UNIT - III

1) what is a robot.
2) Classifications of Robots.
3) Basic component of Robots.
4) Functions of robots.
5) Application of robots.

↳ Mechanical system: Review of Elementary mechanical system concepts, motion conversion & modelling of mechanical system, End efforts, Resolution, Repeatability.

what is Robots/ Robotics:

Robots is a general purpose, programmable machine. It possesses some characteristics i.e human like characteristic that resembles the human physical structure.

A Robot is a machine designed to execute one or more tasks automatically with speed & precision. Robots that resemble humans are known as androids: however, many robots are not built on the human model. The general commercial & technological advantage of robots are listed below:

- Robots are good substitute to human beings in hazardous or uncomfortable work environments.
- A Robot perform its work cycle with a consistency & repeatability.
- Robot can be reprogrammed.
- Robot can be connected to the computer system & other robotic system.

Classification of Robotes:

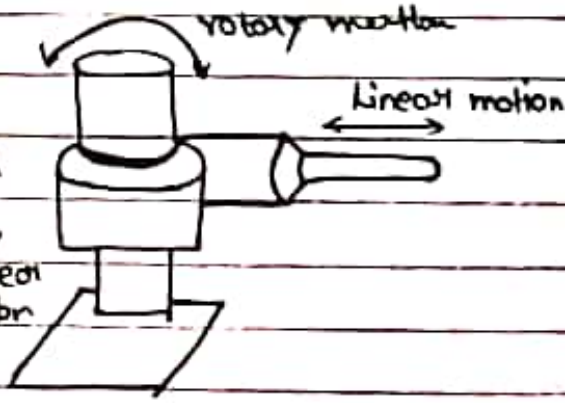
There are 6 types of Robotes according to industrial purposes: which are:-

- ↳ Articulated
- ↳ Cartesian
- ↳ Cylindrical
- ↳ Polar
- ↳ SCARA
- ↳ Delta

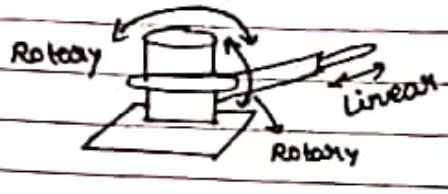
(i) **Articulated :** A robot whose arm has at least 3 rotatory joints.
An articulated robots is a robot with rotary joints. Articulated robots can range from simple two jointed structure to system having 10 or more interacting joints. They are powered by a verity of means, including Electric motors.
These joints of Articulated robot is called axis & provides an additional degree of freedom, or range of motion. Industrial robots commonly have 4 or 6 axis.

(ii) **Cartesian :- (Rectilinear):** These are also called rectilinear or gantry system. Cartesian robots have 3 linear joints, that uses the cartition co-ordinates system (x, y & z). They also may have attached wrist to allow the movements. They are 3 are at right angle to each other. The three sliding joints corresponds to moving the wrist of robot in up ; down ; in-out ; & back-front ; motions.

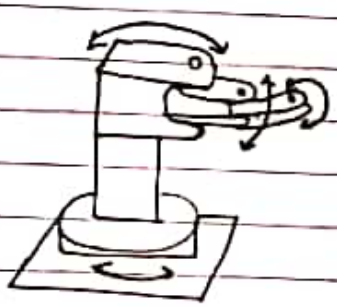
(iii) **Cylindrical :** This robot have at least 1 rotary joint at the base and at least 2 linear joints to connect the link. The rotary joint uses a rotational motion along the joint axes, while the linear joints moves in a linear motion.
Cylindrical robot can work in a cylindrical shap envelops. It is well suited for round shap work space. But it not rotates in a complete cycle.



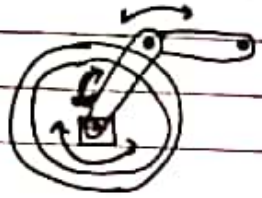
4.) Polar (Spherical) :- Polar robots that sometimes also called as spherical robot are positioned in polar co-ordinate system. They have 1- Linear & 2- Rotary motion. Thus instead of using 2 cylindrical robot, 1 Polar robot can be used.



5.) SCARA : The term SCARA, is stands for Selective compliant Assembly Robot Arm. The SCARA robot is based on 4- axis designe. It is ideal for high speed assembly, kitting, packaging and other material handelling applications. SCARA is a world's first direct drive robot.



(6.) Delta : This spider like Robots are built from jointed parallelograms connected to a common base i.e work on only 3 Rotary motions. Heavily used in the Food, Pharmaceutical & Electronic industries.



Function of Robot: Currently the role of robots is to take over the hard and dangerous jobs. The main function of robotes in out day to day life is to reduce human labor. when we are talking about the functions of any basic robotics, the cost value doesn't matter over there. The Tasks that can not be performed by human easly, can be done by robotics. The field of robott functions having great leaps in robot abilities. The main functions of a common robot may based on their component used.
Thus on the basis of Anatomy of Robot, functions are:-

Body structure: Most robat consis of a metal-based physical body structure that provides form as well as protection to the industrial machanisms. The body shape or structure is based upon the ~~body shape~~ robat intended use or function. The most often used metals for robotft body structure are steel copper & brash.

Function of muscels system of Robot: The muscels system of robat can be made up of a number of different mechanisms. The most popular muscel machanizm are used in cars manufacting & structure modeling. Muscels of Robots are also use in many Electrical instrument or hardware design.

Function based on Sensory system of robat: A robat's sonssory system can be very simple or may also be very complex, depending on the use or functions of the robot. Simple sensory systems are use in devices such as simple motion detect-ors.

while complex sensory systems are used in optical cameras that Enable the robot to not only see the Environment around it, but interact with the environment based on it's surroundings.

Function based on Power source Robot : The Power source used in most robots comes from Electric power supply. The two most common form of electric power supplies for robots are grounded electrical power outlets for stationary robots or internal battery units for mobile robots.

The Brain system Based function : The "Brain" system of robots are closely related to, & work hand in hand with the sensory system. "Brain" systems of robots can also be either very simple or very complex, depending on the function of robot. A simple "Brain" system would sends a signal to the robots muscle system telling it to stop if a sensory system detected was activated. A complex "Brain" System would allow a robot to identify objects within the Environment around it, based on the Information gather by the sensory systems. The "brain system" would then sends signals to the muscle systems based on that Information, Enabling the robot to interact with the object surrounding it.

Some other functions of specific robots in day to day life are:

↳ Pool-playing Robot Shoots Billiards
Humanoid robots swims
Flying robot Assemble Buildings
Robot pooper scooper cleans the Yard
Robot Butler cooks with microwave
Robotic chaplain comforts the Dying.

Application of Robotics in day to day life:

Robots are used for jobs that are dirty, dull & dangerous. Today robotics have many different application areas. Some of those are:

(i) **Collaborative Robots:** These collaborative Robots are built to work together with other Robots, on enormous assembly lines. Robots must collaborate between handling & welding robots to make such assembly lines function properly.

(ii) **Medical Robots Application:** Robots employed in medical & medicine institutes. First & foremost surgical treatment robots. Also, a number of robotics directed automobiles are use as lifting supporters.

(iii) **Domestic & house hold applications of Robots:** Robots which are used at home. This type of Robots consist of numerous different External parts for Ex-: Robotic pool cleaners, Robotic sweepers, Robotic vaccume cleaners, Robotics sewer cleaners & other robots that can perform different household tasks.

(iv) **Industrial Application of Robot:** These robots pay in Industrial manufacturing atmosphere. Particulary these are created for applications like- material handelling, painting, welding & others. This sort of robots also consist of some automatically guided automobiles & other robots.

(iv.) Military purpose robot: Robots brought into play in military & armed forces. This sort of robots consist of bomb discarding robots, various shipping robots, Exploration drones. Often robots are produced for military and armed forces purposes.

(v.) Entertainment robots: These type of robots are Employed for entertainment. This is an Extremely wide-ranging category. It begins with model robot such as robosapien or the running photo-frames & concludes with real heavy weight like articulated robot arms Employed as movement simulators.

(vii) Space robots: This type of robots would consist of the robots play use in space Shuttles, the International Space Station, together with mars Explorers & other robots or activities.

(viii) Agricultural Robotics: The robots also used in Agrical-tural & transfor applications. Its objective is to increase the performace of machines and processes to reduce resources consumption at the same time. Research is focused on technology applications used in the cultivation of land.

Ans: mention the basic components of Robot:

A robot is a machine - specially one programmable by a computer - capable of carrying out a complex series of actions automatically. Robots can be guided by an external control device or the control may be embedded within.

A robot generally consis of five basic components.

(i) Controller: Every Robot is connected to a computer controller, which regulates the components of the arm & keep them working together. The controller also allows the robot to be networked to other systems, so that it may work together with other machines, processors or robot. Almost all robots are pre-programmed using teaching devices or offline shoftware programs. In the future controllers with Artificial intelige-nce (AI) could allow robots to think on their own, Even program themselves. This could make robots even more self reliant and independent.

(ii) Arms: The arm is the part of the robot that positions the End-effect & sensors to do their pre programmed bussiness. Many are built to resemble human arms, & have shoulders, Elbows, wrists, Even fingers, Each joint is said to give the robot 1 degree of freedom. A simple robot arm with 3 degree of freedom, could move in 3 ways -

up & down,
left and right,
forward and backward.

most working robot today have 6 degree of freedom to allow them to reach any possible point in space within its work Envelope. The human arm has 7.

(3.) **Drive**: The links (the section between the joints) are moved into their desired position by the 'drive'. Typically, a drive is powered by pneumatic or hydraulic pressure, or Electricity.

(4.) **End - Effector**: The End Effector could be thought of as the "hand" on the End of the robotic arm. There are many possible End-Effectors including a gripper, a vaccum pump, tweezers, scalpel, blow-torch, welder, spray gun or just about anything that helps it do its job. Some robots can change end Effectors, and be reprogrammed for a different set of tasks.

(5.) **Senssors**: The senssor send's informations, in the form of Electronic signals back to the controller. Senssor also gives the robot controller information about its surroundings & lets it know the exact position of the arm, or the state of the world around it. One of the more Exciting areas of senssor developments is occoring in the field of computer vision & object recognization. Robot senssor can detect infrared radiation to see in dark.

Robotic Mechanical Systems -

A robotic mechanical systems is composed of a few subsystems, namely,

(i) a mechanical subsystem composed in turn of both rigid and deformable bodies

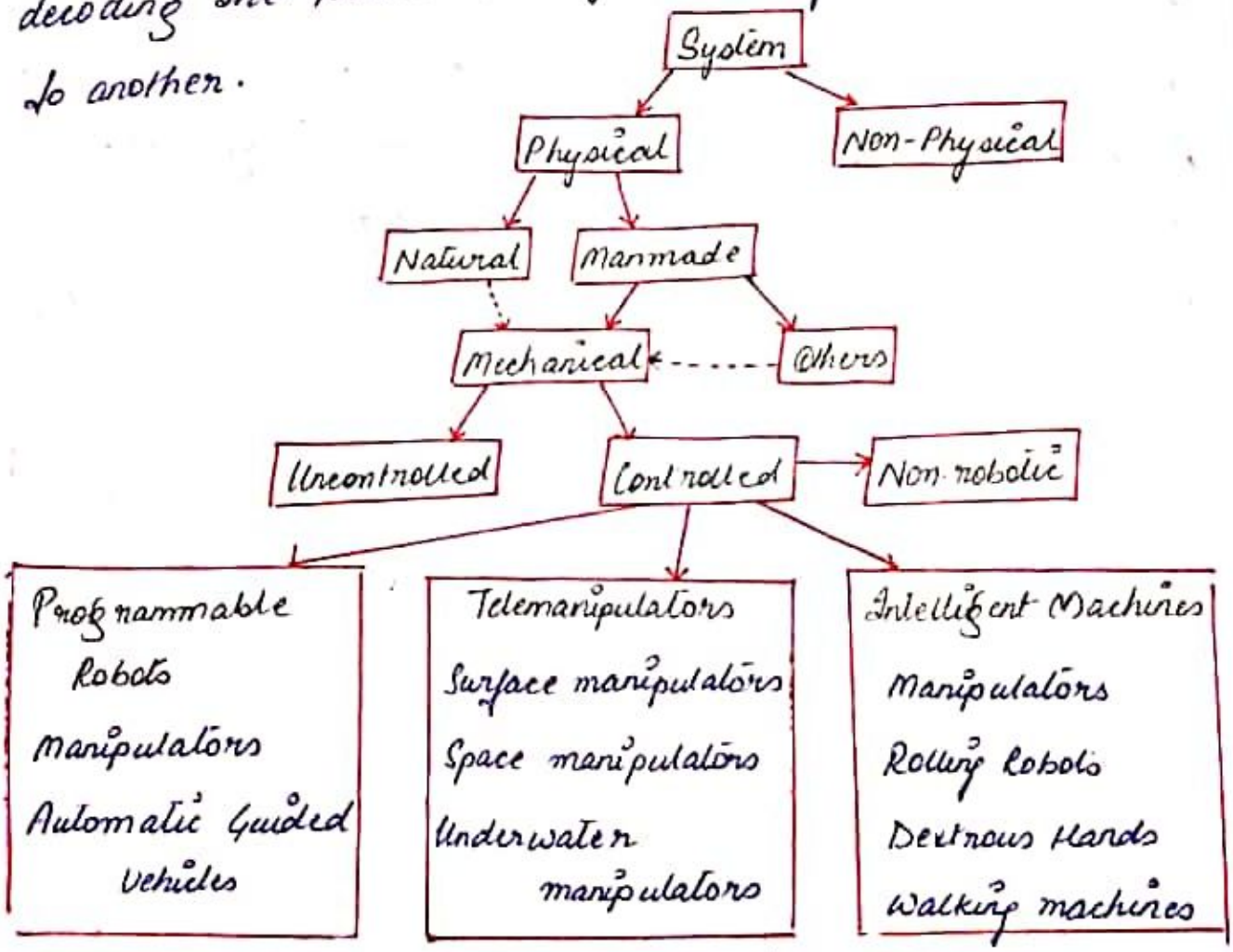
(ii) a sensing subsystem

(iii) an actuation subsystem

(iv) a controller

(v) an information processing subsystem

These subsystems communicate among themselves via interfaces, whose function consists basically of decoding the transmitted information from one medium to another.



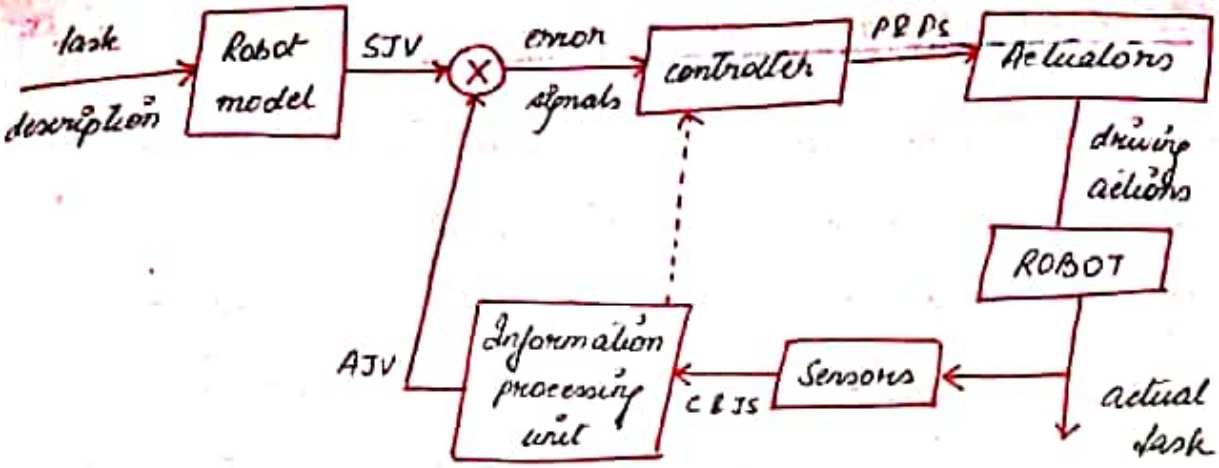
This is the representation of a typical robotic mechanical system. Its input is a prescribed task, which is defined either on the spot or offline. The former case is essential for a machine to be called intelligent, while the latter is present in programmable machines. Thus, tasks would be described to intelligent machines by a software system based on the techniques of artificial intelligence (AI). This system would replace the human being in the decision making process. The output of a robot mechanical system is the actual task, which is monitored by the sensors. The sensors, in turn, transmit task information in the form of feedback signals, to be compared with the prescribed task. The errors between the prescribed and the actual task are then fed back to the controller, which then synthesizes the necessary corrective signals. These are in turn fed back into the actuators, which then drive the mechanical system through the required task, thereby closing the loop.

SJV - synthesized joint variables (angles and torques)

P&FS - position and force signals

C&JS - cartesian and joint signals

AJV - actual joint variables (angles and torques)



Robotic mechanical systems with a human being in their control loop are called telemanipulators. Thus, a telemanipulator is a robotic mechanical system in which the task is controlled by a human with the help of sophisticated sensors and display units.

Robotic mechanical systems in operation are the well known six-axis industrial manipulators, six degrees of freedom flight simulators, walking machines, mechanical hands and rolling robots.

• Symbolic Representation of Links -

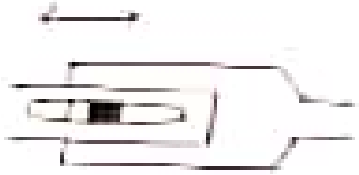
Robot manipulators are composed of links connected by joints to form a kinematic chain. Joints are typically rotary (revolute) or linear (prismatic). A revolute joint is like a hinge and allows rotation between two links. A prismatic joint allows a linear relative motion between two links. We denote revolute joints by R and prismatic joints by P. Each joint represents the interconnection between two links.

Eg A three link arm with three revolute joints is an RRR arm

The axis of rotation of revolute joint or of prismatic joint is denoted by Z. If the joint is the interconnection of links i and i+1.

The joint variables denoted by θ for a revolute joint and d for a prismatic joint, represents the relative displacement between the adjacent links

Revolute (2D view)



Prismatic (2D view)

• The Configuration Space -

The configuration of a manipulator is a complete specification of the location of every point on the manipulator. The set of all possible configurations is called configuration space.

An object is said to have n Degrees of freedom (DOF) if its configuration can be minimally specified by n parameters. Thus, the no of DOF is equal to the dimensions of the configurational space. For a robot manipulator, the no. of joints determines the number of DOF. A rigid body in three dimensional space has six DOF: three for positioning and three for orientation. Therefore, a manipulator should typically posses atleast 6 independent DOF.

The manipulator having more than 6 links is referred to as Kinematically Redundant manipulator.

• The State Space -

The state of a manipulator is a set of variables that, together with a description of the manipulator's dynamics and input are sufficient to determine any future state of the manipulator. The state space is a set of all possible states. The dimensions of a state space is 2n, if the system has n degrees of freedom.

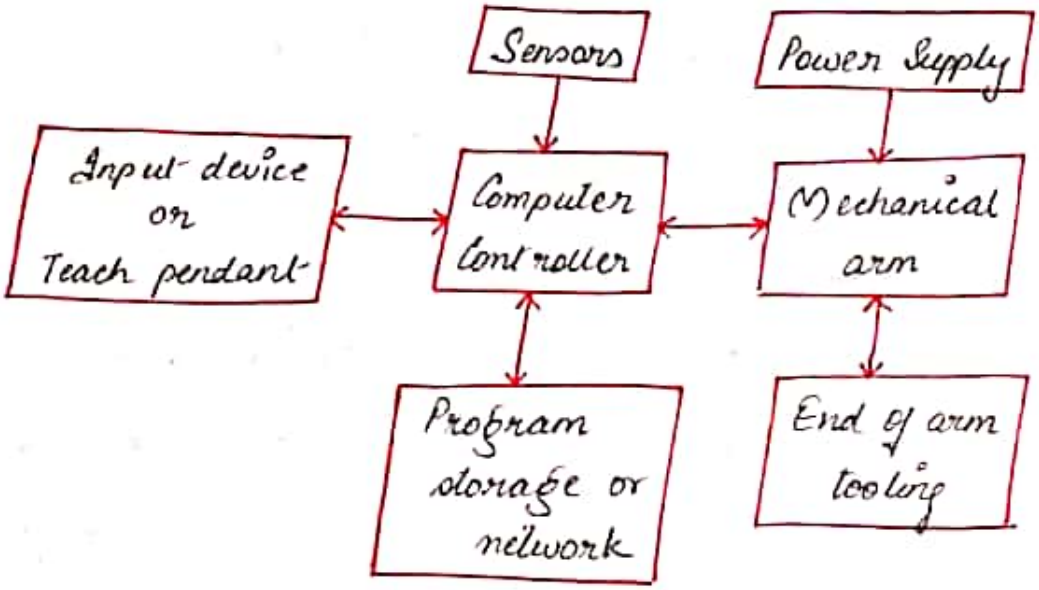
- **The Work Space -**

The workspace of a manipulator is the total volume swept out by the end effector as the manipulator executes all possible motions. The workspace is often broken down into a Reachable workspace and Dextrous workspace.

The reachable workspace is the entire set of points that the manipulator can reach, whereas the dextrous workspace consists of those points where the manipulator can reach with an arbitrary orientation.

- **Robotic Systems -**

A robot manipulator is more than just a series of mechanical linkages.



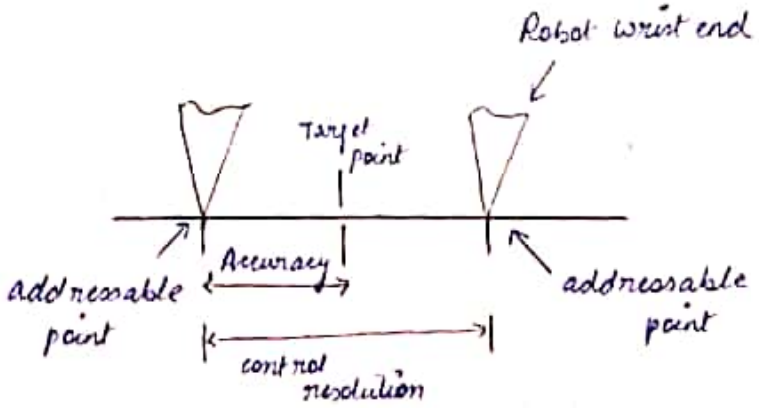
The robotic system consists of a mechanical arm, an external power source, end of arm tooling, external and internal sensors, computer interface and control computer. Even the programmed software is also considered as an integral part of the overall system.

• Resolution -

The resolution of a robot is a feature determined by the design of a controlled unit and is mainly dependent on the position feedback sensor. It is important to distinguish the programing resolution from the control resolution. The programing resolution is the smallest allowable position increment in robot programs and is referred to as the Basic Resolution unit (BRU). The control resolution is the smallest change in position that the feedback device can sense. Best performance is obtained when the programing resolution is equal to the control resolution. In this case, both the resolutions can be replaced with one term - the system resolution.

• Accuracy -

Accuracy refers to the robot's ability to position its wrist end at a desired target point within the work volume, and is defined in terms of spatial resolution.
Initially, we define accuracy as one half of the control resolution, when the target point is exactly in between the two control points.



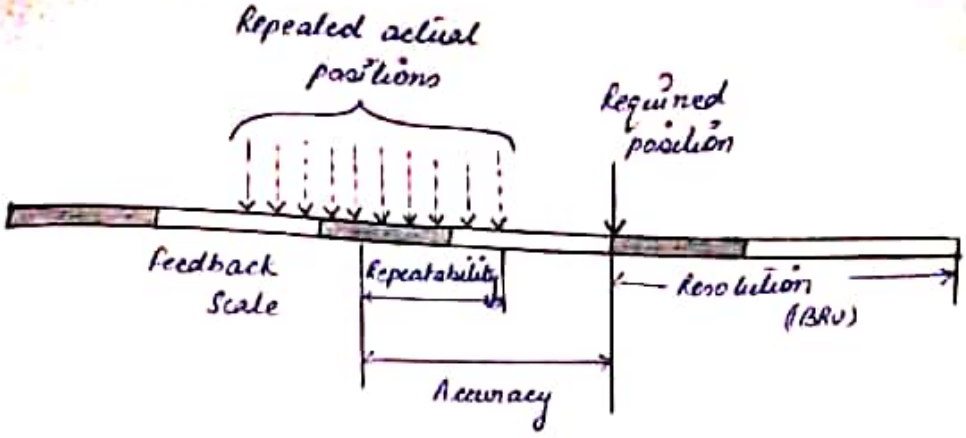
The term accuracy in robotics is often confused with the terms resolution and repeatability. The final accuracy of a robotic system depends on its mechanical inaccuracies, the computer control algorithms and the system resolution.

$$\text{Robot accuracy} = \frac{\left(\text{Basic resolution unit} + \text{Mechanical accuracy}\right)}{2}$$

- **Repeatability** -

Repeatability is a statistical term associated with accuracy. If a robot joint is instructed to move by the same angle from a certain point a number of times, all with equal environmental conditions, it will be found that the resultant motions lead to differing displacements. Although, a target is always missed by a large margin, if the same error is repeated, then we say that the repeatability is high and the accuracy is poor.

Repeatability does not describe the error with respect to the absolute coordinates. System repeatability is the positional deviation from the average of displacements. Accuracy depends upon the particular load that the gripper carries, while the repeatability value, however, is almost independent of the gripper load. The repeatability of robots will usually be better than the accuracy.



- **Compliance** -

Compliance refers to the displacement of the wrist end in response to a force or a torque exerted against it. A high compliance means that the wrist is displaced a large amount by a relatively small force. Compliance is important because it may reduces the robot precision of movement under load as in the case of a robot pressing a tool against a workpart, the reaction force of the part may cause deflection of the manipulator.