors need to be very cold in order to have the levitating properties. This means that you need to add something like liquid nitrogen (-320°F or 77K) to keep them cold.

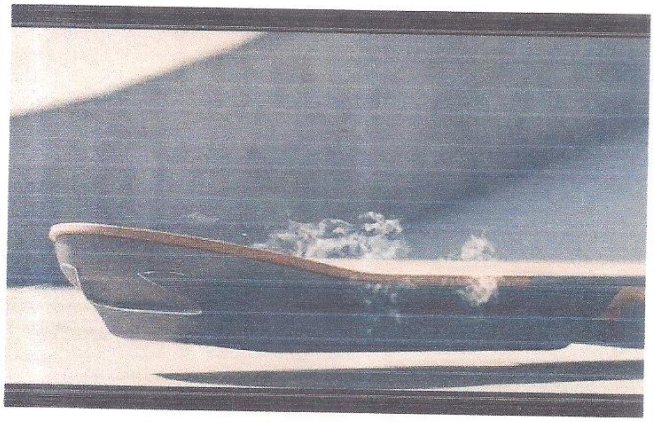


Fig. 2.4 Lexus Hoverboard

The Slide hoverboard contains a series of metal alloy superconducting blocks cooled to -197°C by reservoirs of liquid nitrogen. The track below contains three magnets that induce a current in the blocks, causing the Meissner effect to take hold and expel the magnetic field back towards the track in a mirror image. These mirroring magnetic forces repel each other and so the board is lifted above the track. Even if someone stands on the board, the magnetic forces are strong enough to keep it levitating because the lack of electrical resistance in the superconductor means the magnetic field can adjust to deal with external pressure.

CHAPTER 3

IMPLEMENTATION AND DESIGN

3.1 12V DC SQUARE GEAR/GEARED MOTOR 100 RPM

3.1.1 Description

- Square geared DC motor is a very high torque motor which should be used to make big robots or robotized platform.
- Gear box is built to handle the stall torque produced by the motor.
- Drive shaft is supported from with metal bushes.
- High Torque Square Gear DC Motor 10 RPM for Arduino/Raspberry-Pi/Robotics.
- This is a high torque square gear dc motor providing 20000gm-cm torque. The motor generates a very low RPM which is very ideal for making gripper to pick and place heavy objects with greater accuracy.
- This Square geared DC motor gives a mechanical throughput of 10 rpm.
- A DC Square Geared motor is a simple DC motor with gear box attached to the shaft of the motor which is mechanically commutated electric motor powered from direct current (DC).

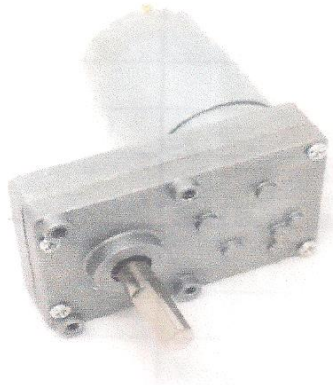


Fig. 3.1 DC Motor

3.1.2 Working

The working of the gears is very interesting to know. It can be explained by the principle of conservation of angular momentum. The gear having smaller radius will cover more RPM than the one with larger radius. However, the larger gear will give more torque to the smaller gear than vice versa. The comparison of angular velocity between input gear (the one that transfers energy) to output gear gives the gear ratio. When multiple gears are connected together, conservation of energy is also followed. The direction in which the other gear rotates is always the opposite of the gear adjacent to it. In any DC motor, RPM and torque are inversely proportional. Hence the gear having more torque will provide a lesser RPM and converse.

3.1.3 Specifications

Motor Base RPM	**6000**
Speed (RPM)	**100**
Operating Voltage	**12 V DC**
Operating Current	**220 mA to 1.3 A (max)**
Rated Torque (kg-cm)	**14**
Stall Torque (Kg-Cm)	**54**
Shaft Diameter (mm)	**(D-type) 8**
Shaft Length (mm)	**25.6**
Gear Material	**Mild Steel**
Gearbox Shape	**Rectangle**
Operating Temperature (°C)	**-10 to 85**
Body Dimensions	**Body Diameter: 36 mm** **Gear Box Dimension: 72 x 47 x 20 mm (LxWxH)**
Weight (gm)	**446g**
Shipment Weight	**0.47 kg**
Shipment Dimensions	**20 x 20 x 15 cm**

Table 3.1

3.2 4-CHANNEL RELAY

This is a 5V 4-Channel Relay interface board, be able to control various appliances, and other equipment with large current. It can be controlled directly by Micro-controller (Arduino, 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic).

If you have ever had a project that required an interface with a high-power device that needed AC or DC voltage and high current levels you have probably already discovered that attempting to control those devices directly with your Arduino, Raspberry PI, or other Microcontroller/Microprocessor can be a real challenge. This board is designed to interface easily with your 5V IO's without consuming much current on your IO pins.

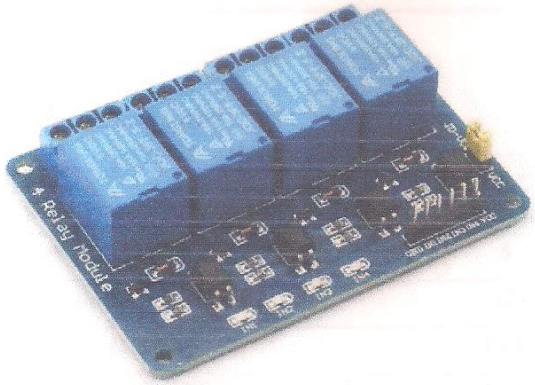


Fig. 3.2 4-Channel Relay

3.2.1 Working Principle

From the picture below, you can see that when the signal port is at low level, the signal light will light up and the optocoupler 817c (it transforms electrical signals by light and can isolate input and output electrical signals) will conduct, and then the transistor will conduct, the relay coil will be electrified, and the normally open contact of the relay will be closed. When the signal port is at high level, the normally closed contact of the relay will be closed. So, you can connect and disconnect the load by controlling the level of the control signal port.

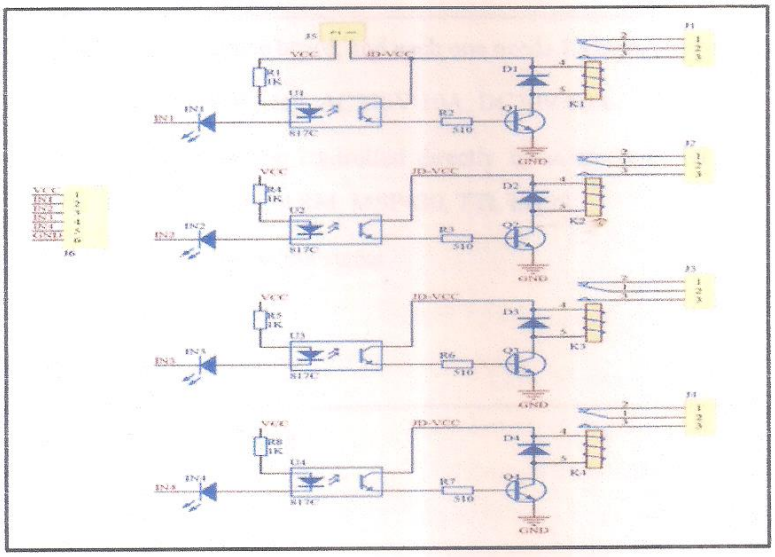


Fig. 3.3 Circuit Construction

3.2.2 Technical Specifications

Channel	4
Operating Voltage (VDC)	12
Current Capacity at AC250V	10A
Current Capacity at DC30V	10A
Length (mm)	72
Width (mm)	54
Height (mm)	18
Weight (gm)	58
Contact switch voltage	220VAC
Relay contact capacity	250V10A

Table 3.2

3.2.3 Features

- 5V 4-Channel Relay interface board, and each one needs 15-20mA Driver Current
- Equipped with high-current relay, AC250V 10A, DC30V 10A
- Standard interface that can be controlled directly by microcontroller (Arduino, 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic)
- Indication LED's for Relay output status
- Opto-isolator

3.2.4 Applications

- Microcontroller based switching
- Robotics
- Interfacing high power devices

3.3 DC-DC BUCK CONVERTER STEP DOWN MODULE

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

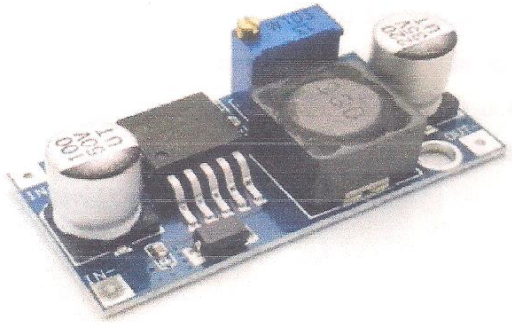


Fig. 3.4 DC to DC Buck Convertor

3.3.1 Specifications

Conversion efficiency	92%(highest)
Switching frequency	150KHz
Output ripple	30mA9maximum)
Load Regulation	± 0.5%
Voltage Regulation	± 0.5%
Dynamic Response speed	5% 200uS
Input voltage	4.75-35V
Output voltage	1.25-26V(Adjustable)
Output current	Rated current is 2A, maximum 3A (Additional heat sink is required)
Conversion Efficiency	Up to 92% (output voltage higher, the higher the efficiency)
Rectifier	Non-Synchronous Rectification
Module Properties	Non-isolated step-down module (buck)
Short Circuit Protection	Current limiting, since the recovery
Operating Temperature	Industrial grade (-40 to +85) (output power 10W or less)

Table 3.3

3.4 ARDUINO

An Arduino is actually a microcontroller-based kit which can be either used directly by purchasing from the vendor or can be made at home using the components, owing to its open source hardware feature. It is basically used in communications and in controlling or operating many devices. It was founded by Massimo Banzi and David Cuartielles in 2005.

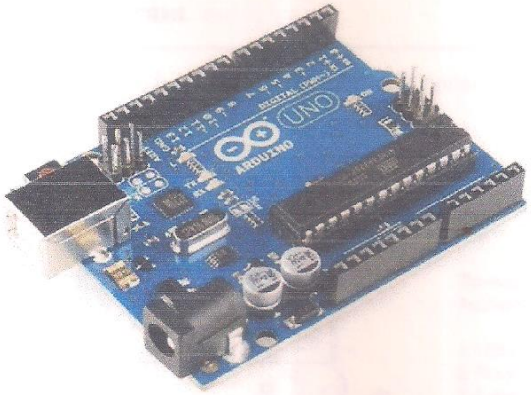


Fig. 3.5 Arduino UNO

3.4.1 Arduino Architecture

Arduino's processor basically uses the Harvard architecture where the program code and program data have separate memory. It consists of two memories- Program memory and the data memory. The code is stored in the flash program memory, whereas the data is stored in the data memory. The Atmega328 has 32 KB of flash memory for storing code (of which 0.5 KB is used for the bootloader), 2 KB of SRAM and 1 KB of EEPROM and operates with a clock speed of 16MHz.

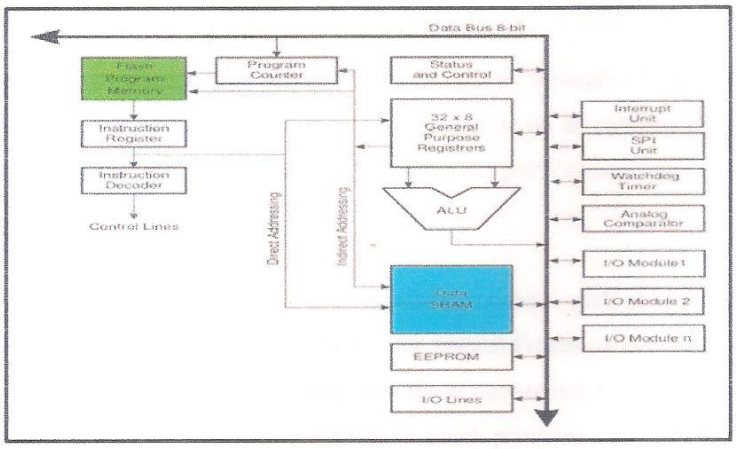


Fig. 3.6 Arduino Architecture

3.4.2 Arduino Pin Diagram

A typical example of Arduino board is Arduino Uno. It consists of ATmega328- a 28 pin microcontrollers.

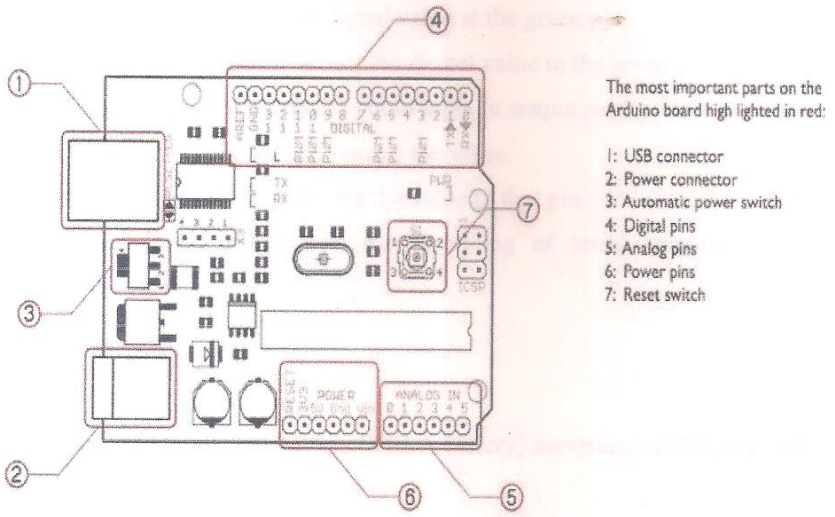


Fig. 3.7 Pin Diagram

Arduino Uno consists of 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button

Power Jack: Arduino can be power either from the pc through a USB or through external source like adaptor or a battery. It can operate on an external supply of 7 to 12V. Power can be applied externally through the pin Vin or by giving voltage reference through the IORef pin.

Digital Inputs: It consists of 14 digital inputs/output pins, each of which provide or take up 40mA current. Some of them have special functions like pins 0 and 1, which act as Rx and Tx respectively, for serial communication, pins 2 and 3- which are external interrupts, pins 3,5,6,9,11 which provides pwm output and pin 13 where LED is connected.

Analog inputs: It has 6 analog input/output pins, each providing a resolution of 10 bits.

ARef: It provides reference to the analog inputs

Reset: It resets the microcontroller when low.

Few of basic Arduino functions are:

- **digitalRead(pin):** Reads the digital value at the given pin.
- **digitalWrite(pin, value):** Writes the digital value to the given pin.
- **pinMode (pin, mode):** Sets the pin to input or output mode.
- **analogRead(pin):** Reads and returns the value.
- **analogWrite(pin, value):** Writes the value to that pin.
- **serial.begin(baud rate):** Sets the beginning of serial communication by setting the bit rate.

3.5 BATTERY

A valve-regulated lead-acid battery (VRLA battery) sometimes called sealed lead-acid (SLA) or maintenance free battery.

There are three primary types of VRLA batteries, sealed VR wet cell, absorbent glass mat (AGM) and gel cell. Gel cells add silica dust to the electrolyte, forming a thick putty-like gel. These are sometimes referred to as "silicone batteries". AGM (absorbent glass mat) batteries feature fiberglass mesh between the battery plates which serves to contain the electrolyte. Both designs offer advantages and disadvantages compared to conventional batteries and sealed VR wet cells, as well as each other.

Due to their construction, the gel cell and AGM types of VRLA can be mounted in any orientation, and do not require constant maintenance. The term "maintenance free" is a misnomer as VRLA batteries still require cleaning and regular functional testing. They are widely used in large portable electrical devices, off-grid power systems and similar roles, where large amounts of storage are needed at a lower cost than other low-maintenance technologies like lithium-ion.

Nominal Voltage of Battery	12 volts
Rated Capacity at C20 Discharge	7.2 AH
No. of Cells Per Battery	6 No.
Material of Container	ABS
Volume of Electrolyte	420ml ml
Battery Condition	Charged
Dimensions (L X W X H)	151 X 65 X 100 mm x mm x mm x mm x mm
Weight of Dry Battery	2.2 KG

Table 3.4

Fig. 3.8 Battery

3.6 BLUETOOTH MODULE

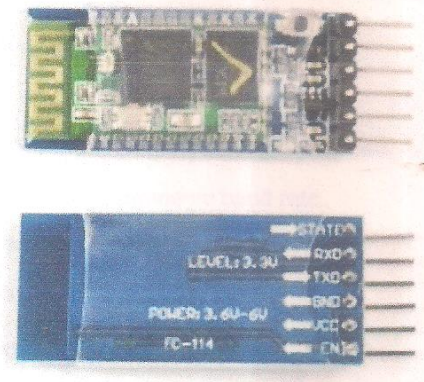


Fig. 3.9 Bluetooth Module

3.6.1 Introduction

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. The HC-05 Bluetooth Module can be used in a Master or Slave configuration, making it a great solution for wireless communication. This serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate)3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Blue core 04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature).

The Bluetooth module HC-05 is a MASTER/SLAVE module. By default, the factory setting is SLAVE. The Role of the module (Master or Slave) can be configured only by AT COMMANDS. The slave modules cannot initiate a connection to another Bluetooth device, but can accept connections. Master module can initiate a connection to other devices. The user can use it simply for a serial port replacement to establish connection between MCU and GPS, PC to your embedded project, etc. Just go through the datasheet for more details File:Datasheet.pdf

3.6.2 Hardware Features

- Typical -80dBm sensitivity.
- Up to +4dBm RF transmit power.
- 3.3 to 5 V I/O.
- PIO (Programmable Input/Output) control.
- UART interface with programmable baud rate.
- With integrated antenna.
- With edge connector.

3.6.3 Software Features

- Slave default Baud rate: 9600, Data bits:8, Stop bit:1, Parity: No parity.
- Auto-connect to the last device on power as default.
- Permit pairing device to connect as default.
- Auto-pairing PINCODE:"1234" as default.

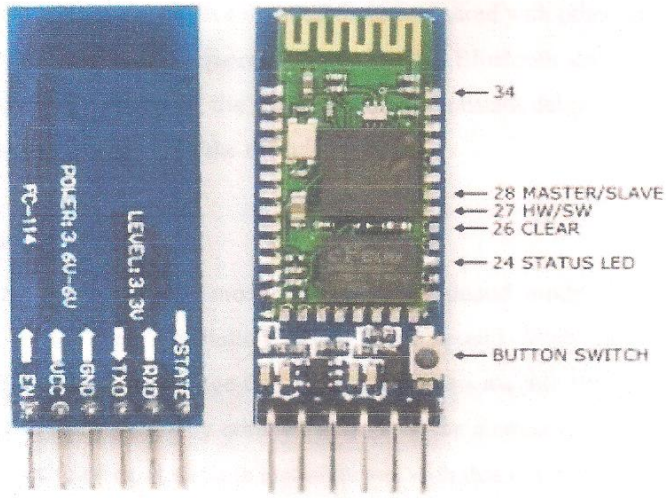


Fig. 3.10 Pin Description

3.6.4 Pin Description

The HC-05 Bluetooth Module has 6pins. They are as follows:

ENABLE:

When enable is pulled LOW, the module is disabled which means the module will not turn on and it fails to communicate. When enable is left open or connected to 3.3V, the module is enabled i.e. the module remains on and communication also takes place.

Vcc:

Supply Voltage 3.3V to 5V

GND:

Ground pin

TXD & RXD:

These two pins act as an UART interface for communication

STATE:

It acts as a status indicator. When the module is not connected to / paired with any other Bluetooth device, signal goes Low. At this low state, the led flashes continuously which denotes that the module is not paired with other device. When this module is connected to/paired with any other Bluetooth device, the signal goes High. At this high state, the led blinks with a constant delay say for example 2s delay which indicates that the module is paired

BUTTON SWITCH:

This is used to switch the module into AT command mode. To enable AT command mode, press the button switch for a second. With the help of AT commands, the user can change the parameters of this module but only when the module is not paired with any other BT device. If the module is connected to any other Bluetooth device, it starts to communicate with that device and fails to work in AT command mode.

3.6.5 Hardware and Software Required

- HC-05 Bluetooth Module
- Arduino Uno
- Arduino IDE (1.0.6V)

3.6.6 Hardware Connections

As we know that Vcc and Gnd of the module goes to Vcc and Gnd of Arduino. The TXD pin goes to RXD pin of Arduino and RXD pin goes to TXD pin of Arduino i.e. (digital pin 0 and 1). The user can use the on board Led. But here, led is connected to digital pin 12 externally for betterment of the process.

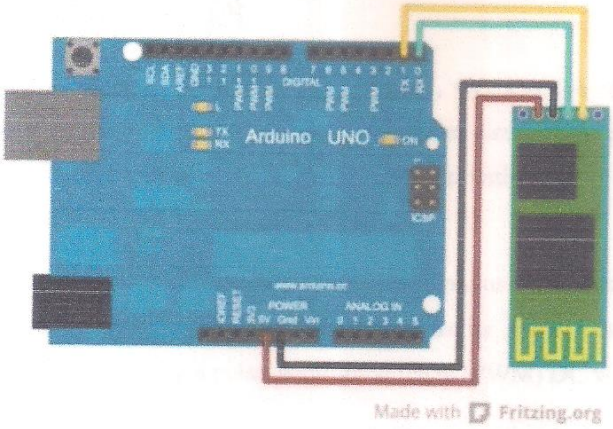


Fig. 3.11 Arduino Bluetooth Connection

3.6.7 Program for HC-05 Bluetooth Module

The program given below is the HC-05 Bluetooth module program. This process is quite different from others since we are going to use android mobile to control and communicate with Arduino. Here the Bluetooth module acts as an interface between our mobile and Arduino board. Before getting into the execution process, follow the given procedure:

- First of all, the user should install an application called Bluetooth SPP PRO from the play store which is a free application.

- After installation, pair the Bluetooth module to your mobile as like connecting one device to other using Bluetooth. The default pairing code is 1234.
- Upload the given program to the Arduino Uno board. After uploading the code, unplug the USB from the Arduino.
- Now use external power adapter to power the Uno board.
- The Bluetooth SPP PRO has three types of communication mode. Here Byte stream mode is used to communicate. So select that mode and give the input as 1, as soon as the input has given the led will turn on and for 0 led will turn off.

3.7 SPEED CONTROLLER

A DC Motor PWM Speed Regulator 1.8V, 3V, 5V, 6V, 12V-2A speed control switch function for DC Motors allows controlling the direction of a DC motor using a Pulse-Width-Modulated (PWM) DC voltage with a Duty Cycle fully adjustable from 0%-100%.

The motor speed controller can easily provide a continuous current of 2A to your DC motor or other DC load. This motor speed controller allows controlling the direction of a DC motor using a pulse-width-modulated (PWM) DC voltage.

With a resettable fuse, it can automatically break the connection and automatically recover. With a LED indicator and a rotary switch, convenient to use.

3.7.1 Operating instruction

1. Connect your DC motor (or DC load) to the motor terminals as indicated on the wiring diagram.
2. Connect a voltage of 1.8V-15V DC to the circuit making sure of the correct polarity of the connection. Note that the voltage applied to the motor will be the supply voltage applied to the circuit.
3. You can now control the speed of the motor through the potentiometer.

3.7.2 Features

- Output current: 2A(Max).
- With resettable fuse.
- Equipped with LED indicator.
- Potentiometer with switch function for PWM adjustment.

Input Voltage Range	**1.8V- 15V DC**
The maximum output power	**30W**
Output current	**2A(Max).**
Output current: 2A(Max).	**2A(Max).**
Duty Cycle adjustable	**5%-100%**
Weight (gm)	**16**
Dimensions in mm (LxWxH)	**32 x 50 x 15**
Shipment Weight	**0.05 kg**
Shipment Dimensions	**7 x 5 x 5 cm**

Table 3.5

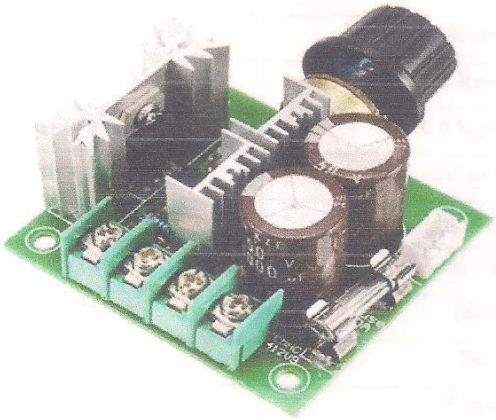


Fig. 3.12 Speed Controller

3.8 SERVO MOTOR

A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use

with servomotors. Servomotors are not a specific class of motor although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing. The input to its control is a signal (either analogue or digital) representing the position commanded for the output shaft.

Fig. 3.13 Servo Motor

Model	SG90
Weight(gm)	9
Operating Voltage	3.0 – 7.2 V
Operating Speed @4.8V	0.10sec/60°
Stall Torque @4.8V	1.2 kg-cm
Stall Torque @6.6V	1.6 kg-cm
Operating Temperature (°C)	-30 to 60
Dead Band Width	7 µs
Gear Type	Glass Fibre
Rotational Degree	180
Servo Plug	JR
Cable Length	25 mm
Length (mm)	22.8
Width (mm)	12.6
Height (mm)	34.5

Table 3.6

The motor is paired with some type of encoder to provide position and speed feedback. In the simplest case, only the position is measured. The measured

position of the output is compared to the command position, the external input to the controller. If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction, as needed to bring the output shaft to the appropriate position. As the positions approach, the error signal reduces to zero and the motor stops.

3.9 ULTRASONIC SENSOR

As the name indicates, ultrasonic sensors measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receive the wave reflected back from the target. Ultrasonic sensors measure the distance to th target by measuring the time between the emission and reception.

An optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception. In a reflective model ultrasonic sensor, a single oscillator emits and receives ultrasonic waves alternately. This enables miniaturization of the sensor head.

The distance can be calculated with the following formula

Distance $L = 1/2 \times T \times C$

where L is the distance, T is the time between the emission and reception, and C is the sonic speed. (The value is multiplied by 1/2 because T is the time for go-and-return distance.)

Model	HC-SR04
Operating Voltage (VDC)	5
Average Current Consumption (mA)	2
Frequency (Hz)	40000
Sensing Angle	15°
Max. Sensing Distance (cm)	450
Weight (gm)	9
Sensor Cover Dia. (mm)	16
PCB Size (mm)	45×20 (LxW)

Table 3.7

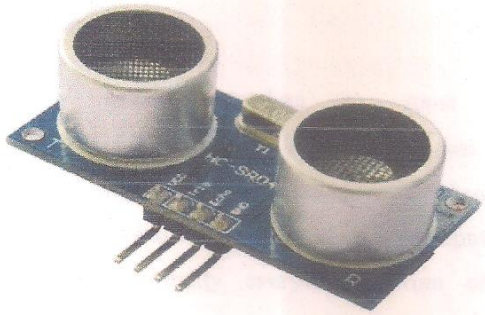


Fig. 3.14 Ultrasonic Sensor

3.10 SWITCH

In electrical engineering, a switch is an electrical component that can "make" or "break" an electrical circuit, interrupting the current or diverting it from one conductor to another. The mechanism of a switch removes or restores the conducting path in a circuit when it is operated. It may be operated manually, for example, a light switch or a keyboard button, may be operated by a moving object such as a door, or may be operated by some sensing element for pressure, temperature or flow. A switch will have one or more sets of contacts, which may operate simultaneously, sequentially, or alternately. Switches in high-powered circuits must operate rapidly to prevent destructive arcing, and may include special features to assist in rapidly interrupting a heavy current. Multiple forms of actuators are used for operation by hand or to sense position, level, temperature or flow. Special types are used, for example, for control of machinery, to reverse electric motors, or to sense liquid level. Many specialized forms exist. A common use is control of lighting, where multiple switches may be wired into one circuit to allow convenient control of light fixtures.

Fig. 3.15 Switch

3.11 CASTER WHEEL

A caster (also known as castor according to some dictionaries) is a wheeled device typically mounted to a larger object that enables relatively easy rolling movement of the object. Casters are essentially housings, that include a wheel and a mounting to install the caster to objects (equipment, apparatus and more). Casters are found virtually everywhere, from office desk chairs to shipyards, and from hospital beds to automotive factories. They range in size from the very small furniture casters to massive industrial casters, and individual load capacities span 100 pounds (45 kg) or less to 100,000 pounds (45 t). Wheel materials include cast iron, plastic, rubber, polyurethane, polyolefin, nylon, thermoplastic rubber, forged steel, stainless steel, aluminum, and more.

Swivel caster

This type of caster allows for movement in all directions. They can have one or two sets of raceways that allow the caster to swivel 360-degrees under a load. Because of displacement of wheel axis from steering axis, in spite of their zero caster angle, the point at which the wheel touches the floor trails behind the steering axis, keeping the wheel oriented in the direction of travel. The different types of swivel casters include:

- Locking casters: There are several devices that can be added to casters to prevent the wheel from rotating or the swivel assembly from turning. Brakes (locks) types are wheel-brakes, total lock, central locking, or add-on butterfly brake.
- Kingpin-less casters: This caster does not have a bolt and nut kingpin. The raceways are a one-piece construction forged together. This design is extremely durable and can be used in abusive applications and shock load applications where kingpin type casters may fail.
- Hollow Kingpin casters: This type of caster has a tubular rivet that holds the caster together. The hole in the rivet can accept a bolt or a customized stem for any type of mounting requirement.
- Plate casters: This is the most common type of means to mount a caster to a unit and is sometimes called the top plate. Most mounting plates contain four

holes used to bolt the caster to the unit. Top plates are offered with various hole patterns to match numerous types of mounting requirements.

- Stem casters: This type caster can have various stem styles to be used to mount the caster to a unit. Some common types of stems are threaded, round or square with mounting holes, grip-ring (also called "friction ring"), and expandable stems.

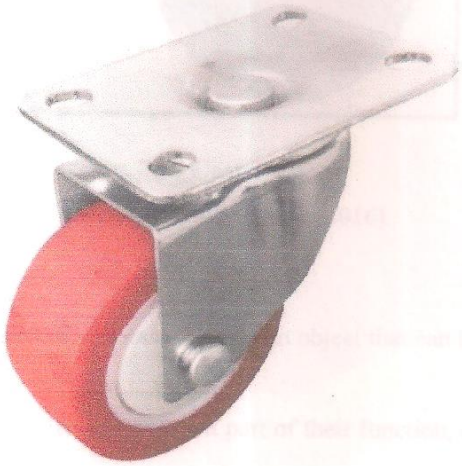


Fig. 3.16 Swivel Caster Wheel

Stainless steel	**Grade 304**
Wheel Size	**3" x 1-1/4"**
Top plate size	**2-1/2" x 3-5/8" with ball bearing swivel**
Bolt hole pattern	**1-3/4" x 2-7/8" to 3"**
Mounting Height	**4-1/8"**
capacity	**250 pound per caster**

Table 3.8

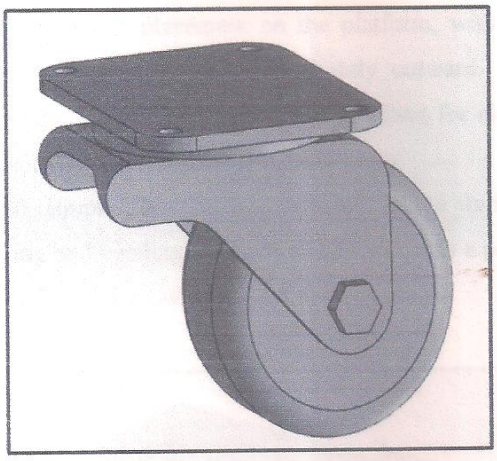


Fig. 3.17 Caster wheel

(Designed in SolidWorks 2016)

3.12 HANDLE

- A handle is a part of, or attachment to, an object that can be moved or used by hand.
- Handles for tools are an important part of their function, enabling the user to exploit the tools to maximum effect.

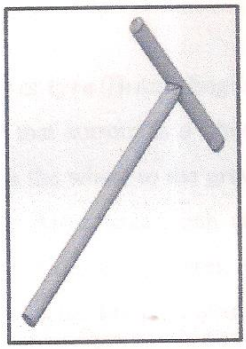


Fig. 3.18 Handle

(Designed in SolidWorks 2016)

3.13 WOODEN BOARD

Seeing as the device would use four wheels in total, it made sense for the platform to be rectangular. The chosen dimensions were 45cmx33cm. The 33cm width

allowed for comfortable feet placement on the platform, with the user placing their heels together and pointing their feet slightly outward. The 45cm length allowed for more room on the underside of the platform for electrical and other structural components. The height of the board is 11cm.

As for the material, simple plywood was selected due to its high strength and resistance to cracking and bending. Its light weight was also a positive factor as it helped exert a lower load on the wheels.

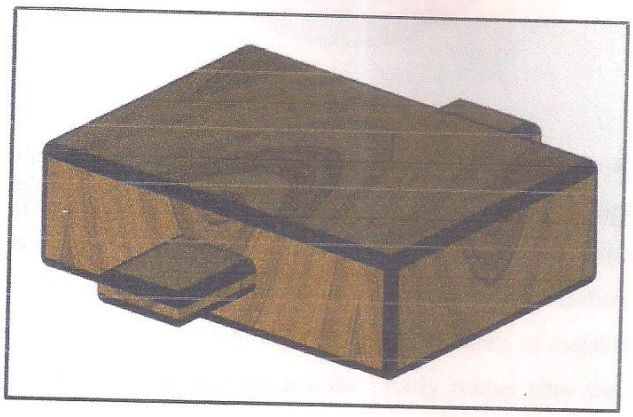


Fig. 3.19 Wooden Board

(Designed in SolidWorks 2016)

3.14 TYRES

A **tire** (American English) or **tyre** (British English; see spelling differences) is a ring-shaped component that surrounds a wheel's rim to transfer a vehicle's load from the axle through the wheel to the ground and to provide traction on the surface traveled over. Most tires, such as those for automobiles and bicycles, are pneumatically inflated structures, which also provide a flexible cushion that absorbs shock as the tire rolls over rough features on the surface. Tires provide a footprint that is designed to match the weight of the vehicle with the bearing strength of the surface that it rolls over by providing a bearing pressure that will not deform the surface excessively.

Fig. 3.20 Tyre

The materials of modern pneumatic tires are synthetic rubber, natural rubber, fabric and wire, along with carbon black and other chemical compounds. They consist of a tread and a body. The tread provides traction while the body provides containment for a quantity of compressed air. Before rubber was developed, the first versions of tires were simply bands of metal fitted around wooden wheels to prevent wear and tear. Early rubber tires were solid (not pneumatic). Pneumatic tires are used on many types of vehicles, including cars, bicycles, motorcycles, buses, trucks and aircraft. Metal tires are still used on locomotives and railcars, and solid rubber (or other polymer) tires are still used in various non-automotive applications, such as some casters, carts, lawnmowers, and wheelbarrows.

When a wheel and tire rotate, they exert a centrifugal force on the axle that depends on the location of their center of mass and the orientation of their moment of inertia. This is referred to as balance, imbalance, or unbalance. Tires are checked at the point of manufacture for excessive static imbalance and dynamic imbalance using automatic tire balance machines. Tires are checked again in the auto assembly plant or tire retail shop after mounting the tire to the wheel. Assemblies that exhibit excessive imbalance are corrected by applying balance weights to the wheels to counteract the tire/wheel imbalance. An alternative method to tire balancing is the use of internal tire balancing agents. These agents take advantage of centrifugal force and inertia to counteract the tire imbalance

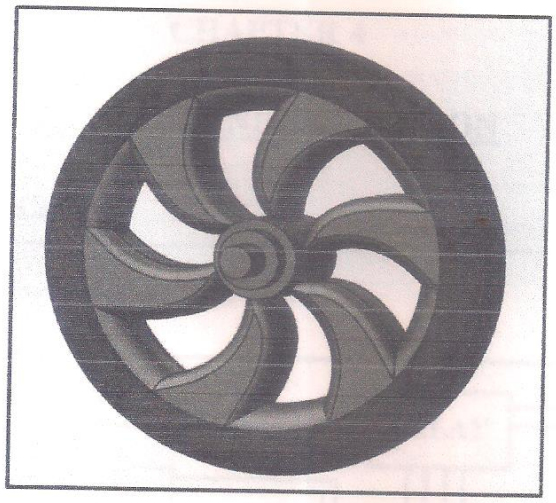


Fig. 3.21 Tyre

(Designed in SolidWorks 2016)

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Simulated Circuit

The circuit of the hoverboard is shown below.

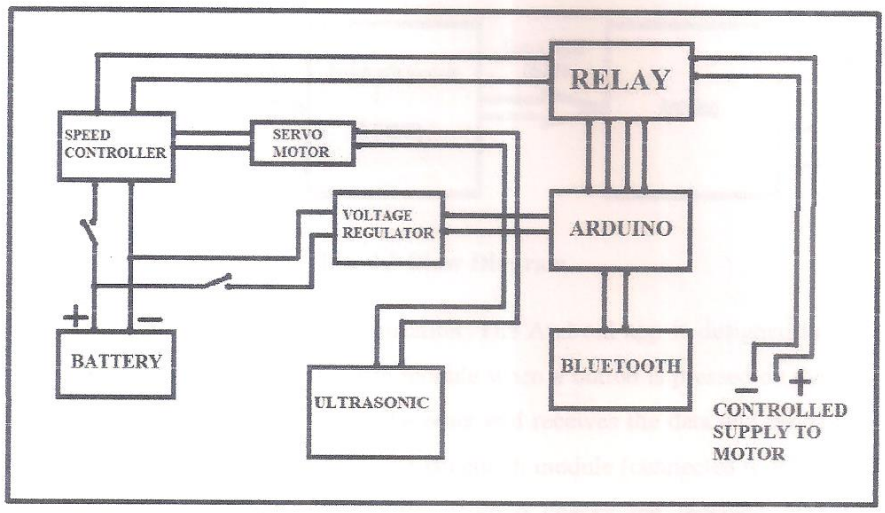


Fig. 4.1 Circuit Diagram

4.2 Connections and Connectivity

The Android app is designed to send serial data to the Arduino Bluetooth module when a button is pressed on the app. The Arduino Bluetooth module at the other end receives the data and sends it to the Arduino through the TX pin of the Bluetooth module (connected to RX pin over thought of controlling any of your electronic devices with your smartphone? How about a robot or any other device? Wouldn't it be cool to control them with your smartphone? Here is a simple tutorial for interfacing an Android smartphone with Arduino via Bluetooth.

Android studio isn't really required here, since I will provide you with the Android application that I made. You can install the given .apk file to use the application.

4.2.1 How Does It Work?

There are three main parts to this project. An Android smartphone, a Bluetooth transceiver, and an Arduino.

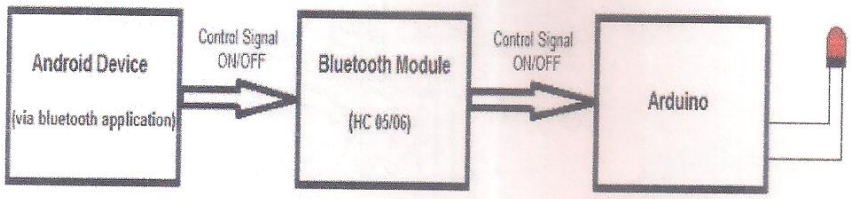


Fig. 4.2 Flow Diagram

HC 05/06 works on serial communication. The Android app is designed to send serial data to the Arduino Bluetooth module when a button is pressed on the app. The Arduino Bluetooth module at the other end receives the data and sends it to the Arduino through the TX pin of the Bluetooth module (connected to RX pin of Arduino). The code uploaded to the Arduino checks the received data and compares it. If the received data is 1, the LED turns ON. The LED turns OFF when the received data is 0. You can open the serial monitor and watch the received data while connecting.

4.2.2 Connecting the Arduino Bluetooth Hardware

This circuit is simple and small. There are only four connections to be made between the Arduino and Bluetooth module.

Arduino Pins | Bluetooth Pins

RX (Pin 0) ———> TX

TX (Pin 1) ———> RX

5V ———> VCC

GND ———> GND

Connect an LED positive to pin 13 of the Arduino through a resistance (valued between 220Ω–1KΩ). Connect its negative to GND, and you're done with the circuit!

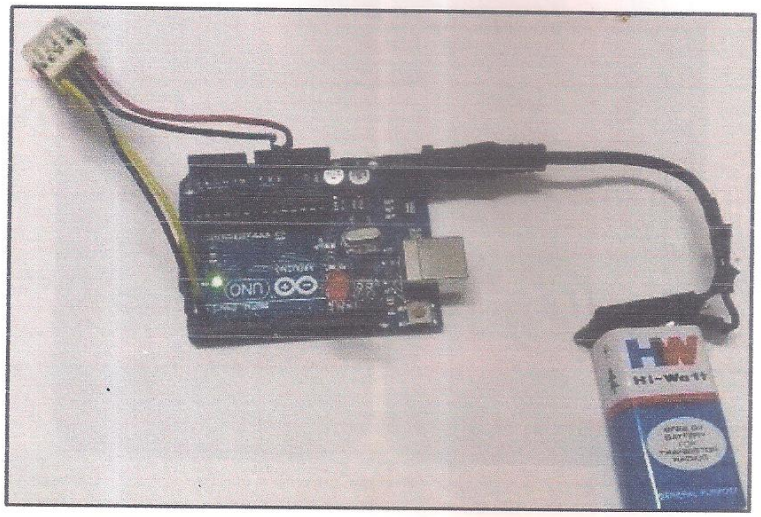
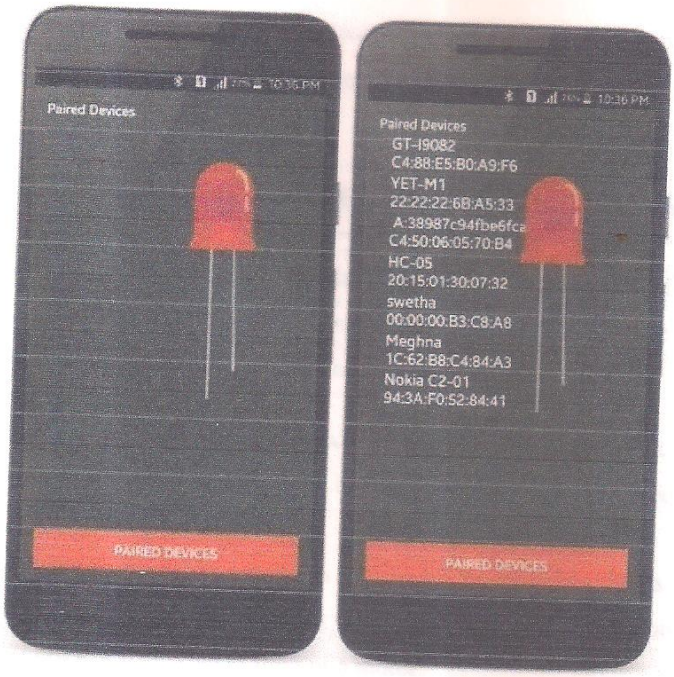


Fig. 4.3 Connection Details

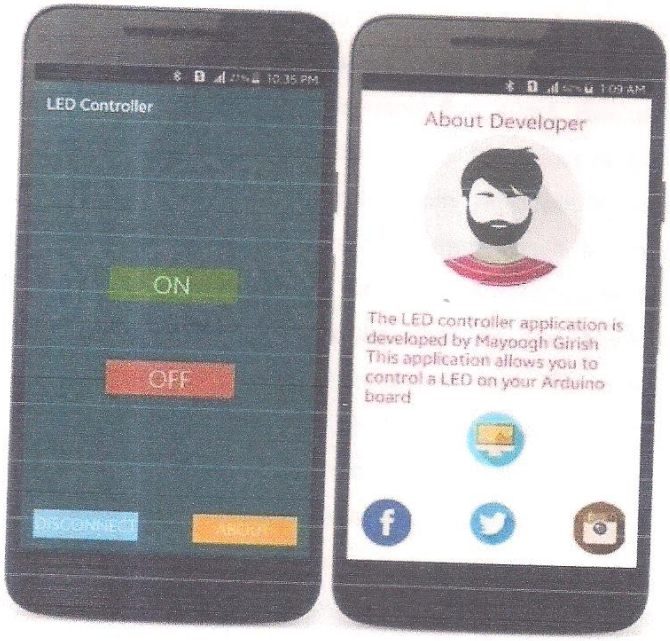
You can connect the Bluetooth module to the Arduino using a set of jumper wires and a connector.

Note: Don't connect RX to RX and TX to TX on the Bluetooth and Arduino. You will receive no data. Here, TX means transmit and RX m Android application from here and the source code of the entire project.

- Download the application from Amazon App Store or Play store.
- Pair your device with the HC 05/06 Bluetooth module:
- Turn ON the HC 05/06 Bluetooth module by powering the Arduino.
- Scan your smartphone for available devices.3. Pair your smartphone to the HC 05/06 by entering default password 1234 OR 0000.
- Install the application on your Android device.
- Open the application.



- Press "paired devices".
- Select your Bluetooth module from the list (HC-05/06)



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Professor & Head
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Moradabad Institute of Technology
Moradabad - 244001

- After connecting successfully, control the motors according your wish
- Disconnect the button to disconnect the Bluetooth module.

4.2.3 Relay Connected to Motor for Switching the Power Supply

One Arduino OUTPUT pin should be used to supply no more than 0.02A (20mA) current. (one pin has an absolute maximum safe current of 40mA, however, that is reduced if other pins on the same 8pin port is being used as an output).

Most electric motors need much more current than an Arduino pin can supply. A small, low-cost, electric motor, the sort of thing used in toys, might require 0.5A current.

A motor uses the most current when it is starting up, or something holds the motor shaft strongly enough to stop it (stall). So, check both the voltage and current rating for running and the stall current of a motor.

A relay may allow an Arduino pin to supply a small amount of current, yet control a much larger current for the motor. A relay may be activated by the Arduino pin, and its contacts might be capable of supplying the motor's needs. It is not automatically true that an Arduino can drive a relay. A relay might also use more current than an Arduino pin can safely supply. So a relay specification has to be checked too. It should not require more than 40mA absolute maximum. When power to motor is switched off, the motor will continue to spin for a short time. While it is spinning, it acts as an electricity generator. If the motor were connected directly to an Arduino pin, that power would try to go via the electronics of the pin, and would likely damage it. A motor connected to a relay will generate electricity when the relay opens. The voltage produced by the motor will rise quickly, and could even cause an 'arc', or spark. The motors generated voltage is usually conducted away to avoid this effect using a diode. (Search for this using the term 'freewheeling diode'). The diode will be connected in the opposite direction to the flow of current to the motor.

If the motor is being driven in both directions, then use four diodes two on each motor wire. Two diodes, one on each wire, will connect motor wires to ground. Two, one on each wire, will connect the motor wire to the positive power supply.

All four diodes will connect so that no power would flow normally. They will conduct away any power produced by the motor, and prevent arcing on a relay, or power running back though electronics.

It is also worth noting that a DC electric motor works by making and breaking contact, through its 'brushes', continuously, while it spins. This can also generate arcing or sparks. This creates a lot of electrical noise, which can 'upset' electronics, like an Arduino. Electrical noise can cause electronics to operate unreliably. This noise is usually dramatically reduced by connecting a ceramic or polyester capacitor, about 1nF to 10nF, across the motor's terminals.

You would normally supply a motor using a relay, and keep other components separate, for example a demultiplexer would not be part of the motors circuit.

4.3 Working Hardware in different modes

When we use it as a hoverboard, we attach a handle in it which helps in supporting the person who rides it as shown in figure.

Fig. 4.4 Hoverboard

(Designed in SolidWorks 2016)

When we use it as a trolley, we detach the handle to make it working as a trolley which can be use to lift heavy weights within industries. The figure shows the designed picture of trolley i.e., Hover-Trolley.

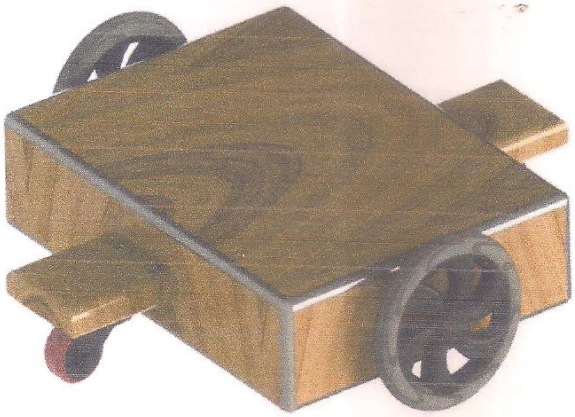

Fig. 4.5 Hover-Trolley
(Designed in SolidWorks 2016)

4.4 Analysis of the Project

The table shows the change in speed and time with change in weight. During testing, the rpm of motors is constant i.e., 100 RPM. Also, the distance is kept constant with the value of 4 meters. These Readings are taken with the help of Digital Tachometer.

WEIGHT (Kg)	TIME (Sec)	SPEED (m/s)
25	4.69	0.85
20	4.26	0.93
15	4	1
10	3.35	1.19
5	3.15	1.26

Table 4.1

The typical speed time variation can be explained with the help of following graph.

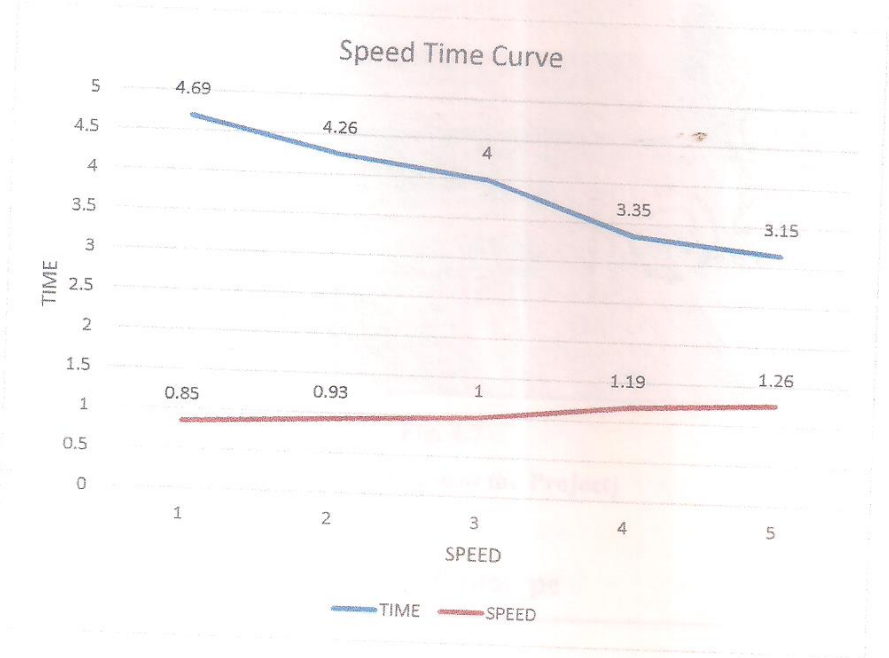

Fig. 4.6 Speed vs Time Graph

4.5 Results

The final design of this project basically contains just a wooden board with two road wheel and two caster wheels attached on the wooden base. One side of the board contain ultrasonic sensor to prevent the hoverboard from the collision. After testing it would be concluded that it can take a weight up to 50 kg and can design can also be used for making it work as trolley. The speed of the model can also be varied with help of servomotor which is placed inside the wooden board. The speed and time relation are also calculated with the help of weights and tachometer. It is found cleared in testing that the microcontroller, relay and the other device also working efficiently and efficiently.

Fig. 4.7

(Original Picture of the Project)

4.6 Engineering Drawings of the Prototype

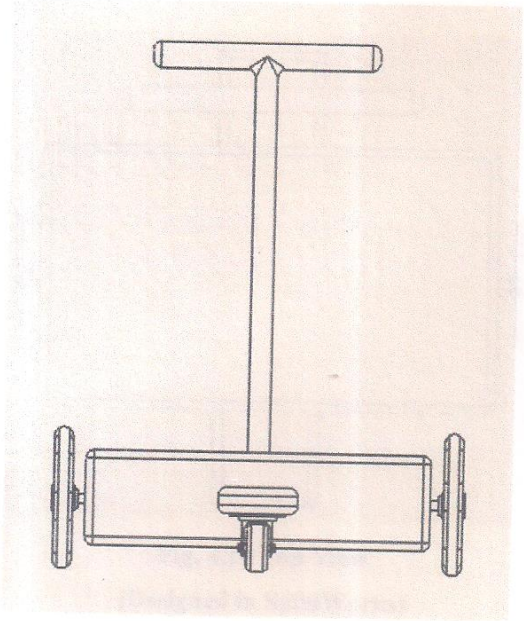

Fig. 4.8 Front View

(Designed in SolidWorks)

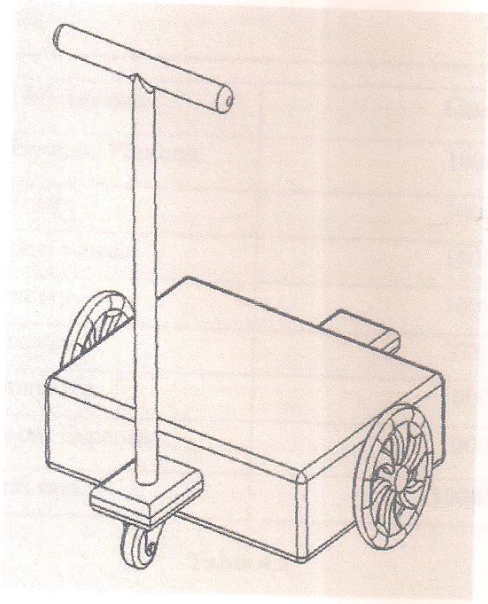

Fig. 4.9 Isometric View
(Designed in SolidWorks)

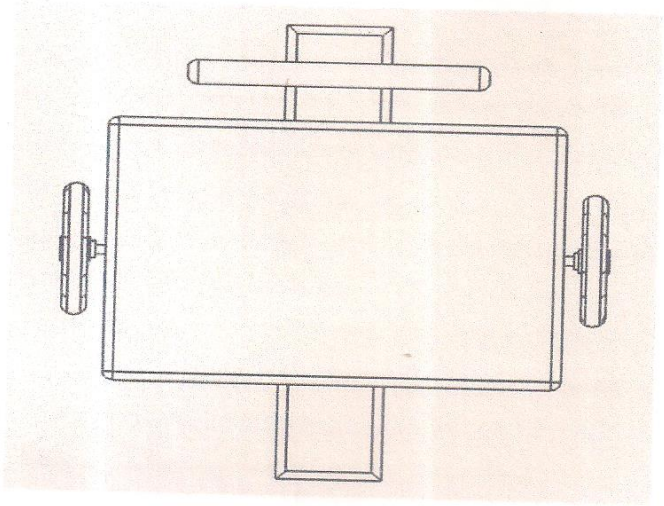

Fig. 4.10 Top View
(Designed in SolidWorks)

4.7 Cost Analysis

List of Materials	Cost
Rectangular Plywood Platform	1000
Motors	3000
Heavy duty wheels	1000
Battery	1000
Sensors	2000
Arduino Kit	1000
Miscellaneous Expenses	1000
Total cost.	**10000**

Table 4.2

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 INTRODUCTION

With the advent of new technologies ranging from global positioning systems to faster, smaller, and lighter computer processors, there has been a surge in development of unmanned vehicles. The benefits of unmanned vehicles include the removal of humans from harm's way and a degree of maneuverability and flexibility in deployment that has historically been unachievable. Many different types of unmanned and autonomous vehicles are currently in development for use over land and self-balancing scooter is one of them.

5.2 CONCLUSION

This hoverboard is specially design for helping people working in industry and it can be used as trolley also for limited load. Let's see how this hover-trolley works: -

- The hoverboard gets its power from battery, with the help of relay which provides required power to motors shafts to rotate the wheels.
- The caster wheels also provided in it for balancing the structure, so that it can also works as hover trolley.
- Arduino is used for making it work with the help mobile phone which make it mobile gesture dominating.
- For controlling the speed of the hoverboard servomotor are used in this project which is attached with the motor controller as we can vary the speed of the hoverboard according to the load and the condition.
- The Arduino needs up to 5-6 volt for its working. To provide this low voltage Dc boosters are used which is connected with the battery as shown in the above construction details.

This hoverboard is flexible for carrying the load up to 60Kg.The maximum rpm of the hoverboard is 100 RPM For controlling it with micro controller it requires basic c language program for its movement. The main key feature of this project

is that speed of the hoverboard can be vary according to the load applied on it which make it efficient in its movement and make it safe for children to use it.

5.3 FUTURE SCOPE

1. The project began with exploring ideas for the design inspired by similar devices in the market. Ultimately, a rectangular platform with two motor-powered wheels and two casters was chosen. Parts were purchased and connected, and the device was built and tested. Main Development is that it is emission free/green vehicle .so in future it can replace the automobiles to keep the environment clean and healthy.
2. Hoverboard companies are working on its longer battery life. This is already a budding issue with the current hoverboards and Internet capabilities will surely drain the battery even more. These are just a few features that hoverboard companies will try to tackle within the next two years and longer battery life is the most important among them.
3. In the near future, we are going to see more high-quality hoverboards manufactured with the highest safety standards. This will definitely improve its use by commuters.
4. Hoverboard is very useful for patrolling in an industrial area. So hoverboard can be used for safety purposes also by inbuilding the camera in it for recording the activity in industries.
5. Arx Pax is the manufacturing company behind the Hendo Hoverboard. Its main goal is to harness electromagnetic energy using magnetic field technology to keep the hoverboard steady on the air for a long time. There is a magnetic hover engine placed at the bottom of the engine which floats on the air when it hovers above an opposing magnetic field below the hoverboard. The specialized surface provides an avenue for the hoverboard to remain above and float in the air.
6. There is ongoing research to improve the overall functionality of hoverboards. Lexus, in particular, is at the forefront of this research. The company has already developed a hoverboard that uses superconducting magnets powered by liquid nitrogen. The device is still a work-in-progress as it's still limited by battery power and other issues.

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