BAHRIA UNIVERSITY ISLAMABAD

ROBOTICS LAB

LAB 1: INTRODUCTION TO ROBOTICS

Name of Student: …….

Roll No.: …….

Date of Experiment: …….

Report submitted on: ……..

Marks obtained: ……

Remarks: ……

Instructor's Signature: ……..

Fall 20211

Objectives:

- To study the parts of the Robot.
- To study classification of robots based on workspace.
- To Study different types of manipulators.
- To study various robot joints.

What is a Robot?

An electromechanical device that is

- Programmable
- Multifunctional
- Sensible for Environment

How does one define Robot?

Oxford American Dictionary:

A machine capable of carrying out a complex series of actions automatically, especially one programmed by a computer.

Merriam-Webster Dictionary:

1. A machine that looks and acts like a human being.
2. An efficient but insensitive person.
3. A device that automatically performs repetitive tasks.
4. Something guided by automatic controls.

Robotics - Definition

The study of Robotics concerns itself with the desire to synthesize some aspects of human function by the use of mechanisms, sensors, actuators and computers.

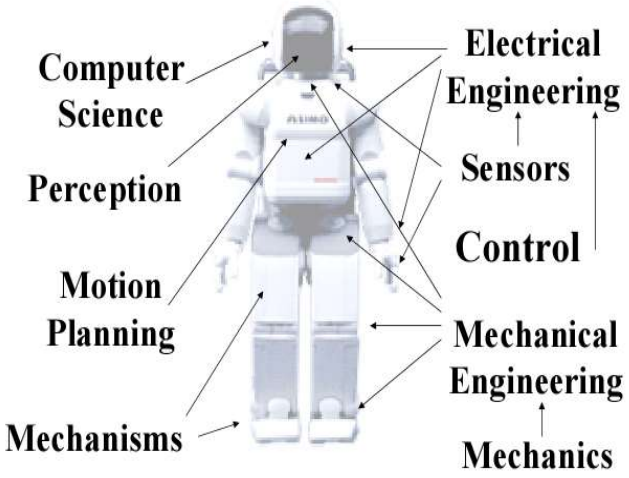
Wikipedia

Robotics is the engineering science and technology of robots, and their design, manufacturing, application, and structural disposition. Robotics is related to electronics, mechanics, and software.

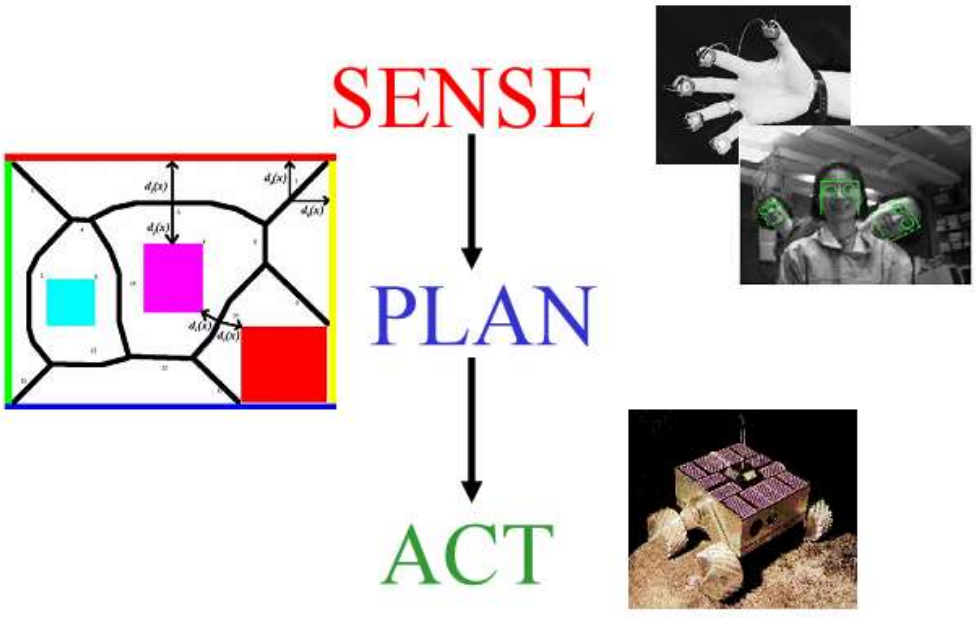
Robot Institute of America

An automatic device that performs functions normally ascribed to humans or a machine in the form of a human.

Fields used in Robotics

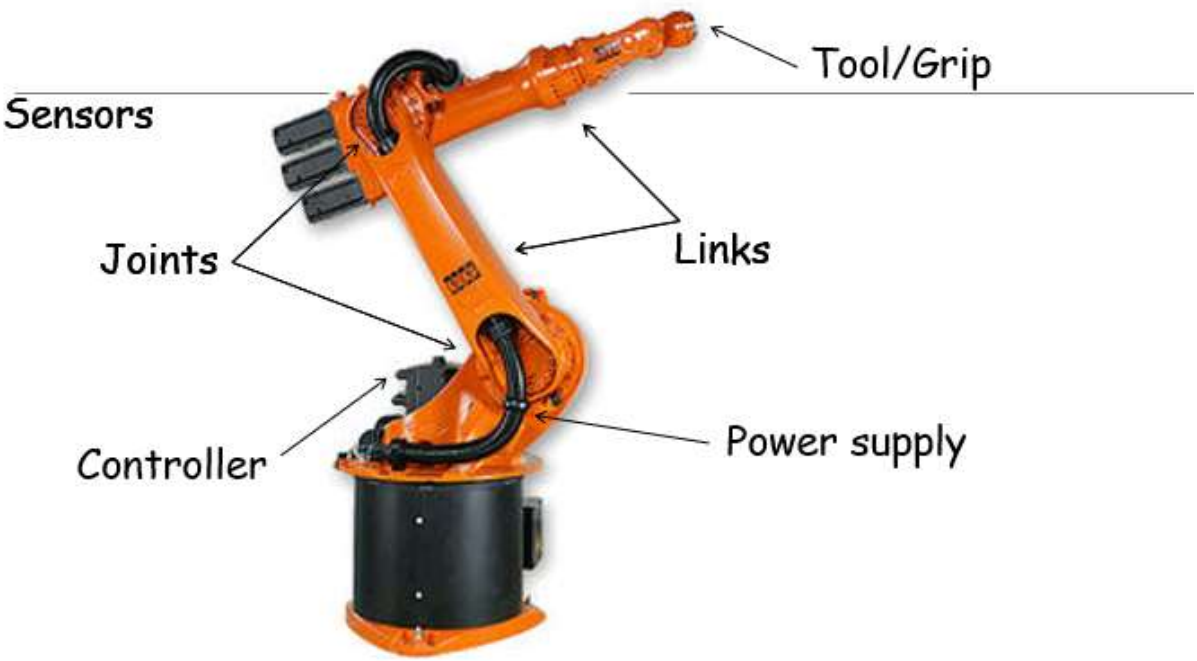


Combining these fields, we can create a system that can:



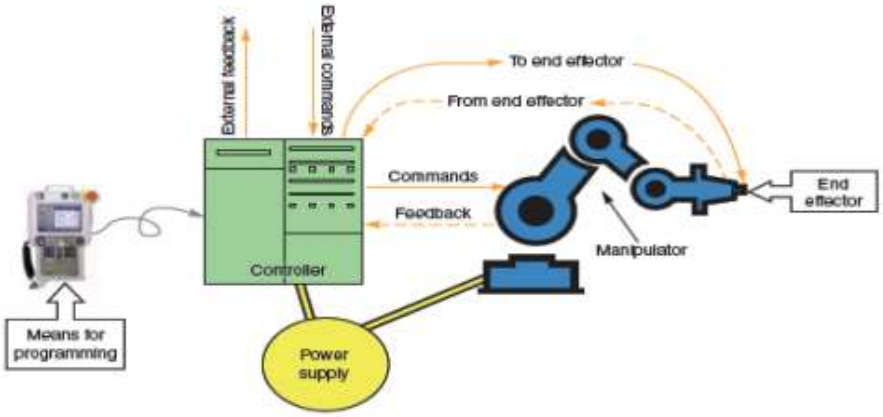
Parts of the Robot

Industrial Robotic Arm:



- The various components of the robots are:
  - Manipulator
  - End effector
  - Actuator
  - Sensors
  - Power supply
  - Means for programming

Basic components of Robot:



Manipulator:

Manipulator is the main body of the robot and consists of the links, joints, and other structural elements of the robot.

End Effector:

End effector is the last part attached the last joint of a manipulator which generally handles objects, makes connection to other machines or performs the required tasks. Grippers, welding torch, point spray gun, glue – laying gun etc. are some of the examples of end effector.

Actuator:

An actuator is a motor or valve that converts power in to robot movements. There are two basic types of actuators namely linear and rotary actuators. Linear actuators provide motion along a straight line. Rotary actuators provide rotation, moving their loads in arc or circle.

Sensors:

Sensors are used to collect information about the internal state of the robot or to communicate with the outside environment. Robots are often equipped with external sensory devices such as a vision system, touch and tactile sensors, speech synthesizers etc., which enables the robot to communicate with the outside world.

Power Supply:

Power supply provides the energy to drive the controller and actuators. It may convert ac voltage to the dc voltage require by the robots internal circuits, or it may be a pump or compressor providing hydraulic or pneumatic power. The three basic types or power supplies are electrical, hydraulic, and pneumatic.

Means for programming:

A robot may be programmed using any of several different methods. The teach pendant, also called a teach box or hand held programmer. The teach pendant, also called a teach box or hand held programmer shown in figure teaches a robot the movements required to perform a useful task. The operator uses a teach pedant to move the robot through the series of points that describes its desired path. Offline programming is one of the other methods where the programming is done on the computer using simulation software without actually connecting it to the robot. After the successful simulation in the software the robot can be loaded with the program.

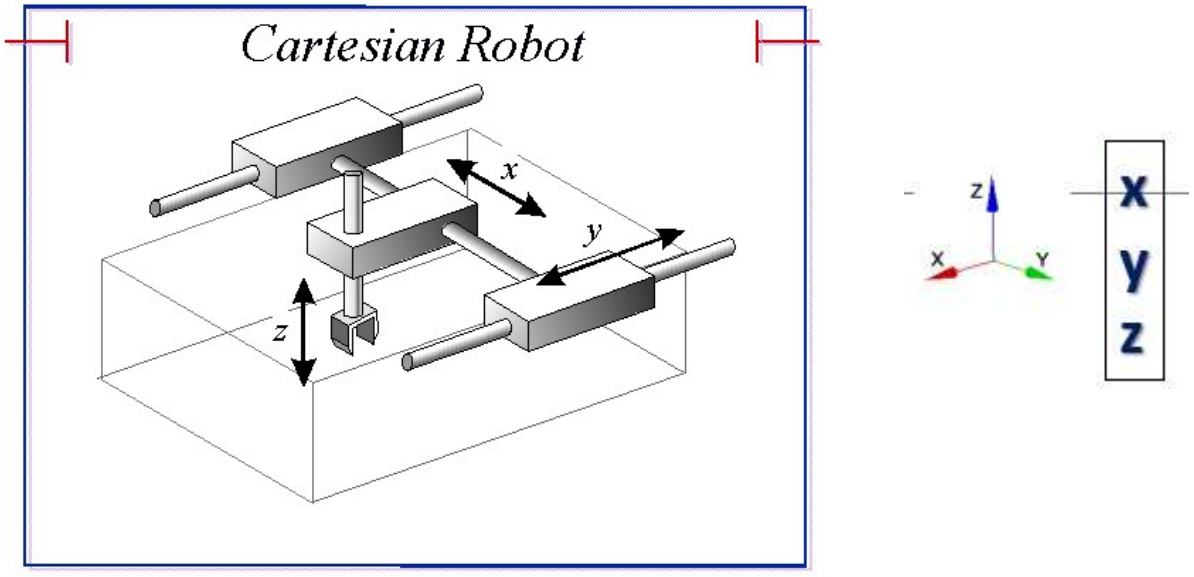
Geometry or kinematic structure of Robot

Robots come in many sizes and shapes. The type of coordinate system used by the manipulator also varies. Work envelopes vary from one manufacturer to another, depending on the exact design of the manipulator arm. Combining different configurations in a single robot can result in another set of possible work envelopes. Before choosing a particular robot configuration, the application must be studied carefully to determine the precise work envelope requirements. Some work envelopes have a geometric shape; others are irregular. One method of classifying a robot is by the configuration of its work envelope. Some robots may be equipped for more than one configuration. The four major configurations are: Articulated, Cartesian, cylindrical, and spherical. Each configuration is used for specific applications.

- ✓ Cartesian – Three linear movement
- ✓ Cylindrical - two linear and one revolute joint
- ✓ Spherical – one linear and two revolute joint
- ✓ Articulated - all three revolute (human arm)

Cartesian Configuration:

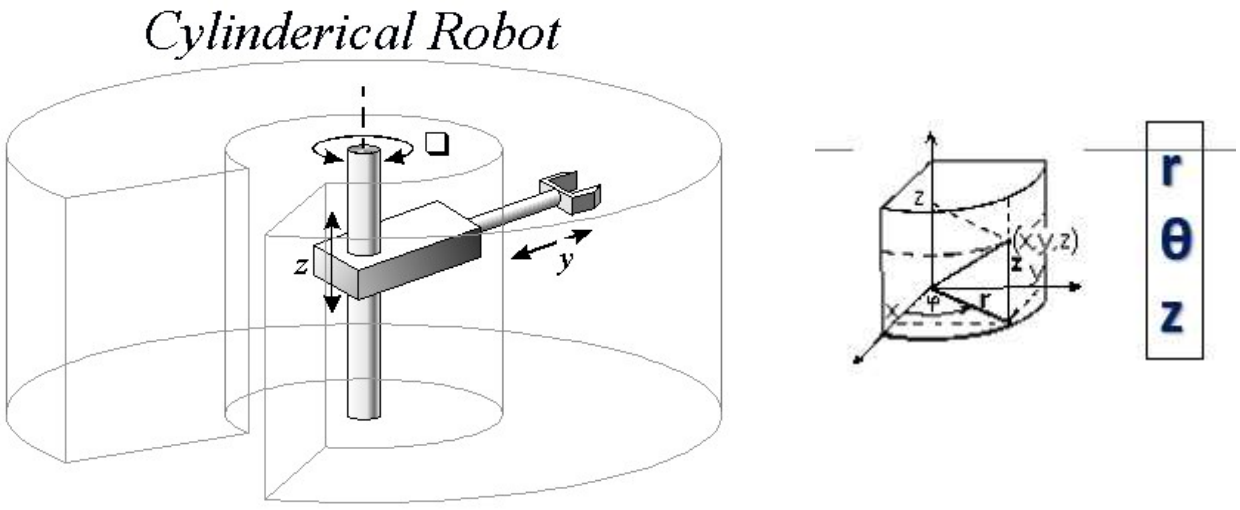
The arm movement of a robot using the Cartesian configuration can be described by three intersecting perpendicular straight lines, referred to as the X, Y, and Z axes. Because movement can start and stop simultaneously along all three axes, motion of the tool tip is smoother. This allows the robot to move directly to its designated point, instead of following trajectories parallel to each axis. The rectangular work envelope of a typical Cartesian configuration is illustrated in figure. One advantage of robots with a Cartesian configuration is that their totally linear movement allows for simpler controls. They also have a high degree of mechanical rigidity, accuracy, and repeatability. They can carry heavy loads, and this weight lifting capacity does not vary at different locations within the work envelope. As to disadvantages, Cartesian robots are generally limited in their movement to a small, rectangular work space.



Configuration of Cartesian Robot

Cylindrical Configuration

A cylindrical configuration consists of two orthogonal slides, placed at a 90° angle, mounted on a rotary axis. Reach is accomplished as the arm of the robot moves in and out. For vertical movement, the carriage moves up and down on a stationary post, or the post can move up and down in the base of the robot. Movement along the three axes traces points on a cylinder. A cylindrical configuration generally results in a larger work envelope than a Cartesian configuration. These robots are ideally suited for pick-and place operations. However, cylindrical configurations have some disadvantages. Their overall mechanical rigidity is reduced because robots with a rotary axis must overcome the inertia of the object when rotating. Their repeatability and accuracy is also reduced in the direction of rotary movement. The cylindrical configuration requires a more sophisticated control system than the Cartesian configuration.

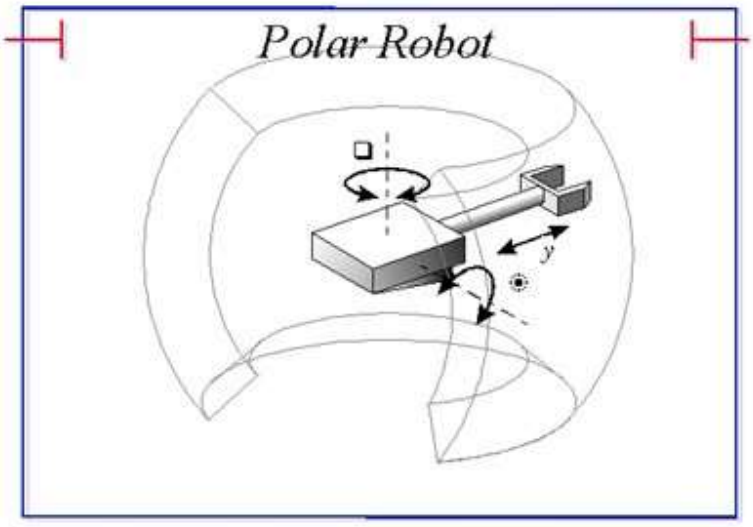


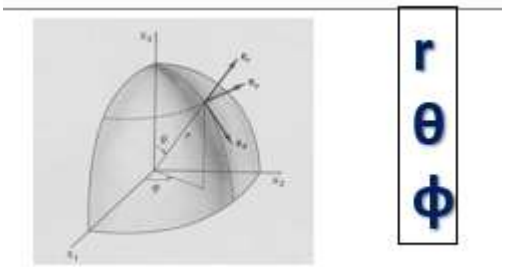
Configuration of Cylindrical Robot

Spherical Configuration (Polar)

The spherical configuration, sometimes referred to as the polar configuration, resembles the action of the turret on a military tank. A pivot point gives the robot its vertical movement, and a telescoping boom extends and retracts to provide reach. Rotary movement occurs around an axis perpendicular to the base. Fig illustrates the work envelope profile of a typical spherical configuration robot. The spherical configuration generally provides a larger work envelope than the Cartesian or cylindrical configurations. The design is simple and provides good weight lifting capabilities. This configuration is suited to applications where a small amount of vertical movement is adequate, such as loading and unloading a punch press. Its disadvantages include reduced mechanical rigidity and the need for a more sophisticated control system than either

the Cartesian or cylindrical configurations. The same problems occur with inertia and accuracy in this configuration as they do in the cylindrical configuration. Vertical movement is limited, as well.



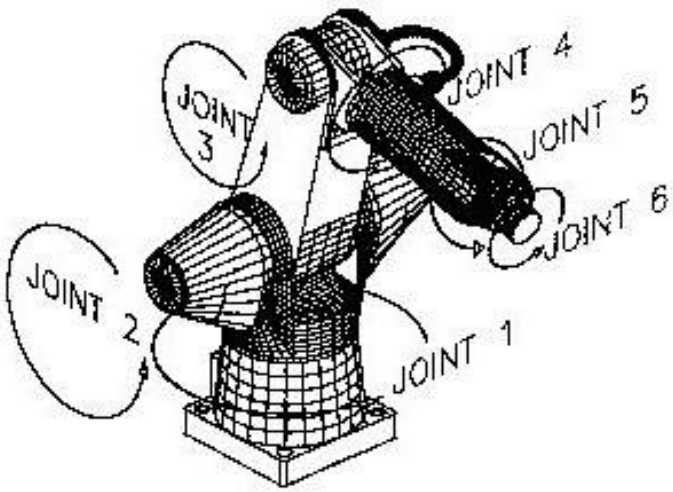


Configuration of Spherical Robot

Revolute Configuration (Articulated)

The revolute configuration, or jointed-arm, is the most common. These robots are often referred to as anthropomorphic because their movements closely resemble those of the human body. Rigid segments resemble the human forearm and upper arm. Various joints mimic the action of the wrist, elbow, and shoulder. A joint called the sweep represents the waist. A revolute coordinate robot performs in an irregularly shaped work envelope.

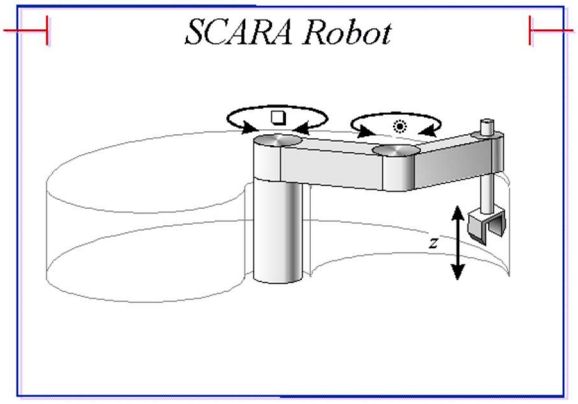
The revolute configuration has several advantages. It is, by far, the most versatile configuration and provides a larger work envelope than the Cartesian, cylindrical, or spherical configurations. It also offers a more flexible reach than the other configurations, making it ideally suited to welding and spray painting operations. However, there are also disadvantages to the revolute configuration. It requires a very sophisticated controller, and programming is more complex than for the other three configurations. Different locations in the work envelope can affect accuracy, load-carrying capacity, dynamics, and the robot's ability to repeat a movement accurately. This configuration also becomes less stable as the arm approaches its maximum reach.

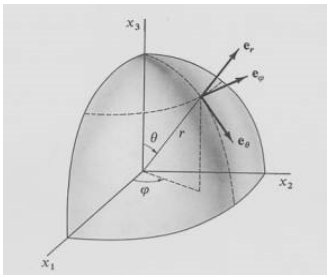


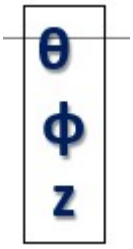
Configuration of Revolute Robot

SCARA Configuration

SCARA robots, also known as Selective Compliance Assembly Robot Arm or joint robotic arm, which are one of the most common forms of industrial robots in today's industrial field. SCARA robots are suitable for mechanical automation in many industrial fields, such as automatic assembly, painting, handling, welding and so on. The robot's robotic arm is made of several rigid rods and rotating or moving joint, which is an open ring joint one end fixed on the base, the other end is freely mounted end actuator (such as a welding gun). When operating the robot, end effector at the front of the robot arm must be in a position and attitude appropriate to the processed workplace, as well as these positions and postures are synthesized by the movement of several arm joint. Advantages of SCARA are Compact structure, large operating range and small installation footprint. Has a high accessibility. Joint coordinate robots can move their hands into a closed space like a car body for work, and right-angle coordinate robots cannot do such work. The required SCARA drive torque is small and the energy consumption is small.







Configuration of SCARA Robot

Tasks:

- Make summary of everything that is discussed in class and submit it in pdf format.