Chapter 5 - Robot Technology of the Future

Explain robot intelligence.

- An intelligent robot is an intelligent machine with the ability to take actions and make choices. Choices to be made by an intelligent robot are connected to the intelligence built into it through machine learning or deep learning as well as inputs received by the robot from its input sensors while in operation.
- Intelligent robot has a well developed "artificial brain," which can arrange actions according to the purpose and also has sensors and effectors. The research of the intelligent robot can be divided into four levels: basic frontier technology, common technology, key technology and equipment, and demonstration application

Telepresence and related technologies

- A telepresence robot helps place "you" at a remote location instantly, providing you a virtual presence, or "telepresence."
- A telepresence robot is a computer, tablet, or smartphone-controlled robot which includes a video-camera, screen, speakers and microphones so that people interacting with the robot can view and hear its operator and the operator can simultaneously view what the robot is "looking" at and "hearing."
- Some robots require a tablet or phone to be attached to the robot, while others include built-in video and audio features.
- A telepresence robot can be used to provide yourself a "far reaching" pair of mobile "eyes" and "ears," enabling you to have a remote presence at any location with an internet connection.
- Telepresence robots go beyond a simple video conference call because the operator has full control of what they wish to see: no more need for multiple people to leave their seats and rotate so they can be seen by the video screen.
- No more need to wait for an employee to have a remote conference; you can go to him at your convenience. No more need to fly out or drive to view a warehouse or visit a patient in an emergency; simply log in to your robot and be there in a heartbeat to assess the situation.

- Simply use your computer, tablet, or smartphone to direct the robots camera to see what or whom you wish to see; whenever you like. This control is further enhanced by the ability to drive the robots around rooms and hallways, offering a more complete virtual presence.

Direct Drive robot

- Direct-drive is, basically, an electrical drive in which no gear reducer is used. The rotor of an electrical motor is directly coupled to the load. hence the mechanical gearing is completely eliminated.
- The direct-drive robot is defined to be a mechanical arm where all or part of the active arm joints are actuated with the direct drive.
- The direct-drive joint consists of a pair of arm links, the motor. and the bearings. The motor consists of the stator and the rotor.
- The stator is housed in the case connected to one of the arm links, usually a proximal link, and the rotor is directly coupled to the joint shaft, which is connected to the other ann link, usually a distal link. Thus the distal arm link is rotated directly by the torque exerted between the rotor and the stator, hence direct drive.
- The problems that the mechanical gearing unavoidably possesses can be solved completely in the direct drive method. Backlash is completely removed and friction is reduced significantly. It may exist only at the bearings supporting the joint shaft.
- The mechanical construction can be much stiffer than drive mechanisms with gearing, wear of gears is no longer troublesome and the simple construction is more reliable and is easy to maintain
- Thus the direct-drive robot can be a desirable test bed for advanced manipulation studies.

Mobility, locomotion and navigation

Mobility :

- Industrial robots are rarely mobile. Work is generally brought to the robot. A few industrial robots are mounted on tracks and are mobile within their work station.

- Service robots are virtually the only kind of robots that travel autonomously. Research on robot mobility is extensive.
- The goal of the research is usually to have the robot navigate in unstructured environments while encountering unforeseen obstacles.
- Some projects raise the technical barriers by insisting that the locomotion involve walking, either on two appendages, like humans, or on many, like insects.
- Most projects, however, use wheels or tractor mechanisms. Many kinds of effectors and actuators can be used to move a robot around. Some categories are:
    - legs (for walking/crawling/climbing/jumping/hopping)
    - wheels (for rolling)
    - arms (for swinging/crawling/climbing)
    - flippers (for swimming)

Locomotion:

- Mobile robot navigation is an essential issue in the field of robotics. They are known for their intelligence tendencies.
- They also cover a wide range of applications, such as in transportation, industry, and rescue robots.
- Path planning is one of the most prominent and essential part of autonomous mobile robot navigation. For the past two decades, researchers are working on path planning problem for which several methods have been developed.
- Path planning involves the determination of collision-free path from one point to another while minimizing the total cost of the associated path.
- Depending on the nature of environment, path planning can be divided into static and dynamic environment. If obstacles change their position with respect to time, it is referred as static path planning and if obstacles change their position and orientation with respect to time, then it is referred as dynamic path planning.
- This knowledge can further be divided into online and offline algorithms. In online path planning, the information about surrounding is obtained from separately attached local sensor installed on robot, then robot construct the map of environment from the information being fed from the locally attached sensors. In offline path planning, robot has complete information of

the surrounding environment without the aid of sensors. For ensuring the satisfactory navigation, numerous strategies have been proposed up till now.

Universal Robot Hand:

- Robot hands are intended to realize the same dexterous and versatile manipulation that we humans can do. Thus, for robot-hand research, understanding the anatomy and motion of the human hand is fundamental
- Universal robot hand has 16 DOFs.
- Thumb has four DOFs, and the other fingers have three DOFs .
- This robot hand has the multi-axis force/torque sensors in every fingertip and tactile sensors on every finger pad.
- The multi-axis force/torque sensor is able to measure the force and torque at fingertips.
- Tactile sensor is able to measure the pressure distribution on the finger pad.
- Universal Robot Hand II has actuators, transmission gears, reduction gears, and Torque Limiter Mechanisms in the fingers. Using the Torque Limiter Mechanisms, the fingers can sustain overload not by the gears but by the structure. This is the imitative behavior of a human finger.

System integration and network.

- Robotic integration uses robotic systems to provide automated solutions. It's the process of programming these systems to complete specific automated manufacturing tasks. A crucial part of robotics systems integration is the integrator. A robotic systems integrator will analyze manufacturing needs, provide custom solutions, design, and then support the robotic system.
- Robotics system integration is an adaptable technology used in many industries, including medical and industrial. Many common industrial uses include assembly, painting, dispensing, palletizing, production inspection, material handling, welding, and production testing. Robotic systems integration is very flexible, scalable, and accurate, providing a significant return on investment.

BENEFITS OF ROBOTIC SYSTEMS INTEGRATION

There are plenty of benefits to introducing robotic systems integration into your manufacturing process. As you will find in the following list, benefits are relational, meaning that when you utilize industrial robots you will receive all of the benefits listed rather than one or two. Robotic systems integration:

- Improves accuracy and precision: Industrial robots achieve an exceptional level of precision.
- Increases consistency: Tasks are always completed with the exact specifications needed, every time. With better consistency and quality, there is also a reduction in production costs.
- Boosts speed: Industrial robots complete automated tasks at a much faster rate. The timing to complete a task is predictable and can positively affect the production line.
- Saves on labor costs and better utilizes employees' skills: When an industrial robot is completing routine tasks, you can either reduce labor or assign employees to other jobs where their skill sets are better utilized.
- Improves floor utilization: Industrial robots take up less space than employees as they don't need aisleways to walk to and from machinery.
- Fosters a safer workplace: Complete high-risk tasks completed by industrial robots keep employees out of danger and reduce occupational hazards.

Future applications of Robots

Military operations:

- As robotics progress from hands-on tools to partners in combat, they significantly reduce the risk for soldiers on the battlefield.
- Robots in combat can be used for a variety of advantage-gaining tactics. For example, some robots may be used strictly for reconnaissance purposes.
- This means they are built with the purpose of entering unsafe spaces, recording video, audio, or other measures, and broadcasting them back to a secured team away from the threat. From there, the team can take the information gained from the robot to make tactical decisions.
- Other robotics, however, could take part in the combat through the remote use of weaponry or bomb-disposal technology. For example, EOD (explosive ordnance disposal) robots can disrupt devices from a safe distance by using tools to prevent activation, all while leaving evidence intact. If disruption is not enough, EOD robots can also deliver counter-charges to explode a threat or remove it from high-traffic areas altogether.
- Future robotic technology that's currently in development also includes gear solutions to lighten the equipment loads of soldiers. These robot prototypes would act as pack-mules for soldiers--traveling alongside them among even the most rugged of terrain allowing for more speed and mobility.

Industry 4.0

- Robots are an important piece of the Industry 4.0 puzzle. Tomorrow's smart factories will depend on new types of machines, such as collaborative and mobile devices that are interconnected. Artificial intelligence (AI), cloud computing and data analytics will also make industrial robots more reliable than ever.
- The goal of Industry 4.0-enabled robotics is zero downtime and maximum efficiency. As robots use more sensors and become more digitally connected, they will become much less susceptible to disruptions.
- Spotting a glitch on an assembly line in real time—and reconfiguring around it can increase productivity, reduce errors and improve quality.

QUESTIONS:

- Explain concept of universal hand.
- Explain mobility, locomotion and navigation technology may use in robots.
- Explain telepresence and related technologies
- Explain system integration and networking approach may use in robot.
- Explain Robot Intelligence
- Explain the benefits of robotic systems integration
- Explain future applications of robots
- List any four future technologies of robots.
- Explain future mechanical design features may use in robots
- Define Industry 4.0
- Discuss how robotics technology can change the future of manufacturing industry.