BTME 3072
Robotics and Automation
Lecture 3

2nd Year

III Semester

Galgotias University

2020-21

Unit I: Introduction to Robotics

- Definition of a Robot –
- Basic Concepts –**Robot configurations –**
- Types of Robot drives –
- Basic robot motions –
- Point to point control –
- Continuous path control.

Objectives of the lecture

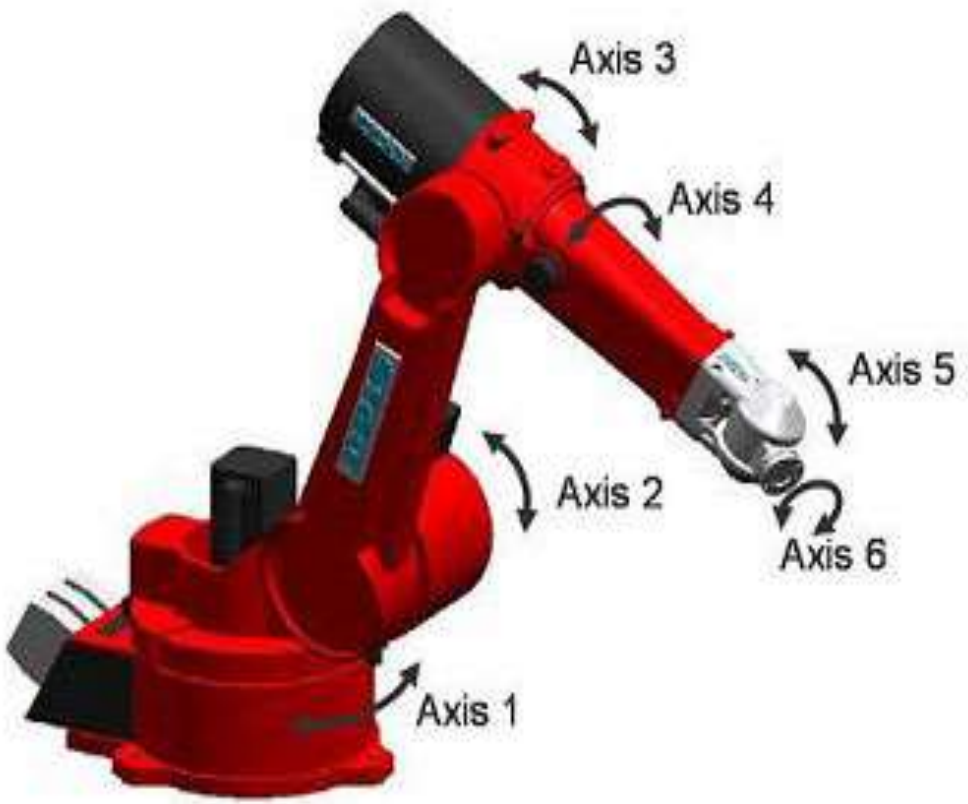
- Understanding of the basic configurations of the robots
- Robots configurations and its applications

Configuration of robots

- **Articulated** - This robot design features rotary joints and can range from simple two joint structures to 10 or more joints. The arm is connected to the base with a twisting joint. The links in the arm are connected by rotary joints. Each joint is called an axis and provides an additional degree of freedom, or range of motion. Industrial robots commonly have four or six axes.
- **Cartesian** - These are also called rectilinear or gantry robots. Cartesian robots have three linear joints that use the Cartesian coordinate system (X, Y, and Z). They also may have an attached wrist to allow for rotational movement. The three prismatic joints deliver a linear motion along the axis.
- **Cylindrical** - The robot has at least one rotary joint at the base and at least one prismatic joint to connect the links. The rotary joint uses a rotational motion along the joint axis, while the prismatic joint moves in a linear motion. Cylindrical robots operate within a cylindrical-shaped work envelope.
- **Polar** - Also called spherical robots, in this configuration the arm is connected to the base with a twisting joint and a combination of two rotary joints and one linear joint. The axes form a polar coordinate system and create a spherical-shaped work envelope.
- **SCARA** - Commonly used in assembly applications, this selectively compliant arm for robotic assembly is primarily cylindrical in design. It features two parallel joints that provide compliance in one selected plane.
- **Delta -** These spider-like robots are built from jointed parallelograms connected to a common base. The parallelograms move a single EOAT in a dome-shaped work area. Heavily used in the food, pharmaceutical, and electronic industries, this robot configuration is capable of delicate, precise movement.

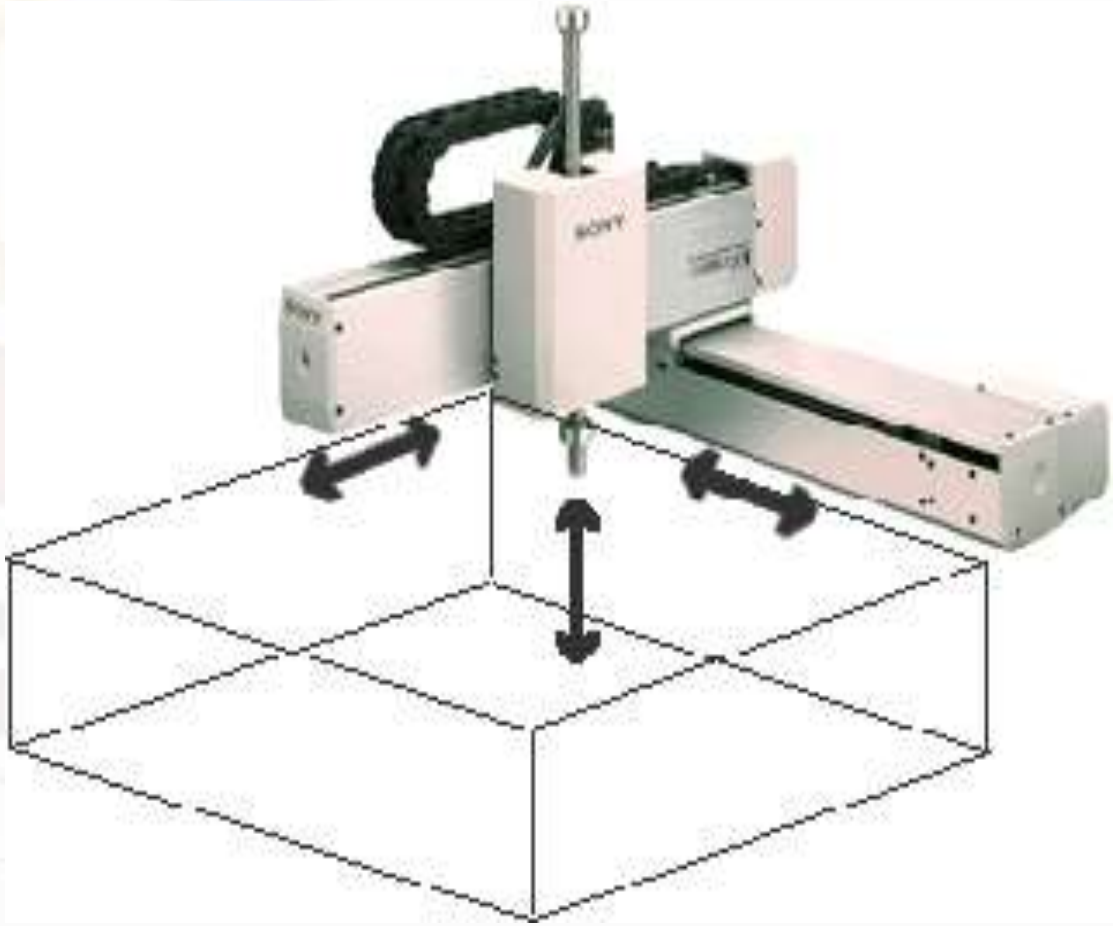
Articulated robots

- An articulated robot is a robot with rotary robot or an industrial robot).
- Articulated robots can range from simple two-jointed structures to systems with 10 or more interacting joints and materials.
- An articulated robot uses all the three revolute joints to access its work space. Usually the joints are arranged in a “chain”, so that one joint supports another further in the chain.



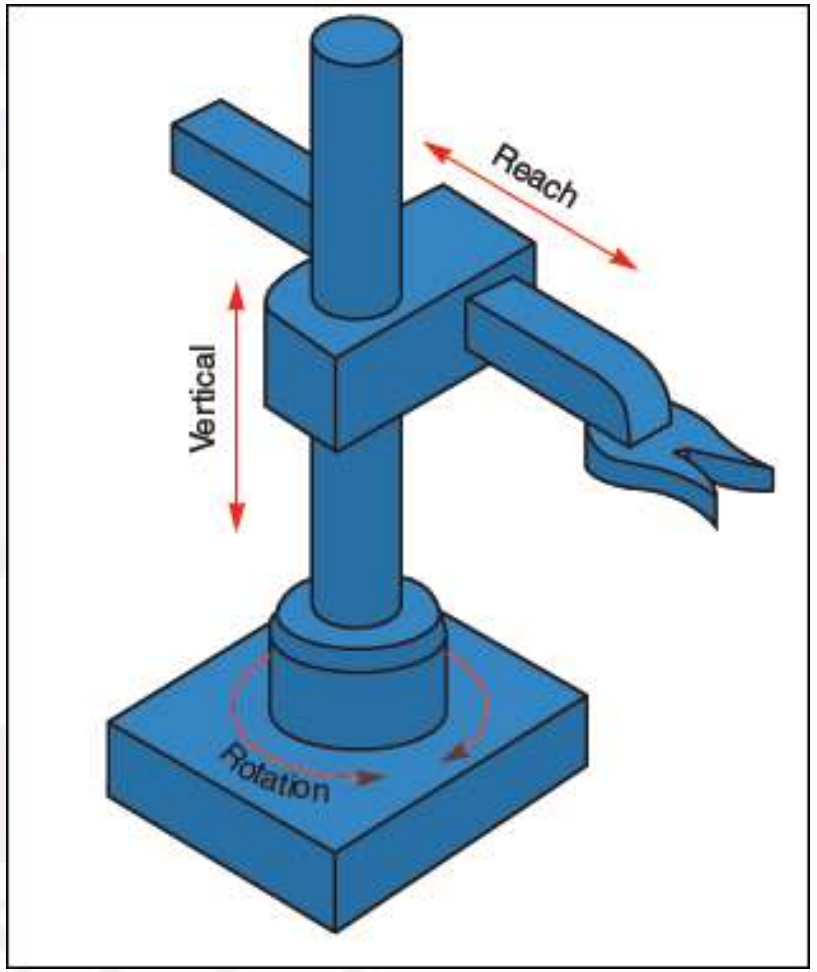
Cartesian robots

- A cartesian coordinate robot (also called linear robot) is an industrial robot whose three principal axes of control are linear.
- The three sliding joints correspond to moving the wrist up-down, in-out, back-forth.
- Among other advantages, this mechanical arrangement simplifies the Robot control arm solution.
- It has high reliability and precision when operating in three-dimensional space.
- As a robot coordinate system, it is also effective for horizontal travel and for stacking bins



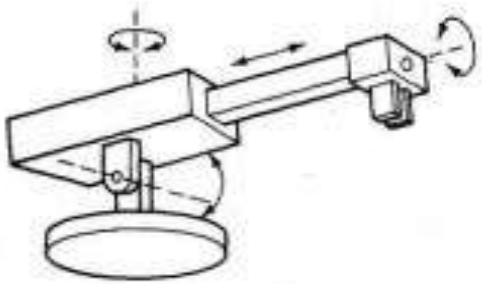
Cylindrical

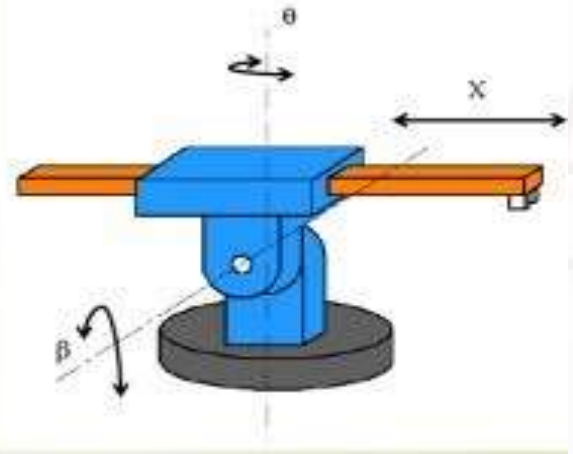
- The robot has at least one rotary joint at the base and at least one prismatic joint to connect the links.
- The rotary joint uses a rotational motion along the joint axis, while the prismatic joint moves in a linear motion.
- Cylindrical robots operate within a cylindrical-shaped work envelope.



Polar configuration

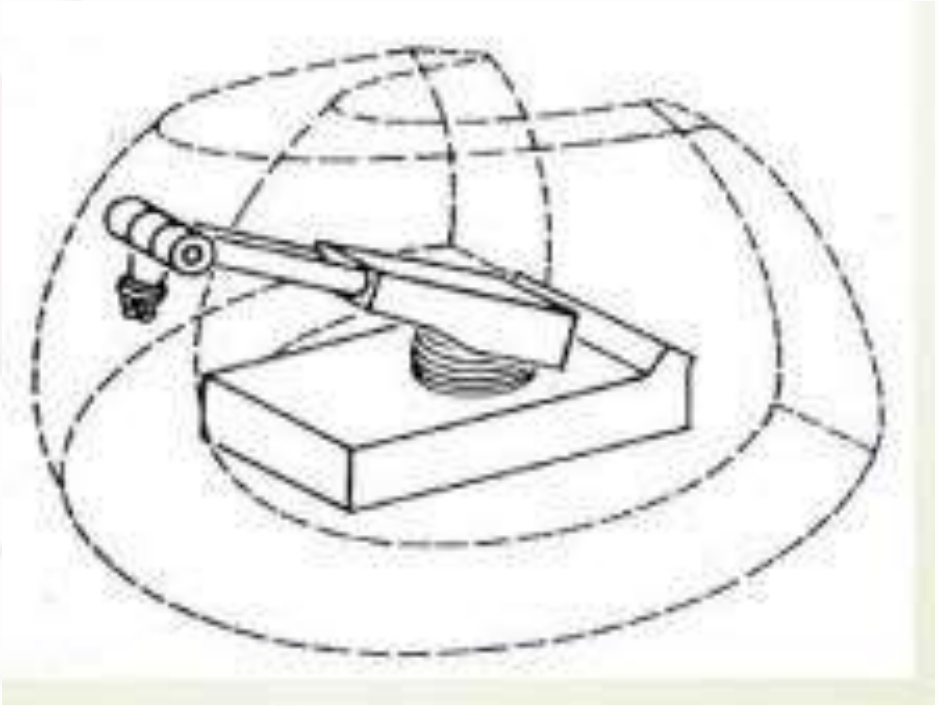
- It uses a arm that can be raised or lowered about a horizontal pivot.
- The pivot is mounted on a rotating base.
- The various joints provide the robot with capability to move its arm within a spherical space, and hence it is also called as " Spherical Coordinate Robot."
- It has one linear and two rotary motions.
- The UNIMATE 2000 series is an example of spherical robot.





Work Volume of a Polar configuration Robot

- The work volume of a polar configuration robot is in the form of a sphere.
- It consist of one linear and two angular motions.
- The linear motion, r, corresponds to a radial in or out translation.
- The angular motion corresponds to a base rotation, θ , about a vertical axis.
- Another angular motion, β , about an axis which is perpendicular to the vertical
- through the base and sometimes is termed as elbow rotation



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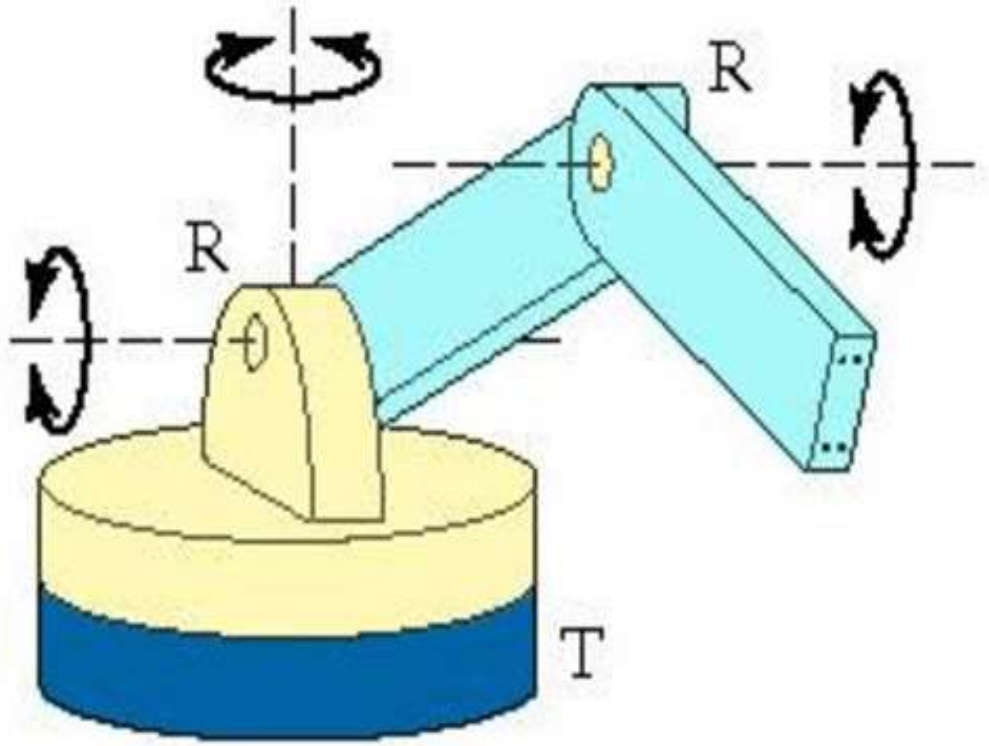
- Advantages
  - Larger work envelope than the rectilinear or cylindrical configuration.
  - Vertical structure conserves less space.
- Disadvantages
  - Repeatability and accuracy are also lower in the direction of rotary motion.
  - Requires more sophisticated control system.

- Applications
  - Die casting.
  - Forging.
  - Glass handling.
  - Injection molding.
  - Stacking and unstacking.

Jointed-Arm Robot.

- The jointed-arm robot resembles a human arm.
- It usually stands on a base on which it can rotate, while it can articulate at the "shoulder" joint, which is just above the base.
- The robot can also rotate about its "elbow" and "wrist" joints.
- With the swiveling and bending at the wrist, six degrees of freedom can be obtained. T
- he jointed-arm robot is the most popular form for a robot and is capable in welding and painting work



Work Envelope of Jointed-Arm Configuration

- It is similar to the configuration of a human arm.
- It consists of a vertical column that swivels (rotate) about the base using a T-joint.
- Shoulder joint (R-joint) is located at the top of the column.
- The output link is an elbow joint (another R joint).

SCARA

- SCARA is a special type of jointed arm configuration.
- It stands for Selective Compliance Automated Robot Arm (or) Selective Compliance Articulated Robot Arm.
- It is similar to jointed-arm except that the vertical axes are used for shoulder and elbow joints to be compliant in horizontal direction vertical insertion tasks.

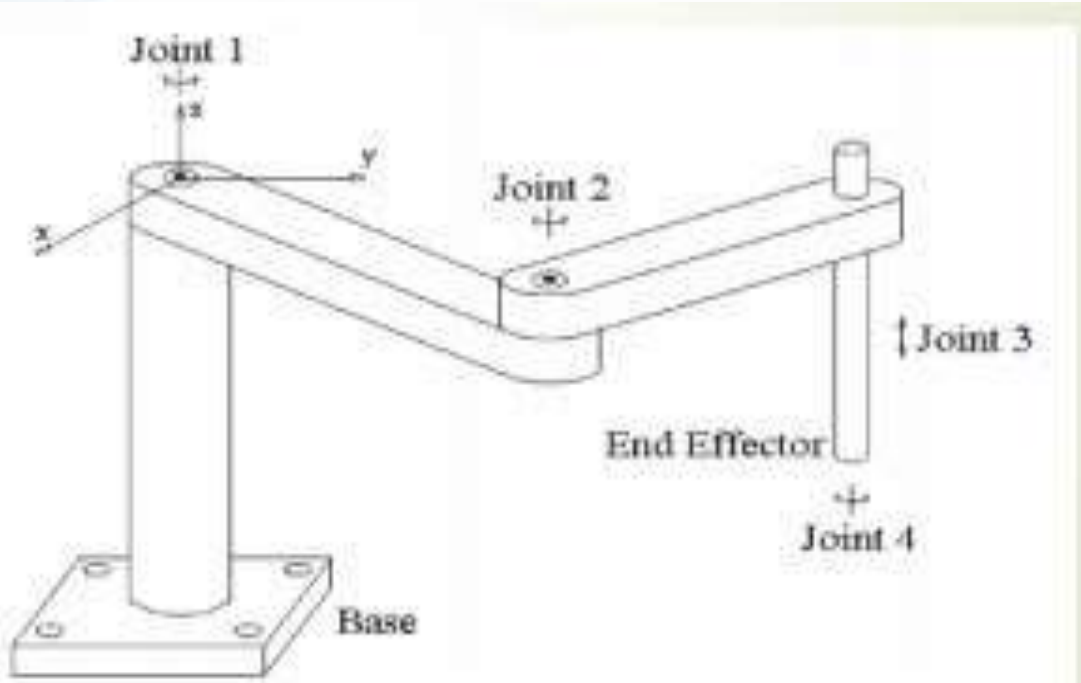


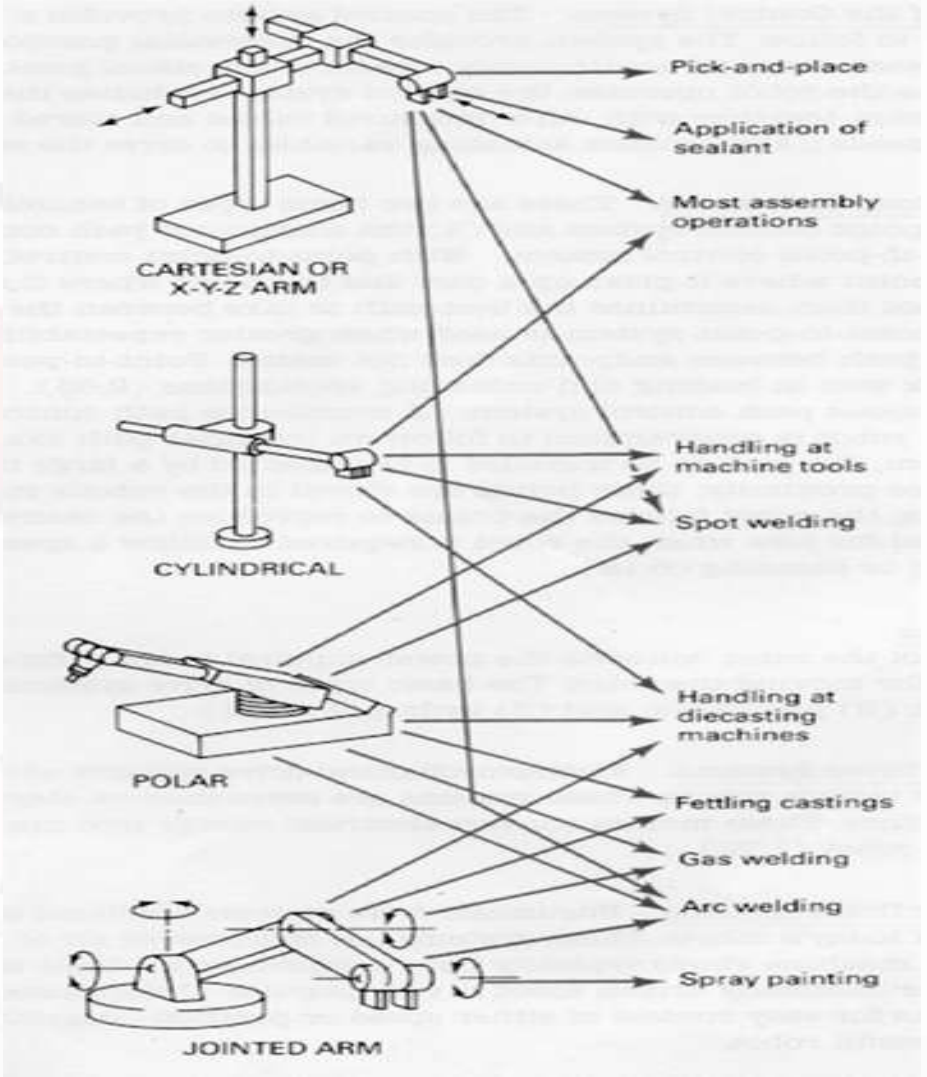
Figure 5. SCARA - Selective Compliance Assembly Robot Arm.

Delta Robots

- These spider-like robots are built from jointed parallelograms connected to a common base.
- The parallelograms move a single EOAT in a dome-shaped work area.
- Heavily used in the food, pharmaceutical, and electronic industries,
- This robot configuration is capable of delicate, precise movement.

Comparative study of robots

- Cartesian - These are also called rectilinear or gantry robots
- Cylindrical - The robot has at least one rotary joint at the base and at least one prismatic
- Polar - Also called spherical robots, in this configuration the arm is connected to the base with a twisting joint and a combination of two rotary joints and one linear joint.

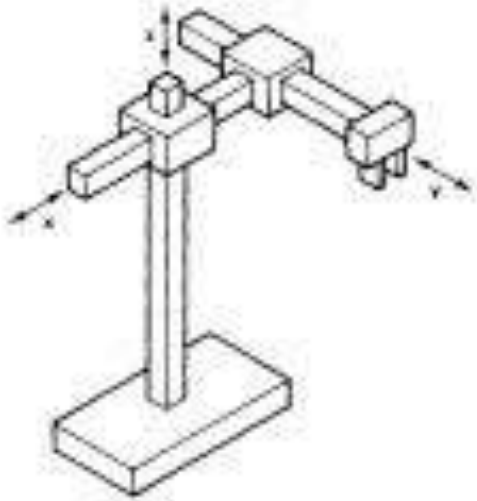


JOINT NOTATION SCHEME

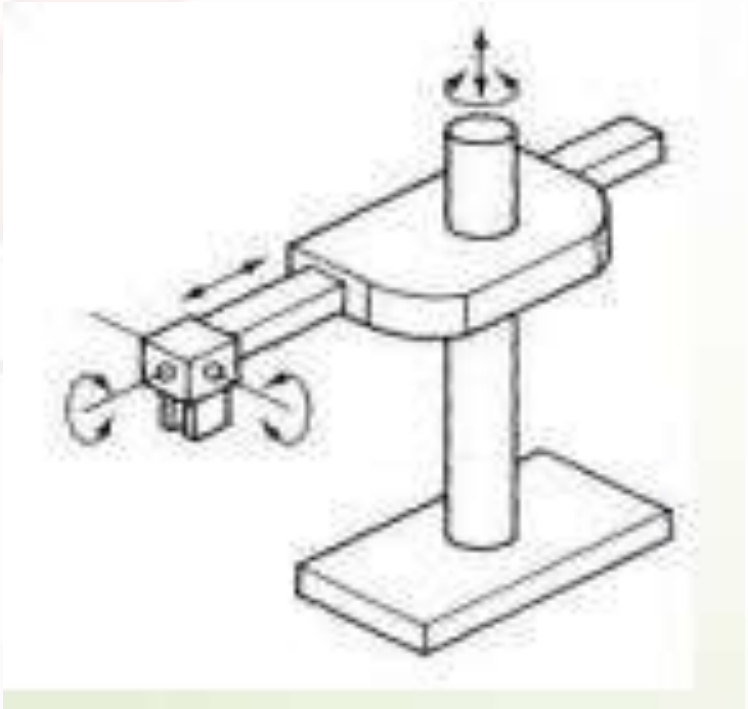
- The physical configuration can be described by means of a joint notation scheme.
  - • L-Linear Joint
  - • T-Twisting Joint
  - • R-Rotational Joint
  - • V-Revolving Joint

Summery

- Robots with Cartesian Configurations consists of links
- connected by linear joints (L) – LLL

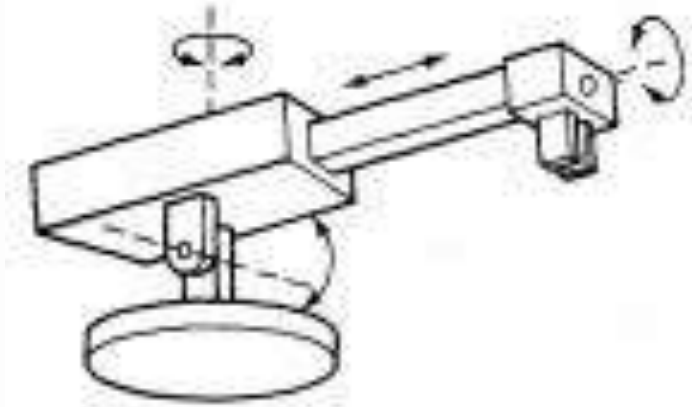


- Robots with Cylindrical Configuration have one rotary (R)
- joint at the base and linear (L) joints succeeded to connect the links – TL

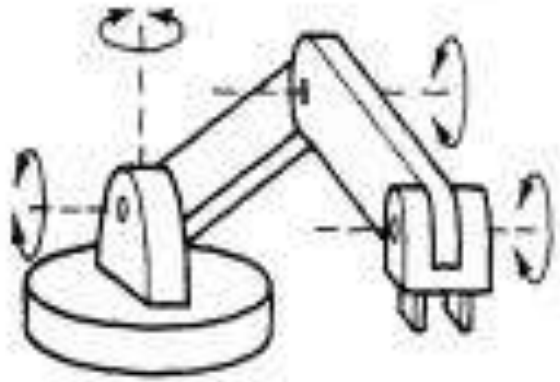


Summery

- Polar Configuration Robot, the arm is connected to the base with a twisting (T) joint and otatory (R) and linear (L) joints follow – TRL



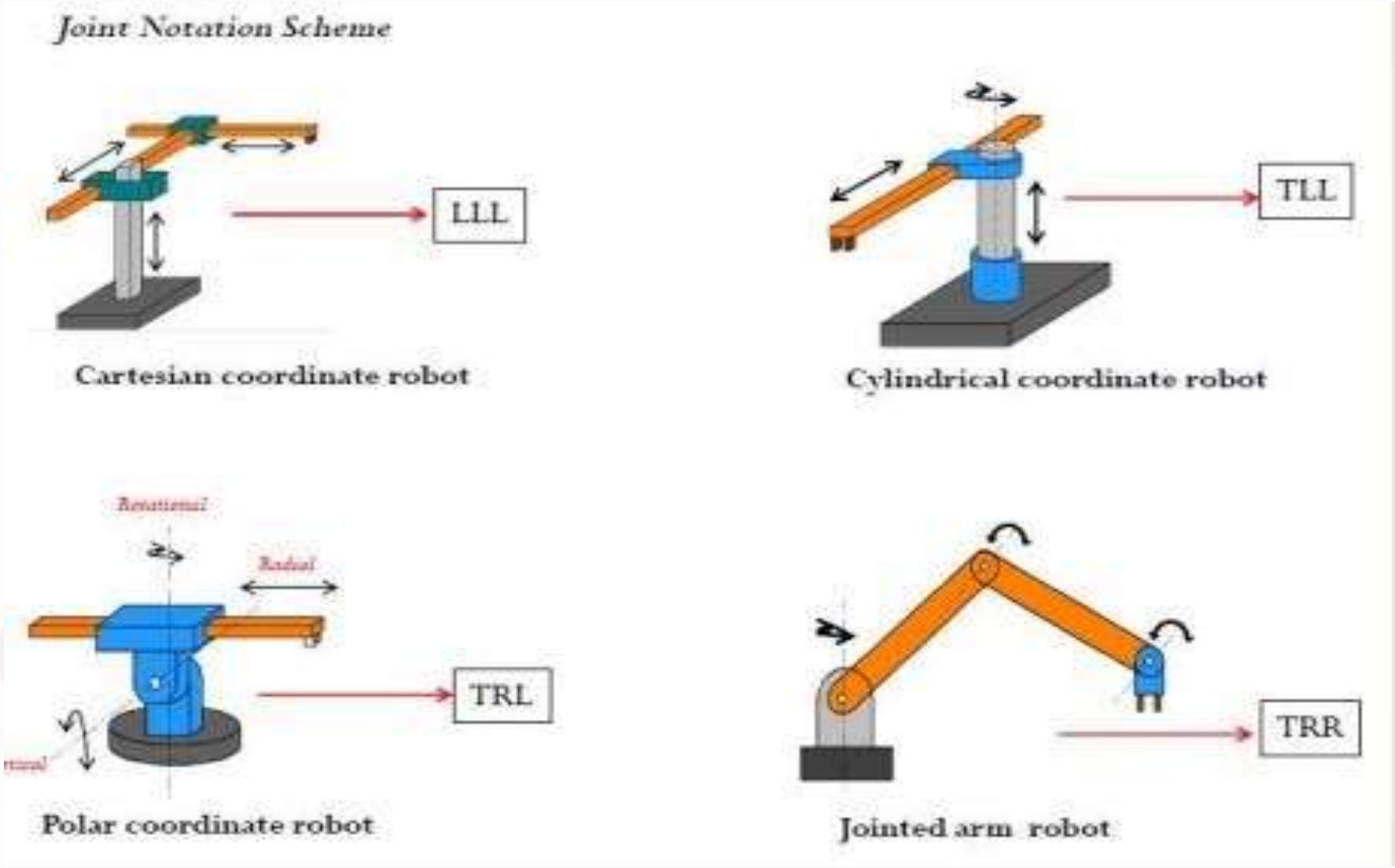
- Joint Arm Configuration, the arm of the robot is connected to the base with a twisting joint.
- The links in the arm are connected by rotatory joints – TRR



Summery

Robot Configuration	(Arm and Body) Symbol
Polar Configuration	TRL
Cylindrical Configuration	TLL,LTL,LVL
Cartesian Configuration	LLL
Jointed Arm Configuration	TRR, VVR

Summery


Joint Notation Scheme
LLL
Cartesian coordinate robot
TLL
Cylindrical coordinate robot
Radial
TRL
Polar coordinate robot
TRR
Jointed arm robot

Questions

- Explain the robot configuration of robots
- Explain in brief the SCARA robot
- Present the comparative study of the robot configuration

Text books

- Introduction to robotics mechanics and control by John J Craig
- Fundamentals of Robotic Mechanical Systems by Jorge Angeles
- Robot Operating System for Absolute Beginners: Robotics Programming Made Easy by Lentin Joseph
- Reference book
  - Robotic process automation
  - Robotic Process Automation For Dummies®, NICE Special Edition

Thank You !