Industrial Applications

Industrial Applications

- Objectives
  - Be acquainted with automation in manufacturing.
  - Understand Robot applications.
  - Recognize material-handling applications
  - Be familiar with processing operations
  - Be informed of assembly and inspection operations
  - Apprehend how to evaluate the potential of a robot application
  - Be aware of future applications
  - Perceive the challenge for the future
  - Be informed of innovations
  - Be acquainted with case studies.

Automation in Manufacturing

- Goal: To integrate various operations to :
  - Improve Productivity
  - Increase product quality and Uniformity
  - Minimize cycle times and effort
  - Reduce labor cost
- Computers allows us to integrate virtually all phases of manufacturing operations.
- Computer-integrated manufacturing(CIM): Is the computerized integration of all aspects of design, planning, manufacturing, distribution, and management.
- Automation Technologies:
  - Numerical Control(NC): capability of flexibility of operations, low cost, and ease of making different parts with lower operator skill.
  - Adaptive Control(AC): Continuously monitor the operation and make necessary adjustments in process parameters.

Automation in Manufacturing

- Flexible Manufacturing System(FMS): Integrate manufacturing cells into a large unit, containing industrial robots servicing several machines, all interfaced with a central host computer.
- Artificial Intelligence(AI): Involves the use do machines, computers and industrial robots to replace human intelligence.
- Expert Systems(ES):Intelligent programs to perform tasks and solve difficult real life problems.

- Hence the applications of Robots in manufacturing are much broader than most people realize.

Robot Applications

- Need to replace human labor by robots:
  - Work environment hazardous for human beings
  - Repetitive tasks
  - Boring and unpleasant tasks
  - Multishift operations
  - Infrequent changeovers
  - Performing at a steady pace
  - Operating for long hours without rest
  - Responding in automated operations
  - Minimizing variation

Industrial Applications(contd.)

- Industrial Robot Applications can be divided into:
  - Material-handling applications:
    - Involve the movement of material or parts from one location to another.
    - It include part placement, palletizing and/or depalletizing, machine loading and unloading.
  - Processing Operations:
    - Requires the robot to manipulate a special process tool as the end effector.
    - The application include spot welding, arc welding, riveting, spray painting, machining, metal cutting, deburring, polishing.
  - Assembly Applications:
    - Involve part-handling manipulations of a special tools and other automatic tasks and operations.
  - Inspection Operations:
    - Require the robot to position a workpart to an inspection device.
    - Involve the robot to manipulate a device or sensor to perform the inspection.

Material Handling Applications

- This category includes the following:
  - Part Placement
  - Palletizing and/or depalletizing
  - Machine loading and/or unloading
  - Stacking and insertion operations
- The robot must have following features to facilitate material handling:
  - The manipulator must be able to lift the parts safely.
  - The robot must have the reach needed.
  - The robot must have cylindrical coordinate type.
  - The robot's controller must have a large enough memory to store all the programmed points so that the robot can move from one location to another.
  - The robot must have the speed necessary for meeting the transfer cycle of the operation.

Material-handling(contd.)

- Part Placement:
  - The basic operation in this category is the relatively simple pick-and-place operation.
  - This application needs a low-technology robot of the cylindrical coordinate type.
  - Only two, three, or four joints are required for most of the applications.
  - Pneumatically powered robots are often utilized.

- Palletizing and/or Depalletizing
  - The applications require robot to stack parts one on top of the other, that is to palletize them, or to unstack parts by removing from the top one by one, that is depalletize them.
  - Example: process of taking parts from the assembly line and stacking them on a pallet or vice versa.

- Machine loading and/or unloading:
  - Robot transfers parts into and/or from a production machine.
  - There are three possible cases:
    - Machine loading in which the robot loads parts into a production machine, but the parts are unloaded by some other means.
      - Example: a pressworking operation, where the robot feeds sheet blanks into the press, but the finished parts drop out of the press by gravity.
    - Machine loading in which the raw materials are fed into the machine without robot assistance. The robot unloads the part from the machine assisted by vision or no vision.
      - Example: bin picking, die casting, and plastic moulding.
    - Machine loading and unloading that involves both loading and unloading of the workparts by the robot. The robot loads a raw work part into the process ad unloads a finished part.
      - Example: Machine operation
- Difficulties
  - Difference in cycle time between the robot and the production machine. The cycle time of the machine may be relatively long compared to the robot's cycle time.

- Stacking and insertion operation:
  - In the stacking process the robot places flat parts on top of each other, where the vertical location of the drop-off position is continuously changing with cycle time.
  - In the insertion process robot inserts parts into the compartments of a divided carton.

Processing Operations

- Processing Operations:
  - Robot performs a processing procedure on the part.
  - The robot is equipped with some type of process tooling as its end effector.
  - Manipulates the tooling relative to the working part during the cycle.
  - Industrial robot applications in the processing operations include:
    - Spot welding
    - Continuous arc welding
    - Spray painting
    - Metal cutting and deburring operations
    - Various machining operations like drilling, grinding, laser and waterjet cutting, and riveting.
    - Rotating and spindle operations
    - Adhesives and sealant dispensing

Assembly Operations

- Assembly Operations:
  - The applications involve both material-handling and the manipulation of a tool.
  - They typically include components to build the product and to perform material handling operations.
  - Are traditionally labor-intensive activities in industry and are highly repetitive and boring. Hence are logical candidates for robotic applications.
  - These are classified as:
    - Batch assembly: As many as one million products might be assembled. The assembly operation has long production runs.
    - Low-volume: In this a sample run of ten thousand or less products might be made.
  - The assembly robot cell should be a modular cell.
  - One of the well suited area for robotics assembly is the insertion of odd electronic components.
    - Figure illustrates a typical overall electronic assembly operation.

Inspection Operations

- Inspection Operation:
  - Some inspection operation require parts to be manipulated, and other applications require that an inspection tool be manipulated.
  - Inspection work requires high precision and patience, and human judgment is often needed to determine whether a product is within quality specifications or not.
  - Inspection tasks that are performed by industrial robots can usually be divided into the following three techniques:
    - By using a feeler gauge or a linear displacement transducer known as a linear variable differential transformer(LVDT), the part being measured will come in physical contact with the instrument or by means of air pressure, which will cause it to ride above the surface being measured.
    - By utilizing robotic vision, matrix video cameras are used to obtain an image of the area of interest, which is digitized and compared to a similar image with specified tolerance.
    - By involving the use of optics and light, usually a laser or infrared source is used to illustrate the area of interest.

Inspection Operations(contd.)

- The robot may be in active or passive role.
  - In active role robot is responsible for determining whether the part is good or bad.
  - In the passive role the robot feeds a gauging station with the part. While the gauging station is determining whether the part meets the specification, the robot waits for the process to finish.

Evaluating the potential of a Robot Applications

- Evaluation of the potential of the robot depends on:
  - Analysis of the application
    - Long- and short-term objectives
    - Manufacturing and processes involved
    - Space availability
    - Budget
    - System objectives
  - Feasibility Study
    - How a more automated system will affect related operations in the plant
    - Material-handling methods
    - Commercial equipment available
    - CAD cell simulation
  - System Proposal
    - Functional specifications
    - System operation
    - Robot type
    - Tooling
    - Peripheral equipment

- System Design
  - Microprocessor control
  - Software
  - Multiple levels of control
- Construction Phase
  - It is a good procedure for the system to be set up and thoroughly tested at the supplier's facility.
  - This will minimize the interruption of current production procedures.
- Installation Phase
  - It is a good practice for the supplier to supervise the step-by-step installation of the system.
- Training and Documentation
  - Hands on robot training should be provided by the supplier for all the persons who will interface with the new automated system.
  - The supplier should provide the design drawings and documentation for system control, operation, and maintenance.

Future Applications

- The keys areas to be explored for robot applications in future are:
  - The medical applications of the robot:
    - Routine examinations
    - Surgical procedures
  - Underwater applications
    - Involve prospecting for minerals on the floor of the ocean.
    - Salvaging of sunken vessels, repair the ship either at sea or in dry dock.
    - Mobile firefighters to be used by Air force and Navy.
  - Surveillance and Guard duty
    - In military
    - Power generating plants, oil refineries and other civilian facilities that are potential targets of terrorist groups.

- In summary, some future foreseen applications are listed as follows:
  - Aerospace
  - Agriculture
  - Construction
  - Health
  - Nuclear
  - Textile
  - Lab automation
  - Underwater surveying
  - Surveillance and guard duty
  - Navigation systems
  - Firefighting
  - Household robot
- Note: All these applications will need to be more intelligent in order to make rapid decisions based on current sensory information.