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Robotics: Applications

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Outline

- **Introduction**
- **Industrial applications**
- **Other applications**
- **Summary**

Introduction

- 90% robots in factories: Industrial robots
- Finding way into
  - Warehouses (e.g., Flipkart, Amazon)
  - Laboratories (e.g., IIT Delhi's PAR Lab.)
  - Research and exploration sites (e.g., oil, gas)
  - Power plants (e.g., NTPC's inspection)
  - Hospitals (e.g., as nurse)
  - Undersea (e.g., search and rescue)
  - Outer space (e.g., Chandrayan, Pathfinder)
  - Entertainment (e.g., RoboMuse@IIT Delhi)

Advantages

- Never gets sick, or needs rest
- Can work 24 hours a day, 7 days a week
- Dangerous for a person, give to robot
- Robots do not get bored.

Repetitive and unrewarding → Use robot

Material Handling

- 95% in manufacturing a part is composed of transfer and waiting time
- 5% is actual processing
- Processing time was reduced by automation
- One needs to reduce in handling and loading

- Fully automatic: Transfer lines in automobile industry → Hard automation
- Not suitable for batch production (50 to 100,000/year)
- Flexible automation → Frequent changes in production is needed (~75% parts)

- Industrial robots is a solution: Handling and m/c tool loading of small/medium parts

- Robots are utilised to load and unload m/c tools for
  - tending a single machine, and
  - serving several machines

Welding

- Spot-welding Robots
  - A spot-welding robot has to carry the welding gun
  - A gun consists of the electrodes, cables to conduct high current, and sometimes water-cooling system
  - The welding gun is heavy (10 to 80 kg)
  - DC motor driven robots cannot handle
  - Hydraulically powered
  - Point to point (PTP) with high positional accuracy
  - Positional repeatability: $\pm$ 1 mm

- Repeatability is better than humans
- Robotised spot welding is very fast
- Positioning of welds is accurate
- For fabrication of structural metal products, domestic appliances, metal furniture, etc.
- Car assembly line (50 to 90 cars/hour)
- Work is performed while the car bodies are moving on conveyors
- Weld locations synchronized by the task programs

Arc-welding Robot

- Robotic arc welding uses a consumable wire as electrode (i.e., MIG welding)
  - Uses an automatic wire feeder
  - Welding with non-consumable tungsten electrodes under shielding gas (i.e., in TIG welding)
- Robot uses the welding gun as a tool
- Welding gun is not heavy (unless the water-cooled) → DC servomotors are used

- Welding speeds: ~0.25 to 3 m/min.
- Robot is to lead welding gun along the programmed trajectory
- Control system in arc welding is continuous path (CP) type
- To synchronized robot's controller is interfaced with control unit of welding equipment

Spray Painting

- Spray painting is unhealthy and unpleasant → Good to use robots
- Solvent materials are toxic → Operators use masks and provided with fresh-air ventilation
- Painting area: Dust-free and temperature-controlled → Painting booth is small and inconvenient
- Noise from air discharge can cause irreversible damage to ears

Spray painting is one of the first applications of robots

- Spray painting robots: CP type, and have
  - high level of manipulator dexterity
  - large working volume
  - compact wrist
  - small payload, and
  - low accuracy and repeatability.
- Repeatability: 2 mm

Assembling and Palletizing

- Assembling is for small products, e.g., electrical switches and small motors.
- Robots
  - Cartesian
  - Cylindrical
  - Spherical, or
  - Articulated

- SCARA Robot: *Selective-Compliance-Assembly Robot-Arm*
- Can assemble in vertical motions, e.g., PCBs.
- 4-DOF robot
  - Pick up parts located on horizontal plane
  - Bring them to assembly location
  - Orient them, and
  - Insert them in a vertical motion

Machining

- Drilling
  - Robots can drill using template hole with a chamfered guide
  - Gripper holds portable pneumatic drill
  - It is PTP operation → manual teaching
- Deburring
  - Burrs are generated in machining of metal parts
  - Removal of burrs is expensive

- Two basic ways to debur using robots
- For lightweight, it is picked up by robot and brought to dubrring tool
- For heavy, the robot holds the tools
- In both, relative motion bet. tool and part is CP with high repeatability (app. 0.2 mm)

Medical

- Used in surgery (e.g., da Vinci)
- Goal: Not to replace surgeons but to assist
- Provide surgeons with a new set of versatile tools that extend his or her ability to treat patients
- Medical robotic systems are *surgical assistants* that work cooperatively with surgeons
- Training simulators using Haptics

Space

- Explorations of planets, moons, and near bodies in space
- Benefits: Lower cost and without endangering human life
- Such robots must be versatile and robust
- A space robot should have
  - Compactness and Lightness
  - Robustness
  - Versatility and Adaptability

Mining and Underwater

- Mining: To enhance productivity
  - Access unworkable mineral seams
  - Reduce human exposure to dust, noise, gas, water
- Underwater: Applications
  - Prospect for minerals on the floor of the ocean
  - Salvaging of sunken vessels
  - Repair of ships

Defence

- Air force, navy, and army are interested
- Indian Robots: R&DE Pune; CAIR, and DEBEL Bengaluru
- Applications
  - Surveillance
  - Security guard in power plants, oil refineries, and other large civilian facilities
- IITD's robots: Truck and Walking simulators

Summary

- Industrial applications were presented
- Other applications were also mentioned
- Photos and videos were shown

Thank You

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