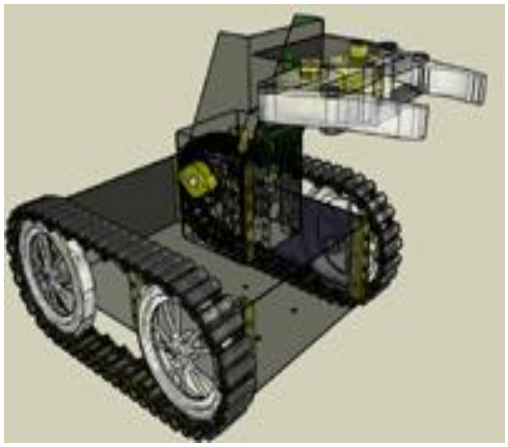
The Gripper Robot

In common usage, **Gripper** is a device which applies equal, opposite forces on two sides of the object to be gripped, using a 'jaw', and thus creates enough normal/frictional force to enable us to lift and move the object around.



The components of a gripper robot should thus be

1. A gripper module to hold and lift the objects we want. Subsequently, release the objects when we want.
2. A base with wheels on which the above module rests, so that we can move our robot, enabling us to move the lifter object from place to place.

1. Gripper, The Fundamentals

This section covers the basic principles that are used.

a) At the effector end- The concept of friction is important here.

Friction, we know depends upon the normal. So, if we want to lift an object, say a cube, by applying pressures from the side, we'll need to apply a normal reaction large enough to increase a friction to a level high enough to enable us to lift a body.

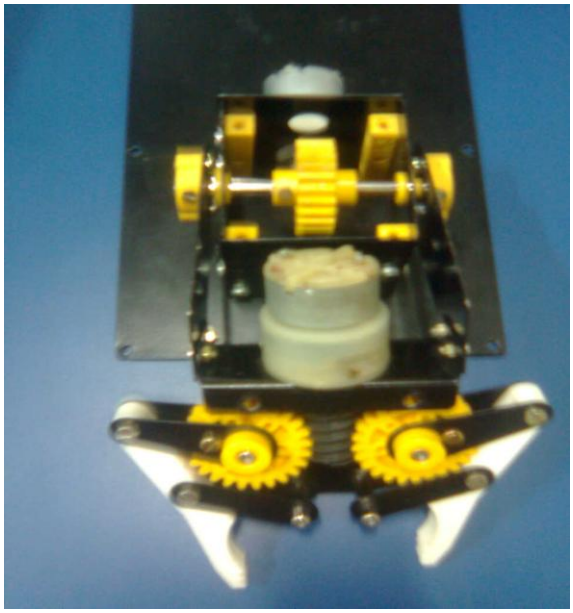
For moving the effectors For moving the effectors, we need a mechanism. The mechanism should have the following desirable characteristics

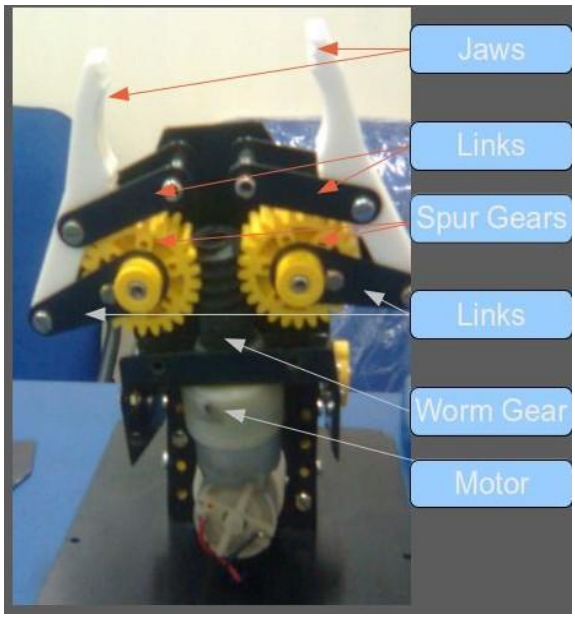
1. **Unidirectional transfer of power**(or self locking mechanism) – The power we transmit from the motor to the jaws for clamping the object, shouldnt be transmitted back to the motor once the motor is powered off. Why? Well, the object will exert a resistive force on the jaws that is in opposition to the one transmitted by the motor to the jaw. The resistive force will increase gradually as the body is deformed, and at on point become equal to the maximum force motor can exert, and thus stopping further deformation and stopping the motor. The motor at low speeds before this stage, and once completely stopped at this stage, will draw enormous power from the battery. We dont want this happening. So, we just switch on the motor and apply some force, large enough to create enough friction. Then we would switch off the motor, but the mechanism should ensure that the present configuration is locked-unidirectional transfer of power/self locking mechanism.

2. **Reversibility**- After gripping the object and moving it, we need to release it. So the entire mechanism, which worked to compress the body, should now work in reverse to release it(by itself the mechanism is locked remember?). For this, the motors should reverse their directions and jaws should, instead of getting closer, should move farther away from each other, thus releasing the body.

2. Gripper-The Construction

Take a look at the following image-





Look on the segment of the machine which has the part, as you read its description below -

1. **Jaws**-These are just two shapes that enable us to grip the object comfortable. The rounded shape, in this case enables us to pick cylindrical/spherical objects properly.
2. **Spur Gears**-These are the most common gears that we all see in day to day life. These move in a circular fashion. In the worm-gear mechanism we use, these are the driven.
3. **Worm Gear**-The long cylindrical gear you see, is the worm gear. It drives the two spur gears. Its rotated by the motor. On rotation, by principle of the archemedian screw, the two spur gears experience torques in two opposite directions. Suppose the spur gear tries to rotate the worm gear (for example, when the motor stops rotating the worm gear), the angle of friction is huge, and hence the mechanism gets locked. This, this mechanism has desirable characteristic one.
4. Achieving the **release of the jaws** is simple. Simple drive the DC motor in the opposite direction. (We use **DPST** for controlling the DC motor). The worm gear now rotates in opposite direction, and all torques and rotations get reversed. Thus, characteristic two is satisfied.
5. The **links** hold the jaws in place, providing guides and constraints ensuring they remain parallel and equiplanar. This is desirable in order to exert uniform forces on the object. Ensuring we have proper control over the whole process of pick and place. Working out the contraints involved, and their effect on the jaw movement on paper may help.

3. Gripper-The Electronics

1. **Switch -** A **switch** is an electrical component that can break an electrical circuit, interrupting or breaking flow of current from one side of the switch to another, or allowing the current to pass when desired.

The most familiar form of switch is a manually operated electromechanical device with one or more sets of electrical contacts. Each set of contacts can be in one of two states: either "closed" meaning the contacts are touching and electricity can flow between them, or "open", meaning the contacts are separated and the switch is nonconducting. The mechanism actuating the transition between these two states (open or closed) can be either a "*toggle*" (flip switch for continuous "on" or "off") or "*momentary*" (push-for "on" or push-for "off") type.

In electronics engineering, an ideal switch describes a switch that:

- has no current limit during its ON state
- has infinite resistance during its OFF state
- has no voltage drop across the switch during its ON state
- has no voltage limit during its OFF state
- has zero rise time and fall time during state changes
- switches without "bouncing" between on and off positions

Practical switches fall short of this ideal, and have resistance, limits on the current and voltage they can handle, etc. The ideal switch is often used in circuit analysis as it greatly simplifies the system of equations to be solved, however this can lead to a less accurate solution. In our application, this doesnt matter

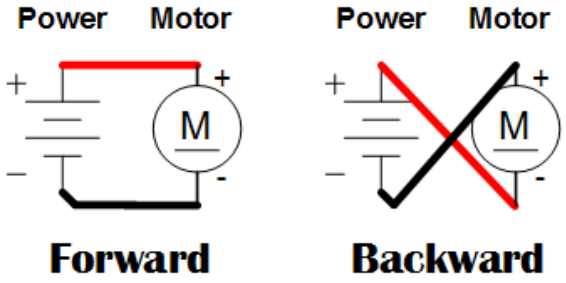
The terms ***pole*** and ***throw*** are used to describe switch contact variations. The number of "*poles*" is the number of separate circuits which are controlled by a switch. For example, a "*2-pole*" switch has two separate identical sets of contacts controlled by the same knob. The number of "*throws*" is the number of separate positions that the switch can adopt. A single-throw switch has one pair of contacts that can either be closed or open. A double-throw switch has a contact that can be connected to either of two other contacts, a triple-throw has a contact which can be connected to one of three other contacts, etc.

The electronic involved in the gripper is mainly to

1. Control the direction of flow of current through the motor that drives the jaws
2. Control the direction of flow of current through the motors that drive the wheel of the robot

Explaination here is for a general motor. Identical to it is the functioning of the control mechanisms of the motors of the jaws and wheels.

This is what we want to acheive -

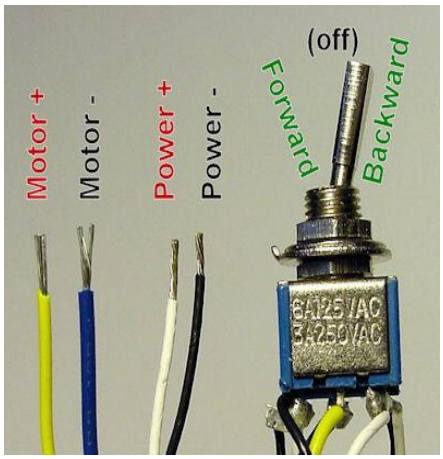


To achieve the above, we cannot rewire the motor everytime we want to change directions. We'll use a Double Pole, Double Throw, Center Off Toggle switch.

Hooking Up The DPDT Center-Off Switch

Inside the switch there are metal strips that either connect the wires or disconnect them, as the lever

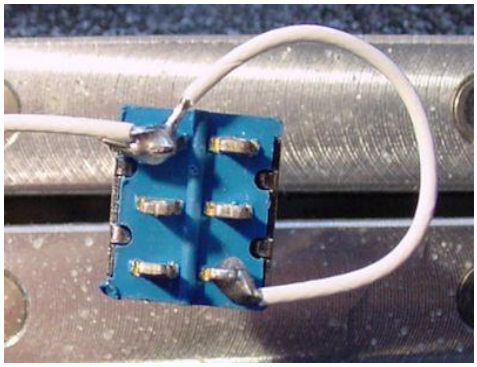
is flipped back and forth.



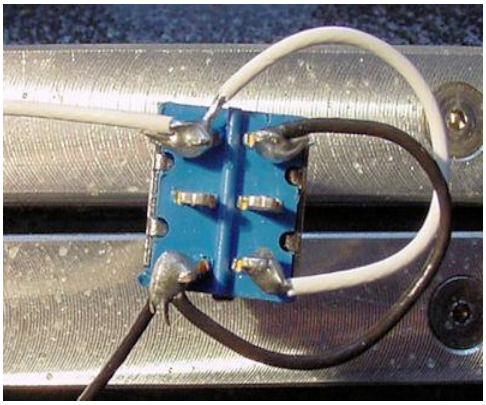
Here are the wire assignments:

- Yellow: Positive terminal of the motor.
- Blue: Negative terminal of the motor.
- White: Positive terminal of the battery.
- Black: Negative terminal of the battery

1. Connect the white wire (positive power) to the DPDT switch as shown above. You'll need one long piece of wire coming from the battery to the first switch terminal. And, you'll need a smaller piece of wire coming from the first switch terminal to the opposite terminal as shown.



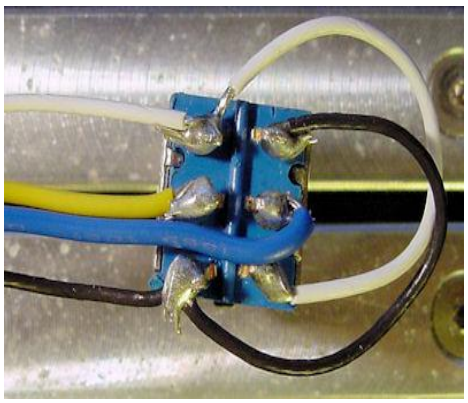
2. Connect the black wire (negative power) to the DPDT switch as shown above. You'll need one long piece of wire coming from the battery to the lower switch terminal. And, you'll need a smaller piece of wire coming from the lower switch terminal to the opposite terminal as shown.



3. Connect the yellow and blue wires from the motor to the center terminals of the DPDT switch as shown above.

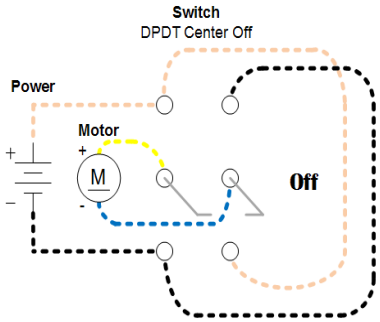
4. Connect the yellow and blue wires to the motor terminals.

5. Make sure the switch is in the center (off) position, before connecting the battery. Connect the white and black wires to the battery.

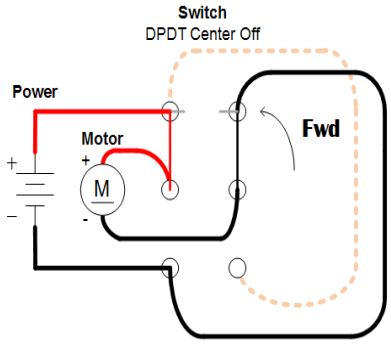


Controlling the Bidirectional Motor Switch

Let's step through what happens when you flip the switch to the top, center, and bottom...



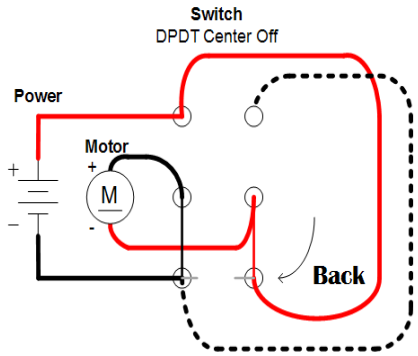
When the switch lever is in the middle position, the motor is off because the metal inside the switch is not connecting the wires from the middle terminals (the motor) to any of the outer terminals (the power source). This is the same as if you simply disconnected the wires to the battery. Nothing will happen. No power is being used.



When the switch lever is in the top position, the motor rotates forward. If your motor rotates in the

opposite direction than you expected or wanted, simply reorient the switch in your hand so that lever is facing the bottom, and then toggle the lever to the top. Alternatively, you could swap the wires on **either** the battery terminals **or** the motor terminals.

Inside the switch, the lever has pushed metal strips such that the motor wires on the middle terminal are electrically connected to one pair of the outer terminals leading to the battery. The term "double pole" refers to that fact that this switch has a pair of terminals that it connects or disconnects at the same time. If we only needed a single wire to be connected or disconnected, we could use a single pole (SP) switch.



When the switch lever is in the bottom position, the motor rotates backward.

Inside the switch, the lever has pushed metal strips such that the motor wires on the middle terminal are electrically connected to the other pair of the outer terminals leading to the battery. Notice that the black and white battery wires are on opposite sides on the top and bottom switch terminals. That's why the motor rotates in the opposite direction.

The term "double throw" refers to that fact that this switch can be thrown to the top and thrown to the bottom (two different throws). If we only needed the motor to go forward or turn off, we could use a single throw (ST) switch.

Thus motor control is complete.

The Base of the bot

For effectively moving a body on a plane with with wheels, we need two wheel whose direction of motion can be controlled, and a third dummy wheel for supporting the body (Merely two wheels will cause the body to topple)

The two main wheels are connected to two motors, each of whose direction can be controlled as described above.

Both wheels forward = Forward motion

backward=Backward motion

right forward, left backward = left turn

left forward, right backward=right turn

(This kind of a control is called differential drive)

The two wheels and the motors are readily available.

The third dummy wheel is called a castor wheel. It can be purchased in hobby robotics shops as well.

Bringing it all together

Individually we have gone through

1. Details of a gripper robot
2. Details of the base.

Actual construction and shape, even the mechanism is completely upto you. This tutorial was just to tell what it takes to make a gripper. Its not the only way. Its not the best. Its not the easiest either! Its upto you.