# Industrial Robotics

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# Car Assembly Plant

# Industrial Robots

General purpose programmable machines

- has arms to perform various industrial tasks
- respond to sensor inputs
- communicate with other machines
- make decision

# Importance of Industrial Robots

- use in hazardous and uncomfortable works
- consistency and repeatability
- easy to reprogram
- easy to connect with other computer systems

❖ **Fukushima atomic power plant, robots making robots at Fanuc, robots in car production**

# Industrial Robotics Anatomy and Different Attributes

- Robot manipulators consists of joints and links

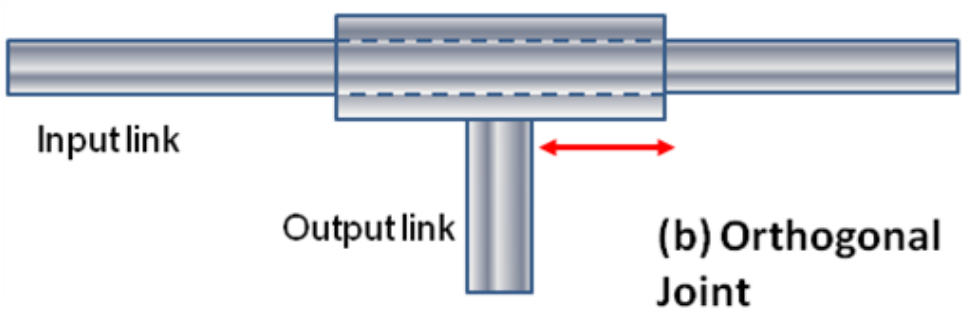
  Joints -provide relative motion between two parts of body
  -provide the robot DOF
  -almost in all cases one joint gives one dof.

  Links -rigid components of the robot manipulator

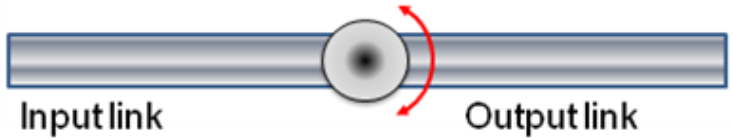
- Types of joint
  - Linear joint (type L joint)
  - Orthogonal joint (type O joint)
  - Rotational joint (type R joint)
  - Twisting joint (type T joint)
  - Revolving joint (type V joint)

# Types of Joints

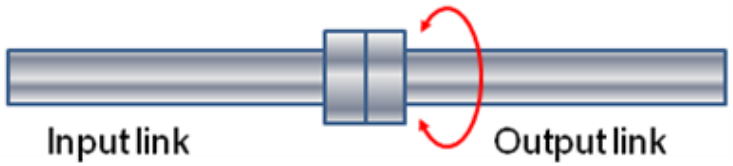

(a) Linear Joint



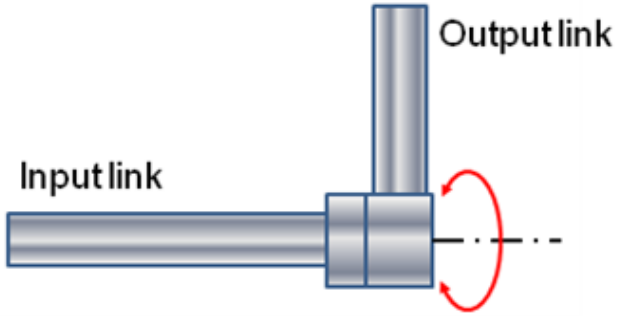

(b) Orthogonal Joint




(c) Rotational Joint




(d) Twisting Joint




(e) Revolving Joint

# Types of Joints

**a) Linear joint (type L joint)**

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.

**b) Orthogonal joint (type U joint)**

This is also a translational sliding motion, but the input and output links are perpendicular to each other during the move.

**c) Rotational joint (type R joint)**

This type provides rotational relative motion, with the axis of rotation perpendicular to the axes of the input and output links.

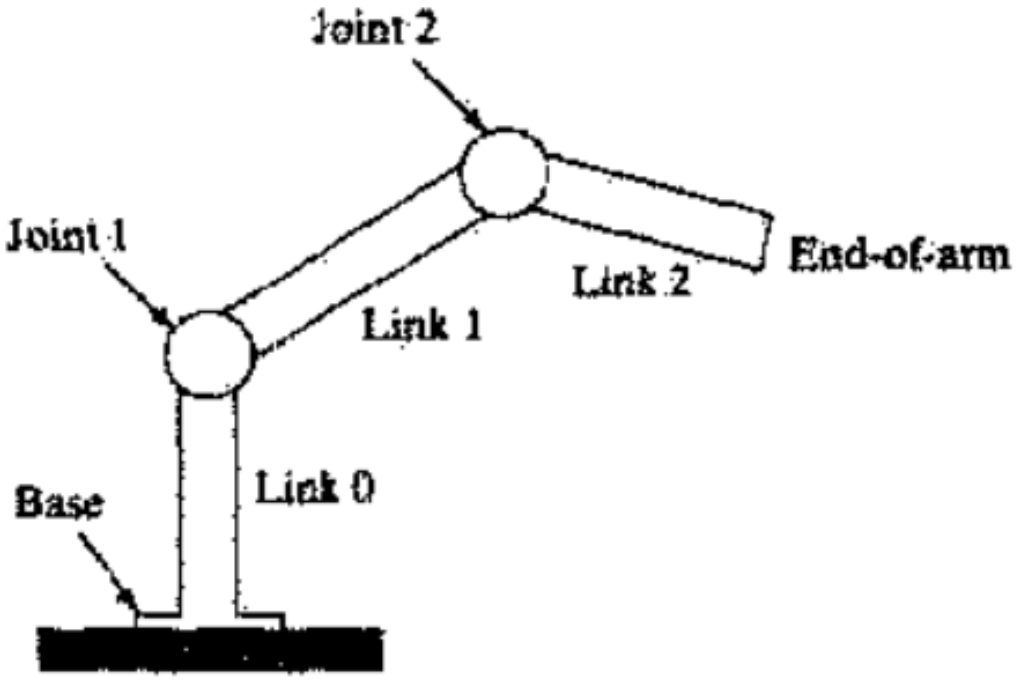
**d) Twisting joint (type T joint)**

This joint also involves rotary motion, but the axis or rotation is parallel to the axes of the two links.

**e) Revolving joint (type V-joint, V from the "v" in revolving)**

In this type, axis of input link is parallel to the axis of rotation of the joint. However the axis of the output link is perpendicular to the axis of rotation.

# Industrial Robotics Anatomy and Different Attributes



# Common Robot Configuration

Sections of a robot manipulator are

1) Body-and-arm assembly
2) Wrist assembly

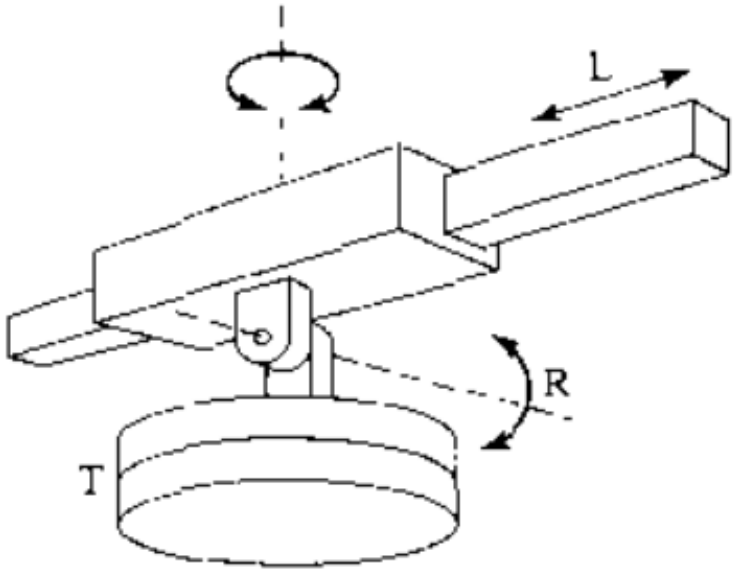
Body-and-arm configurations:

For a three-dof robot manipulator with the five common joints there will be 5x5x5= 125 different combinations of joints. However only five are used in commercial industrial robots:

1) Polar configuration
2) Cylindrical configuration
3) Cartesian coordinate robot
4) Jointed-arm robot and
5) SCARA (Selective Compliance Assembly Robot Arm)

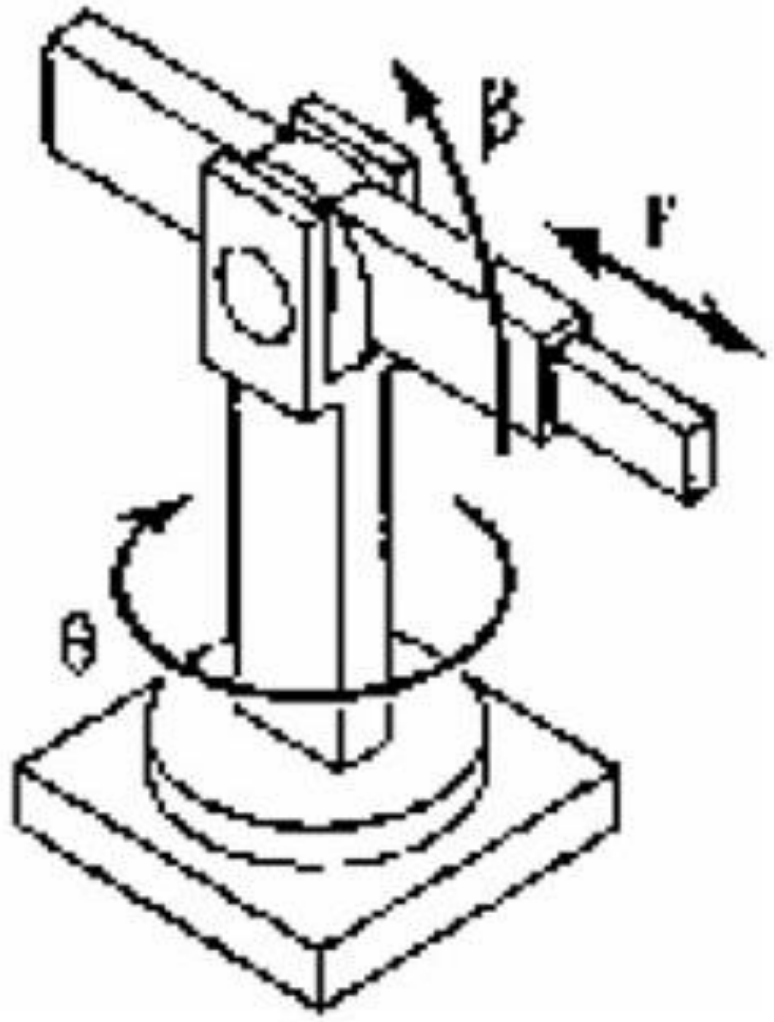
# Industrial Robotics Body and Arm Configuration

## 1. Polar Coordinate Body and Arm Assembly



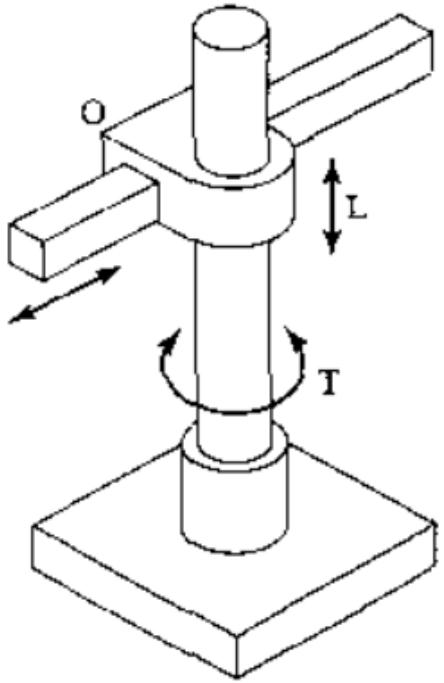

**Motion:**
**TLR**

# 1. Polar Coordinate Body and Arm Assembly



# Industrial Robotics Body and Arm Configuration

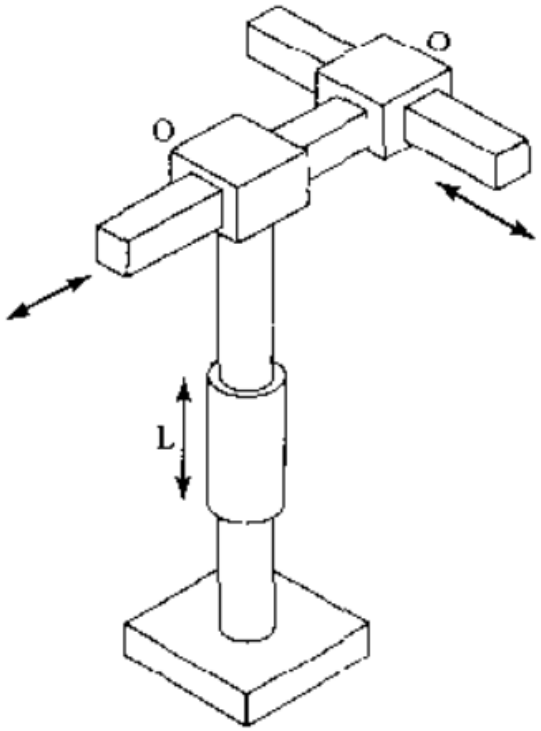
## 2. Cylindrical Body and Arm Assembly




**Motion:**
**TLO**

# Industrial Robotics Body and Arm Configuration

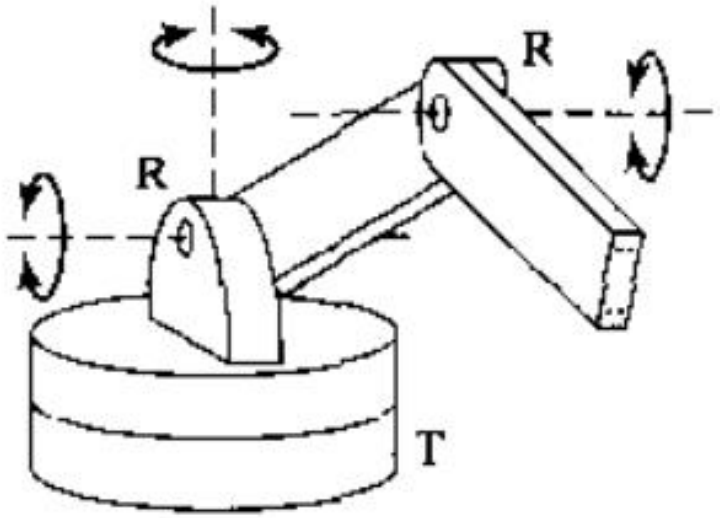
## 3. Cartesian Coordinate Body and Arm Assembly




**Motion:**
**LOO**

# Industrial Robotics Body and Arm Configuration

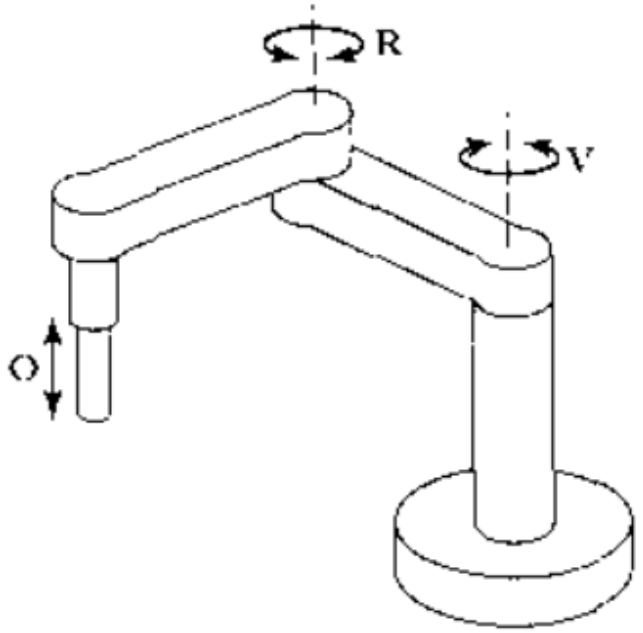
## 4. Jointed Arm Body and Arm Assembly




**Motion:**
**TRR**

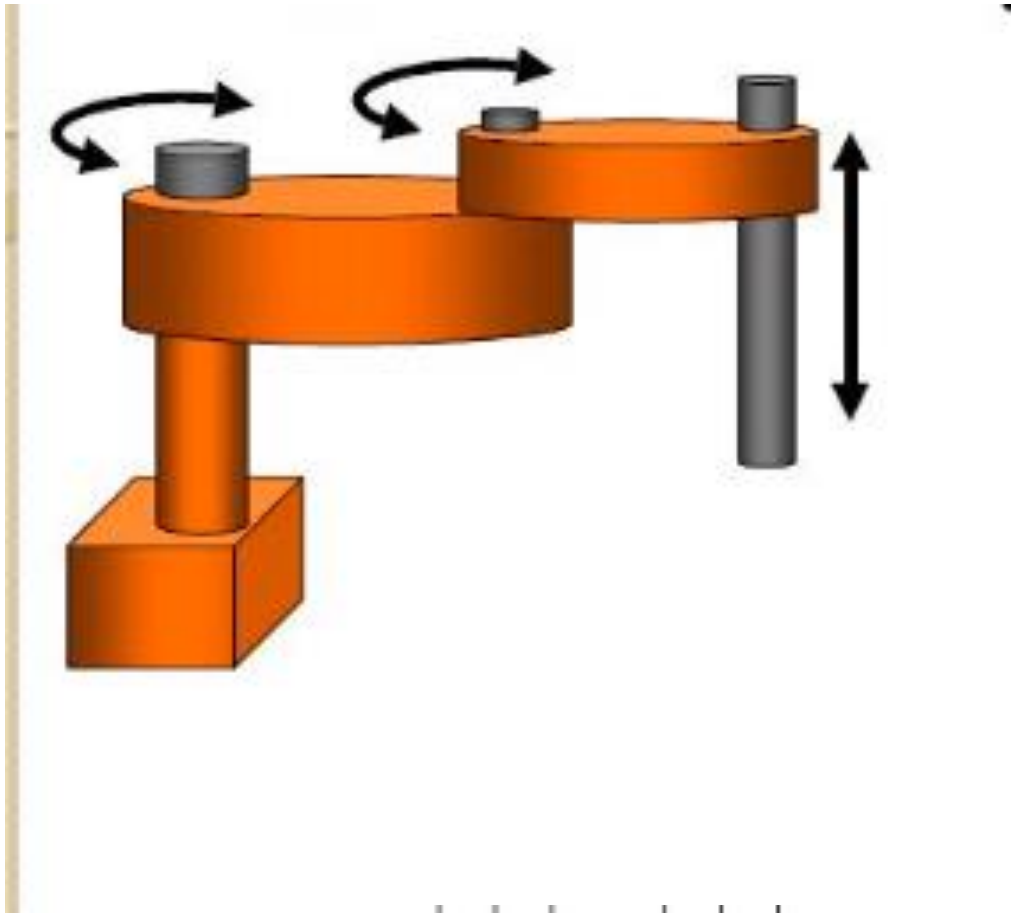
# Industrial Robotics Body and Arm Configuration

## 5. SCARA Body and Arm Assembly



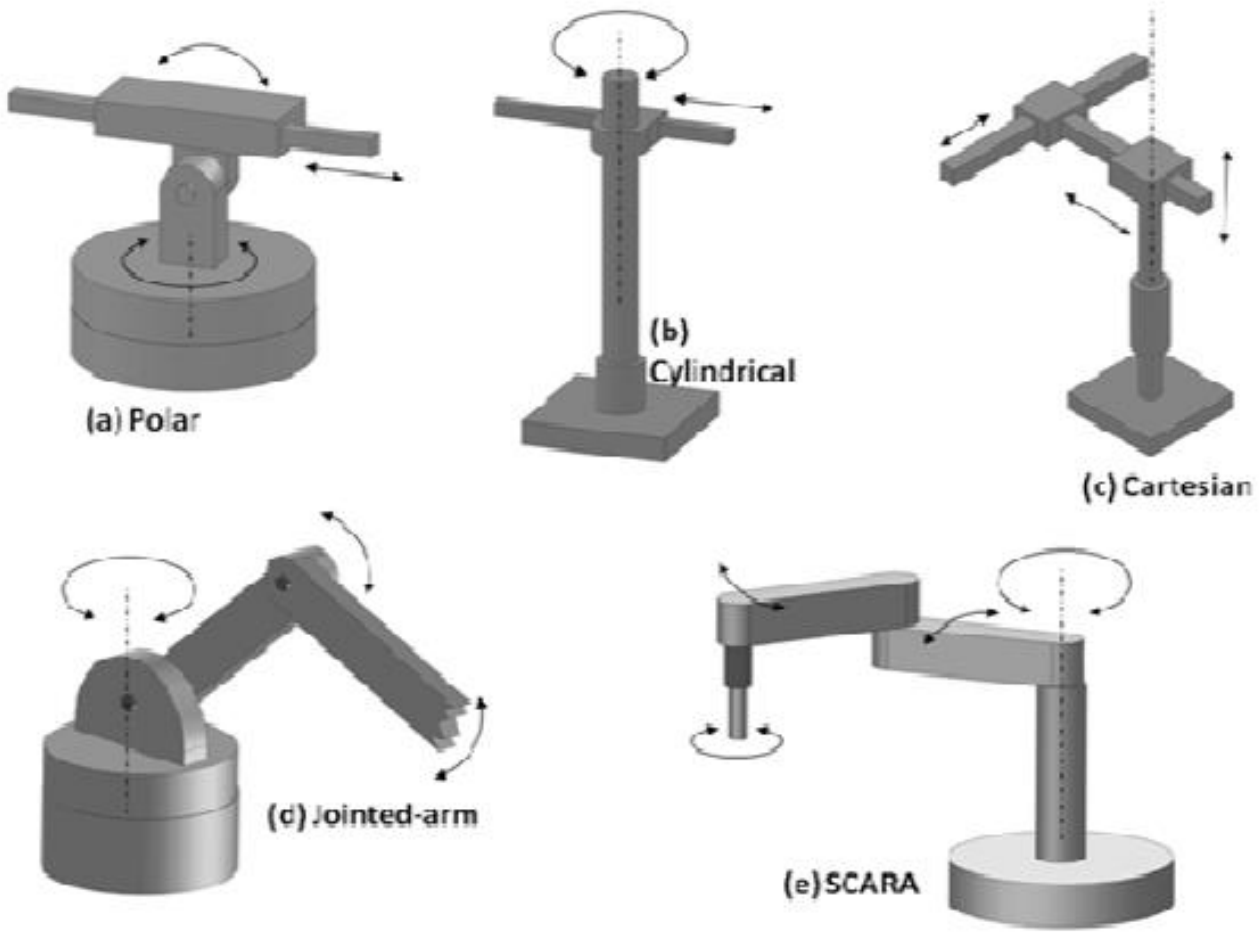

**Motion:**
**VRO**

# 5. SCARA Body and Arm Assembly



**Motion:**
**VRO**

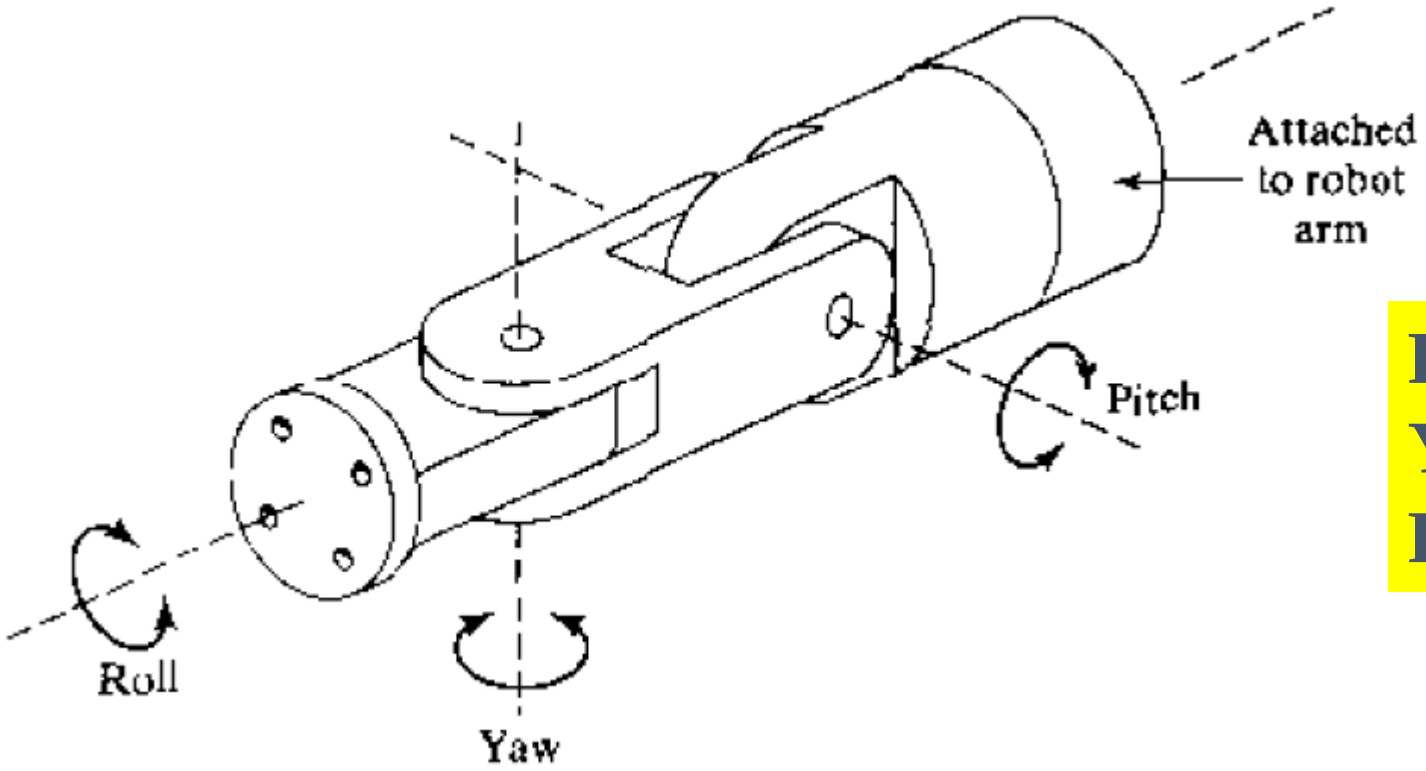
# Body and Arm Configuration



# Industrial Robotics Wrist Configuration

# Industrial Robotics Wrist Configuration

The robot's wrist is used to establish the orientation of the end effector.



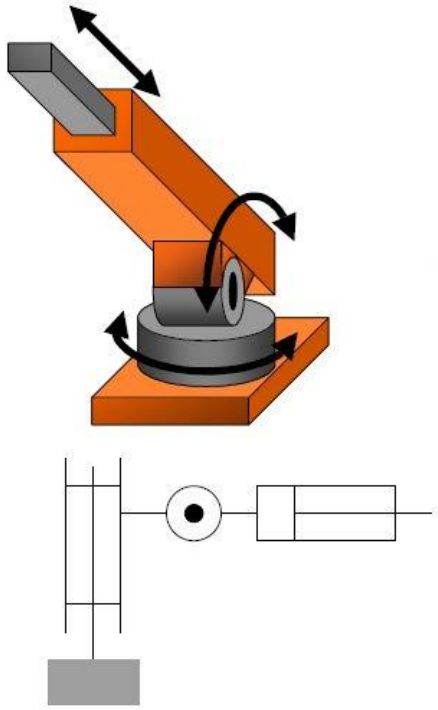

**Roll- Twisting**
**Yaw- Left-right Rotation**
**Pitch- Up-down Rotation**

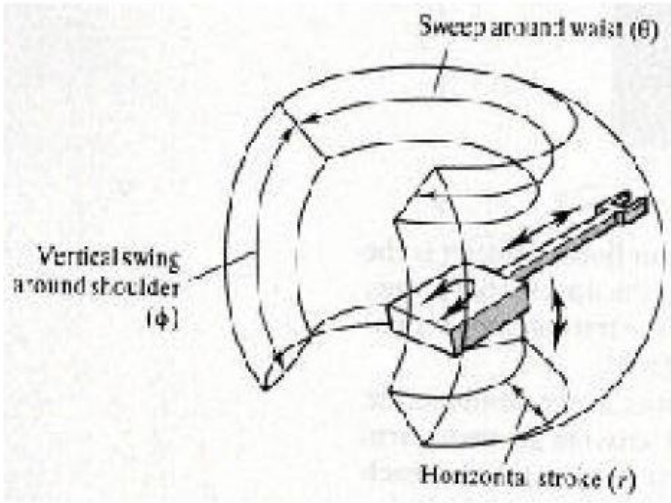
# Industrial Robotics Work Volume

## The envelop within which the robot can manipulate the end of its wrist

### *Robot Anatomy..*

3. **Polar or Spherical Configuration..**






**Spherical Shape**

# Degrees of Freedom

**TLR:TR (5 DoF)**

**TLR(Body and arm assembly)**

**TR (Wrist assembly)**

# Joint Drive System

- **Electric**

  **Ex- servomotor, stepper motor**

- **Hydraulic**

  **Ex-linear piston, rotary vane**

- **Pneumatic**

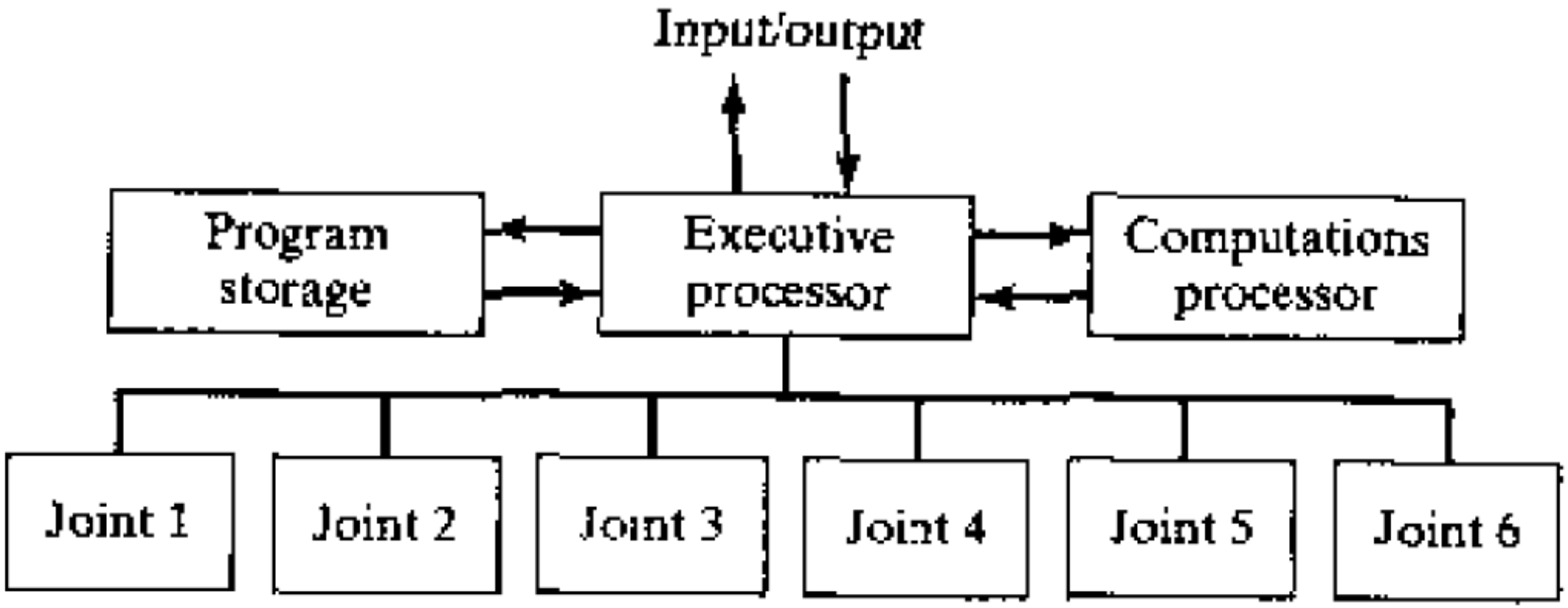
  **Ex-linear piston, rotary vane**

# Dynamic Response Characteristics

- Speed (large robot has ~2m/sec)
- Acceleration and deceleration (0 to 60km/hr in 4sec for sports cars)
- Weight of the object
- Stability

Speed of response, stability

# Control System



# Types of Controller

- ❖Limited Sequence Control
- ❖Playback with point to point
- ❖Playback with continuous path control
- ❖Intelligent control

# Types of Controller

- Limited sequence control
  -is used for simple motion cycles, such as pick and place
  -uses setting limits or mechanical stops
  -no servo control for precise positioning.

- Playback with point-to-point
  -memory records the sequence of motion
  -individual position of the robot arm are recorded in memory

- Playback with continuous path control
  -has greater storage and interpolation capacity
  -Servo control continuously regulate the position and speed

- Intelligent control
  -interact with environment, make decision, communicate etc.

# End Effectors

- **Grippers**
  - Mechanical
  - Vacuum
  - Magnetized
  - Adhesive
- **Tools**
  - Spot welding
  - Arc welding
  - Heating torch
  - Riveting

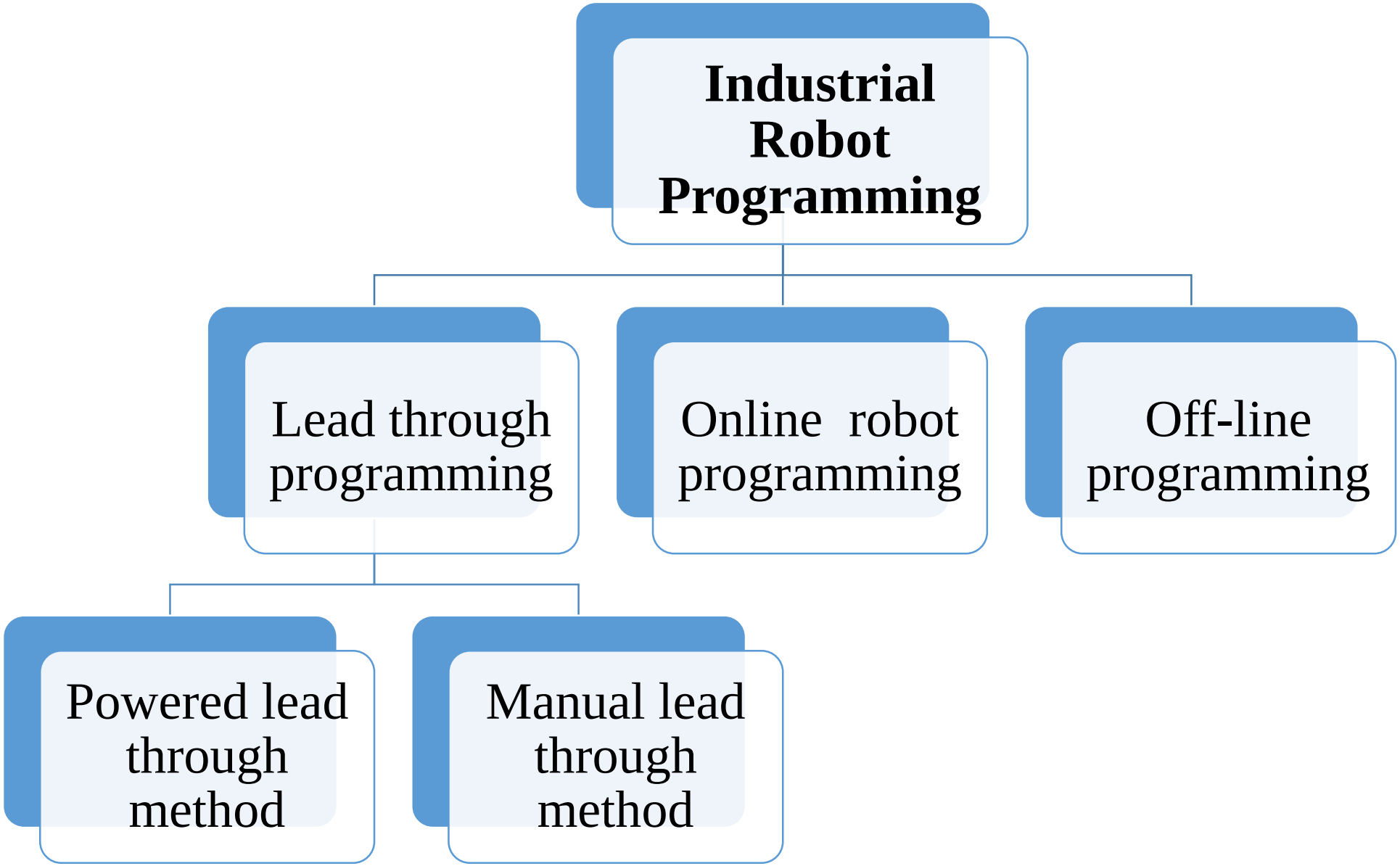
# Sensors in Robots

- Tactile sensors
- Proximity sensors
- Optical sensors
- Optical sensors
- Machine vision

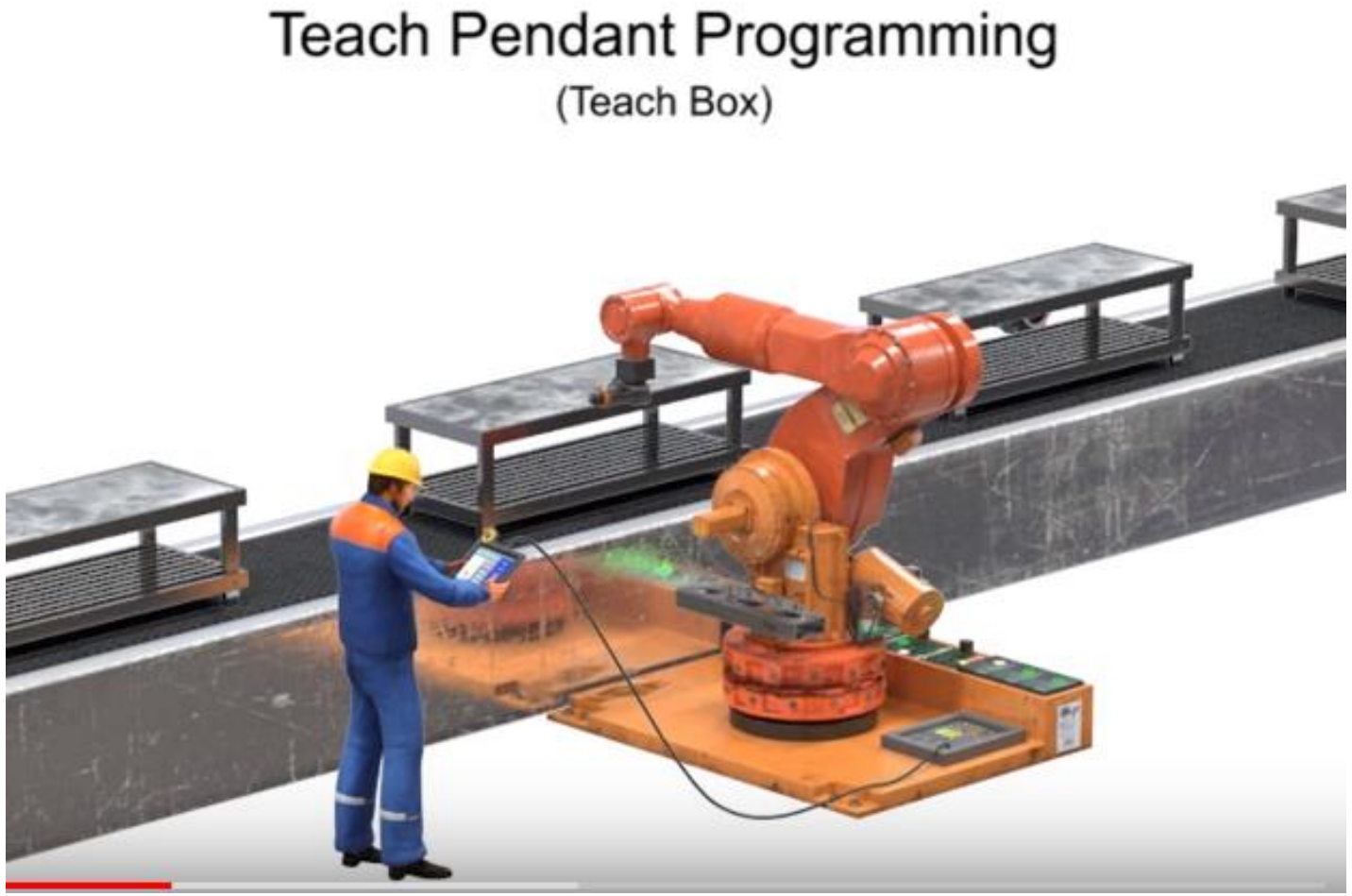
# Applications

## From Book

# Industrial Robot Programming



# Powered Lead Through Robot Programming



# Manual Lead Through Robot Programming

# Online Robot Programming

Online programming allows executing the movements on the real robot at the same time as it is being simulated.

Robot programming languages

Textual statements are used for motion programming.

Examples are:

MOVE P1

HERE P1

# Offline Robot Programming

Offline programming (OLP) is a robot programming method that does not interfere with production as the program for the robot is written outside the production process on an external PC. This allow to prepare the program in a remote place and then after simulation the program can be loaded into the memory

Offline robot programming is done outside the production without stopping production and eliminates production downtime.