iBot – Robotics Club of IIT Madras
Tutorial 1.1.1
Build Your Basic Bot

iBot is a Robotics Club of Indian Institute of Technology (IIT), Madras incubated at Centre for Innovation (CFI).

iBot has been there since few years and has undertaken many challenging projects.

1) Robocon

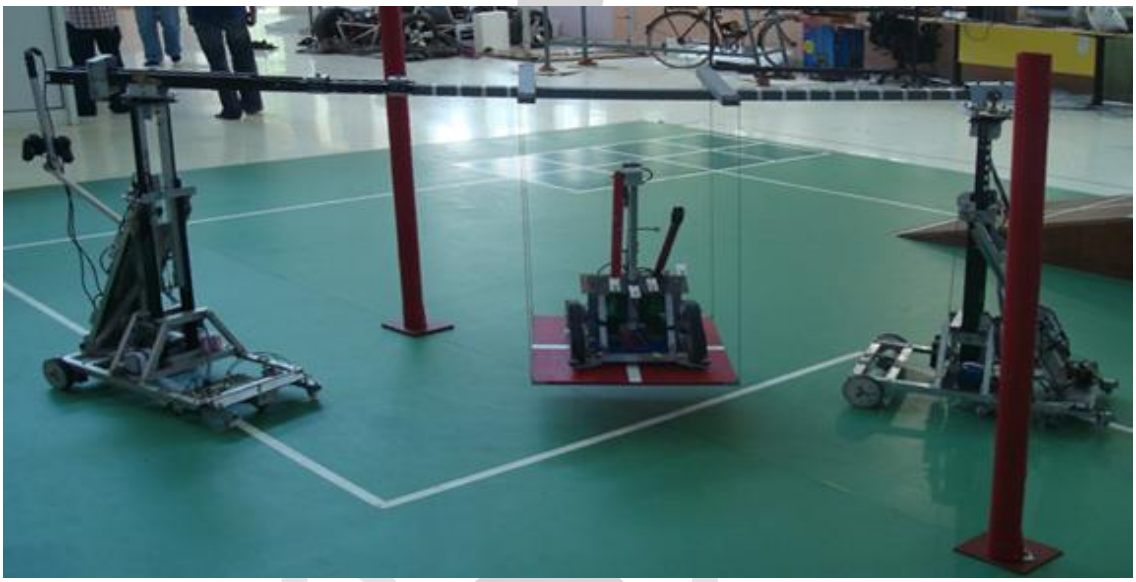


Figure1: Manual and Autonomous Carrier robots carry traveller robot to the drum zone.

Robocon is considered one of the most prestigious Robotics events in India. Robocon is a national and international level Robotics competition held every year in the month of March. IIT Madras has been continuously participating in the same for last 5 years. Every year, the problem statement is released by one of the Asian countries on the basis of their culture and tradition. A winning team in nationals gets a chance to represent India in internationals which is held in host country. In year 2009, the hosting country was JAPAN. Problem statement was based on the ancient Japanese custom of Kago.

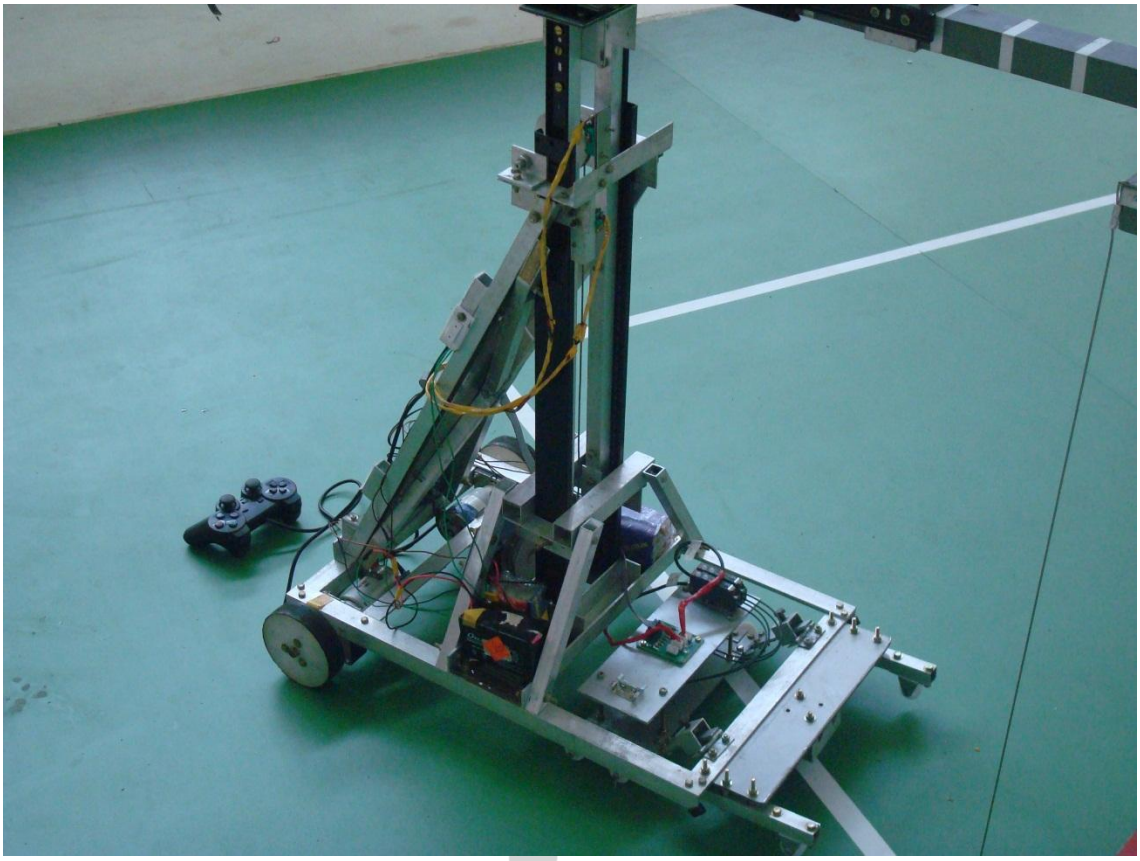


Figure2: Manual Robot

Robocon 2009 was the prestigious one in the history of IITM Robotics. For the first time, our institute earned a privilege to represet india at Roboocn 2009 at **TOKYO, JAPAN**. After an uninspiring performance at the group stages, the underdogs turned giant killers, performed brilliantly at the knockstage and finally emerged victorious.

People all over India watched scenes of joy in the team camp, as IITM also bagged **'The best design award'.**

1. Lets Get Started

There are many ways by which you can get involved in technical activities in our institute.

1.1 Tech Soc – Techsoc is a series of inter hostel technical competitions including both individual and mass events .To involve yourself in it, contact respective Technical Affairs Secretary (TAS).

1.2 You can be a part of any of the ongoing projects provided there is a vacancy for the same. For this, you will have to personally contact one of the project team members.

1.3 If you have an idea which you always wanted to turn it into a reality, you can go ahead and inform one of the iBot members, list of which is provided at the end of this tutorial.

1.4 Become a Robotics Club Member – You can apply for being a robotics club member. iBot expects some kind of basic knowledge and experience, enthusiasm and commitment towards Robotics. One of the ways by which you can gain experience is build your own basic robot as described in this tutorial.

We will try and make a simple remote controlled robot which can be made to move in any desired direction. This is just to get you started and gain enough momentum so as to push you to higher level projects or even propose your own ideas. Remember, the start has always been the trickiest part. Once you are through the first basic levels, you get a knack of it.

Before we start, you can form teams of 4-5 who are determined to 'MAKE THIS HAPPEN'.

First thing that you require is to have a basic understanding of all the required tools.

2. Tools Required:

2.1 Hacksaw or Jigsaw

2.2 Hand drill or Power Drill

2.3 Spanners

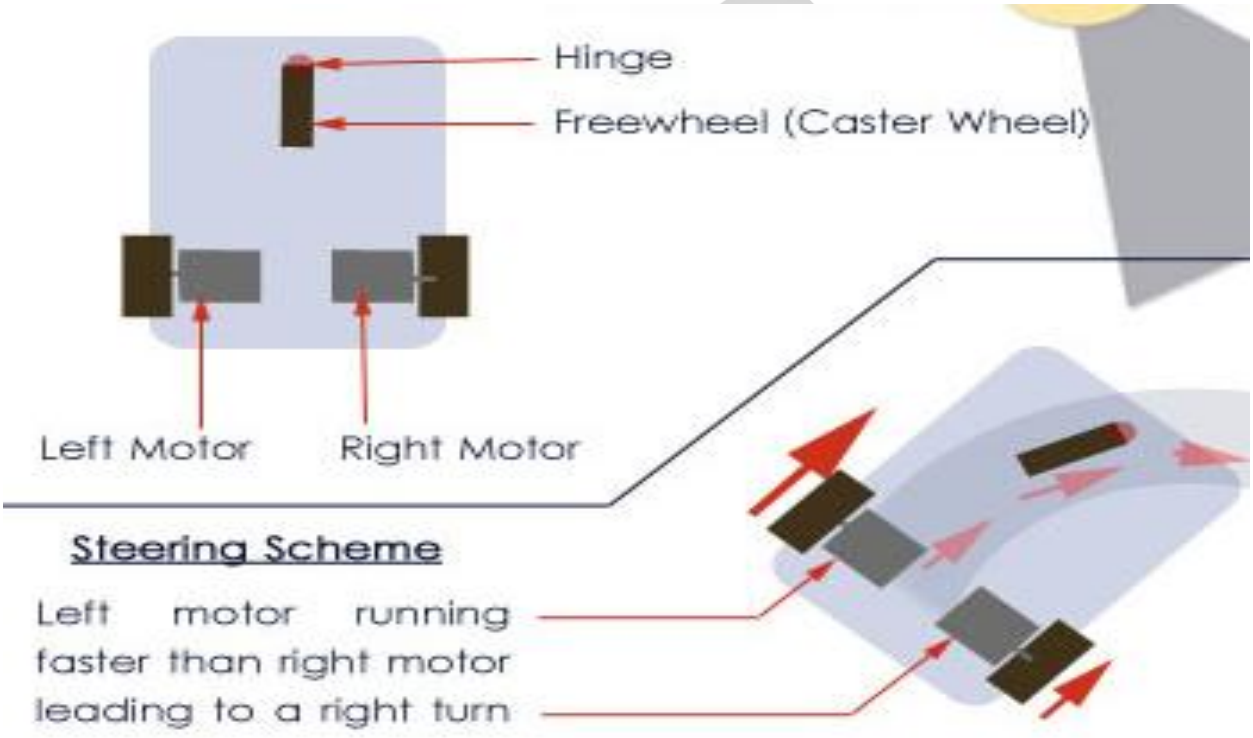
2.4 Pliers

2.5 Screwdriver

2.6 Wire stripper

Hope you all are familiar with these tools and know how to operate on them. If not, spend some time in doing so.

3. Differential Drive System (Robot Locomotion)



As suggested by its name itself, the independent control of both the driving motors (both front and back) is called differential drive. With the combination of four switches, i.e,

4. Left motor front
5. Left motor back
6. Right motor front
7. Right motor back

bot can be made to move in any desired direction. Following table shows the resultant direction in which the bot moves when a particular combination of switch is pressed.

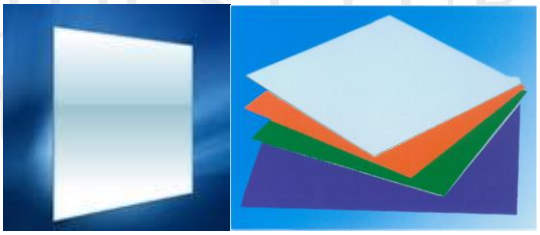
Right Motor	Left motor	Resultant Motion
ON (Forward)	ON (Forward)	Straight (Forward)
OFF	ON (Forward)	Right Turn (Clockwise)
ON (Forward)	OFF	Left Turn (Clockwise)
OFF	OFF	Stop
ON (Backward)	ON (Backward)	Straight (Backward)
OFF	ON (Backward)	Right Turn (Anti-Clockwise)
ON (Backward)	OFF	Left Turn (Anti-Clockwise)
OFF	OFF	Stop

4. Base Material:

   Next thing that you require is the base material on which all our components(motors, battery) will be mounted. You are free to choose any material you want. The most frequent ones used in our institute are

   4.1 Wood (one of the cheapest, readily available, easiest material to work with)

   4.2 acrylic (a transparent sheet to give bot an aesthetic look),



   4.3 aluminium (in case of higher strength requirement)

4.4 FRP, Fibre Glass

Cut the wood into required shape and dimention. The simplest shape to cut is rectangular. However, you are free to give any shape (triangular, octagon, circular etc.) to your bot. Tools to be used is either hacksaw (Hand tool) or Jigsaw (Power tool).

Note: While using hacksaw, its blade's teeth should be forward direction.

5. Motor

These are electromechanical devices which converts electrical energy into mechanical energy. For now, we will cover the bare minimum required for you. More details of this will be covered later.

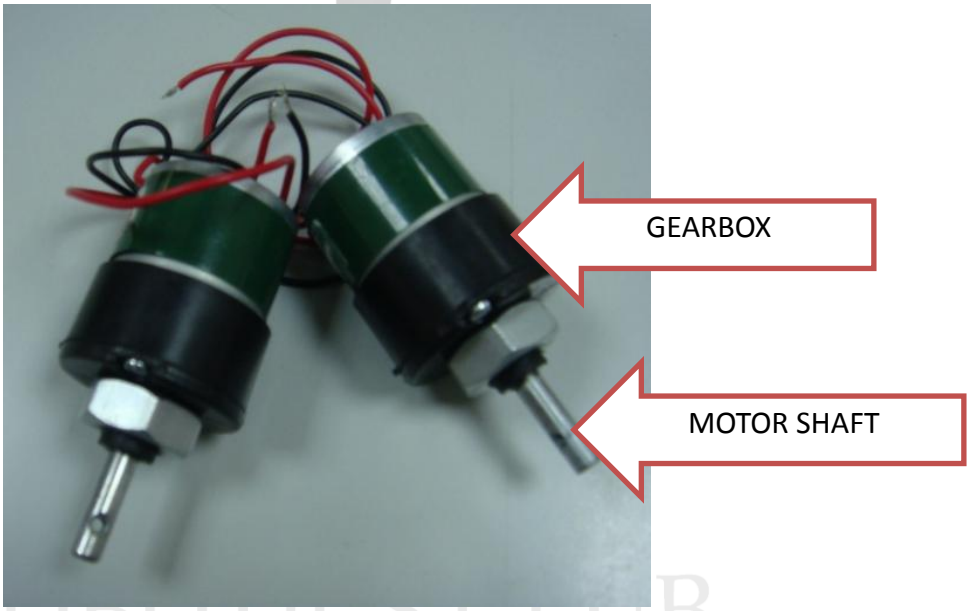
These general motors that are most commonly used in robotics have two terminals which tends to rotate when battery is connected across them. Depending on the way the battery is connected, they have the capability to rotate in both directions (clockwise and anticlockwise).

5.1 Main Specifications:

- RPM (Rotations per minute) :It is the number of rotations that the motor undergoes in one minute when rated voltage is applied across its two terminals. It is recommended to work with 100-150 rpm ones for beginners.
- Torque (Kg-cm): This is one of the most basic parameters of the motors to determine its strength to rotate an object.
- Voltage: Motors that are most commonly used in robotics are 12V and 24V ones.

5.2 Motors Parts:

- Shaft: it is where we attach wheel or an other mechanism
- Gearbox: This is to reduce the basic rpm of the motor to the desired one.
- Motor: High RPM motor which is then reduced using gearbox.

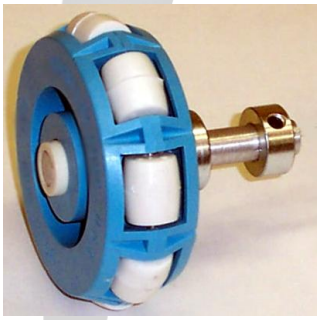


6. Wheels

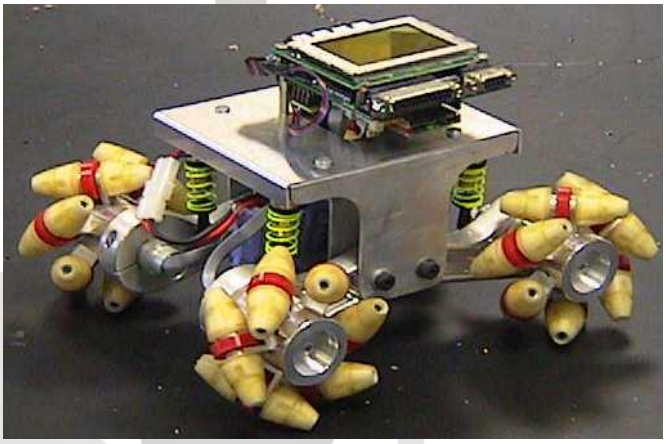
6.1 Types:

6.1.1 Normal Wheels

6.1.2 Omni Wheels



6.1.3 Mecanum Wheels



There are few things to kept in mind while choosing a wheel for your robot. Wheel should firmly fit on the motor shaft. Make sure that it is a tight fit in order to not to allow any relative motion between the two. Grip of the wheel is again a important parameter to be taken cared while purchasing.

Also, the speed of the robot will depend on the wheel diameter (or radius).

Speed of the robot α Wheel diameter (or radius)

7. Motor-Wheel Assembly

7.1 Wheels are fitted to motors using

7.1.1 Flanges

These are special kind of metallic interface between the wheel and the motor. One side of it is screwed to the wheel, while the other on the motor shaft.

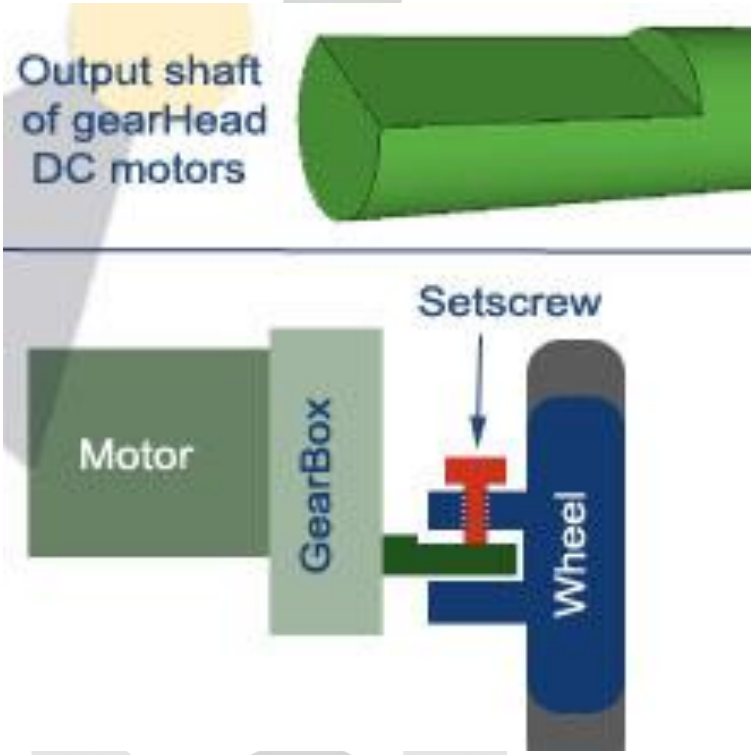


Figure: Wheels along with flanges

7.1.2 Tight fit

You can use a sleeve which can be put on the motor shaft before tight fitting the wheel onto it.

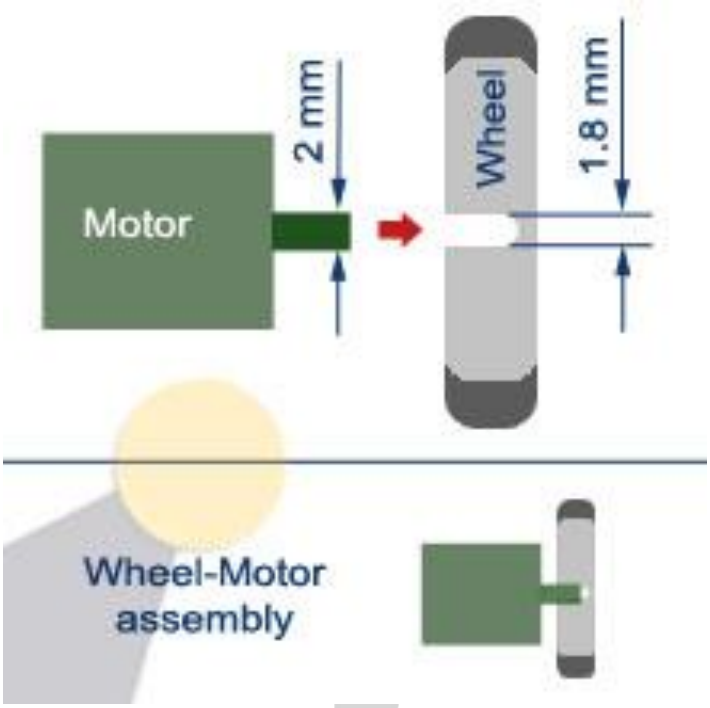
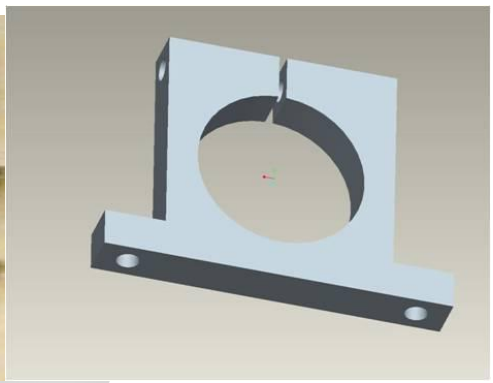


Figure: Tight Fit

8. Motor – Base assembly

8.1 Motor is fixed to the base using clamps of different shapes depending on the kind of motor used.

- 8.1.1 'U' Clamps
- 8.1.2 'C' Clamps
- 8.1.3 'L' Clamps
- 8.1.4 Special Clamps

9. Fixing Motors, Wheels and Base


10. Castor

10.1 Types:

10.1.1 Ball Castor

10.1.2 Wheel Castor

These are the free wheels just to give a third support to your robot (first two being the motor powered wheels). They can move in any direction, which is determined by other two powered wheels. Align this castor (adjust its height) such that the chassis remains parallel to the ground.

11. Final Chassis

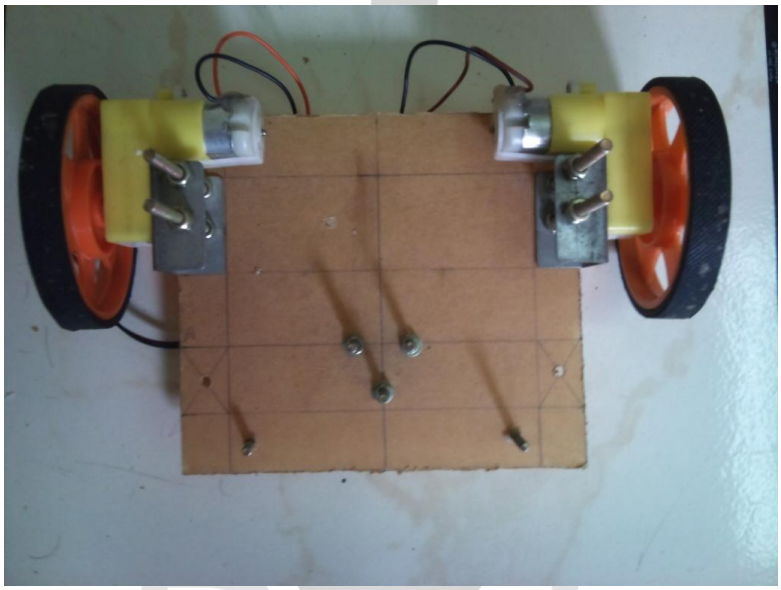


Figure: Chassis with wooden base

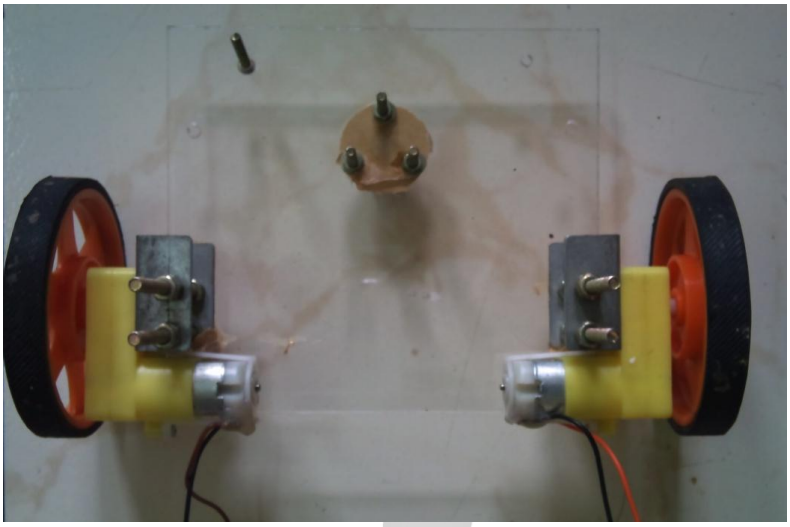


Figure: Chassis with Acrylic Base

Figure: Bottom view of the Chassis

Figure: Side View of the Chassis

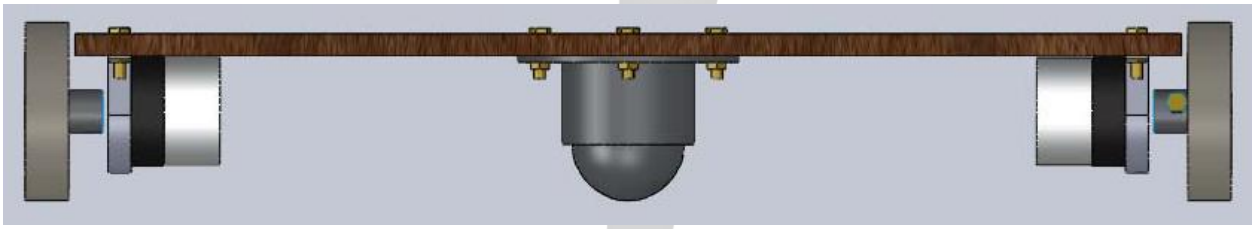


Figure: Front view of the chassis

12. Battery

12.1 Terminologies:

12.1.1 Rechargeable: It is good to have a rechargeable battery so as to keep you going for a longer time.
12.1.2 Voltage: 12V is the most commonly used battery
12.1.3 Amp-hr: This parameter determines how long can you run your robot with a fully charged battery. Commonly used – 1.2 Amp-Hr.

12.2 Types:

12.2.1 Lead Acid

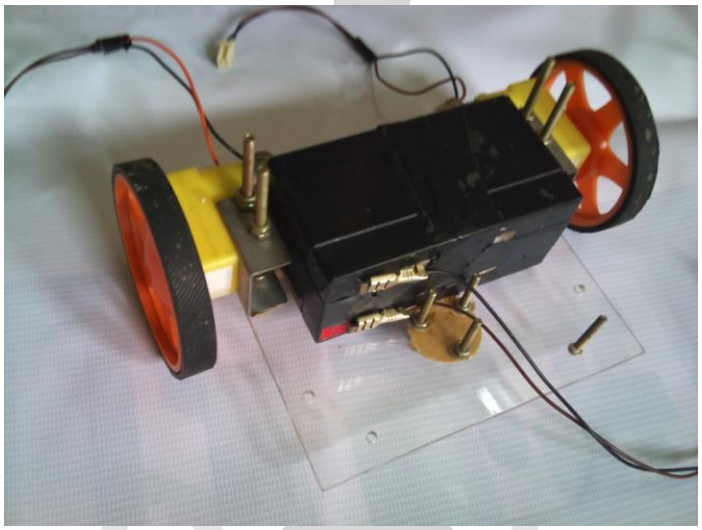
12.2.2 LiPo (Lithium Polymer)

12.2.3 Ni-Mh (Nickel Metal Hydride)

The most commonly used in the beginners project are lead acid batterys which is shown below.

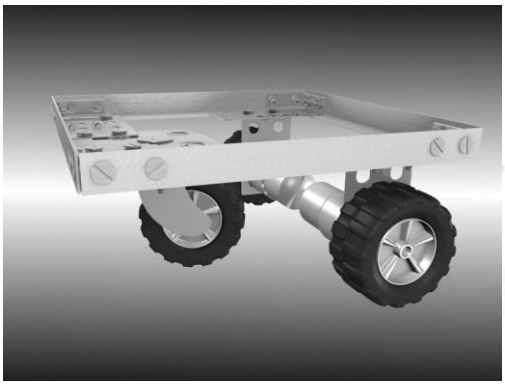
Note: As battery is one of the heaviest components, place the batteries such that center of gravity remains as low as possible.

13. Placing the Battery



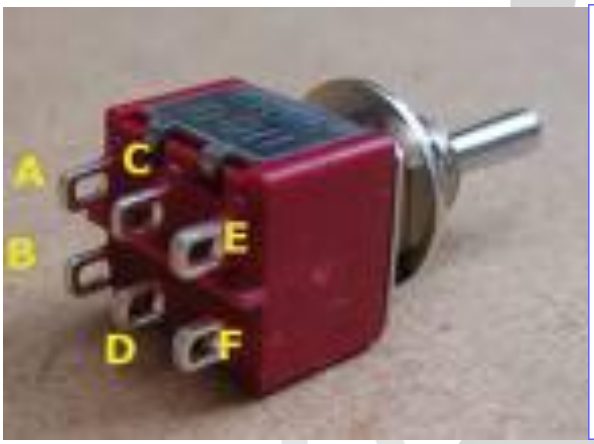
14. Final Bot Structure

You are free to build any kind of structure that suits your purpose and them appropriately mount other components. Following are the some of the examples.



15. Motor Control

DPDT (Double Pole Double Throw) switches controls each motor (for both clockwise and anticlockwise motion).



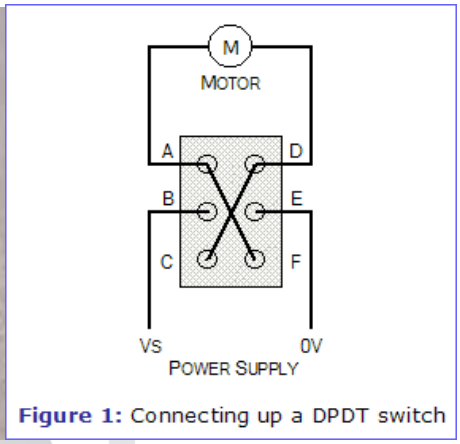


Figure 1: Connecting up a DPDT switch

Manual bot has to be controlled by DPDT switches. The switchboard (remote) should have slots for each DPDT switches.

Ends B and E are connected to the battery and ends A and D are connected to the motor.

16. Materials Required

16.1 Wood
16.2 Nuts and bolts
16.3 Motors – 2 nos.
16.4 Wheels – 2 nos.
16.5 Castor

16.6 Rechargeable Battery
16.7 Wires
16.8 Switches (DPDTs)

Your basic manual robot is now ready and raring to go!!

17. Approximate cost estimation

Prices are all approximate and are subject to change. This is just to give you an idea.

Material	Cost
2 Motors	~250
2 Wheels	60
Castor	30
Battery (Rechargeable Lead Acid)	500
DPDT Switches	50
Wood+Nuts+Bolts	100
Clamps + Flanges	100
Total	1090

18. Shops in Chennai

18.1 Ritchie street (Electronics Market):
18.1.1 Modi electronics, Ajanta Electronics
18.1.2 How to reach
18.1.2.1 23C from Main Gate
18.1.2.2 5C from Taramani
18.1.2.3 Train to Chintadripet from Kasturibai nagar

18.2 Parrys (Hardware Market):
18.2.1 For materials: Castor, clamps, tools etc.
18.2.2 How to reach
18.2.2.1 5C from Taramani
18.2.2.2 Train to Chennai Beach from Kasturibai nagar

19. Reference Sites

19.1 Information

19.1.1 www.howstuffworks.com

19.1.2 www.societyofrobots.com

19.2 Online Roboshops

19.2.1 www.robokits.com

19.2.2 www.thinklabs.com

19.2.3 www.rhydolabz.com

19.2.4 www.sparkfun.com

19.2.5 www.digikey.in

19.2.6 www.nexrobotics.com

20. FAQs

20.1 How to get into Robotics?

20.1.1 There are two main Robotic Tech soc events – Manual and Autonomous Robotics. You can be a part of that.

20.1.2 You can take part in tech fests of other colleges and institutions.

20.1.3 Make your own remote controlled robot as given in this tutorial.

20.1.4 Try to involve yourself with seniors who are into robotics which can prove to be a very good start.

20.1.5 You can volunteer for some of the ongoing projects in CFI.

20.2 I want to be a part of Robotics Club iBot. What are the prerequisites for the same?

20.2.1 You can apply for being a robotics club member. iBot expects some kind of basic knowledge and experience, enthusiasm and commitment towards Robotics. One of the ways by which you can gain experience is build your own basic robot as described in this tutorial. Once you feel that you have gained all prerequisites, contact one of the below given club members.

20.3 I am a beginner, I don't know anything. How do I start? Where do I start from?
Same as 20.1

20.4 I have an 'IDEA'. How do I go about turning it into a reality?
Contact one the club members details of which are provided at the end of this document.

20.5 Where do I get the list of ongoing projects?

20.5.1 Almost all the projects have a common working time of 8:00PM to 11:00PM on weekdays in CFI. You can be there at CFI to get to know about the

projects, interact with the team members, volunteer provided there is a vacancy, discuss your ideas if any.

20.6 Can we control the speed of the motor?

20.6.1 Yes you can by varying the voltage given to the motor, which can be done using a variable potentiometer. The only flaw in this approach is you will wasting part of energy in resistor.

20.6.2 PWM: Energy efficient approach. Will be covered in coming tutorials.

20.7 Why three wheels? Why not 4 wheels?

20.7.1 To define a plane uniquely, you require atleast 3 points. But if you have 4 points, you have to make sure that all the four points lie in a plane. Similarly, here, if you have 4 wheels, it is very hard to make sure that all the four wheels are touching the plane (ground in this case). Hence, 3 is the preferred choice. There is a need of suspensions in case of 4.

20.8 Why 2 motors? Can't this be done using just one motor?

20.8.1 You can move in just 1 direction if you have only one motor on your bot (think about it for a while).
But because, you need two degrees of freedom (have to move on a plane), you require 2 motors to cover that.

Contact Details:

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Sumit Patil	9840662120	235, Narmad
Koustuv Roy	9789015925	240, Narmad
Rajan Gupta	9444563153	418, Jamuna