COMP20170
Introduction to Robotics

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Robots

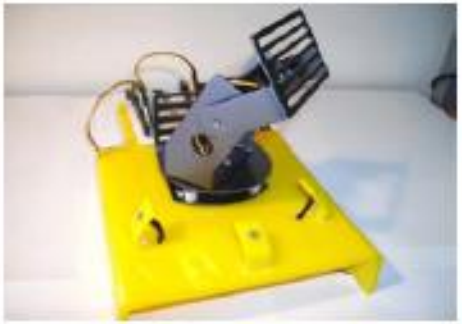
- Their motors are the muscles
- The general purpose computer the human brain
- Robotic vision, the eye

We combine these various elements in different ways to create the robot that we require.

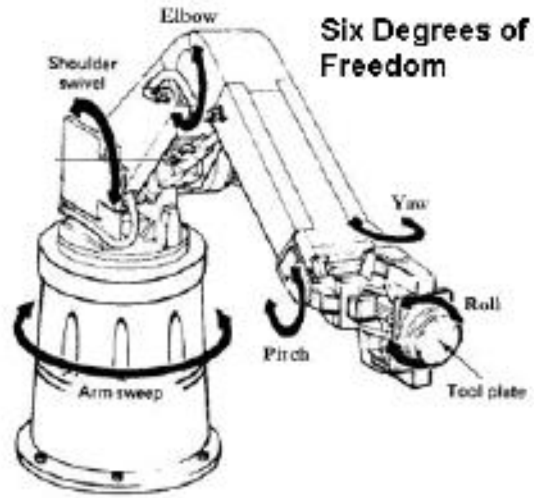
The most common robot used in industry today is the robot arm. These arms are used to weld, package, paint, position and assemble a host of products that we use daily. Basically a robot arm is a series of linkages that are connected in such a way that a servo motor can be used to control each joint. The controlling computer, the brain of the robot, is programmed to control the various motors on the robot in a way that allows it to perform specific tasks.

The robot arm can be designed in a number of different ways, the size and shape of this arm is critical to the robotic architecture of the robot. The arm is the part of the robot that positions the final grabber arm or spray head to do their pre-programmed business. If the design of the arm is too large or small this positioning may not be possible. Many arms resemble the human arm, containing shoulders, elbows wrists

As a rule you need one motor for each degree of freedom that you want to achieve.



A degree of freedom is typically one joint movement. So a simple robot with 3 degrees of freedom can move three ways: up and down, left and right, forward and back. This simple pan and tilt robot has 2 degrees of freedom, powered by two servo motors. It can rotate left to right and lift up and down.



Many robots today can be designed to move with 7 degrees of freedom.

Degrees of Freedom

First Degree: Shoulder Pitch

Point your entire arm straight out in front of you. Move your shoulder up and down. The up and down movement of the shoulder is called the shoulder pitch.

Second Degree: Arm Yaw

Point your entire arm straight out in front of you. Move your entire arm from side to side. This side to side movement is called the arm yaw.

Third Degree: Shoulder roll

Point your entire arm straight out in front of you. Now, roll your entire arm from the shoulder, as if you were screwing in a light bulb. This rotating movement is called a shoulder roll.

Fourth Degree: Elbow Pitch

Point your entire arm straight out in front of you. Hold your arm still, then bend only your elbow. Your elbow can move up and down. This up and down movement of the shoulder is called the shoulder pitch.

Fifth Degree: Wrist Pitch

Point your entire arm straight out in front of you. Without moving your shoulder or elbow, flex your wrist up and down. This up and down movement of the wrist is called the wrist pitch.

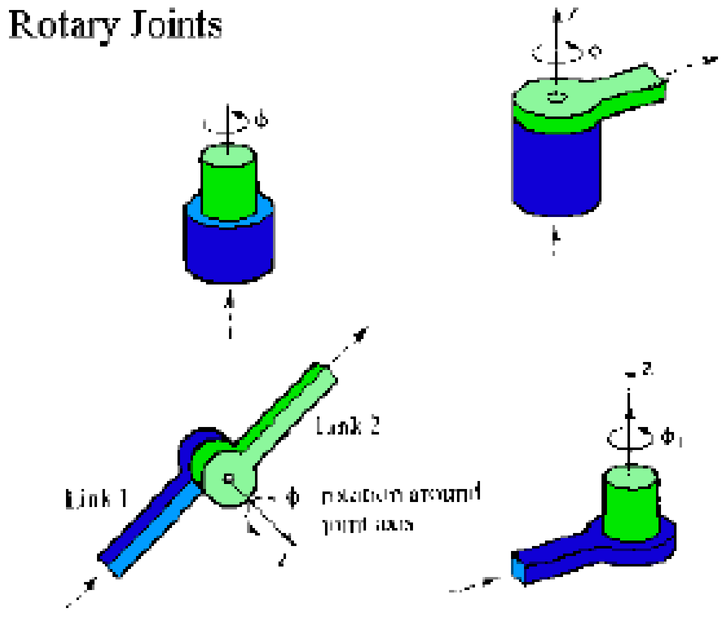
Sixth Degree: Wrist Yaw

Point your entire arm straight out in front of you. Without moving your shoulder or elbow, flex your wrist from side to side. The side to side movement is called the wrist yaw.

Seventh Degree: Wrist Roll

Point your entire arm straight out in front of you. Without moving your shoulder or elbow, rotate your wrist, as if you were turning a doorknob. The rotation of the wrist is called the wrist roll.

Rotary or revolute joints

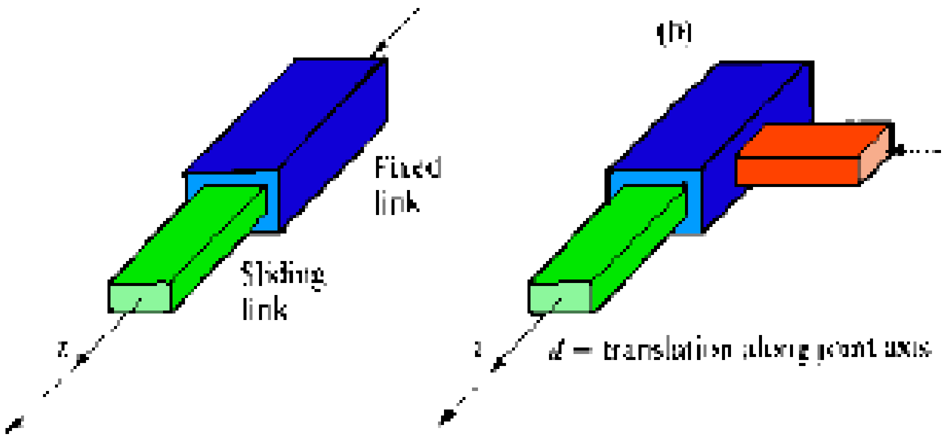


The top two linkages in the diagram above are generally used as a waist joint. An example of a waist joint can be seen in the Crust Crawler robot, it is the joint that pivots the entire robot. The Blue section is fixed and the green rotates about it.

The bottom linkages are examples of elbow joints. In the case of the four joints they are only capable of one degree of rotation, the joint variable is the angle that the joint move to. Most rotary joints cannot rotate through 360° degrees as they are mechanically restrained by the arm construction and the servo motor.

Linear Joints

Linear or prismatic joint



A prismatic joint is a sliding joint. It can be used for merely a simple axial direction. These linear joints are not as common as the rotary joints but are very useful.

The cylindrical robot below has both types of joints evident. The rotary joint allows the grabber to rotate about the axis; while the linear joints Y&Z determine height and reach.

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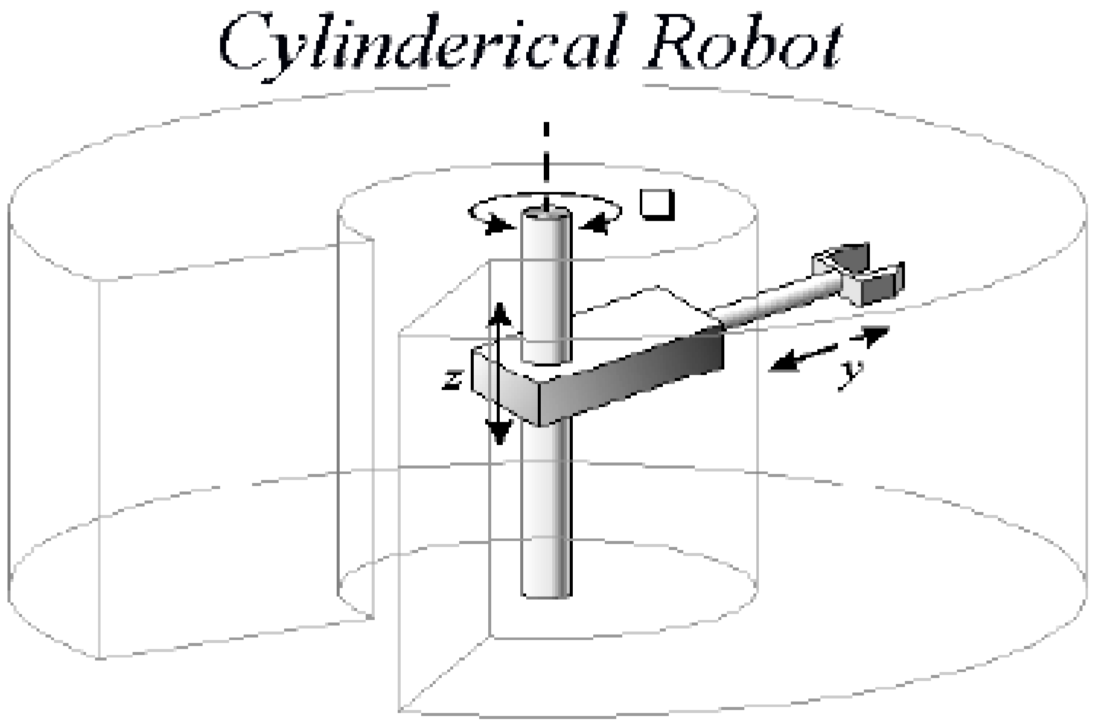
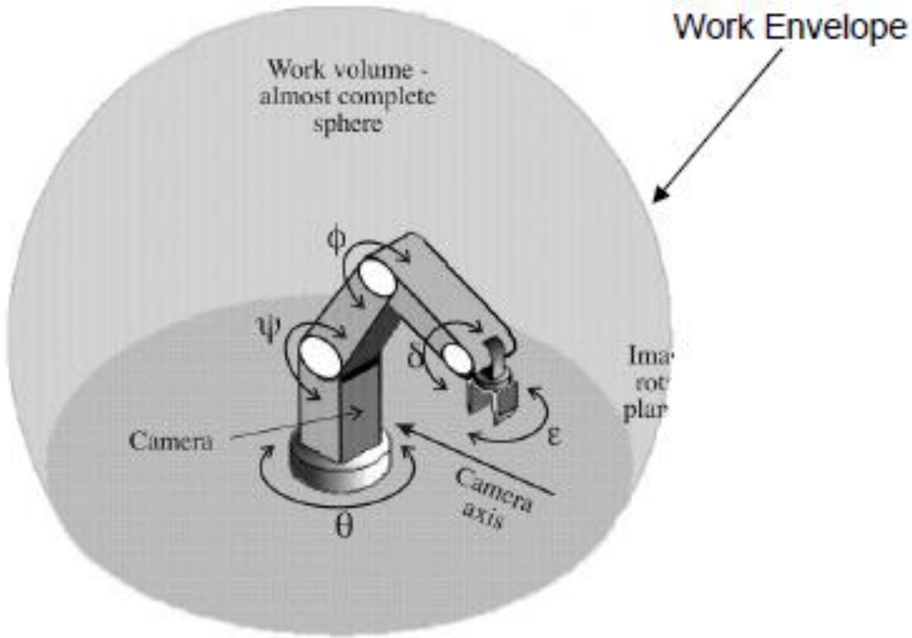


The volume of space that a robot operates within, is called the **Work Envelope**



The work envelope defines the space around a robot that is accessible for the end effector or gripper.

As a robot moves around the limits of its reaches it traces out a specific shape. The Cylindrical robot in the last image has a visible work area of a cylinder. A Cartesian robot sweeps out a rectangular volume, a polar a partial sphere.