INTRODUCTION TO ROBOTICS

Lecture Three

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Joints and Links (continued)

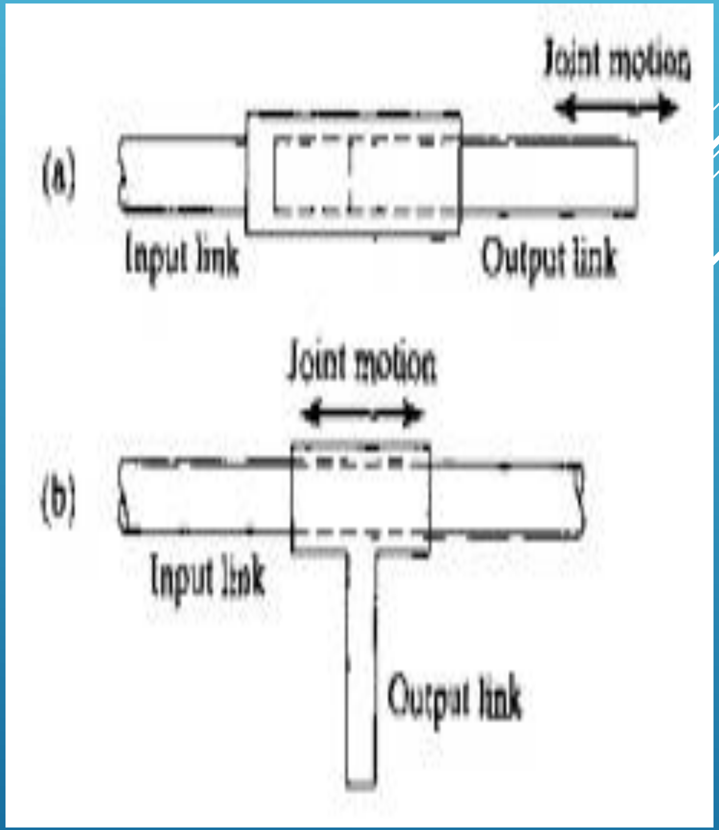
- Each joint, provides the robot with a so called *degree-of-freedom* (d.o.f.) of motion.
- In nearly all cases, only one degree of freedom is associated with a joint.
- Robots are often classified according to the total number of degrees-of-freedom they possess.
- Connected to each joint are two links, an input link and an output link.
- The purpose of the joint is to provide controlled relative movement between the input link and the output link.

Nearly all industrial robots have mechanical joints that can be classified into one of two types:

Types that provide translational motion

✓ Linear joint (L).The relative movement between the input link and the output link is a translational sliding motion, with the axes of the two links being parallel.

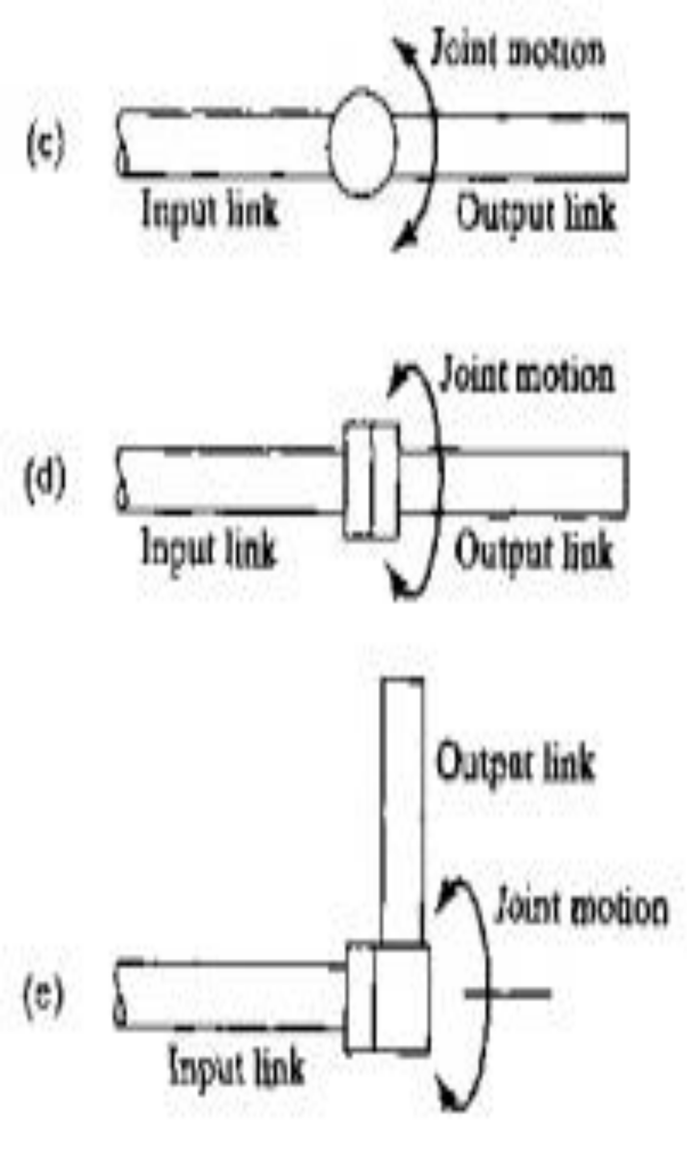
✓ Orthogonal Joint (O). This is also a translational sliding motion, but the input and output links are perpendicular to each other during the move.



Joints and Links (continued)

Types that provide rotary motion

- ✓ Rotational Join (R). This type provides rotational relative motion, with the axis of rotation perpendicular to the axes of the input and output links.
- ✓ Twisting joint (T) This joint also involves rotary motion, but the axis or rotation is parallel to the axes of the two links.
- ✓ Revolving joint (V) the input link is parallel to the axis of rotation of the joint. and the axis of the output link is perpendicular to the axis of rotation.



Degrees of Freedom

- The degrees of freedom (dof) of a rigid body is defined as the number of independent movements it has.
- A degree of freedom can be thought of as the number of variables that are free to vary.
- Higher number dof indicates an increased flexibility in positioning a tool.
- For each degree of freedom a joint is required.
- Three degrees of freedom located in the wrist give the end effector all the flexibility.
- A total of six degrees of freedom is needed to locate a robot’s hand at any point in its work space.

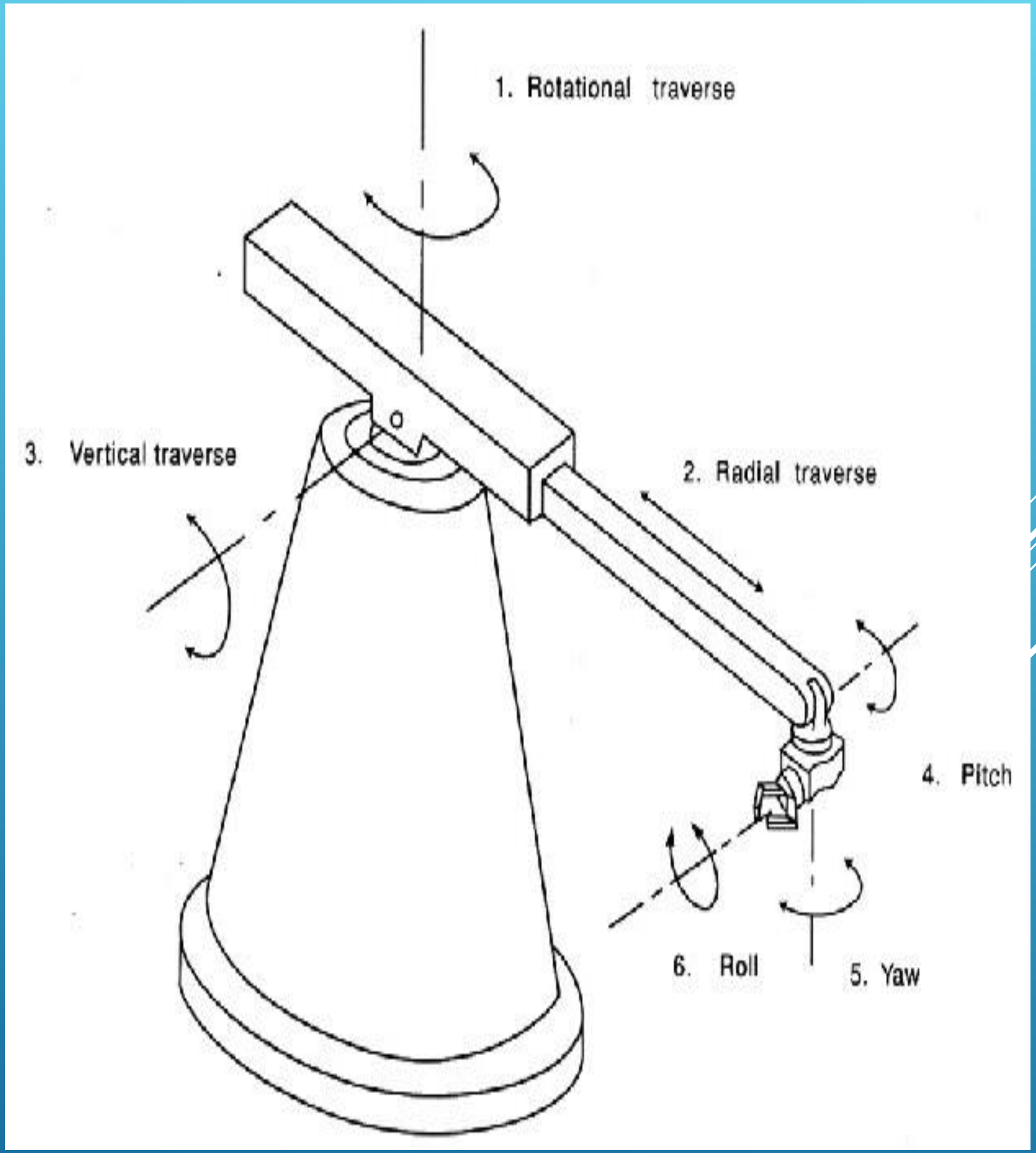
Degrees of Freedom (continued..)

The number of degree of freedom defines the robot's configuration.

For example, many simple applications required movement along three axes X,Y and Z.

These task required three joints or three degree of freedom. The three degree of freedom in the robot arm are:

- ❖ Rotational Traverse: It is a movement on vertical axis.
- ❖ Radial Traverse: The radial Traverse is the extension and retraction of the arm.
- ❖ Vertical Traverse: The vertical traverse provides up and down motion.



Degrees of Freedom (continued..)

A robot manipulator can be divided into two sections:

1. Body-and-arm assembly

Three degrees-of-freedom associated with the body-and-arm.

2. Wrist assembly

Either two or three degrees-of-freedom associated with the wrist.

Wrist assembly is attached to end-of-arm

Degrees of Freedom (continued..)

<u>wrist assembly.</u>

Roll: : is the rotation of the hand.

Pitch: up-and-down movement of the wrist.

Yow: right-and-left movement of the wrist.

Notation :RRT

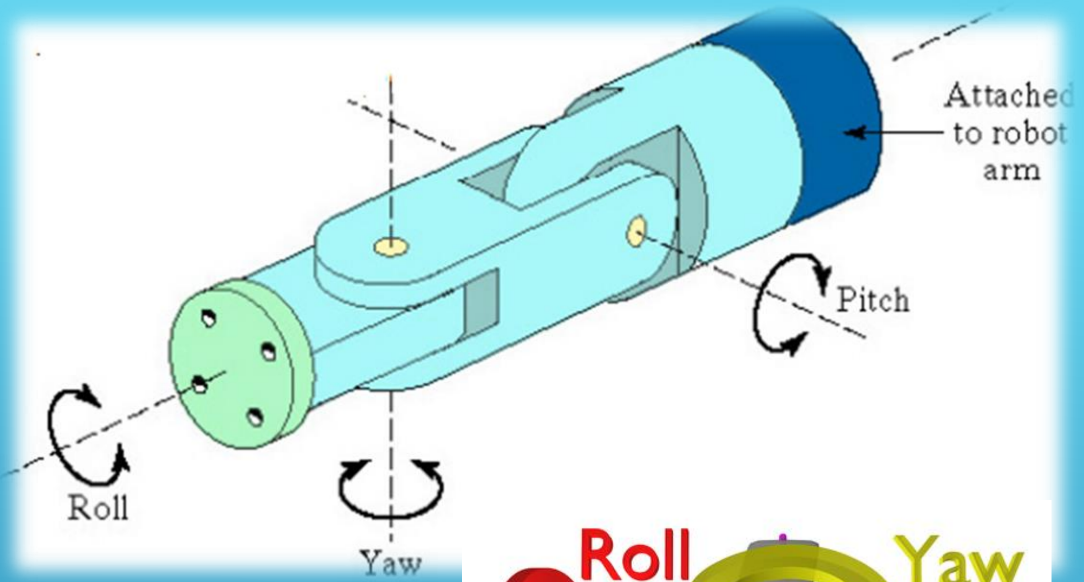
End effector is attached to wrist assembly usually either

(1) a gripper for holding a work-part or

(2) a tool for performing some process.

The body-and-arm of the rotor is used to position the end effector.

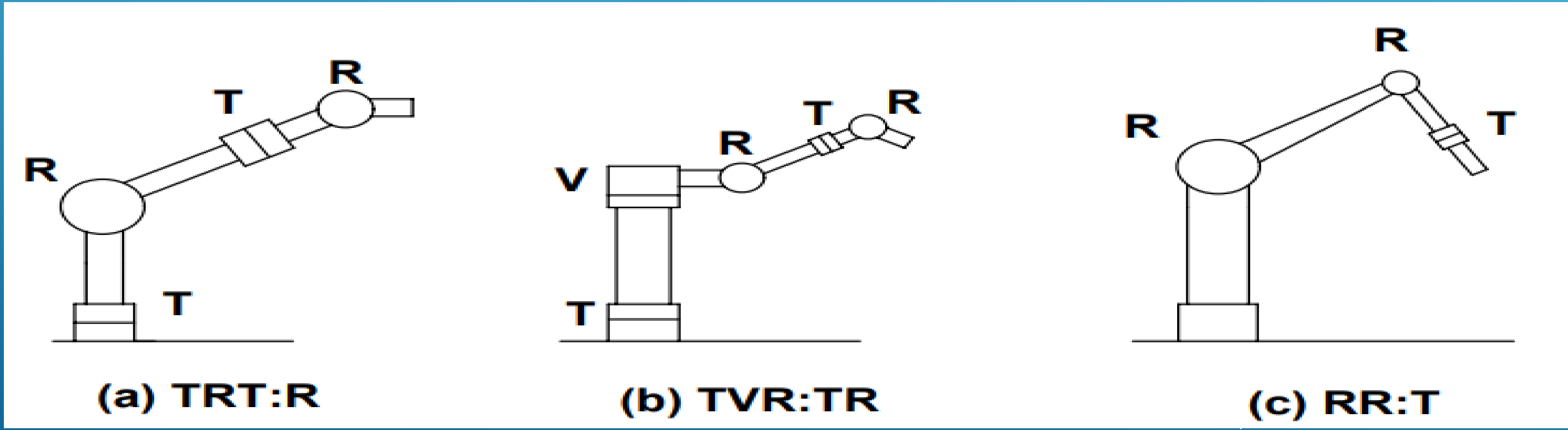
and the robot's wrist is used to orient the end effector.



Joint Notation Schemes

Uses the joint symbols (L, O, R, T, V) to designate joint types used to construct robot manipulator Separates body-and-arm assembly from wrist assembly using a colon (:)

Example:
(a) TRT:R, (b) TVR:TR, (c) RR:T.



Body-and-Arm Configurations.

Given the five types of joints defined above, there are 5 x 5 x 5 = 125 different combinations of joints that can be used to design the body-and-arm assembly for a three-degree-of-freedom robot manipulator.

there are only four basic configurations commonly available in commercial industrial robots.

These four configurations are:

- Polar(Spherical) configuration.
- Cylindrical configuration.
- Cartesian coordinate robot.
- SCARA robot.

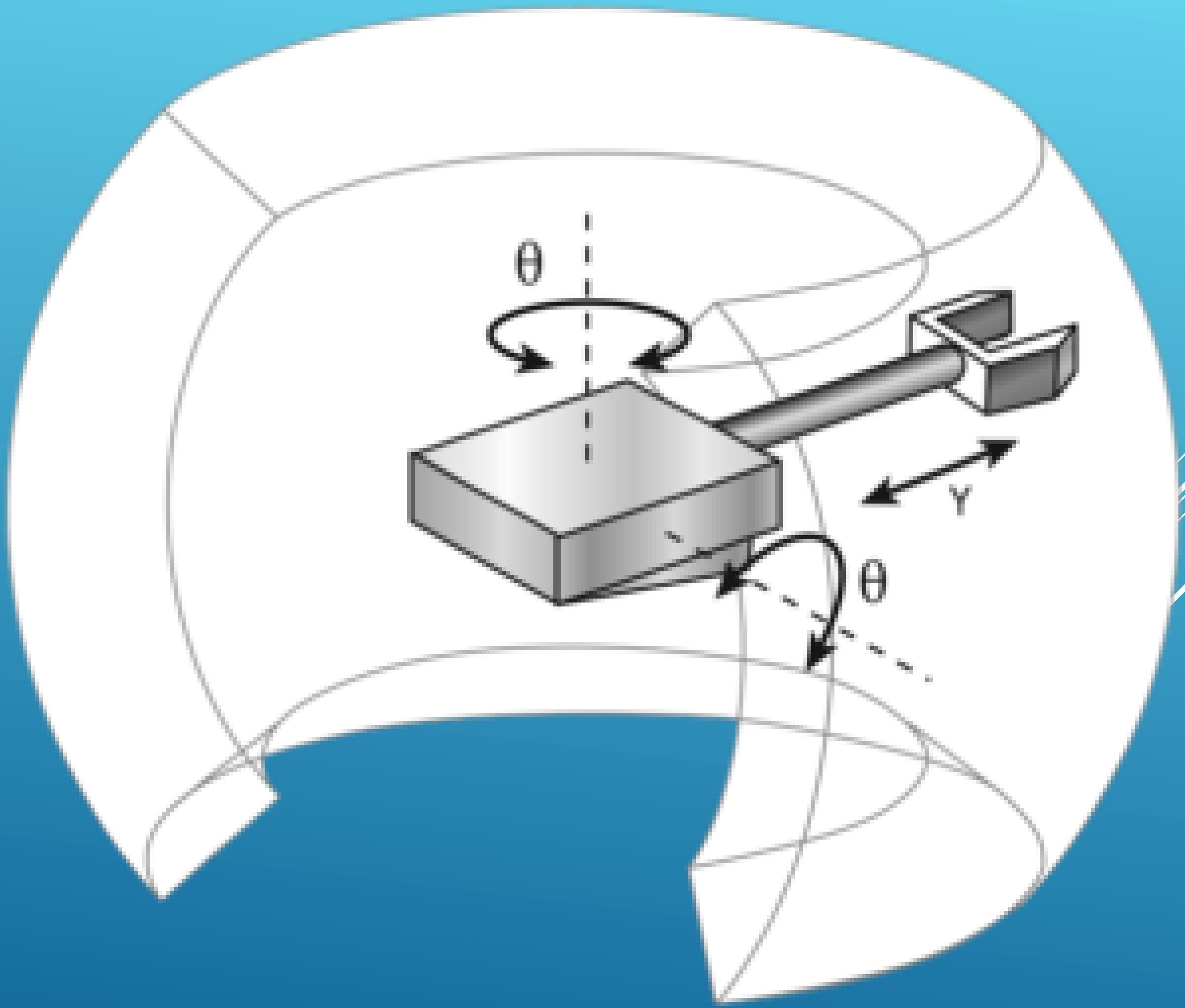
➢ Polar Configuration

Polar robots have a work space of spherical shape.

TRL
The arm is connected to the base with a twisting (T) joint

Rotary (R) and linear (L) joints follow

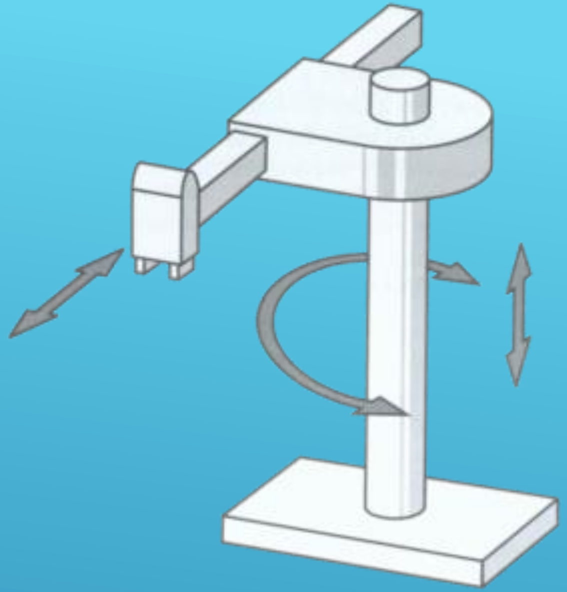
Also called spherical robots.

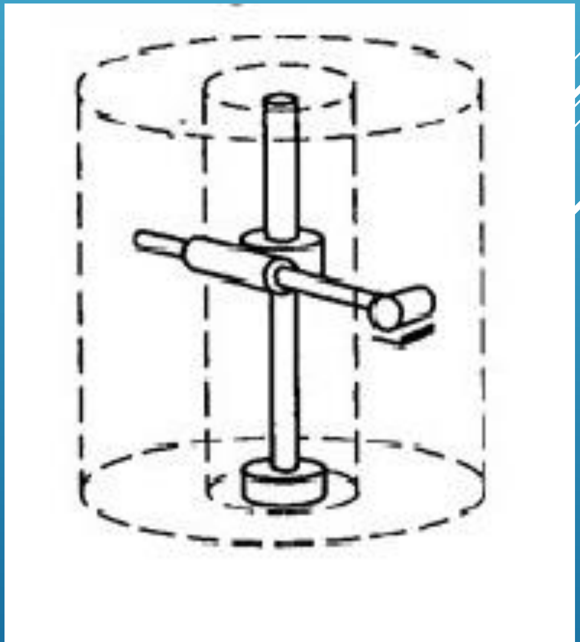


Cylindrical Configuration

The robot arm in this configuration can be designated as TLL.

The robots have a cylindrical-shaped work envelop, which is achieved with rotating shaft and an extendable arm that moves in a vertical and sliding motion.





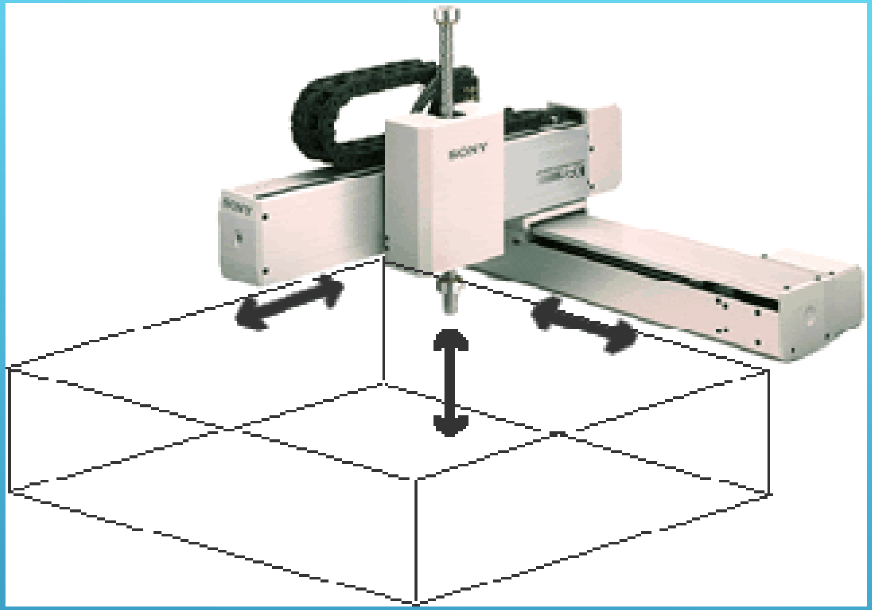
Cartesian Configuration

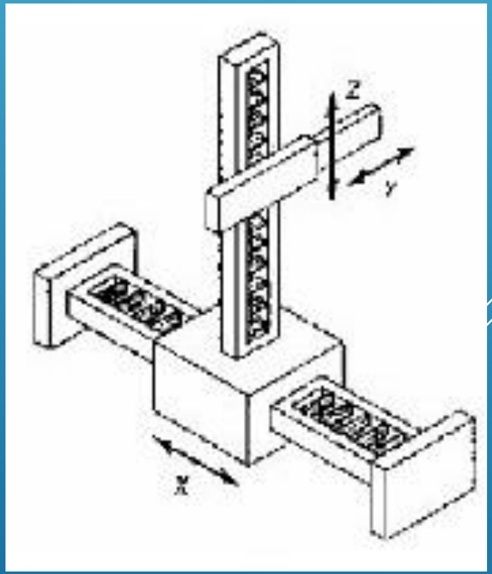
Robots with Cartesian configurations consist of links connected by linear joints (LLL).

A Cartesian coordinate robot has three principal prismatic axes (X, Y and Z) that are at right angles to each other
meaning they move in straight lines on 3-axis (up and down, in and out, and side to side).

Cartesian coordinate robots Gantry robots or linear robots.

Cartesian robots are giving users the ability to adjust the robot’s speed, precision, stroke length, and size. Cartesian Robots are used for CNC machines and 3D printing.





SCARA

SCARA is an acronym that stands for

Selective Compliance Assembly Robot

<u>RRO</u>

SCARA Robots function on 3-axis (X, Y, and Z), and have a rotary motion as well.

SCARA Robots excel in lateral movements and are commonly faster moving and have e

integration than Cartesian Robots.