Chapter 4 - Robot Applications and Maintenance

Applications of Robots

The various applications of robot include the following :

I. Industrial applications:
   1. Material handling :
      (i) Material transfer applications
      (ii) Machine loading and unloading applications
      (iii) Palletizing applications
   2. Processing applications:
      (i) Arc welding (ii) Spot welding
      (iii) Spray painting (iv) Paint scraping
   3. Assembly applications:
      (i) The assembly task (ii) Peg-in-hole assembly
   4. Inspection applications:
      (i) Sensor based inspection (ii) Vision based inspection
      (iii) Testing

II. Non- Industrial applications:
   1. Home sector 2. Healthcare 3. Service sector
   4. Agriculture and farms 5. Research and exploration.

Welding

"Welding" is one of the major uses for an industrial robot. Actually, the following two distinct types of welding operations are readily and economically performed by robots :

1. Spot welding;
2. Arc welding.

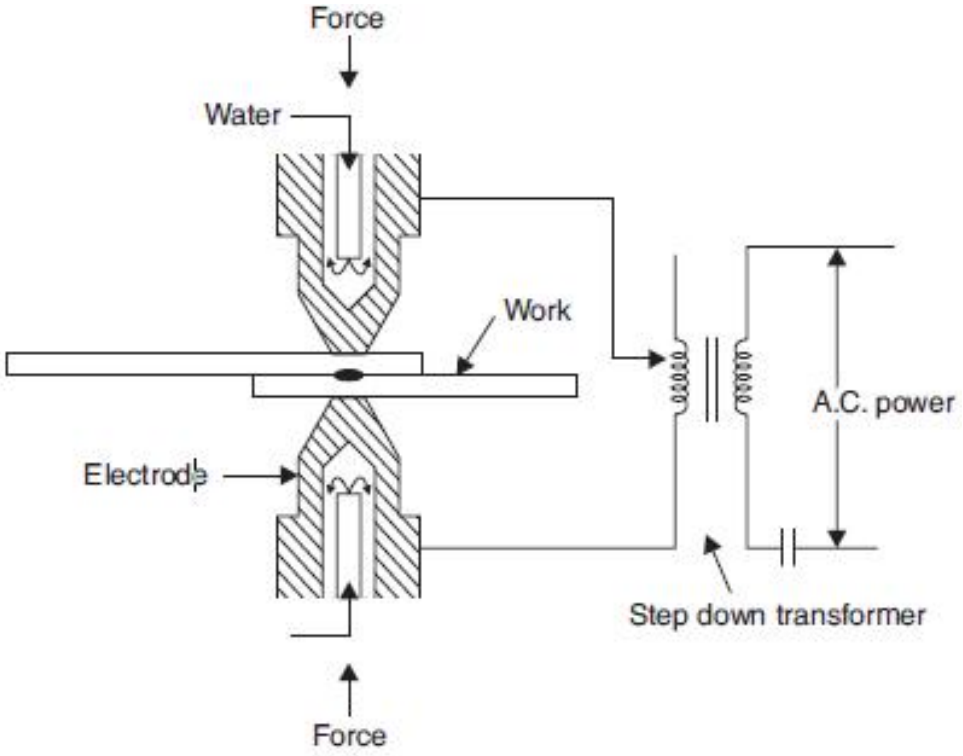
1. Spot welding :

— In this type of welding, the *robot is taught a series of distinct points.*

— Since the metal parts that are to be joined may be quite irregular (in three dimensions), a wrist with good dexterity is often required (*e.g.*, three degrees of freedom). This permits the welding tool to be aligined properly at the desired weld point without the gun coming into contact with other portions of the part.

— Typically, the welding tools carried by these robots are *large, and reasonably heavy.* Also, it is usually necessary for the manupulator to have a *long reach.* As a consequence, *large point-to-point servo-controlled robots (either hydraulically or electrically actuated) are normally used for this purpose;* these robots are widely used in *"automobile industry"*.

— Because the weld points are pre-taught, sensory information is generally *not* required in order to energize the welding gun. It is, however, possible to utilize the increased motor current that results when the tool makes contact with the part to initiate the welding operation.



2. Arc welding :

— In arc welding, an irregularly shaped seam or wide joint must be made.

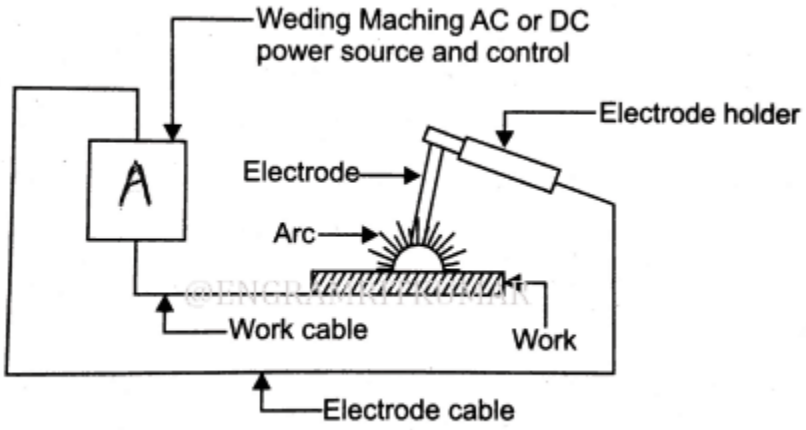
— In this case, *a continuous-path servo-controlled robot that is often specifically designed for this single application is most usually the choice.*

— If the parts to be welded can be accurately positioned and held in place, the complex *three-dimensional path can be pre-taught and no external sensors may be necessary.* At present, a number of manufacturers include a position sensor that is placed in front of the welding tool and can therefore provide information concerning irregularities in the weld path.

— *Where a wide joint is to be handled, th robot can be programmed to produce a weave type of motion.* This ensures that weld covers the entire gap.

— The workspace of the welding robot should be large enough to accommodate size of the parts to be welded. A *five* degrees of freedom (DOF) manipulator can weld parts in a plane while *six* DOFs are required for *welding complex contours.*

- *The "major advantage" of a robotic welder is that arc time (a critical parameter in determining the weld's strength) can be carefully controlled.*
- The arc welding is also extensively used in the *auto-industry.*



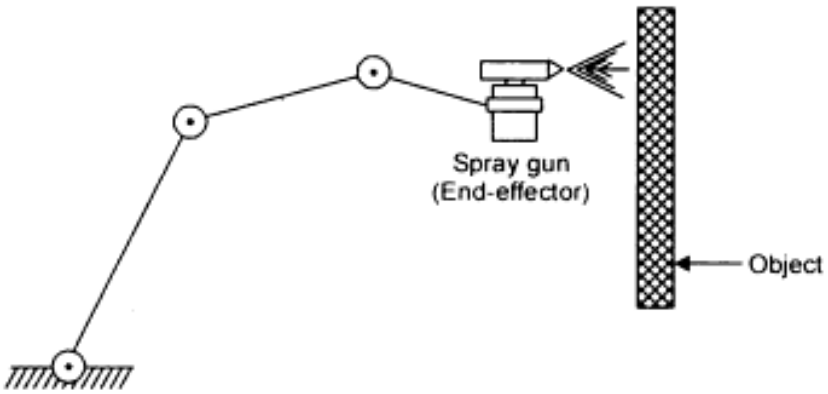
Basic arc-welding circuit.

Advantages of robotic welding :

1. Higher productivity.
2. Improved safety of worker.
3. Good quality of product.
4. Better control over the welding process.

Spray Painting:

— In robot spray painting operations, the spray gun is the robot's end-effector.



Spray painting.

— The use of industrial robots is increasing in spray painting operations due to hazard conditions prevalent in such operations like fumes, and mist in atmosphere, high noise from the spray nozzle, fire hazards due to flammable paint and breathing difficulties in painting area.

— Robots employed for this purpose are usually capable of performing *both straightline and continuous-path motions.*

— Programming a spray-painting robot is usually performed by the best human operator. His actions are then mimicked by one or more robots.

— The spray-painting application generally does *not* require the use of external sensors. However, it is necessary that the part to be painted be accurately presented to the manipulator.

Advnatages : The use of robots in spray painting leads to the following *advantages :*

1. Removal of operators from the hazardous environment.
2. Consistency in operation.
3. High product quality.
4. Increased productivity.
5. Less painting material usage. .
6. Reduced direct labour costs.
7. Saving in energy consumed.

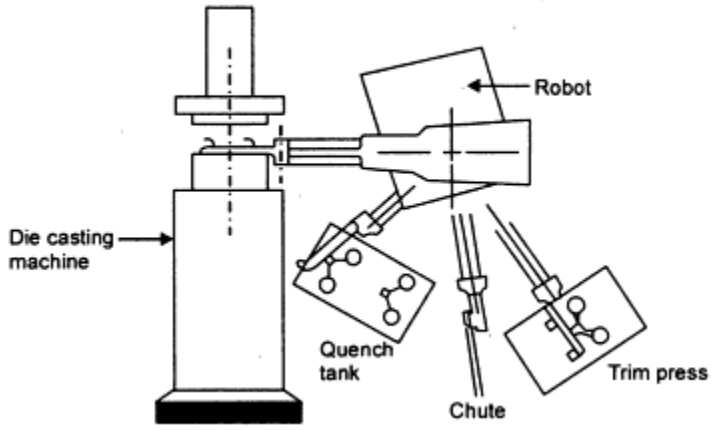
Machine Loading and Unloading Applications:

Robots are commonly used for loading of stock parts and unloading of finished parts on :

- Die casting machines;
- CNC machine tools;
- Forging presses and hammers;
- Transfer machines;
- Testing machines;
- Injection and transfer plastic moulding machines, etc.

- In machine loading and unloading problems, *a robot should be able to orient the workpiece correctly so as to locate it accurately to a particular machine after picking up from the bins or from the conveyor*. In a similar way, the robot gripper should be able to take the part back after processing. Several kinds of machanical, vacuum and magnetic grippers may be employed to handle and manipulate objects of varying shapes, weights and materials.

  Fig. 10.4. shows a loading and unloading a die casting machine by a robot.



APPLICATIONS OF ROBOT IN AUTOMATED ASSEMBLIES

Aassembly robots are ideal for tasks demanding speed, precision, and accuracy. Different robotic assembly applications include but are not limited to:

- Part identification: Identify and validate parts based on shape, size, color, barcode, and other features.
- Part sorting: Sort and select parts based on features like shape, size, color, barcode, and more.
- Bin picking: Select parts presented from a bin.
- Tool changing: Automatically change end gripper configurations for different parts and sizes.
- Part fastening or joining: Assemblies by performing functions, such as screwing, dispensing, welding, or inserting.

APPLICATIONS OF ROBOT IN AUTOMATED INSPECTIONS

- Robotic inspection systems can be used to flag defective parts, measure parts, or verify that all parts are assembled correctly.
- 3D vision systems are suited for inspection applications since they provide a complete six-degree view of any given object.
- Inspection robots can be stationed directly on a production line, monitoring parts or objects as they pass along a conveyor.
- The robots are integrated with vision systems to inspect parts as they are loaded into the workcell. Once the inspection is completed, they are then unloaded from the cell to either continue through the manufacturing process or removed from the manufacturing line if flaws were detected
- Robots excel at highly repeatable tasks and are programmed to follow the same guidelines with every part inspected.
- Automated inspection applications with industrial robots improves accuracy and product quality. All parts are thoroughly evaluated and measured against the same standards for heightened quality control

ROBOT MAINTENANCE

Need of Maintenance :

Generally, the maintenance needs of a robot are determined by its specific application and type. The robot powering system is probably the most important factor that clearly affects its maintenance. Most of the robots used in industry sectors may be classified under the following two categories

- Hydraulic with electrical controls. These are robots whose working parts are driven hydraulically and, generally, are controlled by electrical components or parts.
- Electrical. These are robots that are driven and controlled by electrically powered parts.

Nonetheless, it is to be noted that irrespective of the robot type, the mechanical parts of a robot require proper attention. The following maintenance-related tasks are relevant to robots:

- Attending to seals and replacing protective accessories
- Inspecting all involved parts regularly for wear, particularly wrists
- Cleaning to eradicate corrosive agents
- Lubricating

Specifically, in the case of hydraulic robots, the items that need proper attention include bearings, servo valves, filters, hydraulic oil, and high-pressure hoses.

TYPES OF MAINTENANCE:

- Three basic types of maintenance for robots used in industrial applications are corrective maintenance, preventive maintenance, and predictive maintenance.
- Corrective maintenance is concerned with repairing the robot system to return its operational state whenever it breaks down.
- Preventive maintenance is basically concerned with servicing robot system parts regularly.
- Predictive maintenance is concerned with predicting when a failure might occur and to alert personnel involved with maintenance. Predictive

maintenance is becoming increasingly effective as modern robot systems are equipped with highly sophisticated electronic parts and sensors.

COMMON TROUBLES AND REMEDIES IN ROBOT OPERATION.

Human Errors

Human error occurs in day-to-day activity and this is no different with regard to a robotic work cell. Whether it is programming, preventative maintenance, or teach pendant control, operators have the potential to place themselves in hazardous positions due to over familiarity or lack of knowledge of the robot's motion path.

Control Errors

Errors in the controls software and hardware can lead to hazards within a robotic work cell. If the controls system faults, the system response may lead to a dangerous working environment if it is closely coupled with human interaction.

Unauthorized Access

Access by an unauthorized operator into a safeguarded robotic work cell. If an operator is unfamiliar with the safety hardware associated with the robotic work cell, they can find themselves in a dangerous and potentially fatal area.

Mechanical Failures

During the design and programming stages, mechanical part failure is not always taken into account. When an unexpected failure occurs, this can lead to a potentially hazardous situation for the operator.
Industrial Robots from Bastian Robotics

Environmental Sources

Outside factors and communication interference can create an undesirable effect on a robotic work cell. Unsuppressed power surges or power loss can lead to injury if they are not planned for during the initial stages of the project.

Power Systems

Power sources that have communication to the robotic cell can be disrupted and lead to undesired actions. This can produce a release of energy, creating a hazardous environment for an operator.

Improper Installation

Any time an industrial robot is installed it is vital to the success of the project and safety of the operators that the system is installed correctly before it is fully operational. If the robotic work cell is incorrectly setup, future hazards may occur due to variance from the original design.

REMEDIES:

- Although each of these potential hazards can be dangerous, they are each preventable as long as workers are well educated on the robotic system and the robotic integrator has fulfilled all job requirements, including proper installation, programming, and risk assessment.
- Any dangers should also be taken into account during the initial design phase and shared as a living document throughout the project life cycle.
- As long as these seven potential hazards are addressed early, industrial robots are extremely safe and can help your bottom line.
- Before our clients purchase an industrial robotics system, we always encourage them to become familiar with these safety standards and practices, but no matter what robotic integrator you use, ensure they fully understand and are held accountable to these standards.

General safety norms, aspects and precautions in robot handling.

SAFETY NORMS in ROBOT Handling

- Read the safety sections of the manufacturer's manual before operating a robot for the first time.
- E-stops must be operational and within reach at all times when the robot is powered on.
- When approaching a damaged or possibly stuck robot arm, first remove the power and be wearing proper protection equipment (safety glasses, shoes, attire, etc.)

Before robot operation:

- Check for signs of damage to the robots, observe if there are any fluid spills, broken wires, loose cables, etc.
- Dress properly and use appropriate safety equipment:
- Wear safety glasses and other suitable PPE
- Remove loose-fitting clothing (ties, scarves, extra-long or loose sleeves, etc.)
- Tie up long hair, etc.
- If uncertain of the safety of the operation to be undertaken, notify the IRL Lab Manager or other CSL faculty or staff and obtain guidance before proceeding.
- Use extra caution when performing motion experiments for the first time or if recovering from a collision. When running any new code, observe the robot carefully with a hand on the E-Stop (Emergency-Stop) button

During robot operation:

- Everyone in the vicinity of the robot must be mentally alert and paying attention (no headphones, etc.)
- Have a safety-buddy present when the robot is performing any autonomous function.
- E-Stop pushbuttons must always be within reach of any person working with the robot
- Before starting any robot movement, communicate with others loud and deliberately on the operation about to be executed, such as “Starting robot motion”
- For collaborative robots (ISO/TS 15066:2016), personnel can be within the robot’s workspace while the robot is performing autonomous functions, but it is highly recommended to avoid entering the robot’s workspace unless necessary.
- For non-collaborative robots, all personnel must be outside of the robot workspace while the robot is performing any autonomous function.
- Disable the robot after experimentation is complete.

Interlocking of robot

- An interlock works as a sensor in a robot workcell for permitting the work cycle sequence to continue only after the preferred conditions are satisfied.
- It checks whether the work part is placed at the accurate location in the conveyor for allowing the robot to grasp it perfectly.
- It specifies the work part loaded is perfect for beginning the automatic machining cycle.
- It helps in identifying when the work cycle has been finished for continuing the next machining cycle.

There are two important categories in the interlocks such as:

Input interlocks – It uses a signal that is sent from a robot cells component to the workcell controller for specifying the conditions are satisfied and ready to begin the work cycle.
Output interlocks – It uses a signal that is sent from the workcell controller to a component in the robot cell for indicating the machining center to begin the automatic work cycle.

- The interlocks are implemented not only to prevent the work part from inaccurate starting, but also to protect the components in the workcell from damages. In addition, the interlocks should consider the failures and irregularities that occur in the cell. If a malfunction takes place in a robot workcell, the application engineer must find out a technique to recognize the malfunction and should take a suitable solution.
- Subsequently, interlocks are used to obtain the series control and as well as safety monitoring in both irregular and regular work cycles.
- The electronic controllers can be introduced to produce the interlock signals for the devices in the robot cell. Sometimes, the sensors (e.g. limit switches) can also be implemented in the interlocks to generate the required signals. Moreover, advanced type sensors can be used to gain more accurate performance in the work cycle.

EXPECTED QUESTIONS:

- List different safety rules in robot handling.
- Explain applications of robot in spot welding.
- Explain procedure of robot maintenance.
- List various applications of Robots in manufacturing industries.
- Explain applications of robot in automated assemblies.
- Explain applications of Robot in automated inspections.
- Describe Arc welding application of robot.
- State any six common faults and their remedies in Robot.