3. ROBOTICS

- The Robot Institute of America defines a robot as a programmable, multifunction manipulator designed to move material, parts, tools, or specific devices through variable programmed motions for the performance of a variety of tasks
- We will define robot simply as an active, artificial agent whose environment is the physical world.
- We will be concerned primarily with autonomous robots, those that make decisions on their own, guided by the feedback they get from their physical sensors.

CONT...

- **What is Robotics?**
- Robotics is a branch of AI, which is composed of Electrical Engineering, Mechanical Engineering, and Computer Science for designing, construction, and application of robots.
- **Aspects of Robotics**

- The robots have **mechanical construction**, form, or shape designed to accomplish a particular task.
- They have **electrical components** which power and control the machinery.
- They contain some level of **computer program** that determines what, when and how a robot does something.
- Robots are the artificial agents acting in real world environment.

CONT...

- **Robots are physical agents that perform tasks by manipulating the physical world.**
- A robot is a system which exists in the physical world and autonomously senses its environment and acts in it.
- **What is autonomy?**
  - the ability to make one's own decisions and act on them
  - for robots, the ability to sense the situation and act on it appropriately
  - A robot *acts* through the use of its actuators, also called effectors

CONT...

Difference in Robot System and Other AI Program

Here is the difference between the two –

AI Programs	Robots
They usually operate in computer-stimulated worlds.	They operate in real physical world
The input to an AI program is in symbols and rules.	Inputs to robots is analog signal in the form of speech waveform or images
They need general purpose computers to operate on.	They need special hardware with sensors and effectors.

CONT...

- **Mobile Robots**

- Mobile robots are able to move from one location

  to another location using locomotion. Mobile

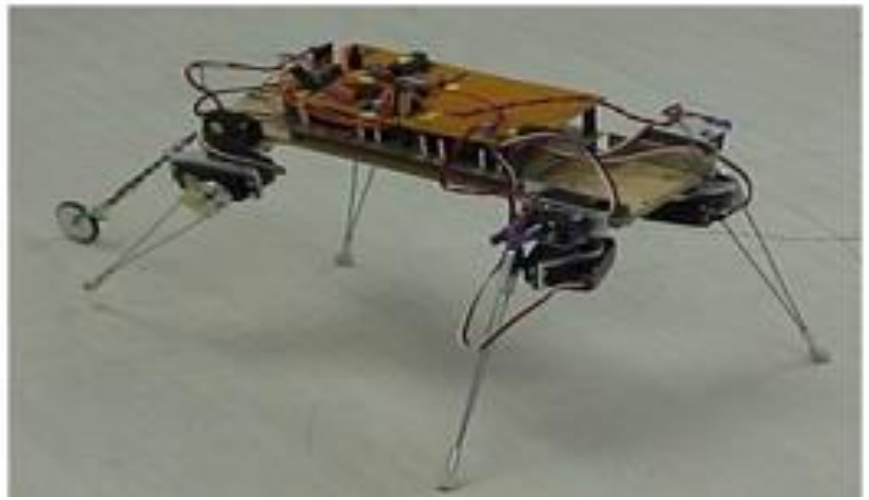
  Robots are of two types:

(a) Rolling robots

- Rolling robots require wheels to move around.
- They can easily and quickly search. But they are only useful in flat areas.

(b) Walking robots - Robots with legs are usually used in condition where the terrain is rocky.

- Most walking robots have at least 4 legs.



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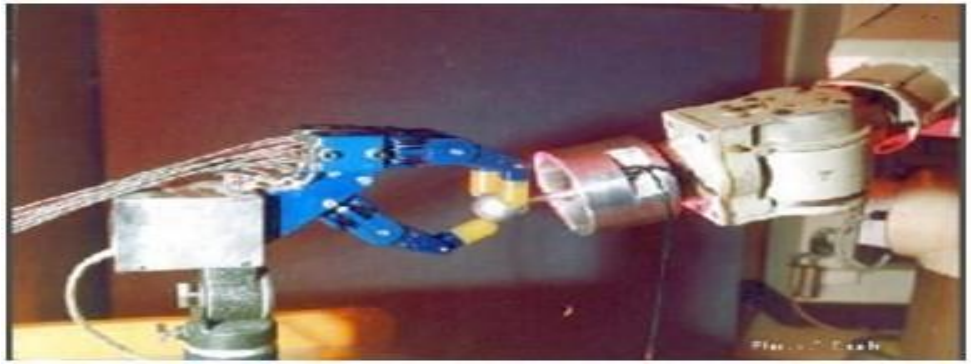
- **Industrial Robots**

- Industrial robots perform same tasks repeatedly without ever moving.
- An industrial robot never tired, it will perform their works day and night without ever complaining.



CONT...

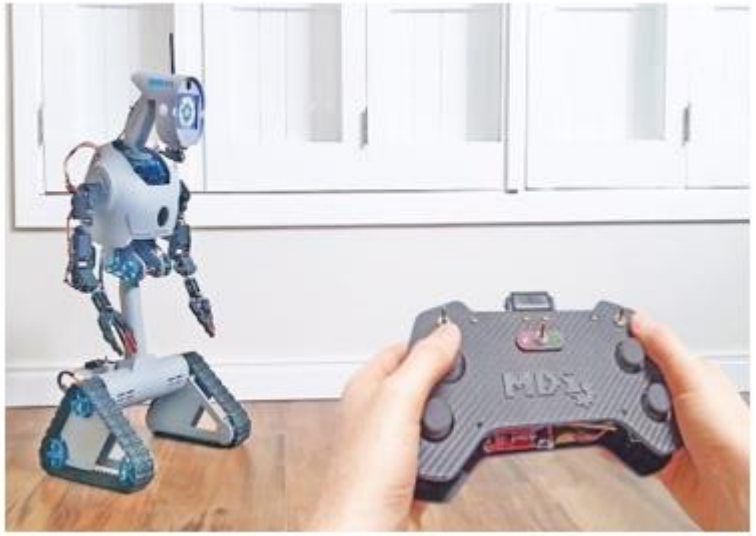
- **Autonomous Robots**

- Autonomous robots are self-supported.
  - They use a program that provides them the opportunity to decide the action to perform depending on their surroundings.
- Using artificial intelligence these robots often learn new behaviour. They start with a short routine and adapt this routine to be more successful in a task they perform. Hence, the most successful routine will be repeated.

CONT...

- **Remote Controlled Robots**

- Remote controlled robot used for performing complicated and undetermined tasks that autonomous robot cannot perform due to uncertainty of operation.
- Complicated tasks are best performed by human beings with real brainpower.
- Therefore a person can guide a robot by using remote
- E.g.: NASA robot designed to explore volcanoes via remote control



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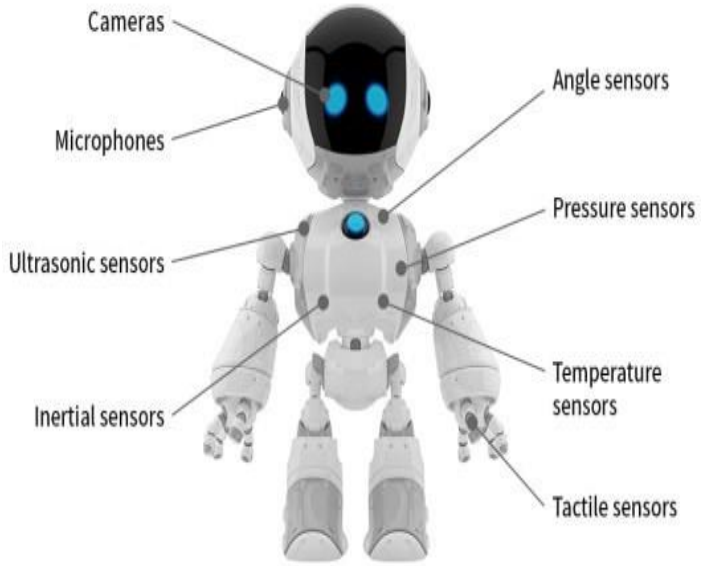
- **SENSING**

- Robotic sensing is **a subarea of robotics science intended to give robots sensing capabilities**.
- Robotic sensing mainly gives robots the ability to see, touch, hear and move and uses algorithms that require environmental feedback.
- **Is the ability to extract insights from sensor data**.



CONT...

Sensors

- Sensors in robots help correctly recognize surroundings and provide the controller or drive with data
- Sensors are the perceptual interface between robots and their environments.
- **Passive sensors:** cameras are true observers of the environment: they capture signals that are generated by other sources in the environment.
- **Active sensors:** sonar sensors (ultrasonic transducer), send energy into the environment. They rely on the fact that this energy is reflected back to the sensor.
- sonar include radar (used primarily by aircraft) and laser.

CONT...

Types of Sensors

- **Light Sensor**
- Light sensor is a transducer used for detecting light and creates a voltage difference equivalent to the light intensity fall on a light sensor.
- **Proximity Sensor**
- Proximity sensor can detect the presence of nearby object without any physical contact.
- In proximity sensor transmitter transmits an electromagnetic radiation and receiver receives and analyzes the return signal for interruptions. Therefore the amount of light receiver receives by surrounding can be used for detecting the presence of nearby object.

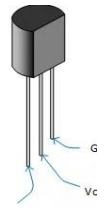
CONT...

Sound Sensor

- Sound sensors are generally a microphone used to detect sound and return a voltage equivalent to the sound level. Using sound sensor a simple robot can be designed to navigate based on the sound receives.

Temperature Sensor

- Temperature sensors are used for sensing the change in temperature of the surrounding. It is based on the principle of change in voltage difference for a change in temperature this change in voltage will provide the equivalent temperature value of the surrounding.



CONT...

Effectors

- Effectors are the means by which robots move and change the shape of their bodies with using the concept of a **degree of freedom (DOF)**
- For nonrigid bodies, there are additional degrees of freedom within the robot itself.

eg. in a human arm, the elbow has one degree of freedom-it can flex in one direction and the wrist has three degrees of freedom-it can move up and down, side to side, and can also rotate.

- Robot joints also have 1,2, or 3 degrees of freedom each.

- **Degrees of freedom (DOF)** is " **a term that describes a robot's freedom of motion in three dimensional space**". Degree of freedom for a robot is defined as "the number of independent movements performed by the robot wrist in three dimensional space, relative to the robot's base".

ROBOT MANIPULATION

- **Robotic manipulation refers to the ways robots interact with the objects around them**: grasping an object, opening a door, packing an order into a box, folding laundry… All these actions require robots to plan and control the motion of their hands and arms in an intelligent way.

- **Manipulation of Robotics**

What is a Robotic Manipulator?

- is a reprogrammable and multifunctional mechanical device responsible for moving materials, parts, objects, or tools through programmed motions in order to perform various tasks.
- A robotic manipulator is capable of moving or handling objects automatically depending
- upon its given number of degrees of freedom.
- Robotic manipulators can range from two axes to ten or more.

CONT...

- **Manipulators, or robot** arms: usually involves an entire chain controllable joints, enabling such robots to place their effectors in any position within their workplace.

❖manipulators have even been used to generate original artwork.

- they can move in 1 or more dimensions.
- the number of dimensions are called the robot's degrees of freedom (DOF).

CONT...

ROBOT Locomotion

- Locomotion is the mechanism that makes a robot capable of moving in its environment. There are various

- types of locomotion's −
  - Legged
  - Wheeled
  - Combination of Legged and Wheeled Locomotion
  - Tracked slip/skid

CONT..

Legged Locomotion

- This type of locomotion consumes more power while demonstrating walk, jump, trot, hop, climb up or down, etc.
- It requires more number of motors to accomplish a movement. It is suited for rough as well as smooth terrain where irregular or too smooth surface makes it consume more power for a wheeled locomotion. It is little difficult to implement because of stability issues.
- It comes with the variety of one, two, four, and six legs. If a robot has multiple legs then leg coordination is necessary for locomotion

CONT...

- The total number of possible **gaits** (a periodic sequence of lift and release events for each of the total legs) a robot can travel depends upon the number of its legs.
- If a robot has k legs, then the number of possible events N = (2k-1)!.
- In case of a two-legged robot (k=2), the number of possible events is N = (2k-1)! = (2*2-1)! = 3! = 6.
- Hence there are six possible different events −
  - ✓ Lifting the Left leg
  - ✓ Releasing the Left leg
  - ✓ Lifting the Right leg
  - ✓ Releasing the Right leg
  - ✓ Lifting both the legs together
  - ✓ Releasing both the legs together

CONT...

Wheeled Locomotion

- It requires fewer number of motors to accomplish a movement. It is little easy to implement as there are less stability issues in case of more number of wheels. It is power efficient as compared to legged locomotion

CONT...

Slip/Skid Locomotion

- In this type, the vehicles use tracks as in a tank. The robot is steered by moving the tracks with different speeds in the same or opposite direction. It offers stability because of large contact area of track and ground.

CONT...

HOW DOES THE HUMAN ROBOT INTERACTION?

- Human–robot interaction is the **study of interactions between humans and robots**. It is often referred as HRI by researchers. Human–robot interaction is a multidisciplinary field with contributions from
  - human–computer interaction,
  - artificial intelligence,
  - robotics,
  - natural-language understanding, design, and
  - psychology.

CONT...

APPLICATIONS OF ROBOTICS

- The robotics has been instrumental in the various domains such as −

- **Industries** − Robots are used for handling material, cutting, welding, color coating, drilling, polishing, etc.
- **Military** − Autonomous robots can reach inaccessible and hazardous zones during war. A robot named *Daksh*, developed by Defense Research and Development Organization (DRDO), is in function to destroy life-threatening objects safely.
- **Medicine** − The robots are capable of carrying out hundreds of clinical tests simultaneously, rehabilitating permanently disabled people, and performing complex surgeries such as brain tumors.
- **Exploration** − The robot rock climbers used for space exploration, underwater drones used for ocean exploration are to name a few.
- **Entertainment** − Disney's engineers have created hundreds of robots for movie making.

The end of chapter Five!