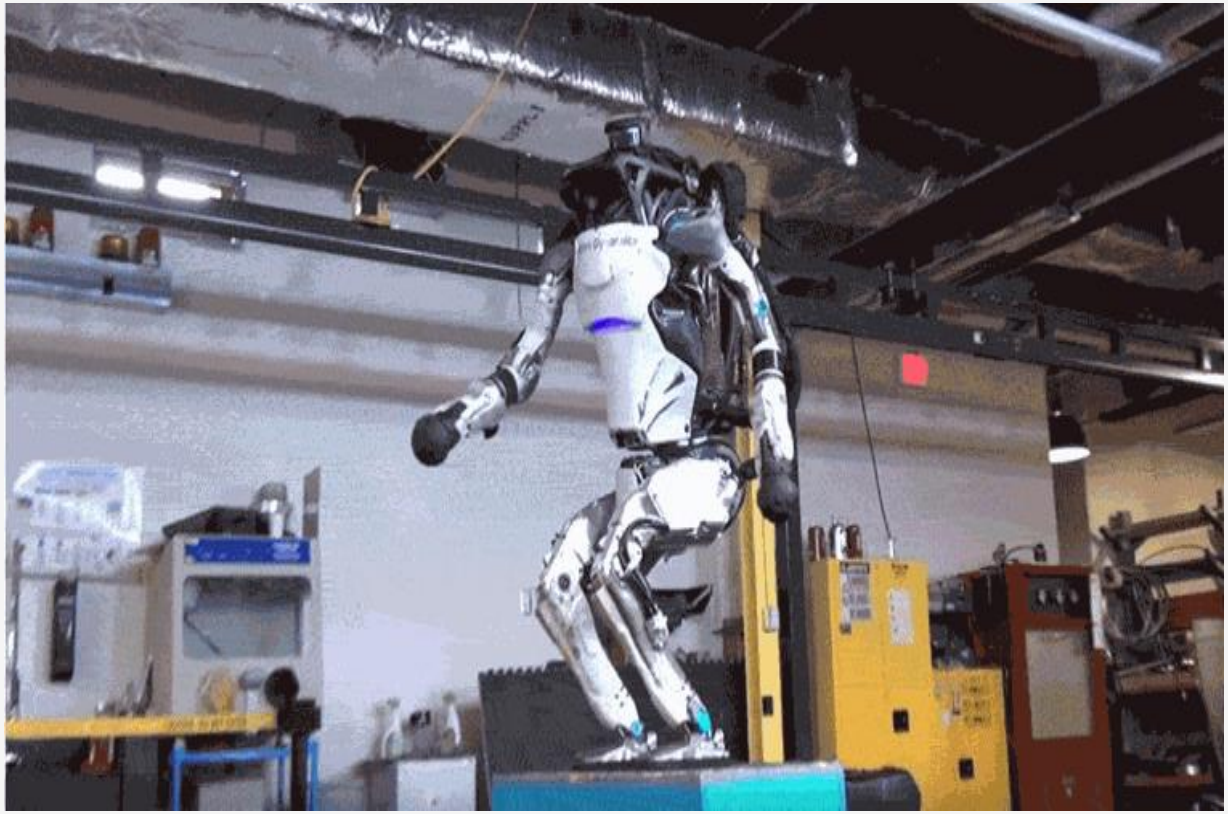
ROBOT: MECHANICS & ELECTRONICS
(RMAE ES1035)

LECTURE- 1

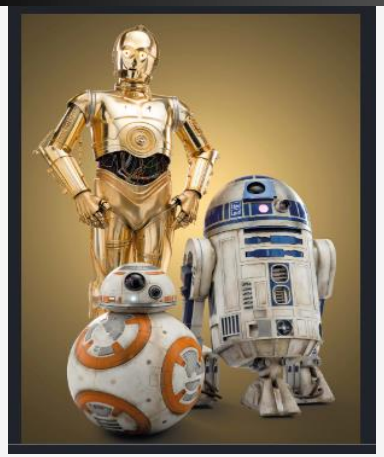
INTRODUCTION TO ROBOTICS

ROBOT Definition



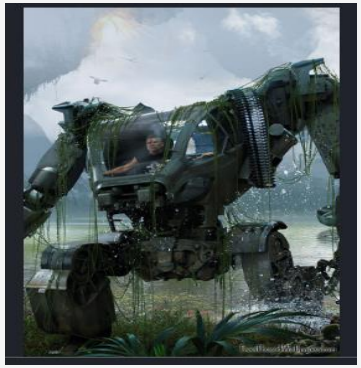
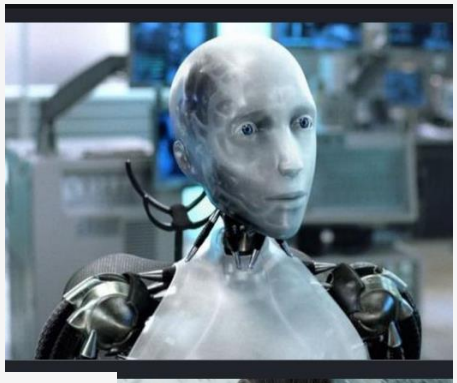
"A ROBOT is a multifunctional, reprogrammable, manipulator (task performer) capable to perform the ordered task in an optimized manner with required accuracy, repeatability, and reliability"

ROBOTS:- SCI-FI MOVIES……









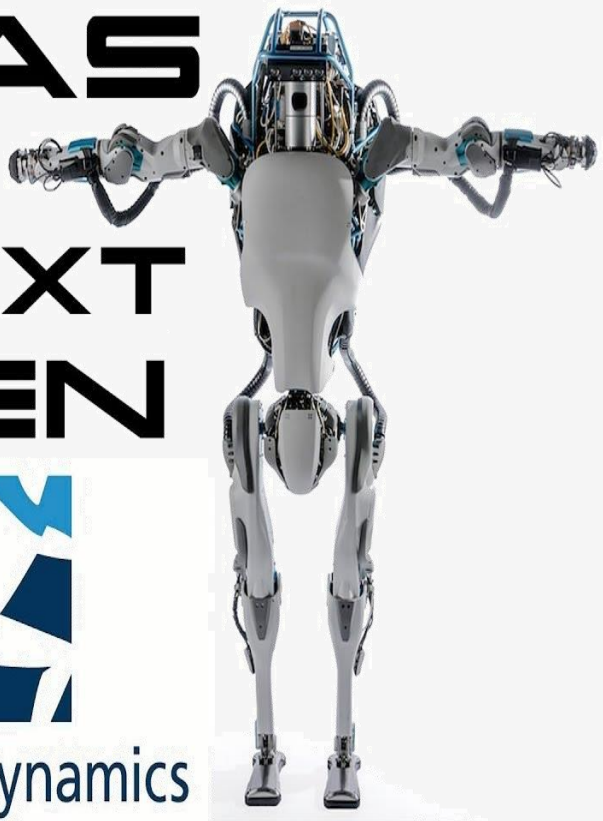
WORLDS DYNAMIC HUMANOID ROBOT….

Can you guess the Name ???

WORLDS DYNAMIC HUMANOID ROBOT….

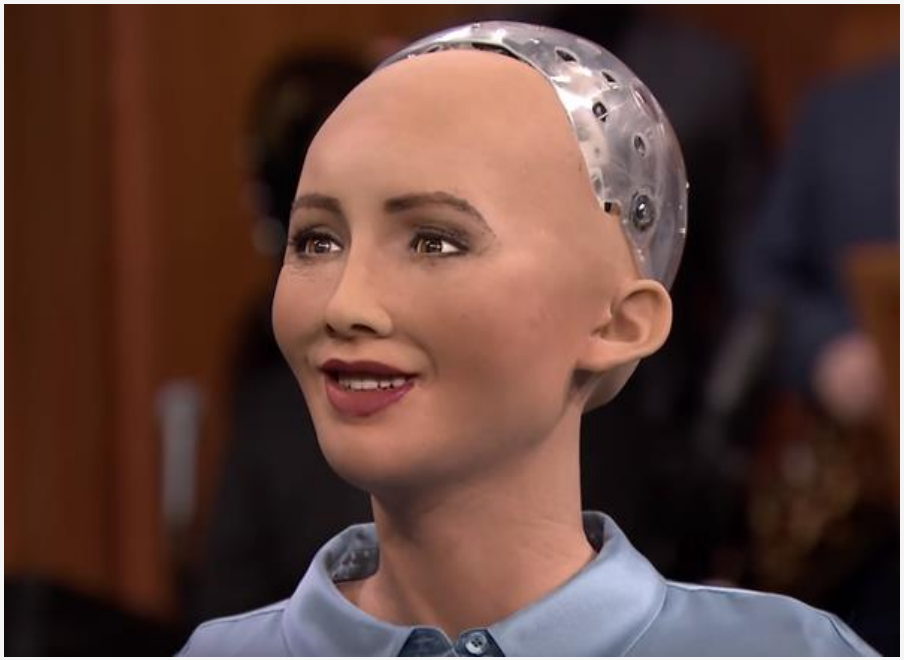
ATLAS

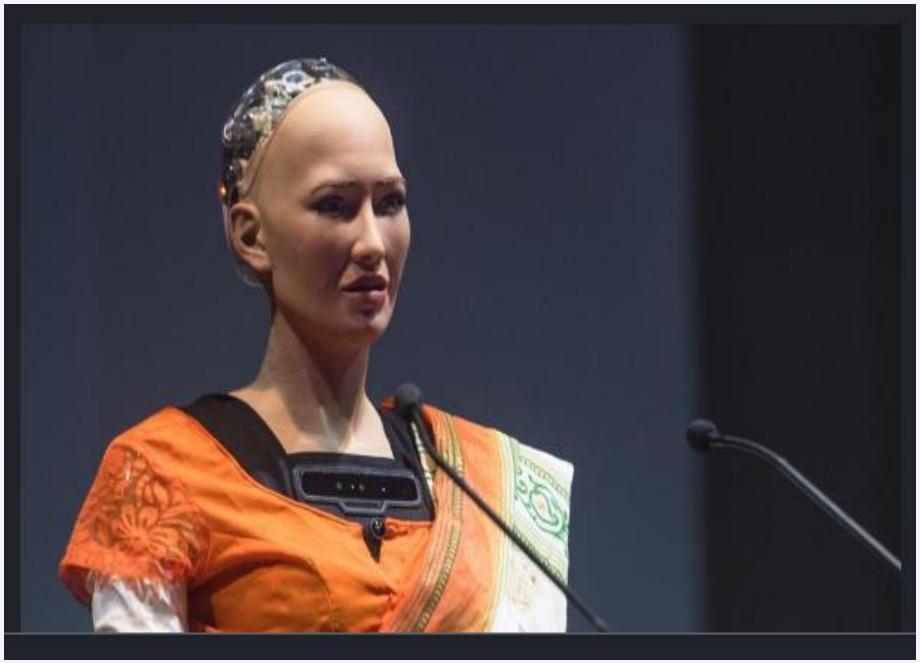
NEXT GEN



BostonDynamics

SOCIAL HUMANOID ROBOT...??





Which are the special feature of this Robot?

SOCIAL HUMANOID ROBOT….SOPHIA…

HANSON ROBOTICS

Sophia in 2018

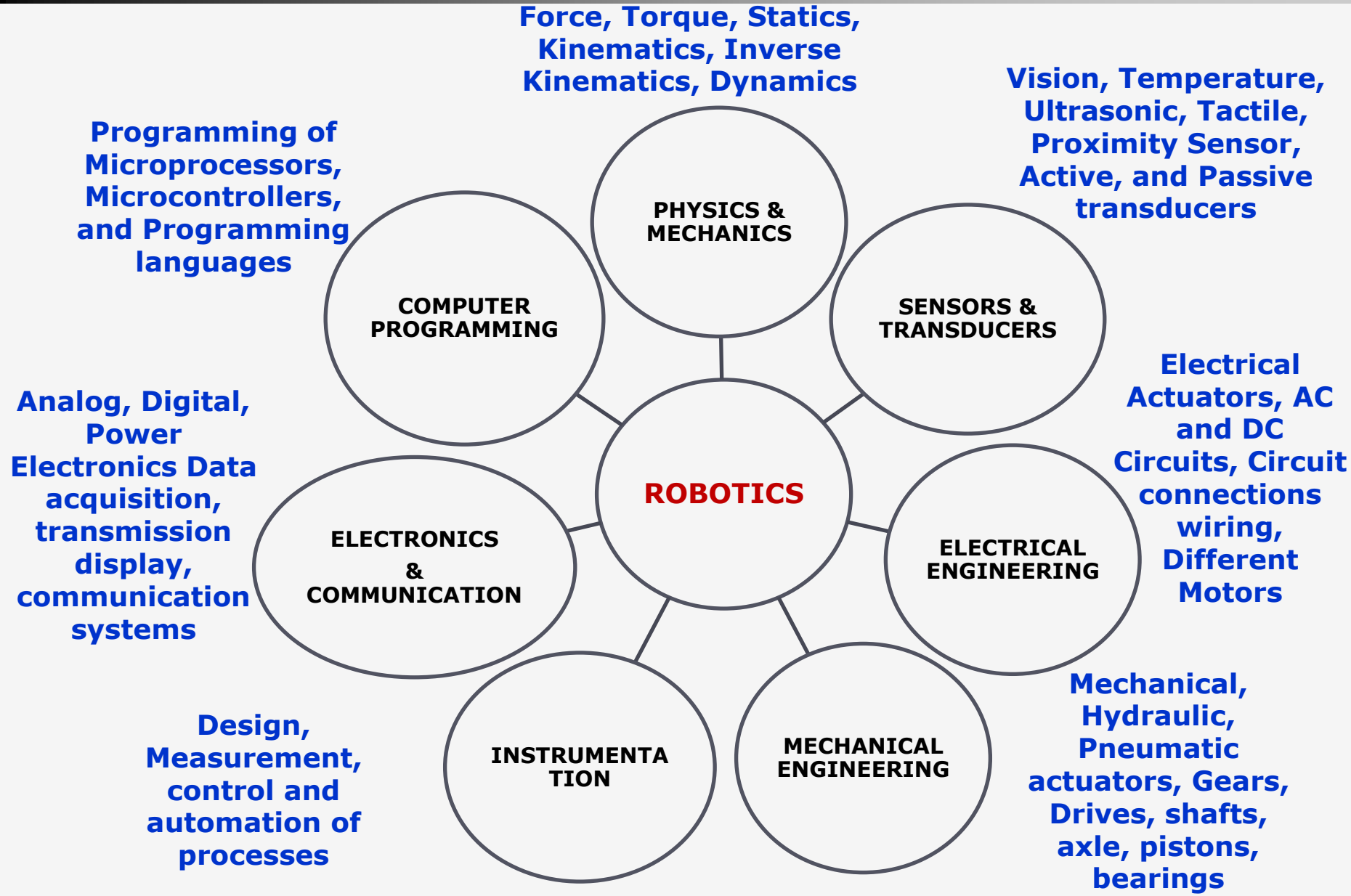
Manufacturer	Hanson Robotics
Inventor	David Hanson
Year of creation	2016
Type	Humanoid
Purpose	Technology demonstrator
Website	www.hansonrobotics.com/hanson-robots/

World's 1st **Robot Citizen** and the 1st **Robot Innovation Ambassador** for the UNDP.

Features: -

1. Computer vision
2. Process Speech
3. Speak (have conversations) – NLP
4. Chatbot
5. Walk (Functional legs)
6. Emulate > 60 facial expressions
7. Understand conversation

ROBOTICS: AN INTERDISCIPLINARY APPROACH



EVOLUTION OF MAN-MADE TECHNOLOGIES

1 ⇩ **MANUAL LABOUR**

2 ⇩ **MECHANICAL SYSTEMS**

3 ⇩ **ELECTRONIC SYSTEMS**

4 ⇩ **AUTOMATION**

5 ⇨ **ROBOTICS**

AUTOMATION & ROBOTICS

WHAT IS THE DIFFERENCE BETWEEN

AUTOMATION & ROBOTICS ????

Automation vs Robotics

	Automation	Robotics
Definition	Work performed by information technology or machines.	Autonomous or semi-autonomous information technology.
Conditions	Requires predictable conditions such as well formatted data and interchangeable parts.	Can do things and make decisions on its own. As such, robots can handle certain real world conditions without direction.

Sense - Act as Programmed

Sense -Analyze – Correlate - Decide-Act as Trained

Source /Reference: www.slideshare.com

Automation vs Robotics

A automated assembly line machine packages peanuts all day long. When an apple appears amongst the peanuts the machine tries to package it. This doesn't work and the machine goes into an error state and the assembly line stops.

A robot that processes recycling materials can identify 200+ different reusable and recyclable parts. It processes all the scrap metal it is fed into dozens of bins. Although the robot has never seen an apple before, when it is given an apple it is able to pick it up and decide to put it into a bin for exceptional items.

The automation takes exact inputs and creates exact outputs. The robot is able to deal with a wide range of inputs and conditions without direction.

Source /Reference: www. slideshare.com

ROBOT: BROADLY SUMMERIZED

R ⇨ **Reliable, Repeatable, Required Accuracy**

O ⇨ **Optimized**

B ⇨ **Bootable (Programmed, Trained)**

O ⇨ **Ordered**

T ⇨ **Task Performer (Intelligently)**

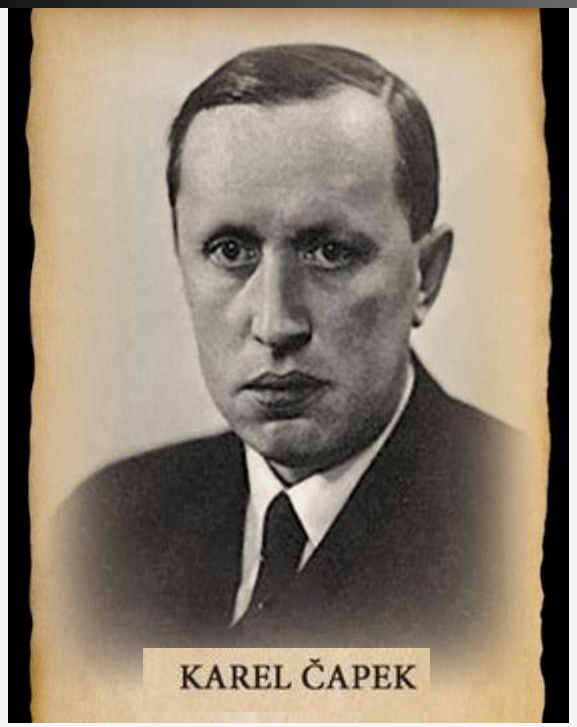
LECTURE- 2

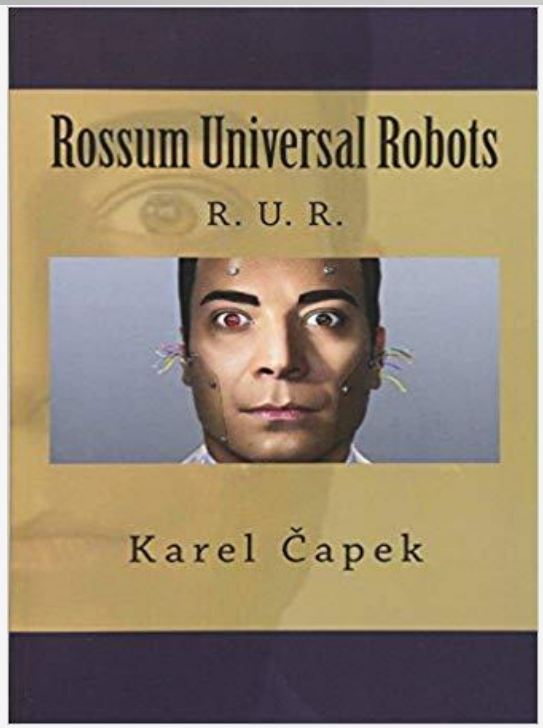
DEFINE THE TERM :- ROBOT

To summarize…….

"A ROBOT is a multifunctional, reprogrammable, manipulator (task performer) capable to perform the ordered task in an optimized manner with required accuracy, repeatability, and reliability"

ROBOT:- DEFINITION





- The word 'ROBOT' was first coined by a Czech novelist Karel Capek in a 1920 play titled "Rassum's Universal Robots (RUR)"
- In Czech language 'Robot' is a word for worker or servant
- According to Karel Capek, a robot is a machine look-wise similar to a human being

Source /Reference: www. google images.com

ROBOT:- DEFINITION

- "Machines that can replace human beings as regards to physical work and decision making are categorized as Robots."

- "A machine that resembles a living creature in being capable of moving independently (as by walking or rolling on wheels) and performing complex actions (such as grasping and moving objects), often, such a machine built to resemble a human being or animal in appearance and behavior. "---Merriam-Webster Dictionary

- "A machine capable of carrying out a complex series of actions automatically, especially one programmable by a computer" ------ Oxford English Dictionary

ROBOT:- DEFINITION

- "An automatically controlled, reprogrammable, multipurpose manipulator programmable in three or more axes, which can be either fixed in place or mobile for use in industrial automation applications" --- International Organization for Standardization (ISO):

- ***"A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks."----------Robot Institute of America, 1979

** This standard definition is to be written in exam, if asked

FUNCIONS OF A ROBOT

SENSING

- ✓ Sensing the environment by external sensor
- ✓ Vision, voice, touch, proximity etc.

DECISION MAKING

- ✓ To make appropriate decision based on the information received from Sensors

PERFORMING THE TASK

- ✓ To Implement/Perform appropriate Task

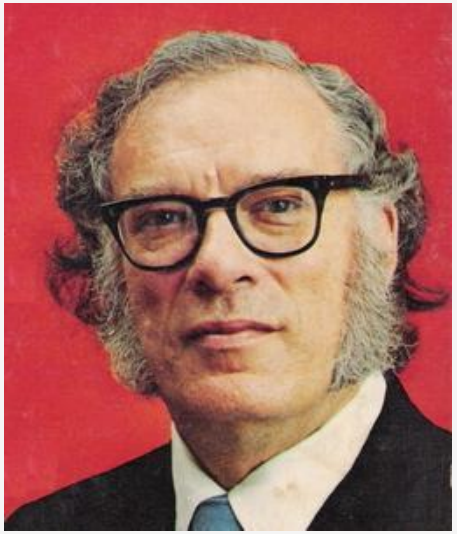
ROBOTICS: DEFINITION

- "Robotics is the art, knowledge base, the know-how of designing, applying and using robots in human endeavors"
- "Robotics is a science, which deals with the issues related to design, manufacturing, usages of robots"
- "Robotics is the science of designing and building robots suitable for real-life applications in automated manufacturing and other non-manufacturing environments"
- In 1942, the term: **Robotics** was introduced by Isaac Asimov in his story named "**RUNAROUND"**
- In Robotics, we use the fundamentals of Physics, Mathematics, Mechanical Engg., Electronics Engg., Electrical Engg., Computer Sciences, and others

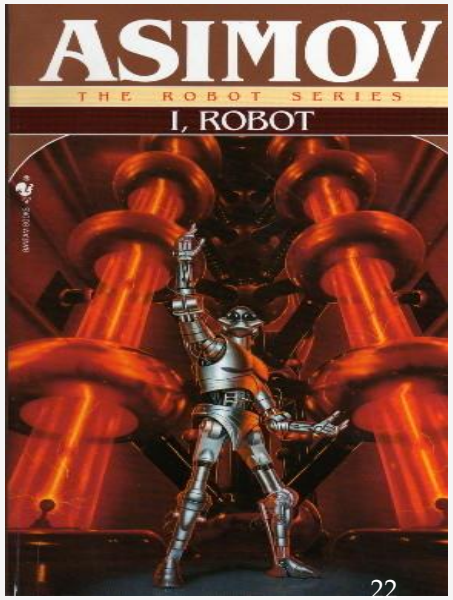
LAWS OF ROBOTICS

Asimov proposed three "Laws of Robotics" and later added the "zeroth law"

- ✓ Zeroth Law: A robot may not injure humanity or through inaction, allow humanity to come to harm
- ✓ First Law: A robot may not injure a human being or through inaction, allow a human being to come to harm, unless this would violate a higher-order law
- ✓ Second Law: A robot must obey orders given to it by human beings, except where such orders would conflict with a higher order law (First law)
- ✓ Third Law: A robot must protect its own existence as long as such protection does not conflict with a higher order law (Second law)



Isaac Asimov



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ADVANTAGES AND DISADVANTAGES OF ROBOTS

ADVANTAGES

- Lifting and Moving Heavy objects
- Working in Hostile environments
- Repeatability and consistency
- Working during unfavorable hours
- Performing dull or monotonous jobs
- Increasing productivity, safety, efficiency, and quality of products
- Achieving more accuracy than human beings
- Can process multiple stimuli or task simultaneously

DISADVANTAGES

- Lack of capability to respond in emergencies
- Initial and Installation costs of equipment of robots are quite high
- Replacement for human workers, thus causing resentment among workers
- Limited capabilities in degrees of freedom, sensors, agility, real-time response
- Needs to be programmed or instructed for every task or predicted situation and appropriate action to be carried out

Why Robotics? - Advantages

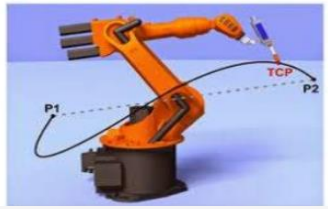
- ✓ Human Safety
- ✓ Speed
- ✓ Consistency
- ✓ Accuracy
- ✓ Reliable
- ✓ Productivity
- ✓ Suitable for Dangerous/dirty atmosphere
- ✓ No Fatigue
- ✓ They don’t go on strike!

Why Robotics? - Disadvantages

- ✓ Creates Unemployment
- ✓ High expertise required
- ✓ Huge initial cost
- ✓ Restricted by the Programming
- ✓ Takes a long time for a small change in the setup
- ✓ Electricity is a must
- ✓ High maintenance cost
- ✓ Can be fatal if accidents occur
- ✓ They might take over the world in future!

LECTURE- 3

GENERAL CLASSIFICATION OF ROBOTS



GENERAL CLASSIFICATION OF ROBOTS

INDUSTRIAL ROBOTS

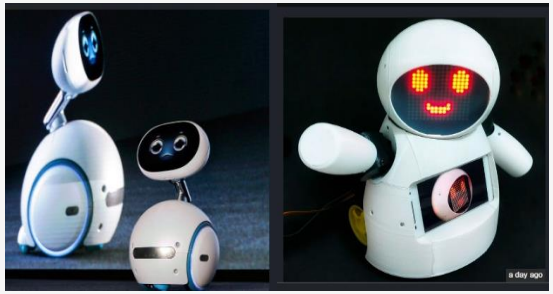
- MANUAL HANDLING DEVICE
- FIXED SEQUENCE
- VARIABLE SEQUENCE
- AUTOMATIC HANDLING
- PLAYBACK ROBOT
- NUMERICAL CONTROL ROBOT
- INTELLIGENT ROBOT

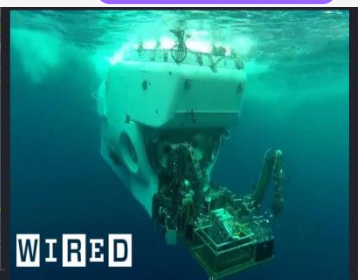
SPECIAL PURPOSE ROBOTS

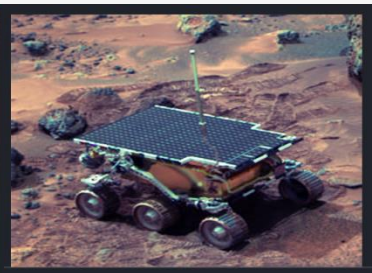
- DEFENCE PURPOSE
- ARIAL-DRONE
- ROBOT SURGON
- UNDER WATER ROBOTS
- SPACE OPERAION
- ROBOT SOLDIER

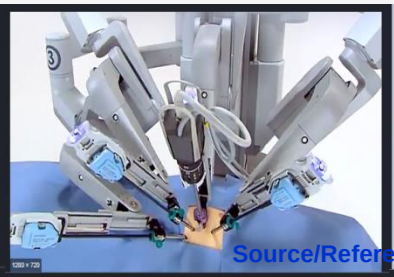
SOCIAL ROBOTS

- HUMANOID
- CARE TAKER
- FRIENDLY COMPANION
- PERSONAL ASSISTANCE
- ACTIVITY TEACHER
- DOMETIC HELPER









Source/Reference: www. google images.com

ASSOCIATIONS OF ROBOTICS

There are many robotics association in world

- **JIRA** (Japan industrial robotics association)
- **WRO** (world robotic Olympiad)
- **RIA** (robotics institute of America)
- **IFR** (international federation of robotics)
- **CRIA** (China Robot Industry Alliance)
- **IEEE robot & automation society**

Source/Reference: www. slideshare.com

CLASSIFICATION:- INDUSTRIAL ROBOTS

According to JIRA

JIRA's chiefly concerned with industrial robots but has created a robot classification system.

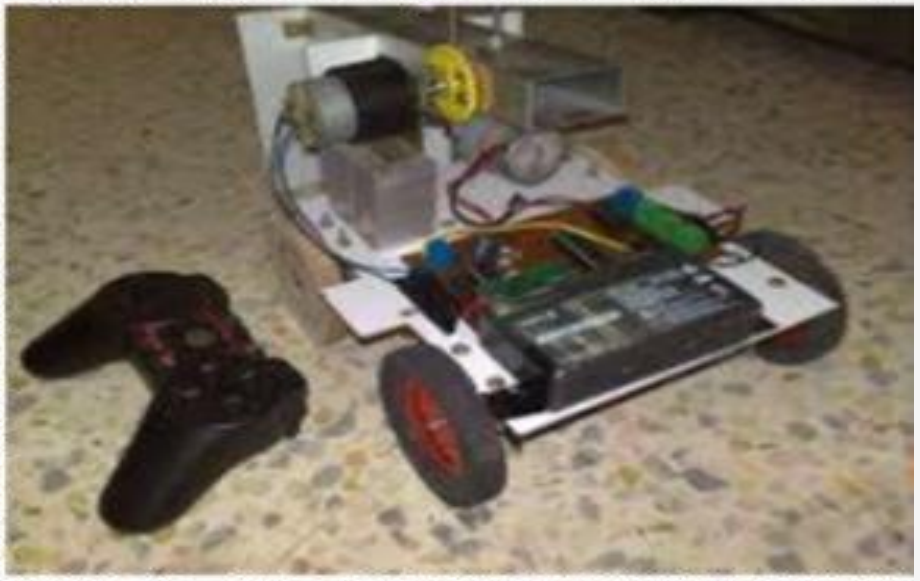
i. Manual Robot
ii. Fixed Sequence robot
iii. Variable sequence robot
iv. Numerical robot
v. Playback robot
vi. Intelligent robot

Reference: www. slideshare.com

CLASSIFICATION:- INDUSTRIAL ROBOTS

MANUAL ROBOT

- This type of robot has multiple degrees of freedom, but all of its actions are performed under the direct control of an operator.



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CLASSIFICATION:- INDUSTRIAL ROBOTS

FIXED SEQUENCE ROBOT

- This type of robot repeats a fixed sequence of actions without needing to be controlled by an operator

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CLASSIFICATION:- INDUSTRIAL ROBOTS

VARIABLE SEQUENCE ROBOT

- This type of robot is similar to class 2, except that the sequence of actions can be reprogrammed easily allowing it to be quickly adapted to perform new tasks

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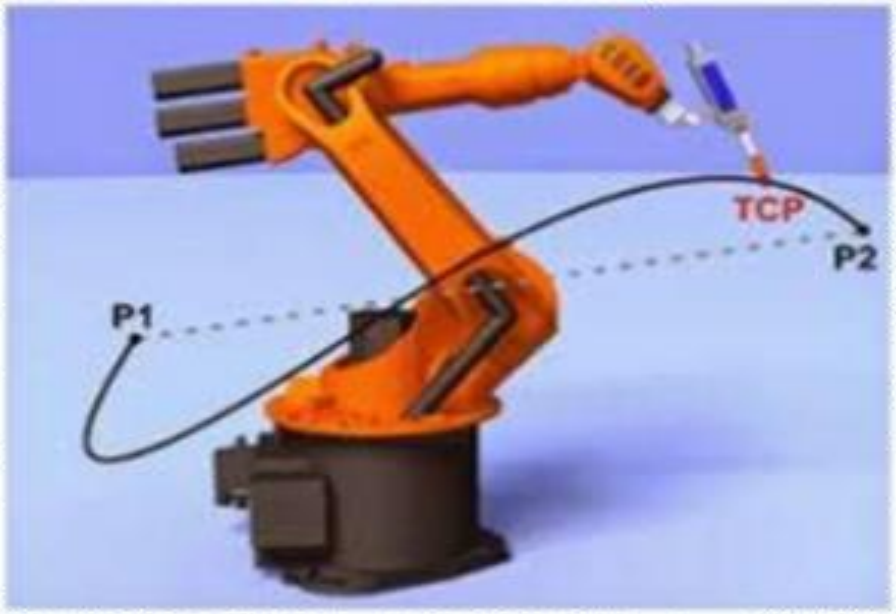
CLASSIFICATION:- INDUSTRIAL ROBOTS

PLAYBACK ROBOT

- This type of robot is first guided through a sequence of actions by an operator, then repeats the same actions automatically.



playback robot with point to point control

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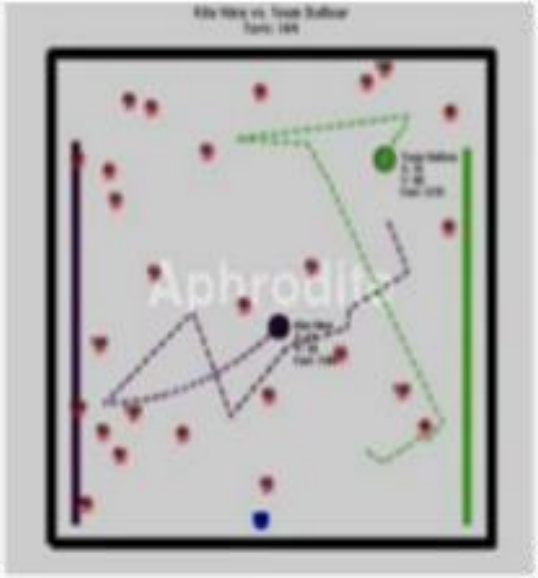
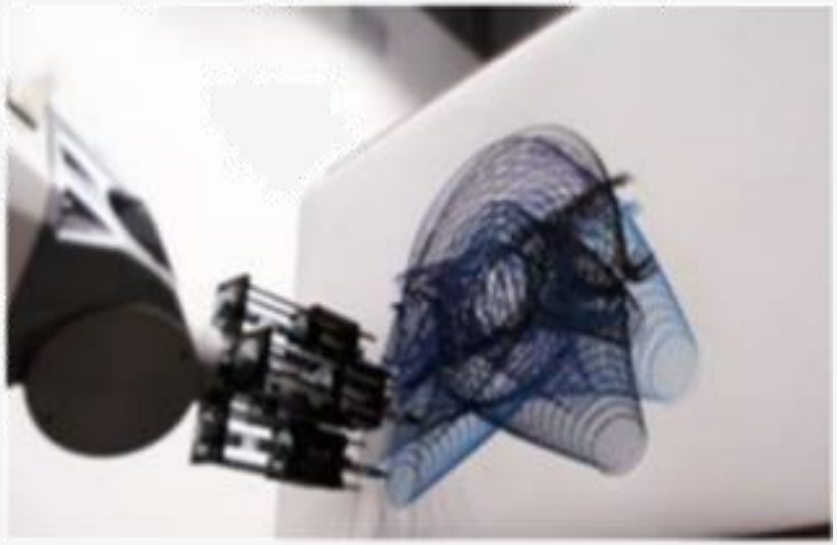
CLASSIFICATION:- INDUSTRIAL ROBOTS

NUMERICAL ROBOT

- This type of robot moves through a sequence of actions, which it receives in the form of numerical data.





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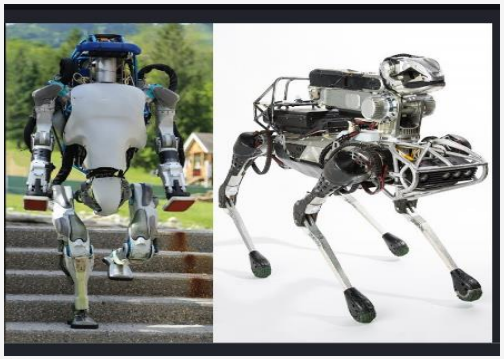
CLASSIFICATION:- INDUSTRIAL ROBOTS

INTELLIGENT ROBOT

- A robot that senses its environment and responds to changes in it in order to continue performing its function.



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Terminology of a Robot

- **Mechanisms –**
  - Cartesian
  - Cylindrical
  - Polar
  - Jointed Arm
- **End Effecters –**
  - Mechanical
  - Vacuum
  - Magnetic etc.
- **Tools –**
  - Welding guns
  - Spray paint guns
  - Spindle for drilling
  - Screw drivers
  - Heating torch …… and many more …..

ANATOMY OF A ROBOT

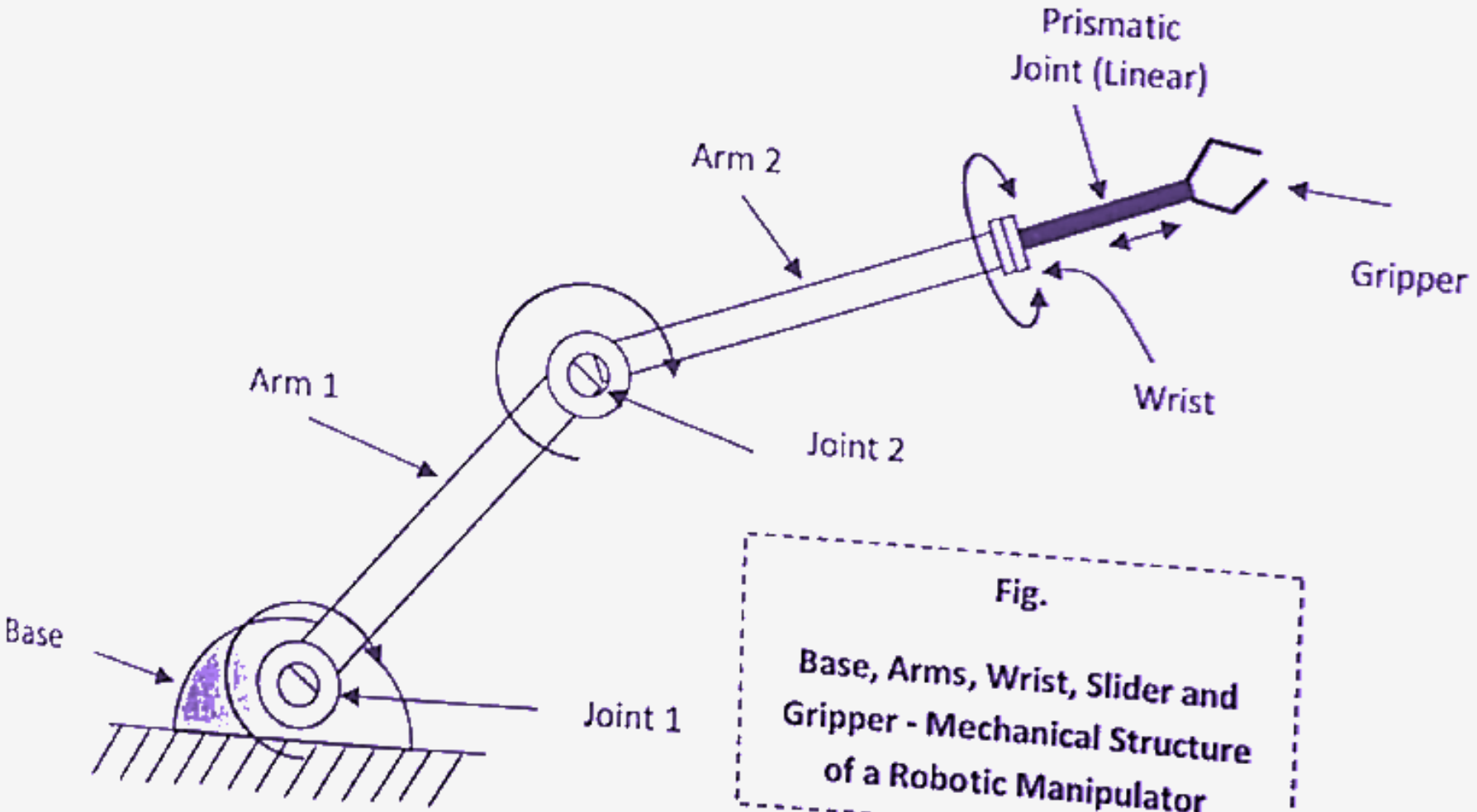
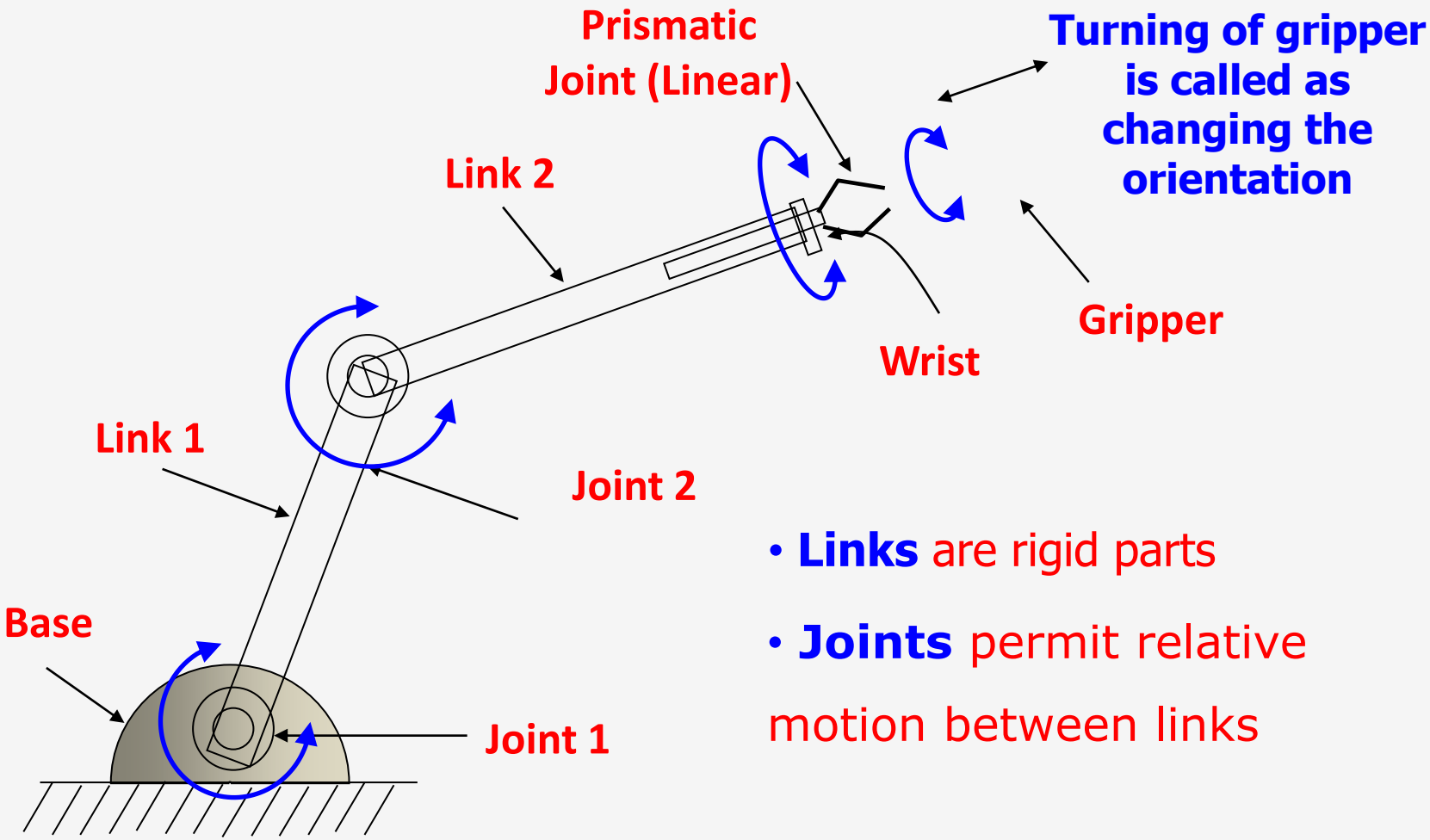


Fig.

Base, Arms, Wrist, Slider and Gripper - Mechanical Structure of a Robotic Manipulator

ANATOMY OF A ROBOT



- **Links** are rigid parts
- **Joints** permit relative motion between links

Base, Arms, Joints, Wrist, Slider and Gripper –

Mechanical Structure of a Robotic Manipulator

BODY PARTS OF ROBOT

- BASE :- Robotic arm or manipulators are generally mounted on a fixed base fastened to the floor or on the mobile platform
- JOINT, ARM:- The mechanical structure of a manipulator that consists of rigid bodies (links) connected by means of articulations **(Joints),** [see joint 1 and joint 2] is segmented into an (Arm) [see arm 1 and arm 2] that ensures mobility and reachability.
- WRIST:- A wrist that makes the orientation.
- END EFFECTOR:- The End Effector performs the required Task.

  At the end of SLIDER, there is a GRIPPER'

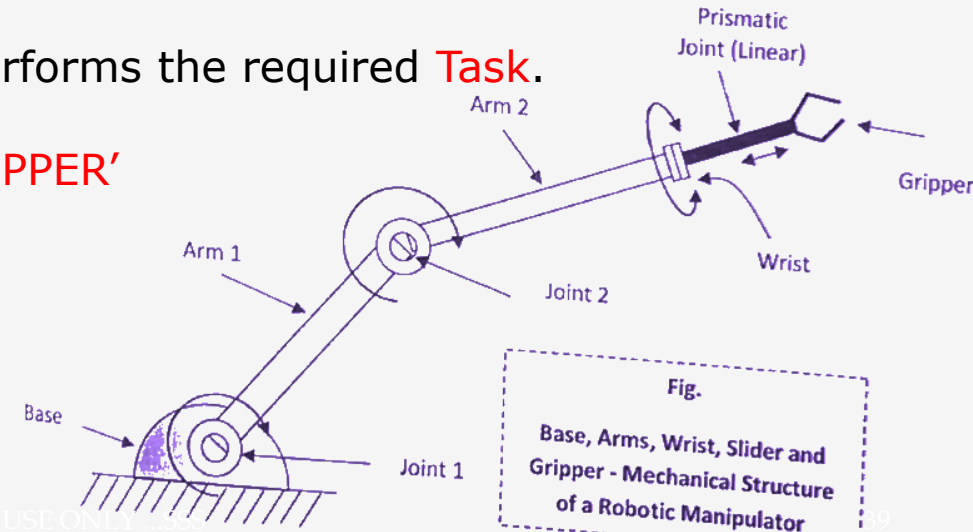


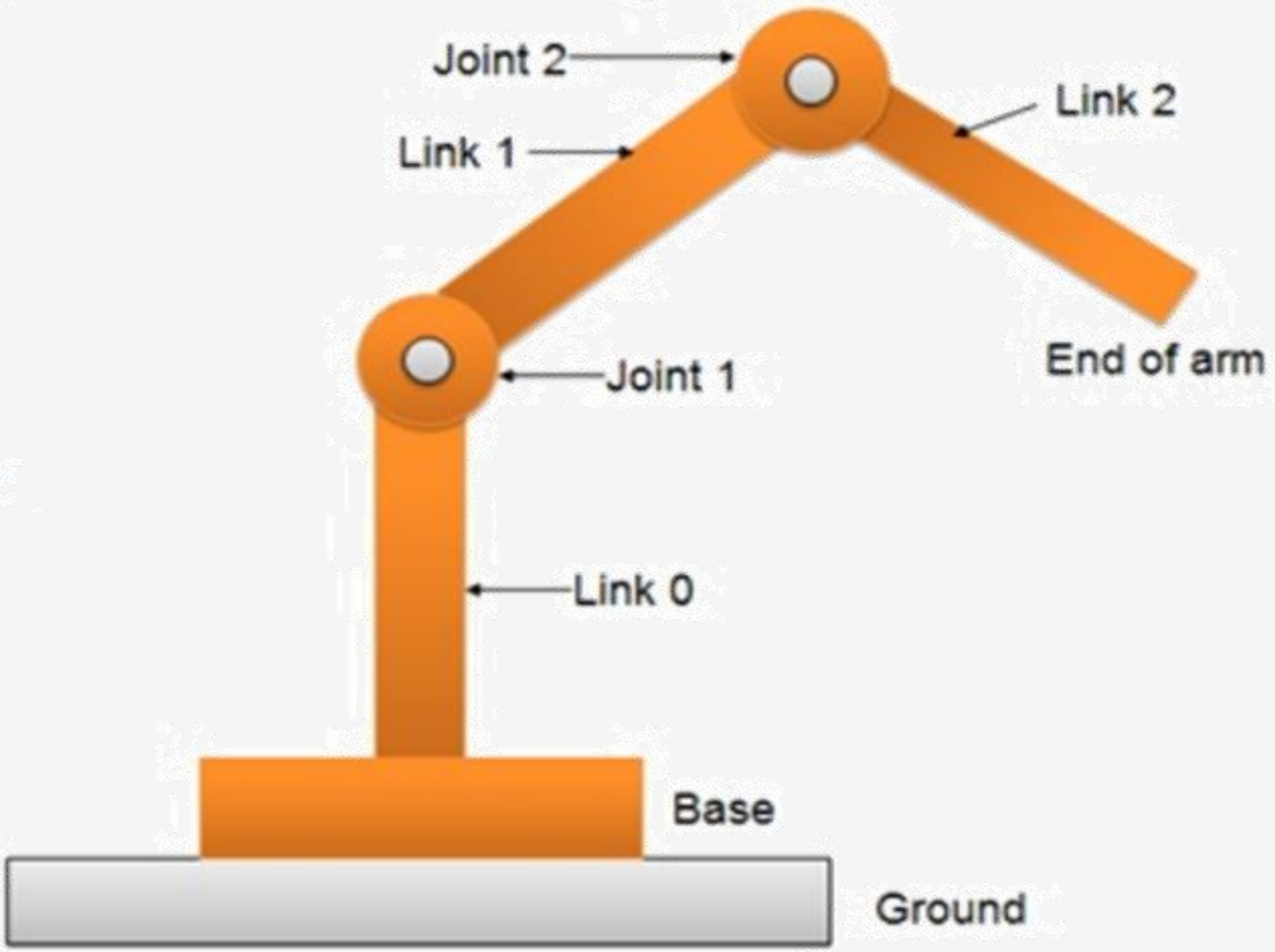
Fig.

Base, Arms, Wrist, Slider and Gripper - Mechanical Structure of a Robotic Manipulator

ANATOMY OF A ROBOT

- Robotic arm or Manipulator has many similarities to the human
- Robot Anatomy means, the study of the skeleton of the robot / Physical construction of the manipulator structure.
- It generally consists of **JOINTS** and **LINKS**
- Robot anatomy deals with the study of different joints and links and other aspects of the manipulator's physical construction.

Joint-link scheme for robot manipulator



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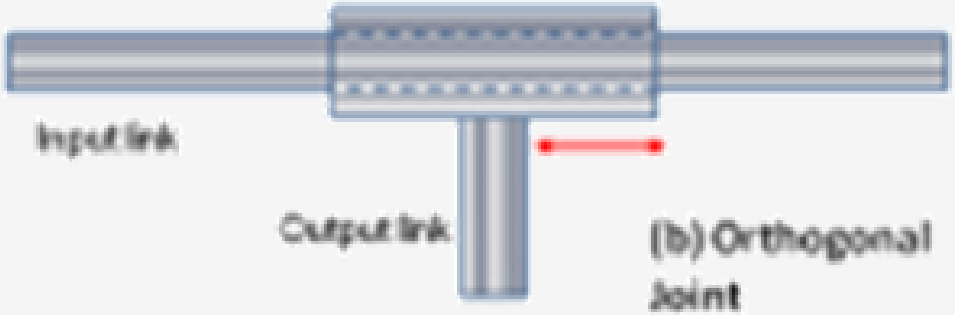
ANATOMY OF A ROBOT

- "Each joint is connected to two links, an input link, and an output link. Joint provides controlled relative movement between the input link and output link.
- A robotic link is the rigid component of the robot manipulator
- Most of the robots are mounted upon a stationary base, such as the floor. From this base, a joint-link numbering scheme may be recognized as shown in the earlier figure below
- The robotic base and its connection to the first joint are termed as link-0.
- The first joint in the sequence is joint-1. Link-0 is the input link for joint-1, while the output link from joint-1 is Link-1—which leads to joint-2.
- Thus Link 1 is, simultaneously, the output link for joint-1 and the input link for joint-2. This joint-link-numbering scheme is further followed for all joints and links in the robotic systems.

JOINTS

Prismatic Joints (P)

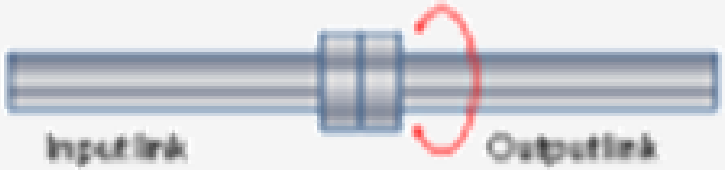
(a) Linear Joint



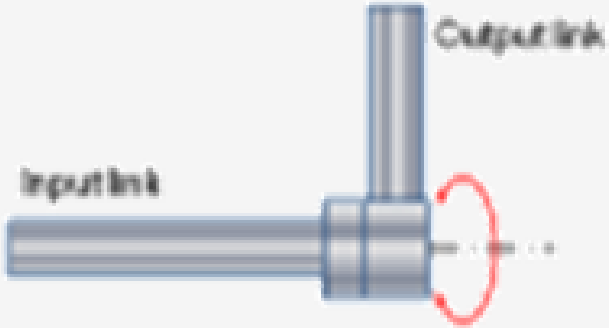
(b) Orthogonal Joint

Revolute Joints (R)

(c) Rotational Joint



(d) Twisting Joint



(e) Revolving Joint

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Joints Types

- There of are mainly two types of Joints:-
  1. Prismatic Joints (P)
  2. Revolute Joint (R)
- 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)

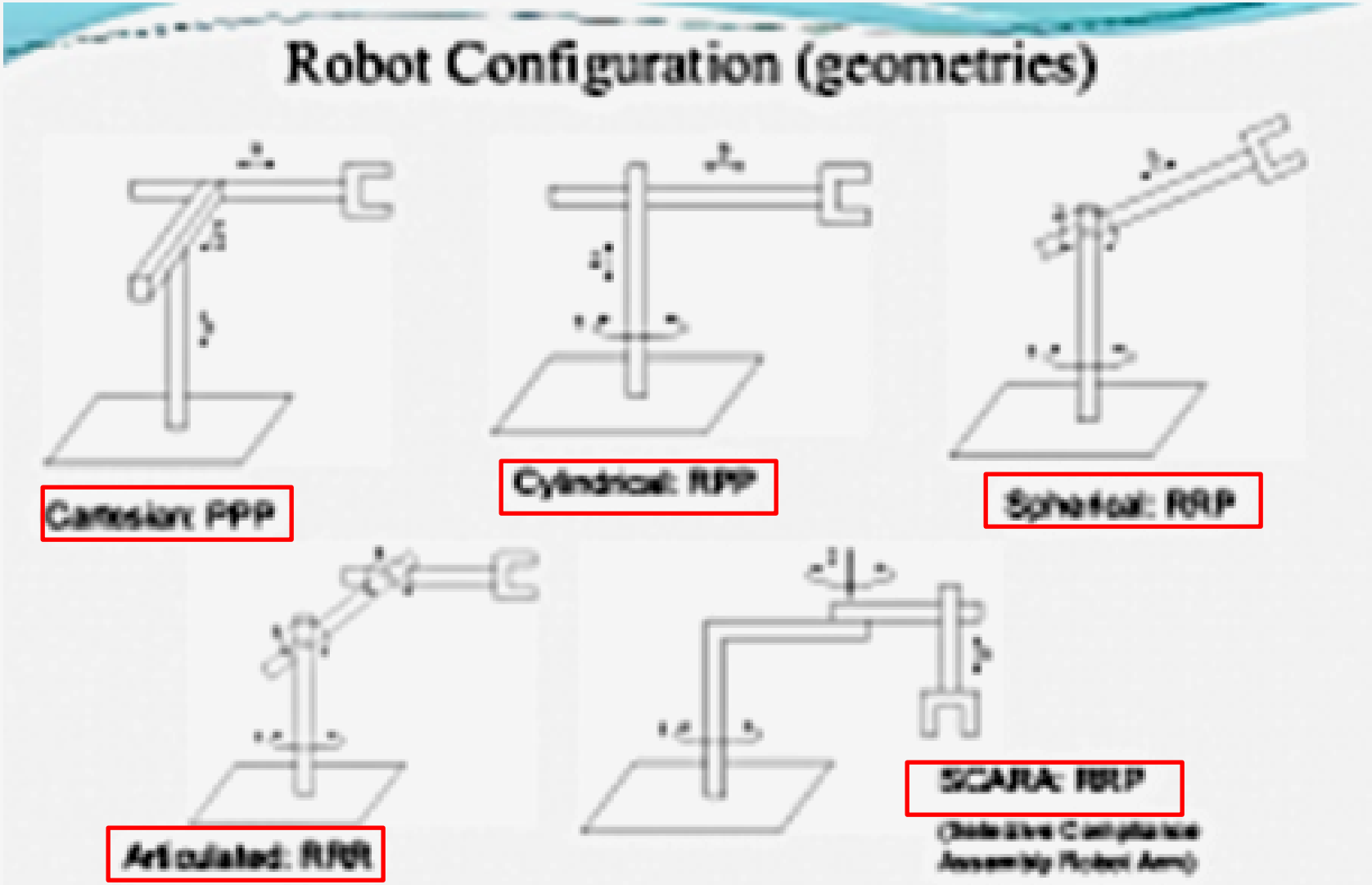
  This joint also involves rotary motion, but the axis or rotation is parallel to the axes of the two links.
- e) Revolving joint (type V-joint, V from the "v" in revolving)

  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.

ROBOT CONFIGURATION WITH JOINT TYPES

Revolute Joints (R)

Prismatic Joints (P)



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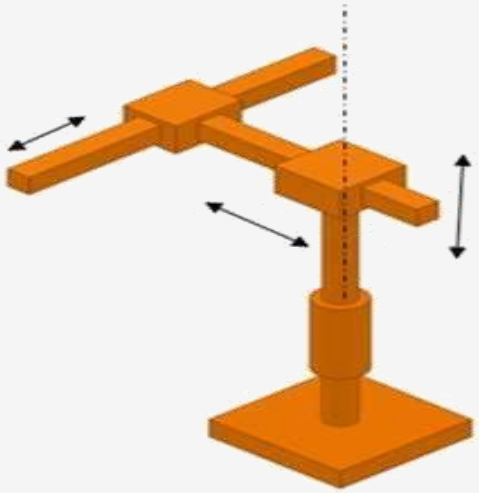
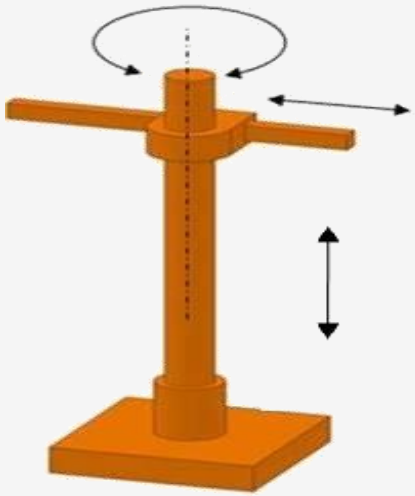
ROBOT CONFIGURATIONS

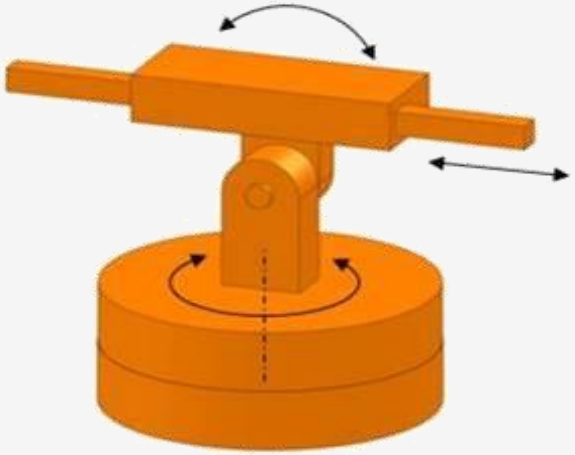


a) Cartesian

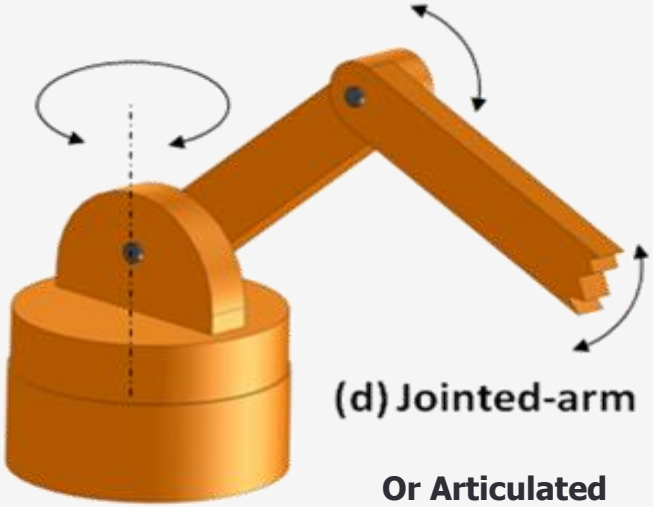


b) Cylindrical

Or Spherical

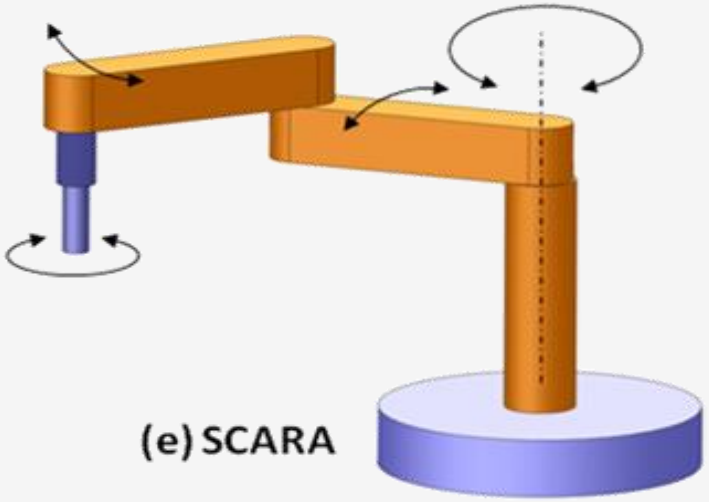


c) Polar



(d) Jointed-arm

Or Articulated



(e) SCARA

(Selective Compliance Articulated Robot Arm)

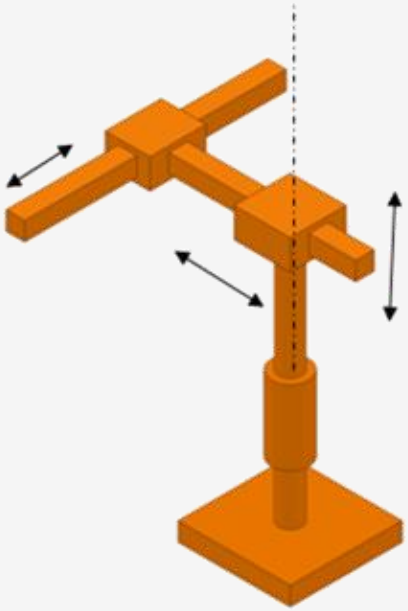
Source /Reference: www. google images.com

ROBOT CONFIGURATIONS AND WORK SPACE

Workspace - The set of locations that can be reached by the robot.

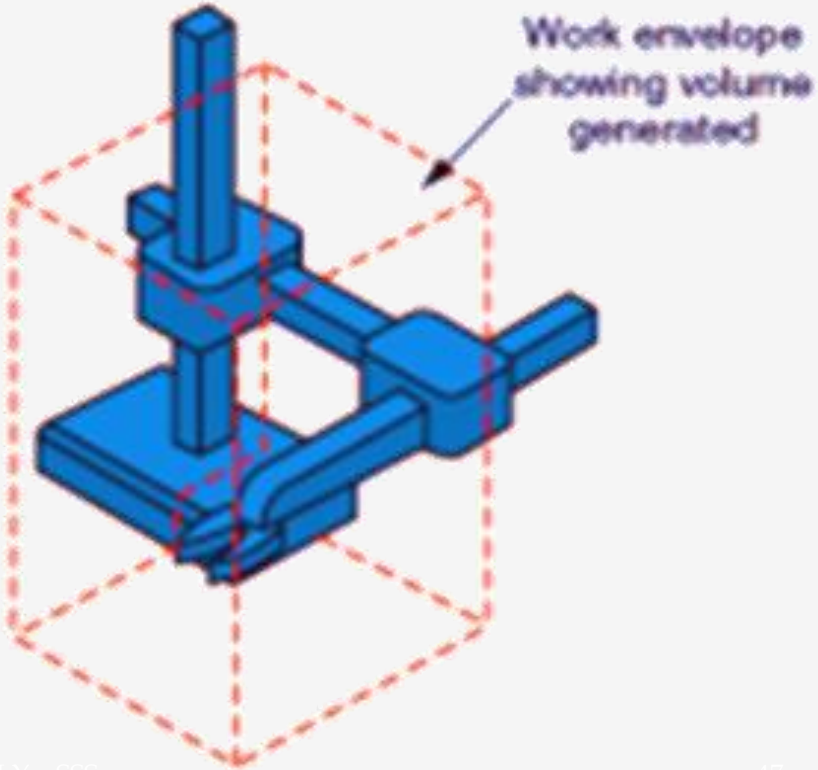
a. Cartesian co-ordinate robot

It is also known as the rectilinear robot and x-y-z robot. It consists of three sliding joints, two of which are orthogonal O-joints.



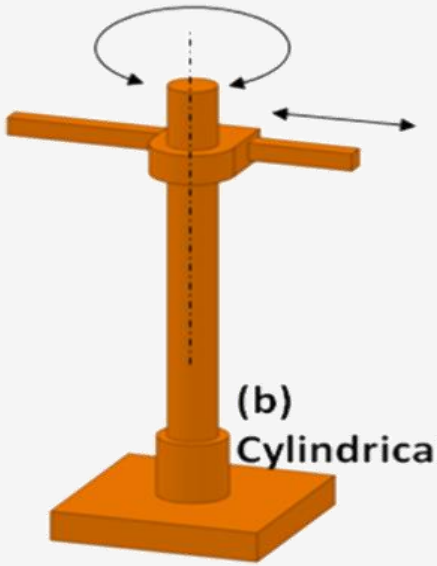
(c) Cartesian

Work Space
or
Work Envelope

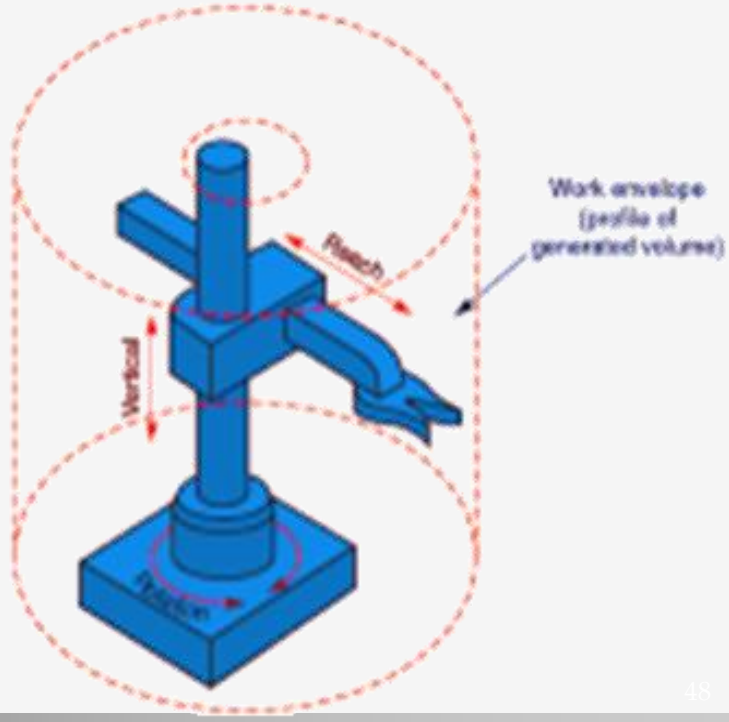


b. Cylindrical configuration

It consists of a vertical column. An arm assembly is moved up or down relative to the vertical column. The arm can be moved in and out relative to the axis of the column. A common configuration is to use a T-joint to rotate the column about its axis. An L-joint is used to move the arm assembly vertically along the column, while an O-joint is used to achieve radial movement of the arm.



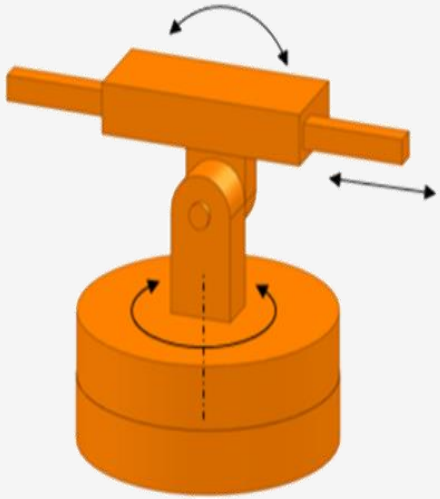
Work Space
or
Work Envelope



Source /Reference: www. google images.com & slideshare.com

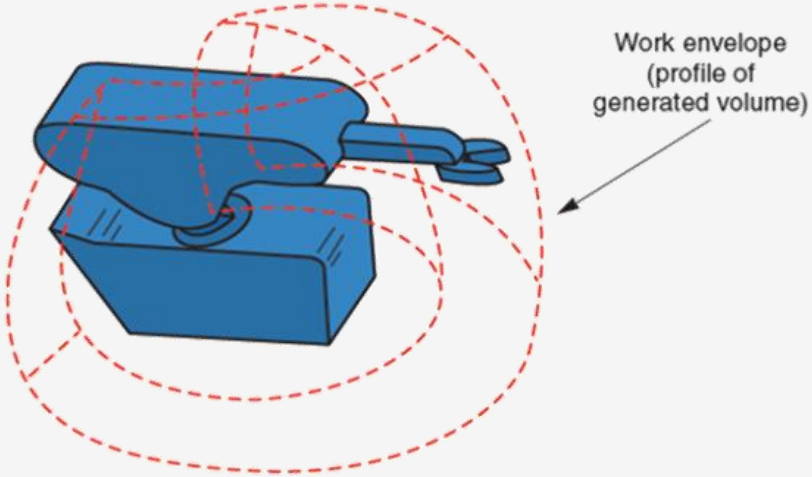
c. Polar configuration (or Spherical)

It consists of a sliding arm L-joint, actuated relative to the body, which rotates around both a vertical axis (T-joint), and a horizontal axis (R-joint).



(a) Polar

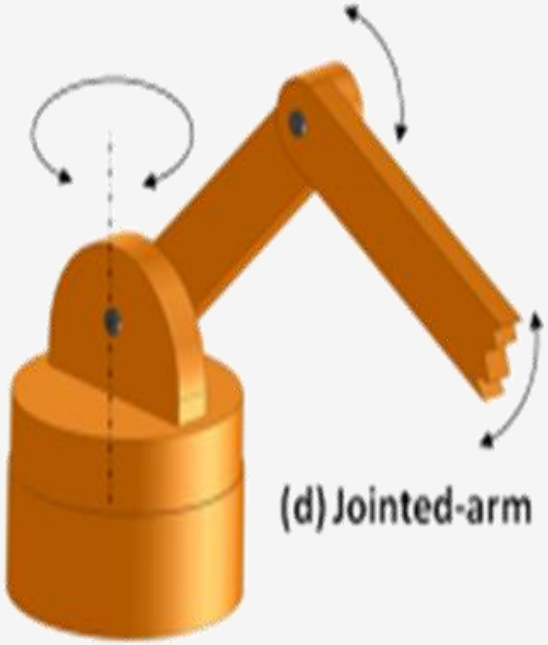
Work Space
or
Work Envelope



Source /Reference: www. google images.com & slideshare.com

d. Jointed-arm robot (Articulated)

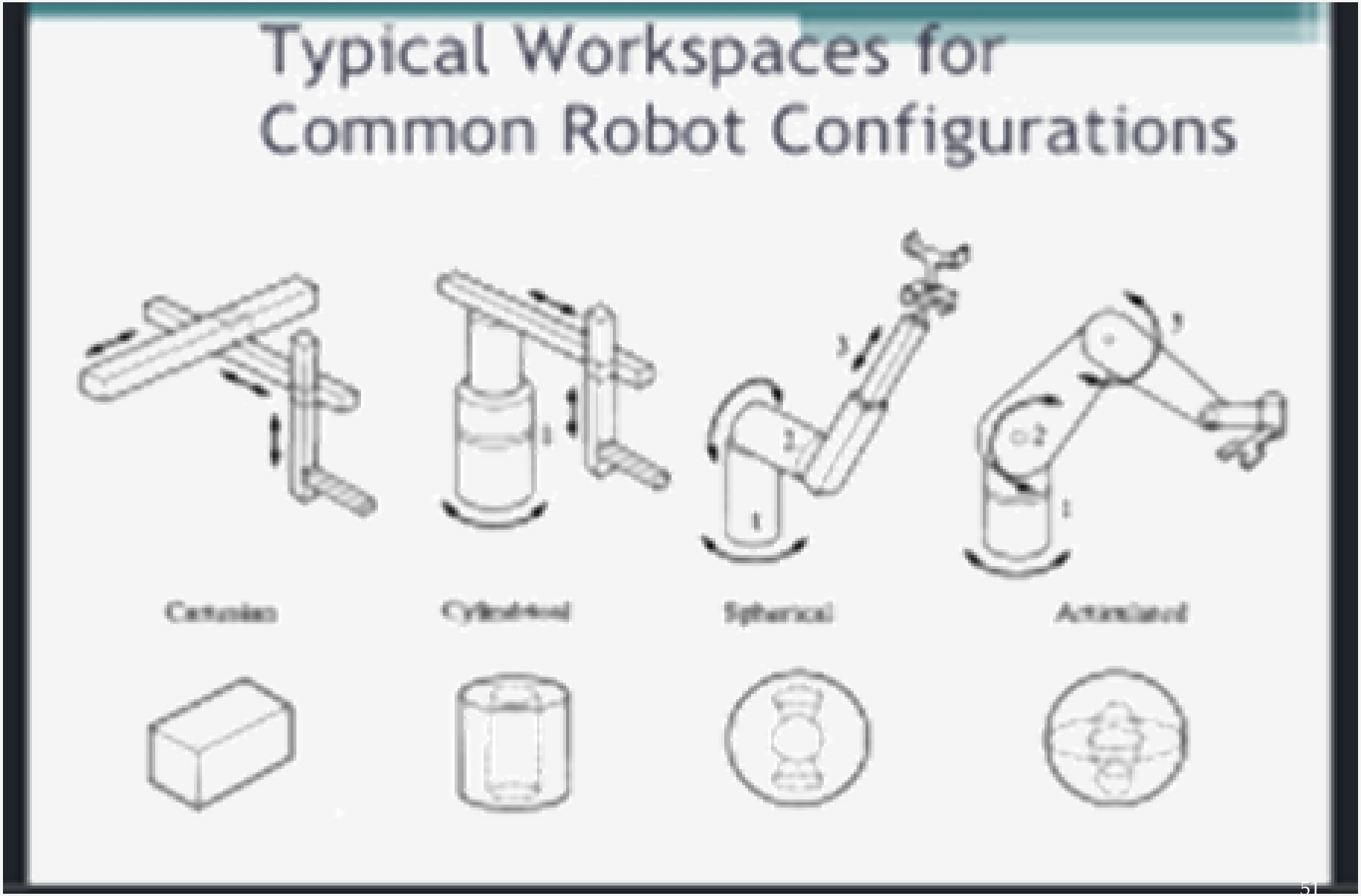
It is similar to the configuration of a human arm. It consists of a vertical column that swivels about the base using a T-joint. Shoulder joint (R-joint) is located at the top of the column. The output link is an elbow joint (another R joint).



(d) Jointed-arm

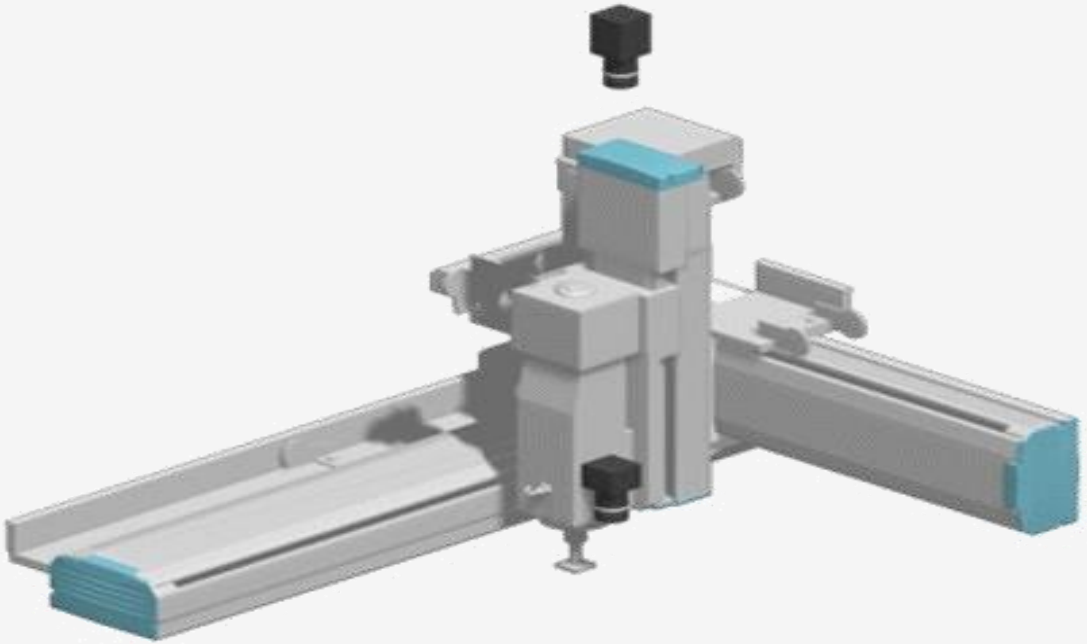
Work Space
or
Work Envelope

ROBOT WORKSPACE/ ENVELOPE



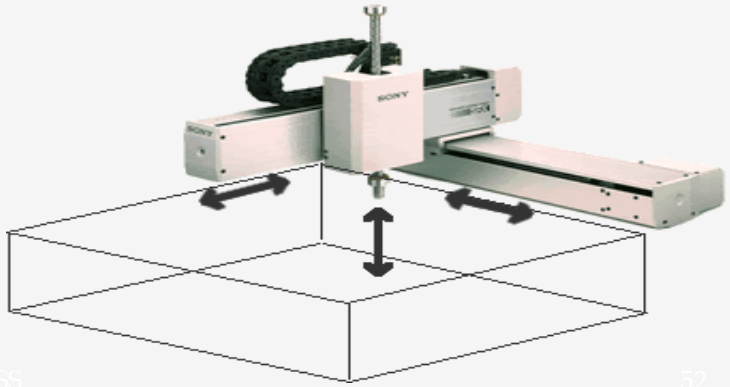
Source /Reference: www. google images.com & slideshare.com

ROBOT WORKSPACE/ ENVELOPE

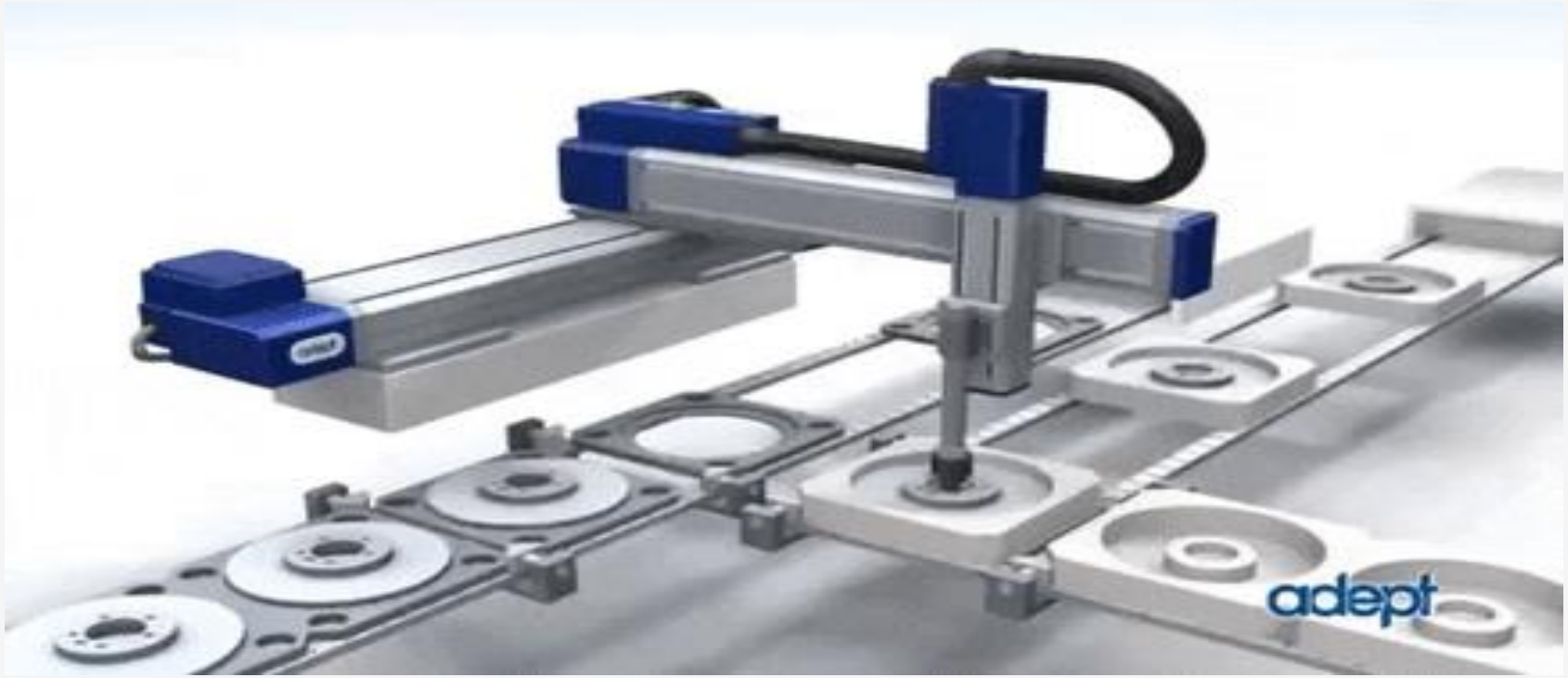


Cartesian Robot

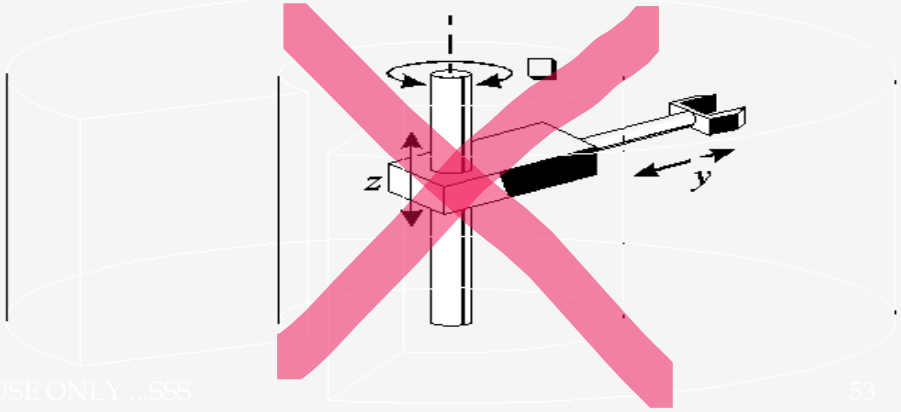
Cartesian System Robot



What is this co-ordinate system ?



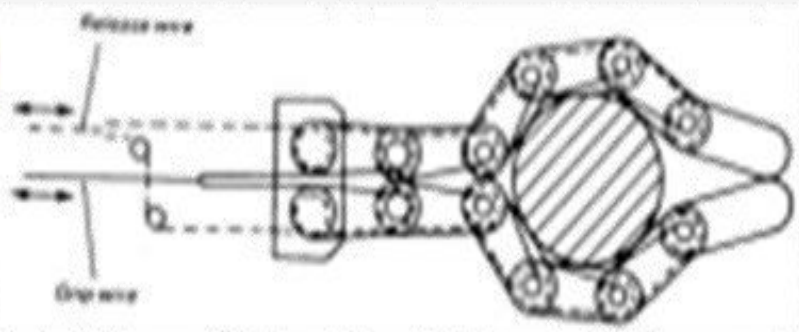
Cylinderical Robot



LECTURE- 4

END EFFECTOR_GRIPPERS

- ✓ End Effector is Gripper or end-of-arm tooling attached to the wrist of manipulator to accomplish the desired task
- ✓ Just like a human hand……
- ✓ End Effector is a Device attached to Robot's wrist to perform a specific task



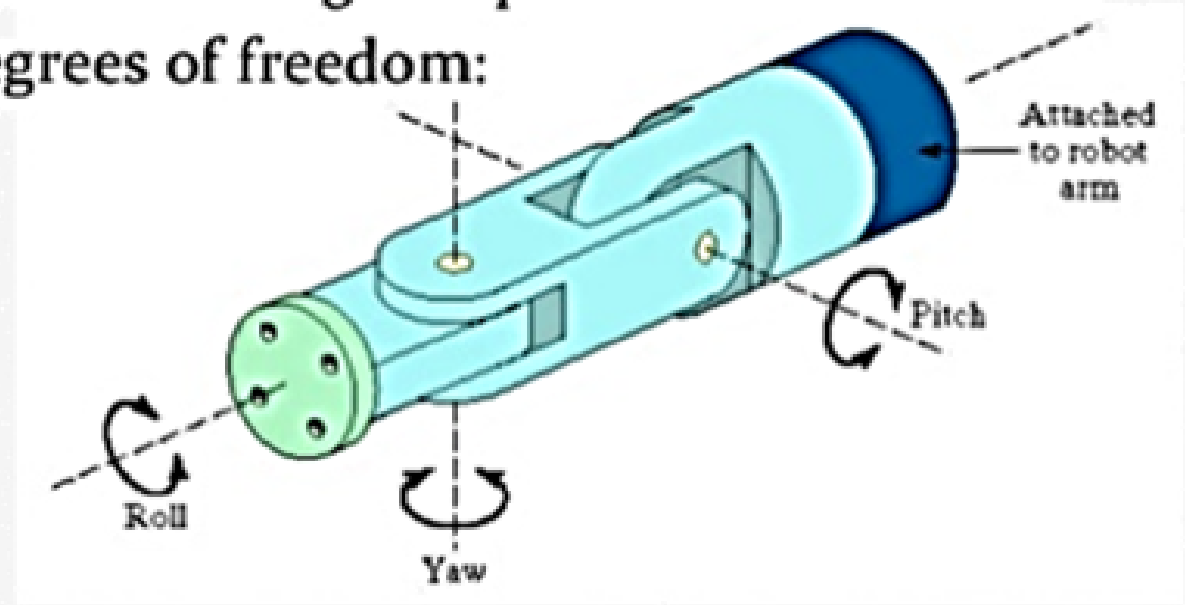
Grippers

- Mechanical Grippers
- Suction cups or vacuum cups
- Magnetized grippers
- Hooks
- Scoops (to carry fluids)

Source /Reference: www. google images.com

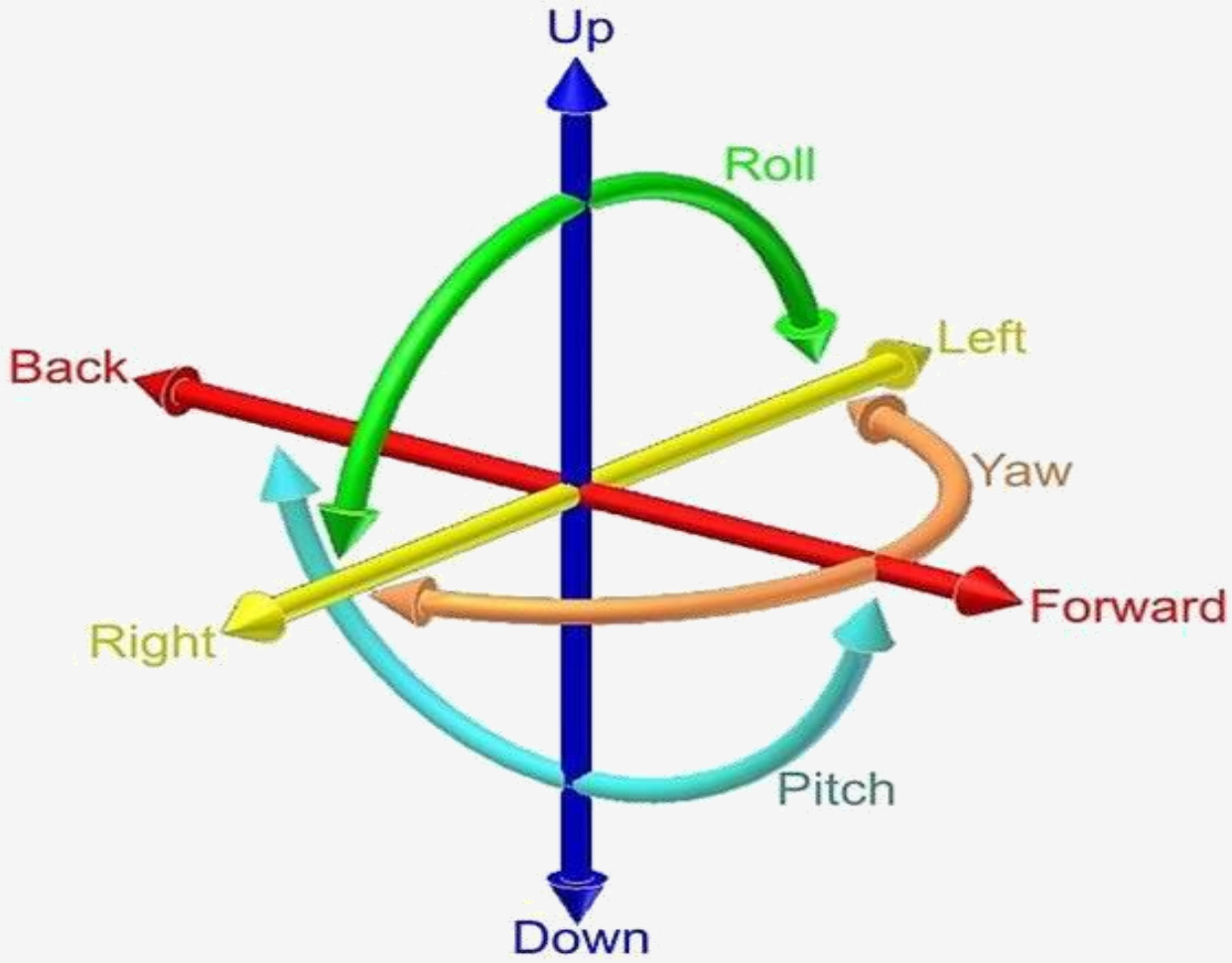
Wrist Configurations

- Wrist assembly is attached to end-of-arm
- End effector is attached to wrist assembly
- Function of wrist assembly is to orient end effector
  - Body-and-arm determines global position of end effector
- Two or three degrees of freedom:
  - Roll
  - Pitch
  - Yaw
- Notation :RRT



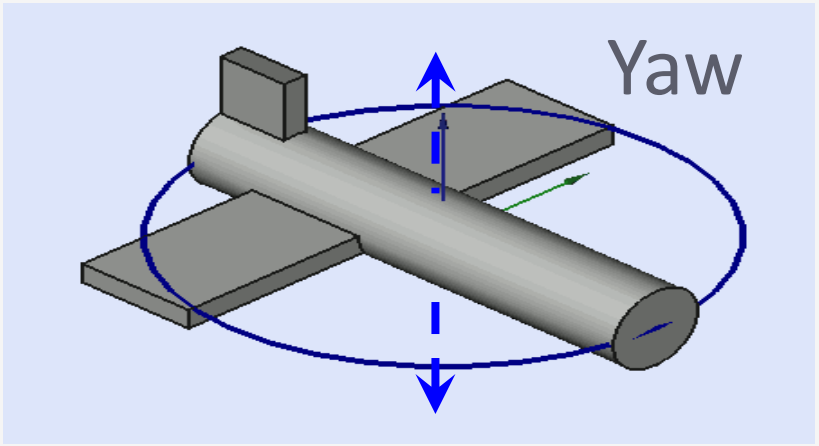
Source /Reference: www. slideshare.com

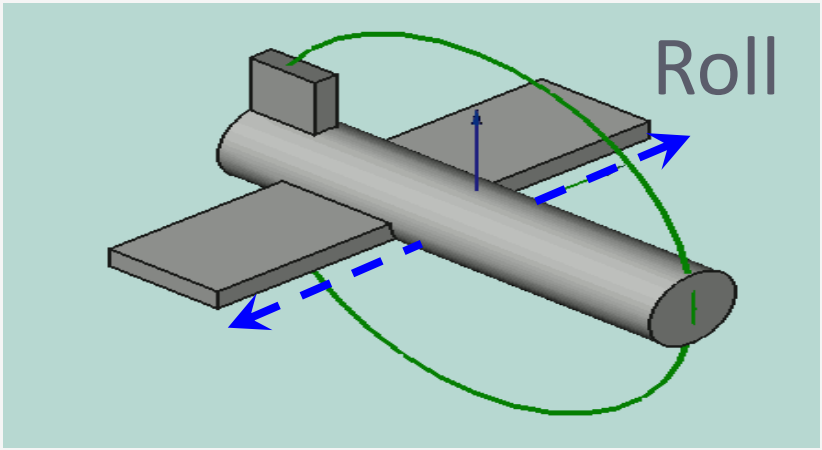
ROLL,PITCH,YAW

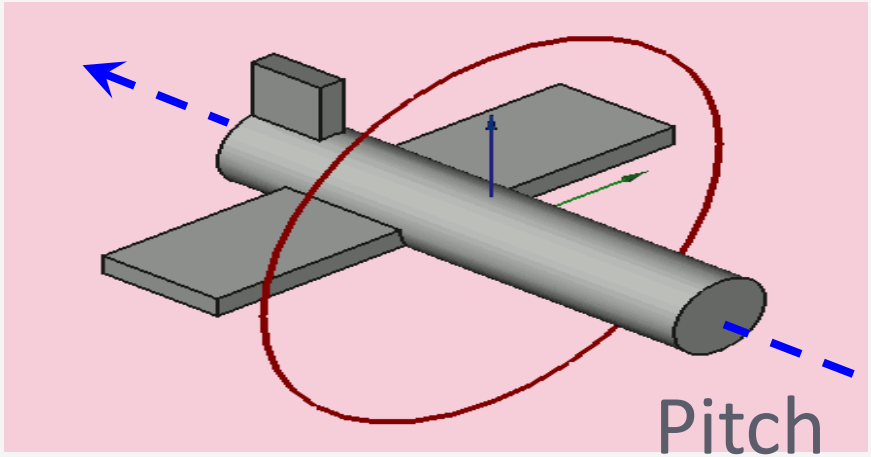


Source /Reference: www. slideshare.com

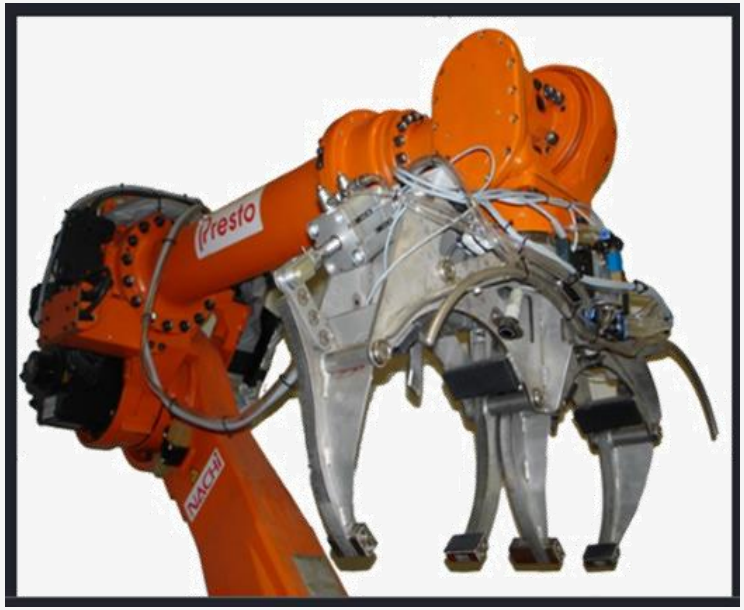
ROLL,YAW,PITCH

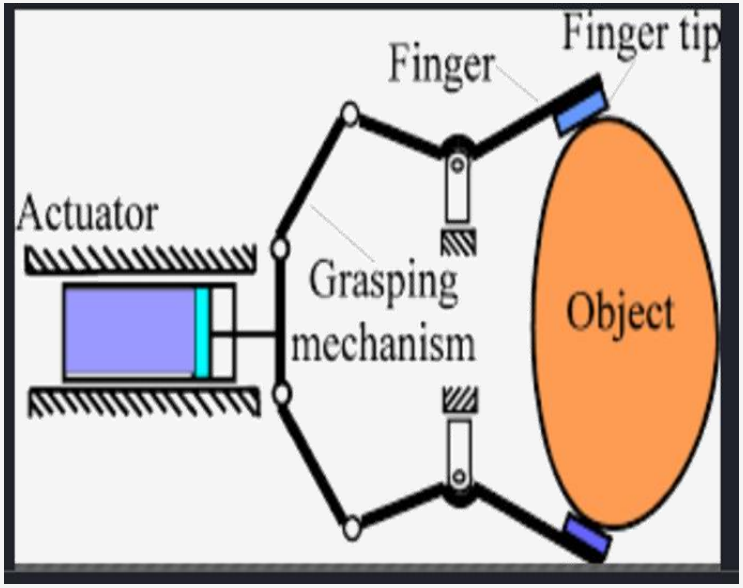






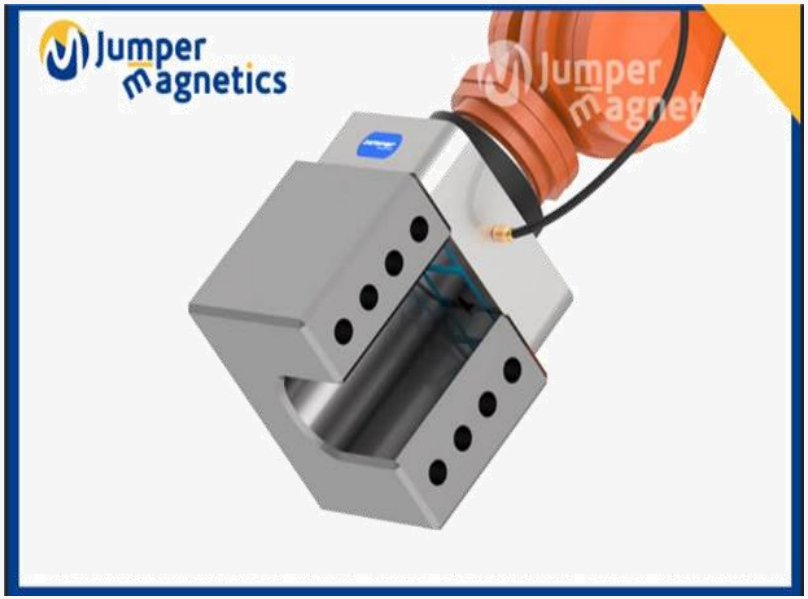
Mechanical Gripper





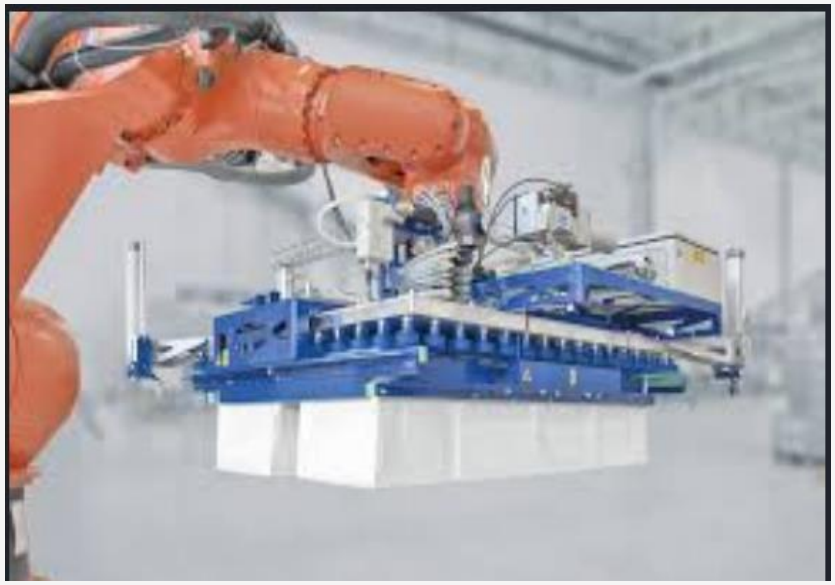
Source /Reference: www. google images.com

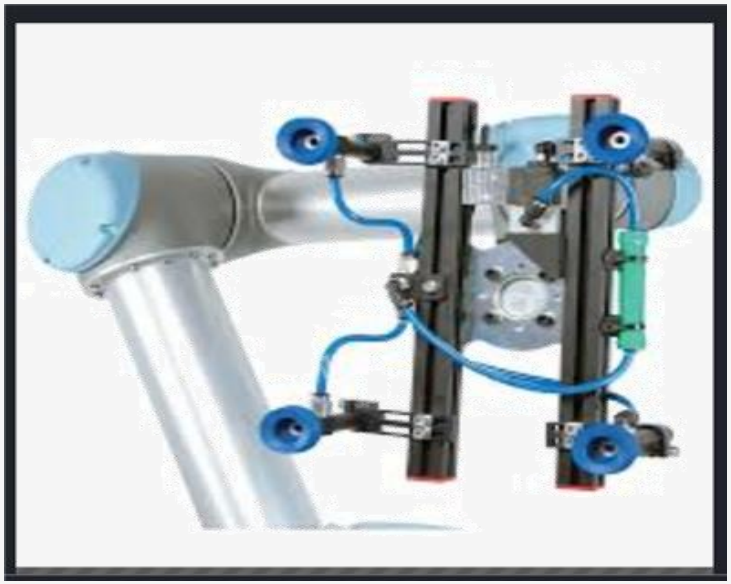
Magnetic Gripper



Source /Reference: www. google images.com

Vacuum Gripper

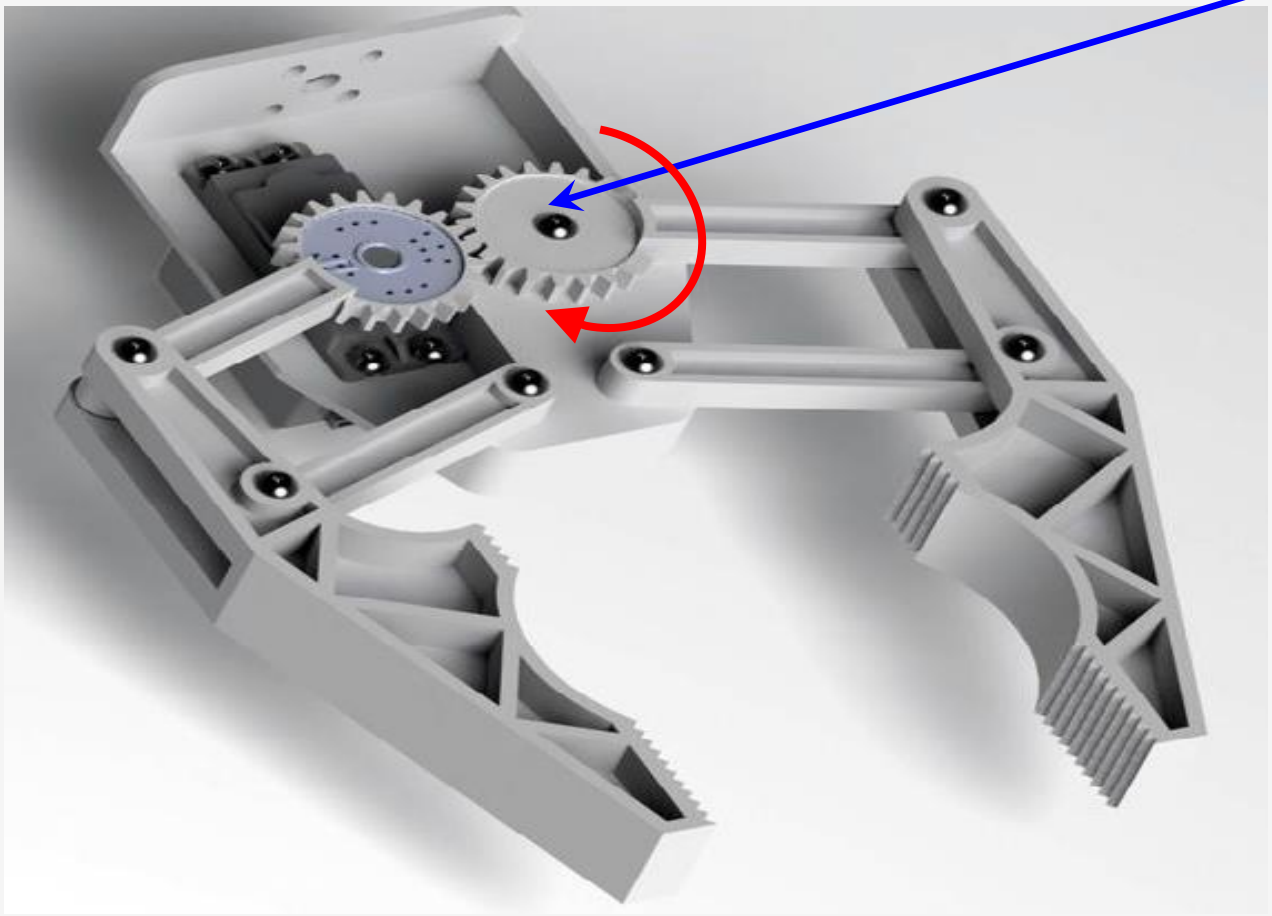




Source /Reference: www. google images.com

Mechanical Gripper

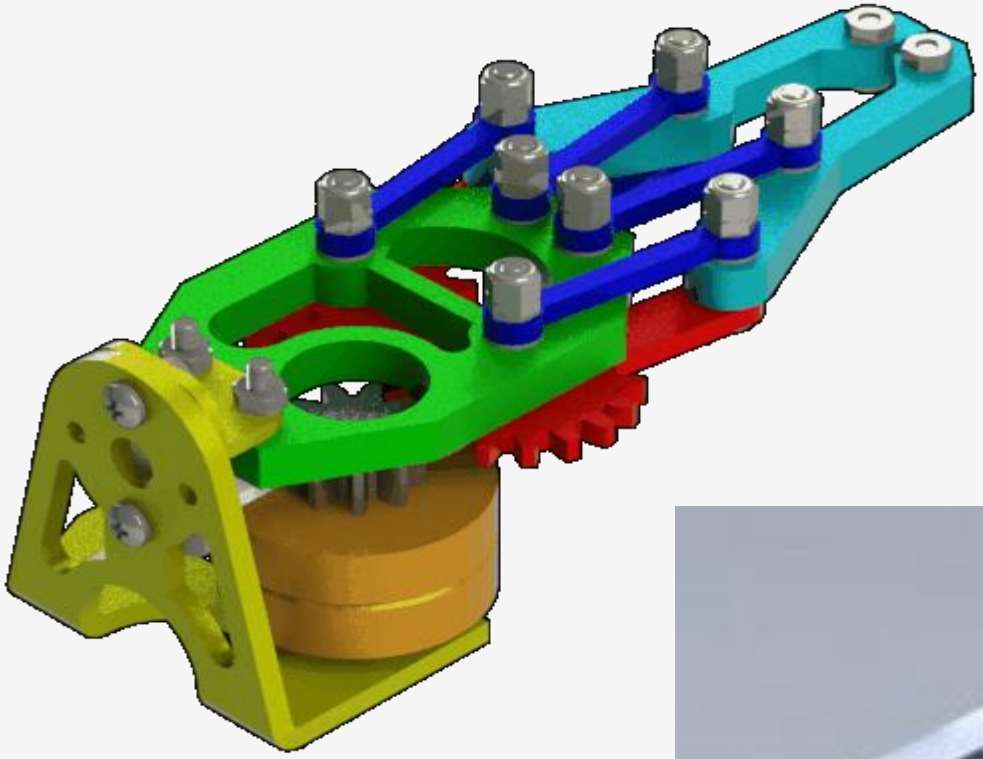
If the gripper has to close, what should be the direction of Rotation of this gear ?

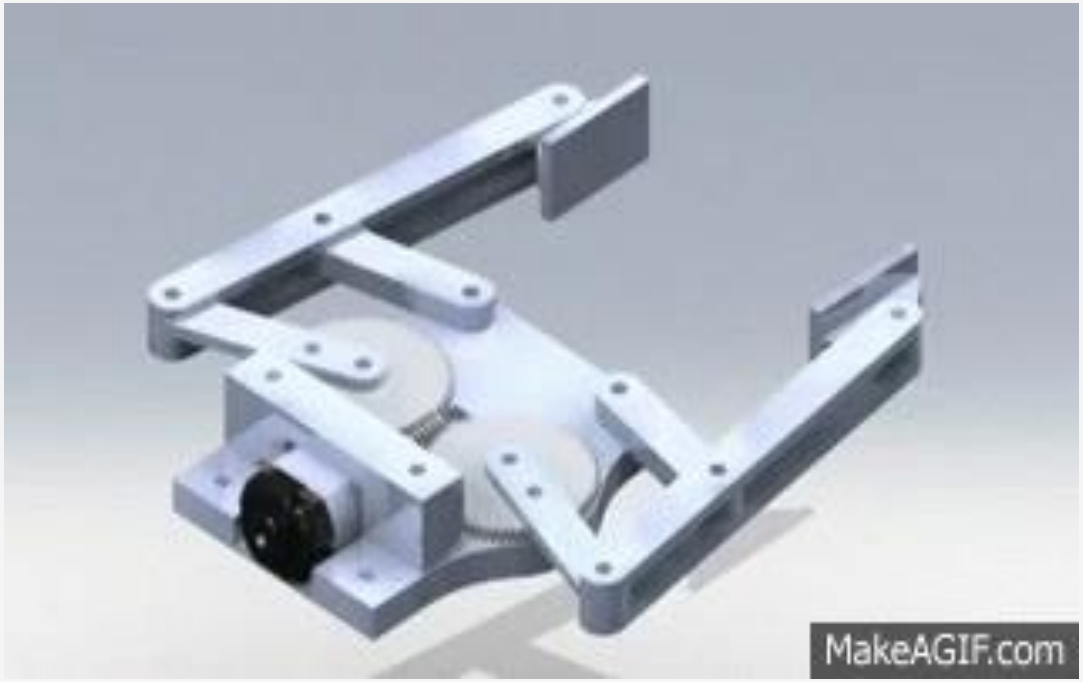


CW or CCW ?

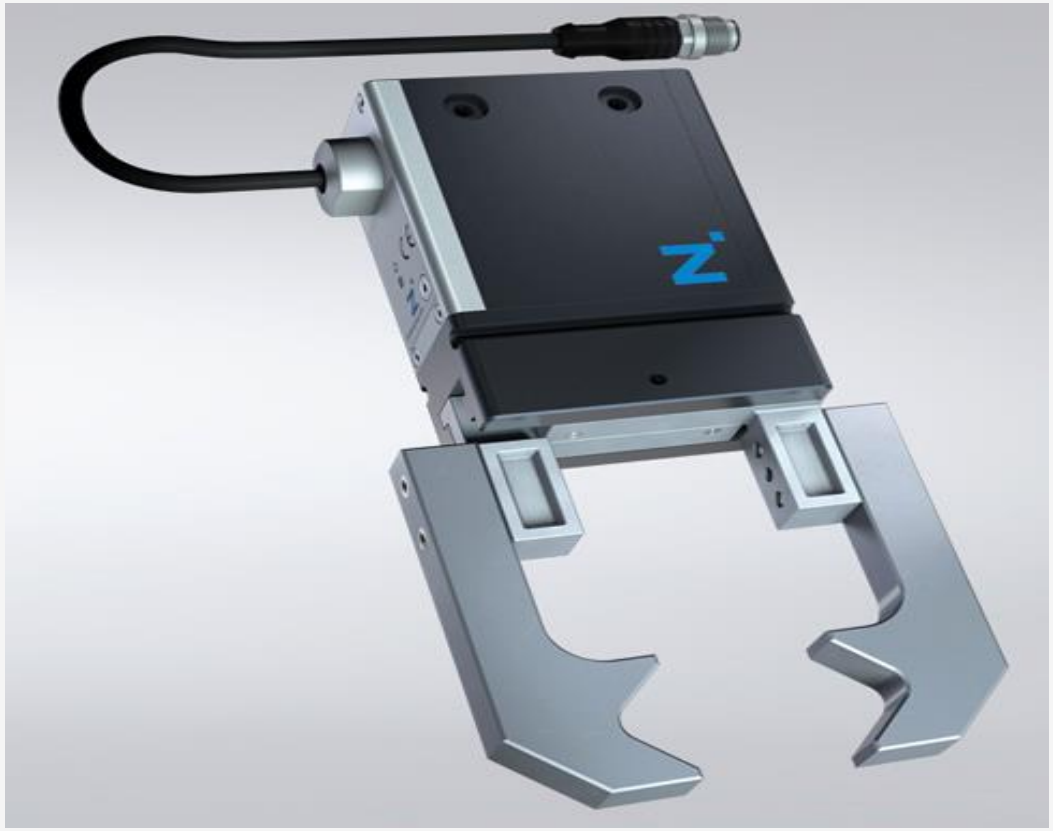
Clockwise !

Mechanical Gripper



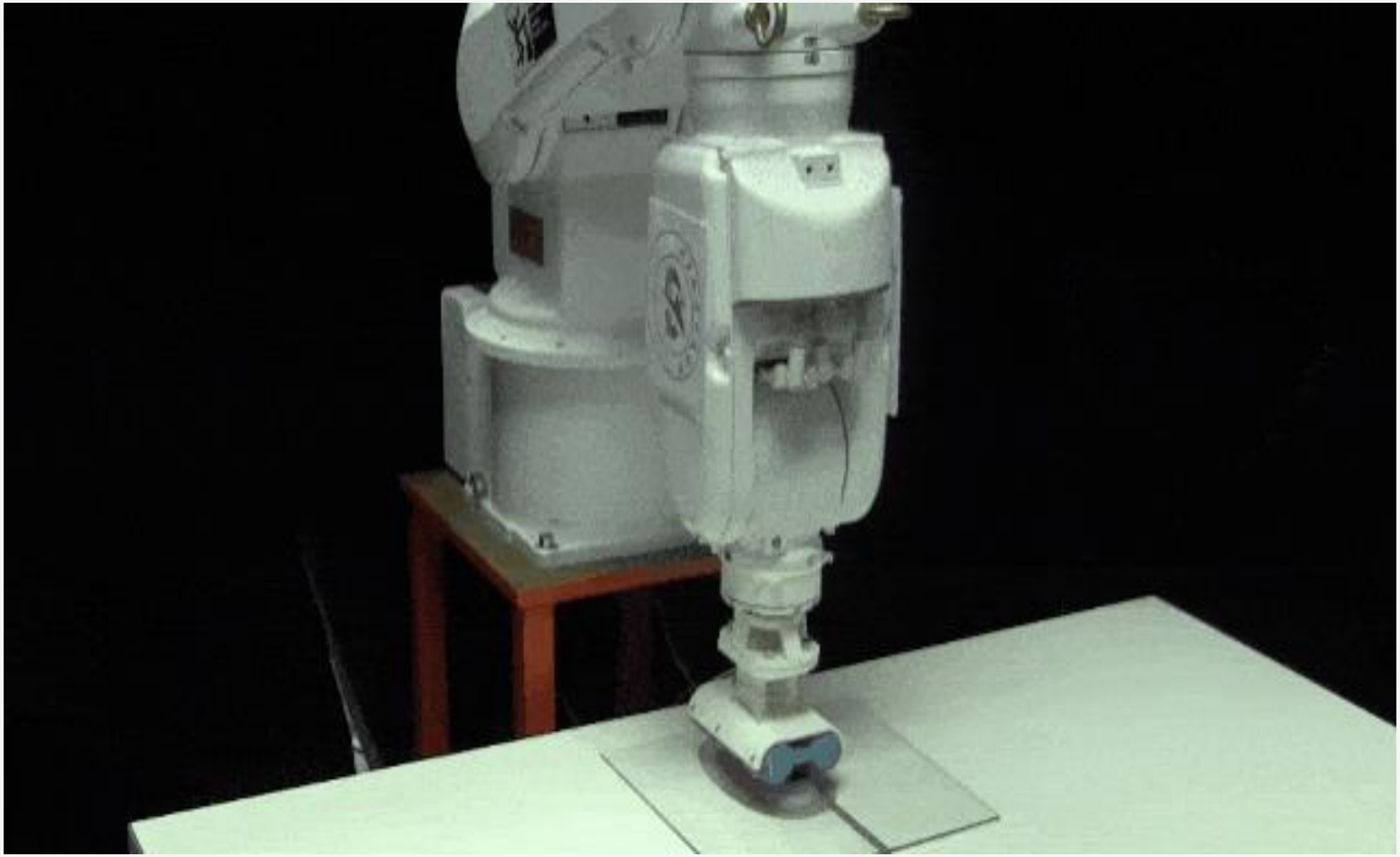


Electrical Gripper



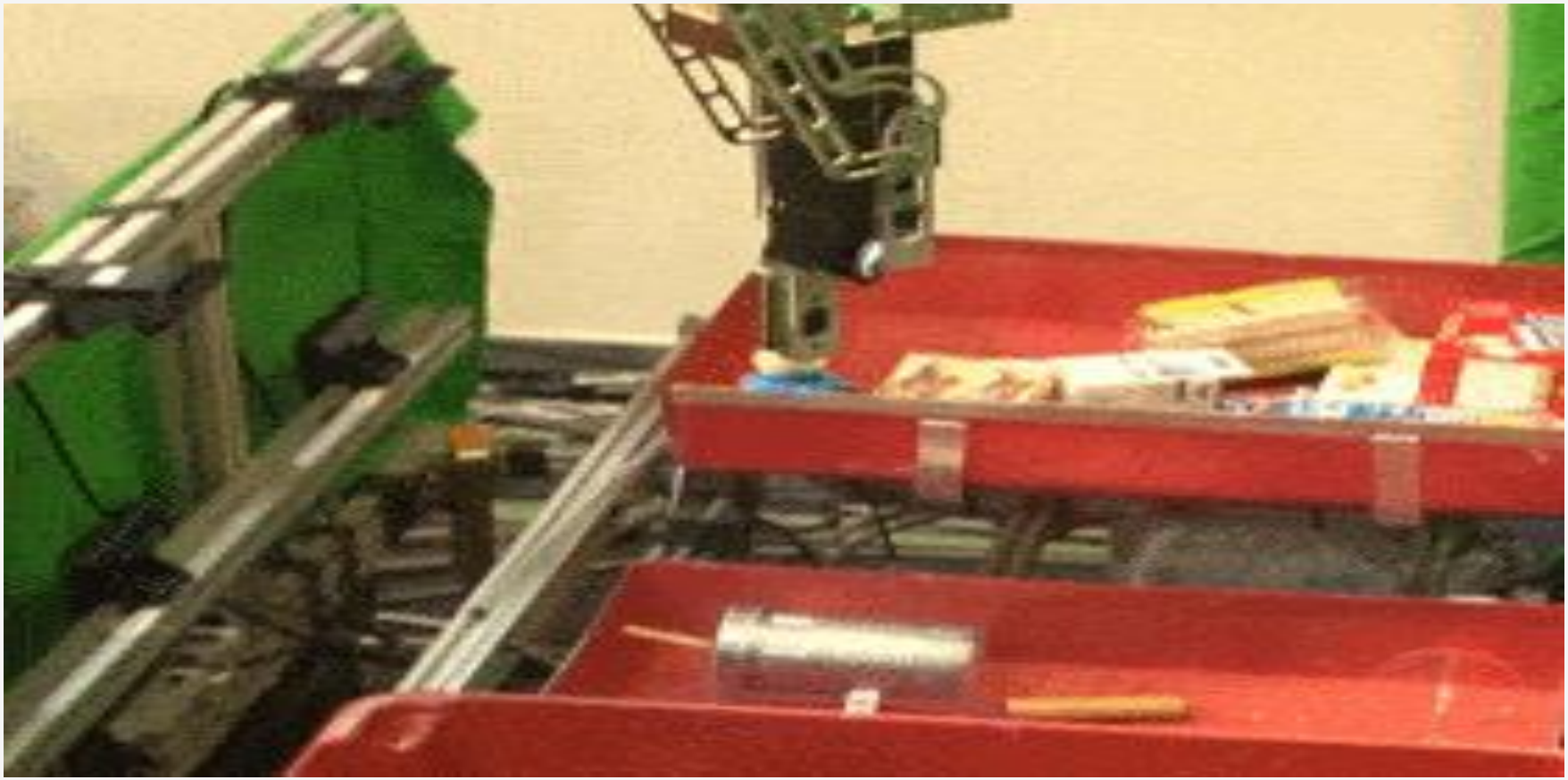
Vacuum or Suction Gripper

Vacuum or Suction Gripper



Orientation of the job changed by Gripper – Wrist action

Vacuum or Suction Gripper



Orientation of the job changed by Gripper – Wrist action

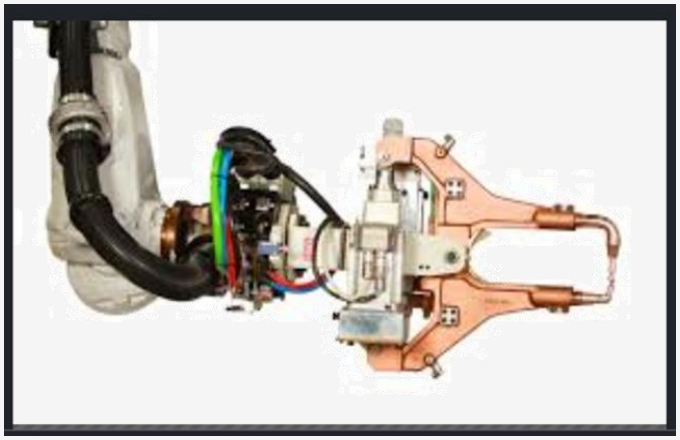
END EFFECTOR_TOOLS

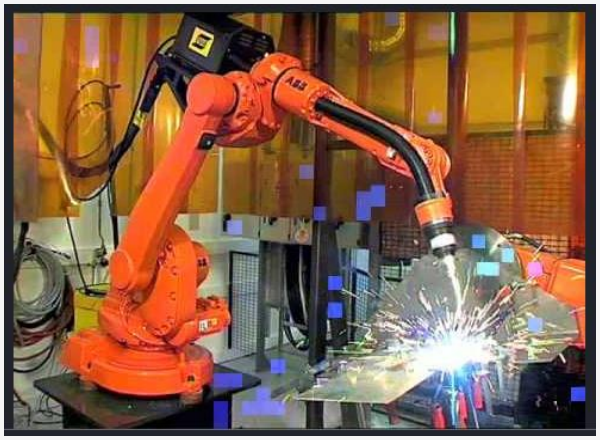
Tools

- Spot Welding gun
- Arc Welding tools
- Spray painting gun
- Drilling Spindle
- Grinders, Wire brushes
- Heating torches

Source /Reference: www.slideshare.com

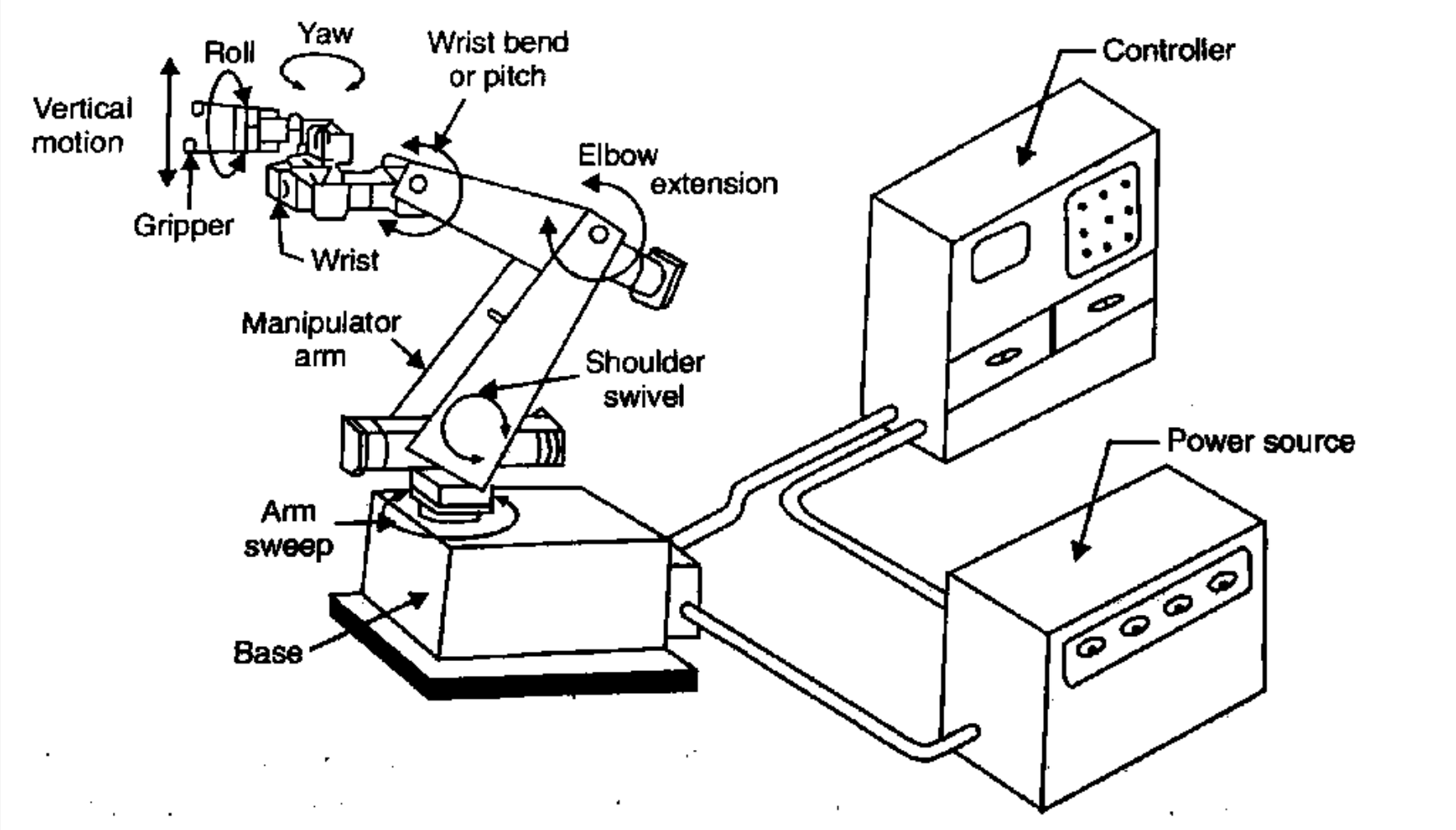
END EFFECTOR_TOOLS





Source /Reference: www. google images.com

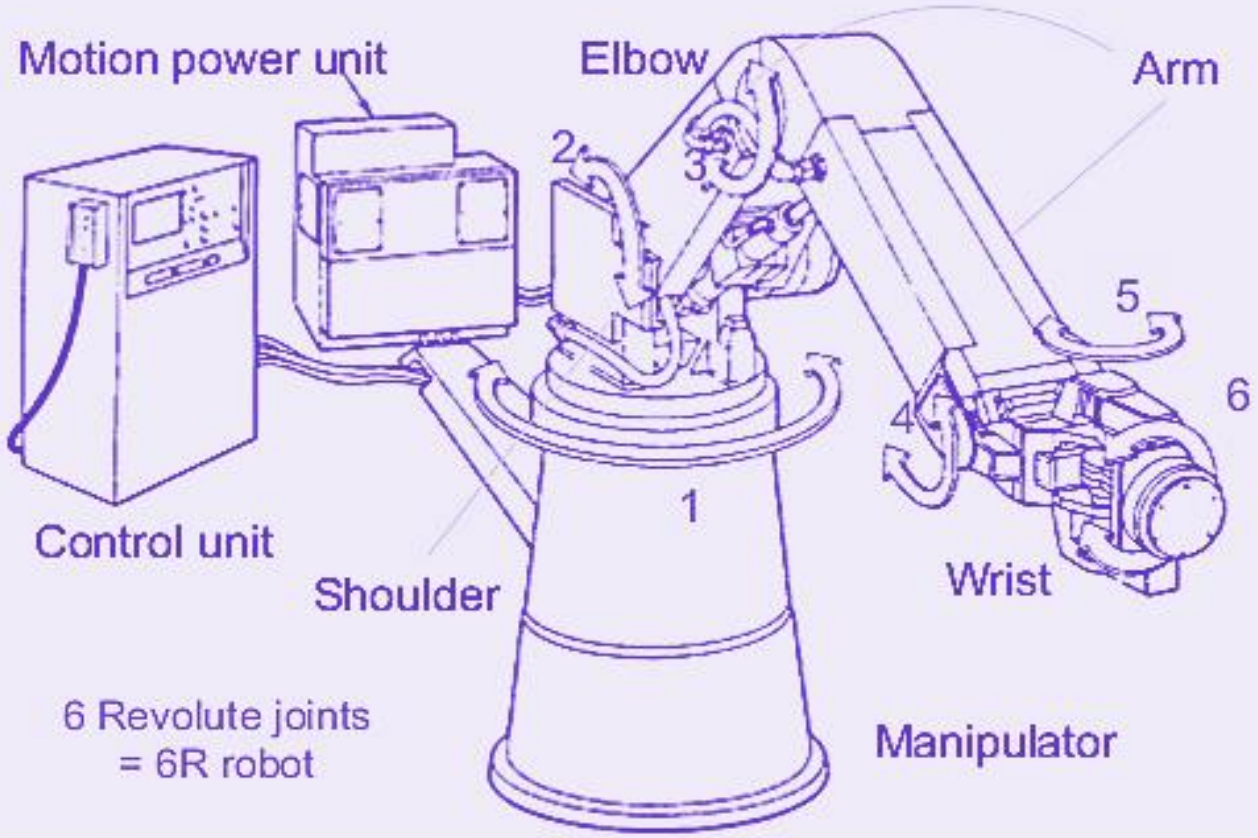
ROBOT COMPONENTS AND SYSTEM



LECTURE- 5

ROBOT COMPONENTS AND SYSTEM

Basic components of robot



Source /Reference: www.slideshare.com

What does a Robot comprised of ?

A robot is a group of several subsystems each with its own function:

Mechanical system By which the robot interacts with the surrounding environment.

It usually performs one particular task. It consists of actuators, joints, wrists, tools, etc. . .

Electrical system Consisting of sensors, electrical/pneumatic/hydraulic actuators, computers, etc. .

Control system This system receives high level orders and translates them into commands for actuators.

Sensor system It measures different physical magnitudes so that control system is able to perform the correct action.

Terminology of a Robot –

❖Actuators –

1) Electric motors (Most commonly used)

2) Pneumatic cylinders (Used in small robots)

Fast operation, low powers

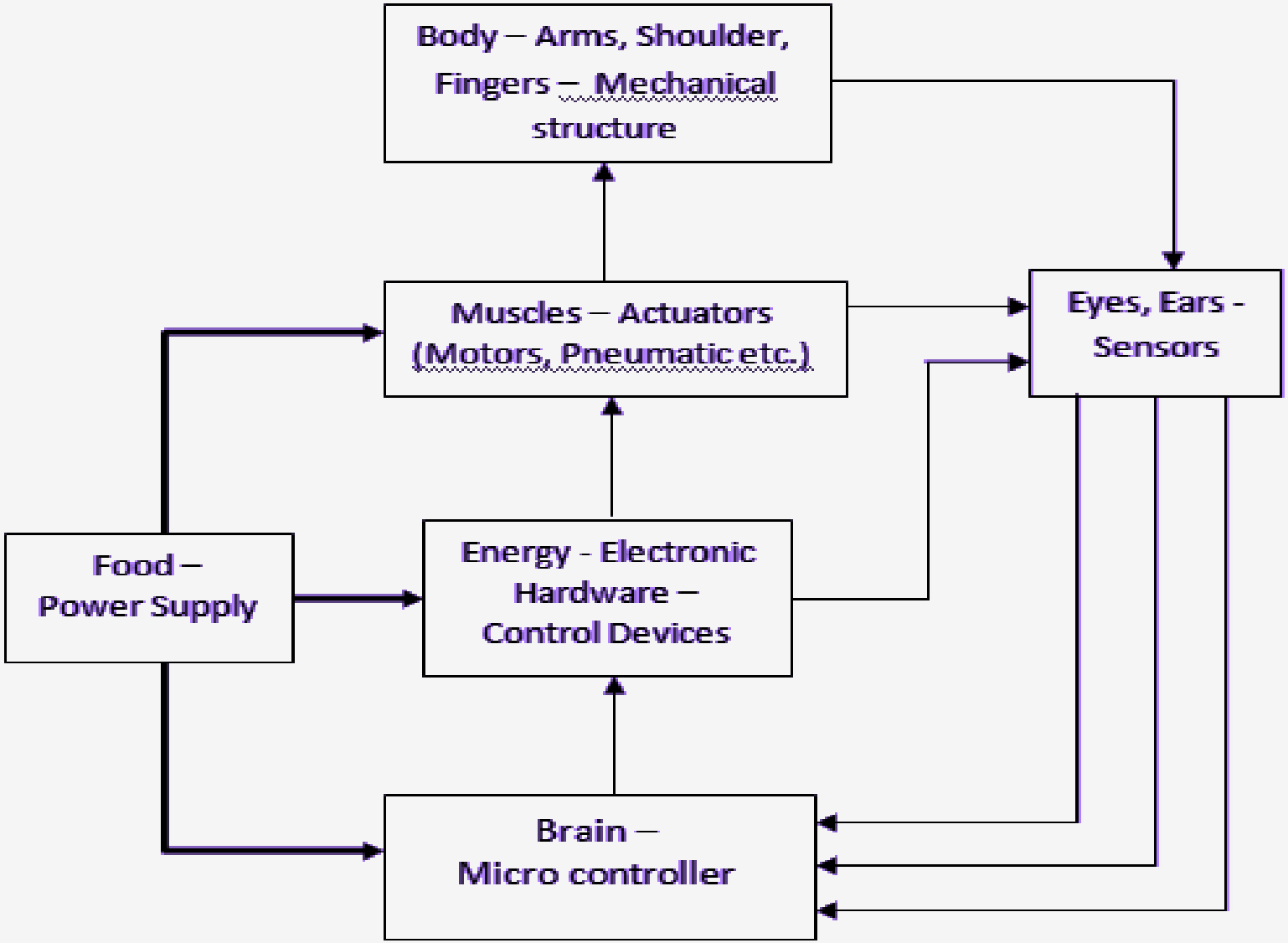
3) Hydraulic cylinders (Used in very large robots)

Slow operation, high powers

Terminology of a Robot

- **Sensors –**
  - Proximity sensor – to understand nearness.
  - Tactile sensor – to sense touch / pressure.
  - Current sensor –
  - Tilt sensor – Inclination.
  - Gyroscope – Orientation / Angular Velocity.
  - Encoders – Speed of Motor.
  - Hall effect sensor – Magnetic field.
  - Temperature sensor.
  - Acceleration sensor.
  - Image sensor, Camera etc.

Analogy of Human Body and Robots



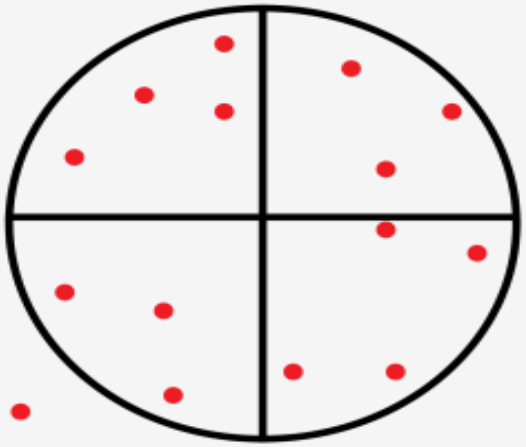
Terminology of a Robot

- ✓ Programming Interface –
  - ✓ Embedded C
  - ✓ Python
  - ✓ Many "Proprietary" languages are also used.
  - ✓ MATLAB – MathWorks
  - ✓ Robot C – LEGO
  - ✓ KRL – KUKA
  - ✓ KAREL – Fanuc

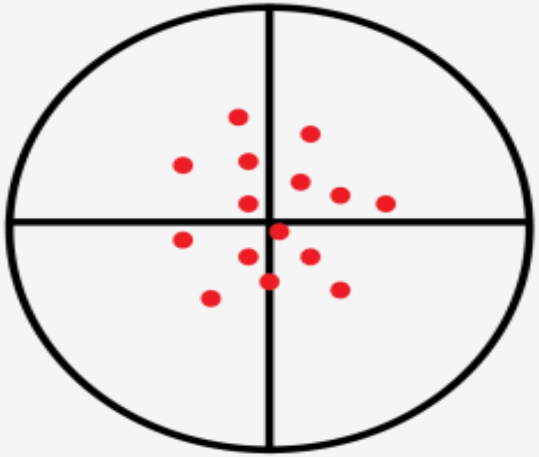
Terminology of a Robot

- **Accuracy** is a measure of how close the robot reaches to the programmed point in the workspace.
  - **Nearness to the target to be achieved.**
  - Thus Accuracy is a property of one single event.
- **Precision** is measure of how close the robot reaches to the point previously reached.
  - **It is nearness of different targets achieved w.r.t. each other.**
  - Thus Precision is a property of a set of events.
- **Repeatability** is the ability to perform the same task again and again with same accuracy and same precision.
  - Thus Repeatability is a property of a set of events.

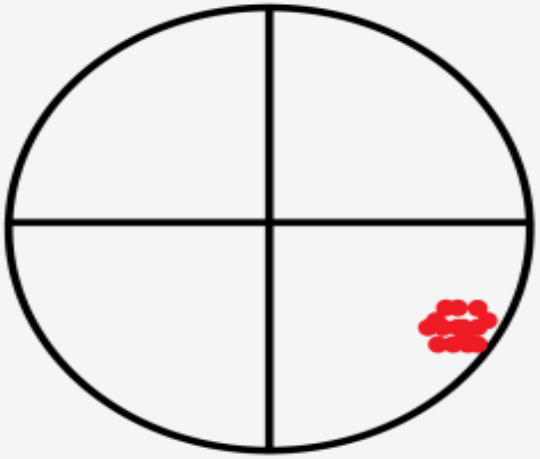
Accuracy and Precision -



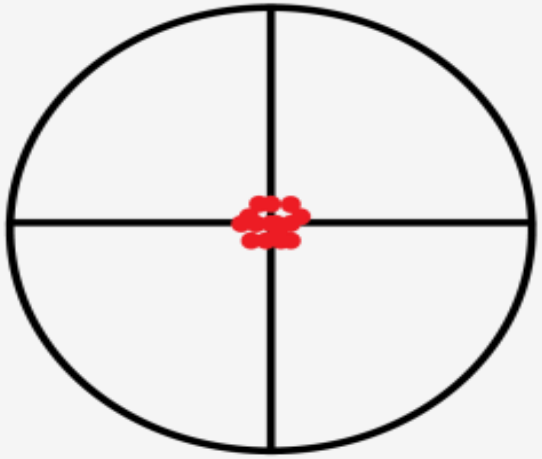
Very Low Accuracy and
Very Low Precision



Good Accuracy and Low Precision



Low Accuracy and High Precision



High Accuracy and High Precision

❖ **Resolution** - It is the smallest movement/measurement or any other output that a Robot is capable of making.

❖ **Ability to showcase more details.**

Assume that following are the readings of distance measured between two points using some sensor in mm.

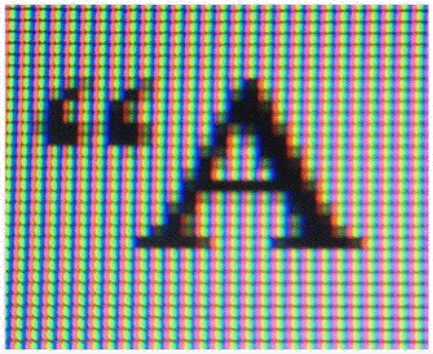
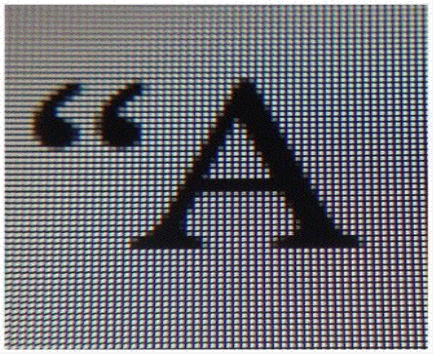
1) D = 6.4 2) D = 6.41 3) D = 6.399 4) D = 6.40

Which of the above 4 readings has a better resolution ?

Which of the above 4 readings has better accuracy ?

What is the difference between readings 1) and 4) ?



- Resolution -

Resolution	Measurements (In pixels)	Pixel count
4K (UHD)	3,840 x 2,160	8,294,400
1080p (Full HD)	1,920 x 1,080	2,073,600
720p (HD Ready)	1,280 x 720	921,600
480p (SD)	640 x 480	307,000

Pixel = Picture Element

DEGREES OF FREEDOM

Connectivity / Degrees of Freedom of a Joint

It indicates the number of rigid (bodies) that can be connected to a fixed rigid body through the said joint

DOF of a mechanical system is the number of independent parameters that define its configuration (Translational, Rotational). The number of DOF is equal to the total number of independent displacements or aspects of motion.

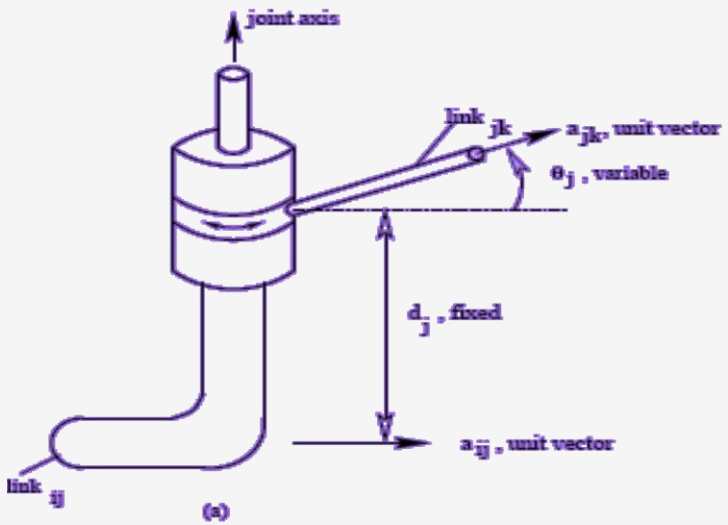
Degrees of Freedom of a System

It is defined as the minimum number of independent parameters / variables / coordinates needed to describe a system completely

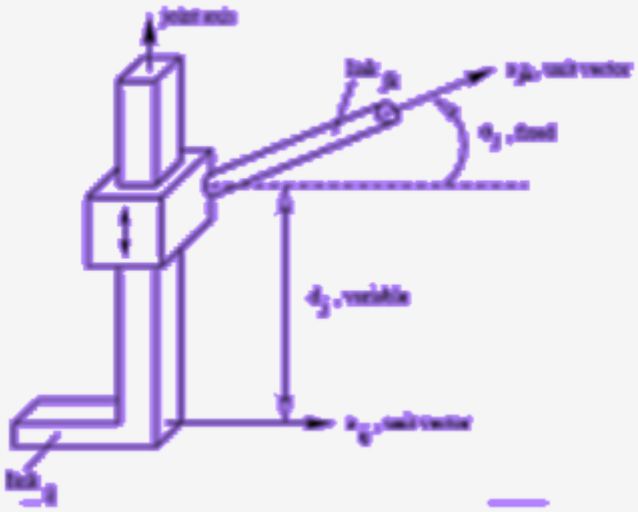
The number of independent movements that an object can perform in a 3-D space is called the number of *degrees of freedom* (DOF). Thus, a rigid body free in space has six degrees of freedom—three for position and three for orientation.

DEGREES OF FREEDOM

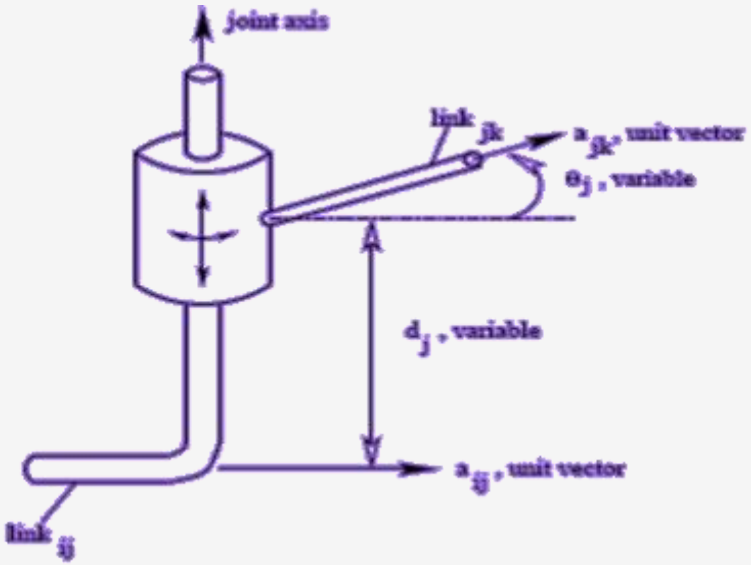
Joints with One dof Revolute Joint (R)



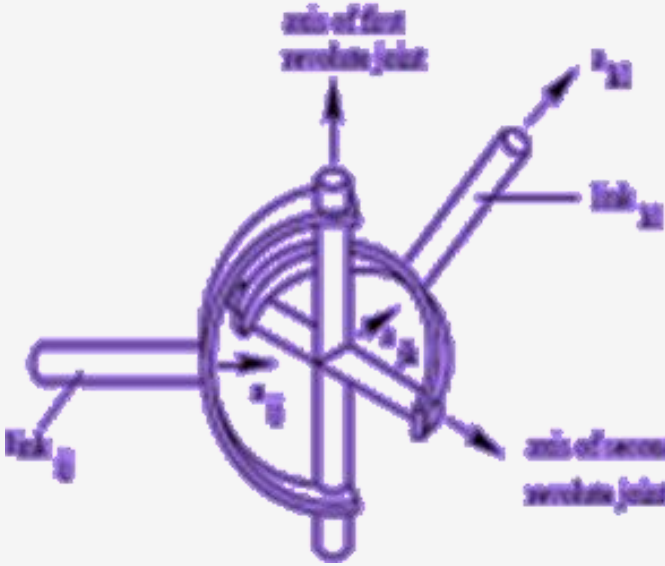
Joints with One dof Prismatic Joint (P)



Joints with Two dof Cylindrical Joint (C)

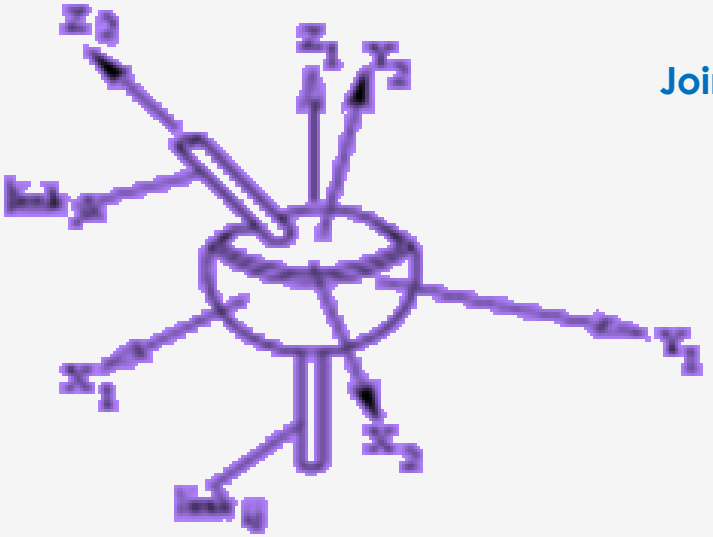


Joints with Two dof Hook Joint /Universal Joint (H)

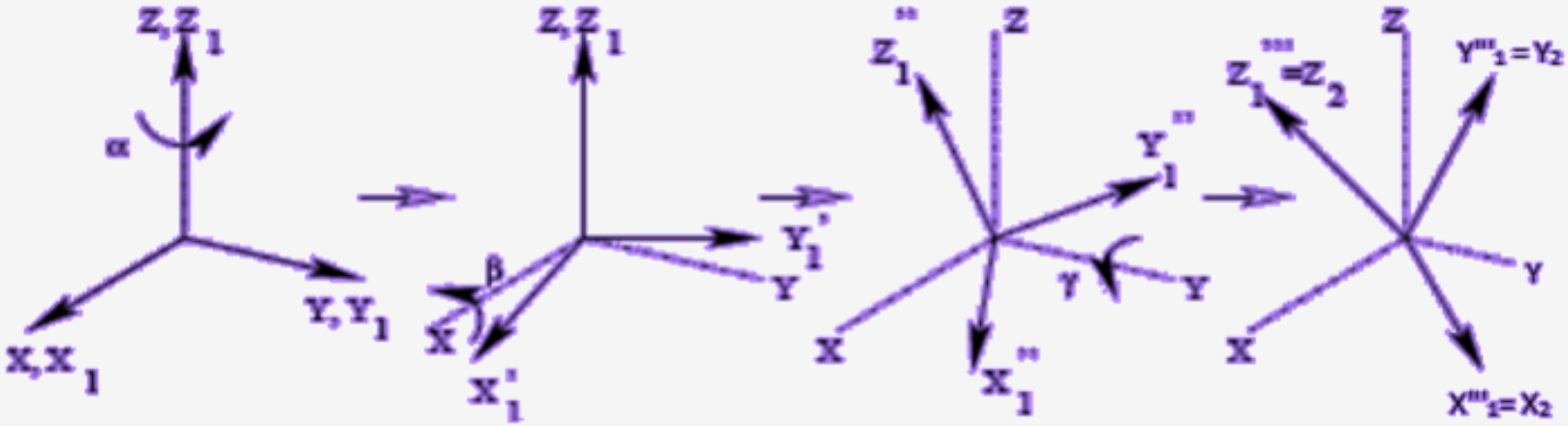


Source :-www. nptel.ac.in / ppt by Prof. D.K. Pratihar,IITKh

DEGREES OF FREEDOM



Joints with Three dof **Ball and Socket Joint /Spherical Joint (S)**



Source :-www. nptel.ac.in / ppt by Prof. D.K. Pratihar,IITKh

Terminology of a Robot

- ✓ Workspace - The set of locations that can be reached by the robot.
- ✓ Forward Kinematics - Given joint parameters, determine the final end effecter location.
- ✓ Inverse Kinematics - Given desired end effecter position and orientation determine the joint parameters.
- ✓ Inverse Kinematics - Given desired end effecter position and orientation determine the joint parameters.
- ✓ Trajectory - A path through the space at the specified velocities

A BRIEF HISTORY OF ROBOTICS

Year	Events and Development
1954	First patent on manipulator by George Devol, the Father of robot
1956	Joseph Engelberger started the first robotics company: Unimation
1962	General Motors used the manipulator: Unimate in die-casting application

Source :-www. nptel.ac.in / ppt by Prof. D.K. Pratihar,IITKh

A BRIEF HISTORY OF ROBOTICS

Year	Events and Development
1967	General Electric Corporation made a 4-legged vehicle
1969	❖ SAM was built by the NASA, USA ❖ Shakey, an intelligent mobile robot, was built by Stanford Research Institute (SRI)
1970	❖ Victor Scheinman demonstrated a manipulator known as Stanford Arm ❖ Lunokhod I was built and sent to the moon by USSR ❖ ODEX 1 was built by Odetics

Source :-www. nptel.ac.in / ppt by Prof. D.K. Pratihar,IITKh

A BRIEF HISTORY OF ROBOTICS

Year	Events and Development
1973	Richard Hohn of Cincinnati Milacron Corporation manufactured T^3 (The Tomorrow Tool) robot
1975	Raibart at CMU, USA, built a one-legged hopping machine, the first dynamically stable machine
1978	Unimation developed PUMA (Programmable Universal Machine for Assembly)

A BRIEF HISTORY OF ROBOTICS

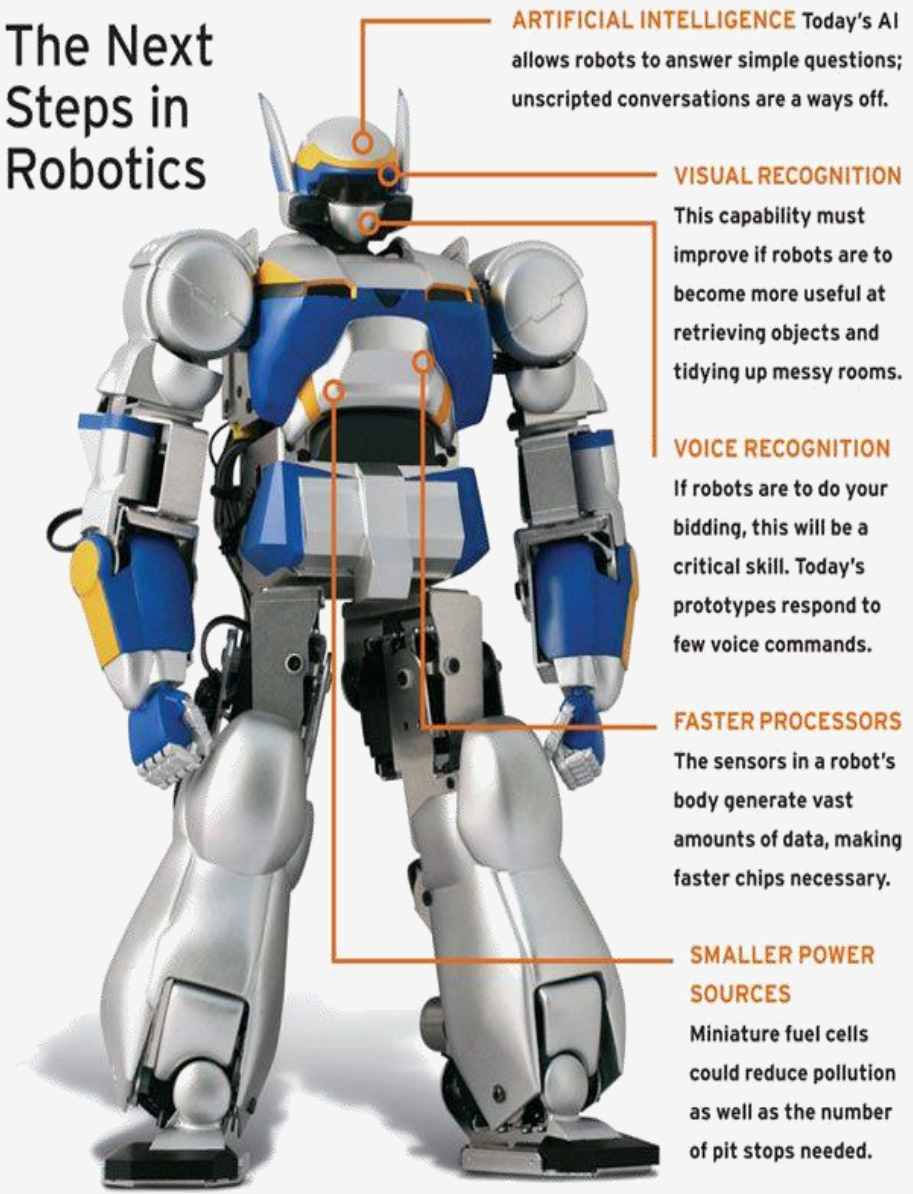
Year	Events and Development
1983	Odetics introduced a unique experimental six-legged device
1986	ASV (Adaptive Suspension Vehicle) was developed at Ohio State University, USA
1997	Pathfinder and Sojourner was sent to the Mars by the NASA, USA

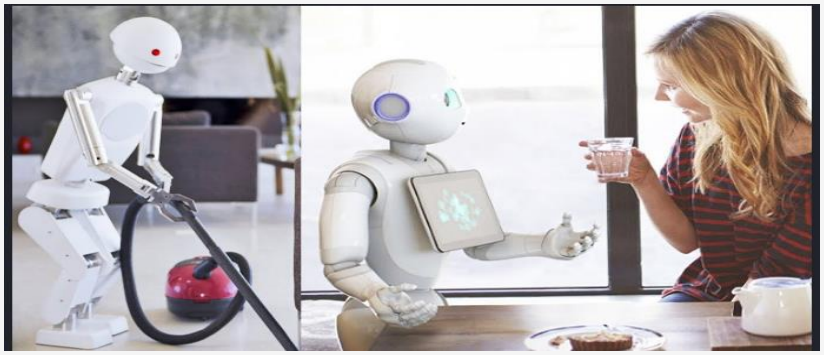
A BRIEF HISTORY OF ROBOTICS

Year	Events and Development
2000	Asimo humanoid robot was developed by Honda
2004	The surface of the Mars was explored by Spirit and Opportunity
2012	Curiosity was sent to the Mars by the NASA, USA
2015	Sophia (humanoid) was built by Hanson Robotics, Hong Kong

Source :-www. nptel.ac.in / ppt by Prof. D.K. Pratihar,IITKh

FUTURE ROBOTICS:- SOCIAL,DOMESTIC,HUMANOID





SOPHIA

ROBOT EVOLUTION

Source /Reference: www. google images.com

Thanks !