08/04/2024

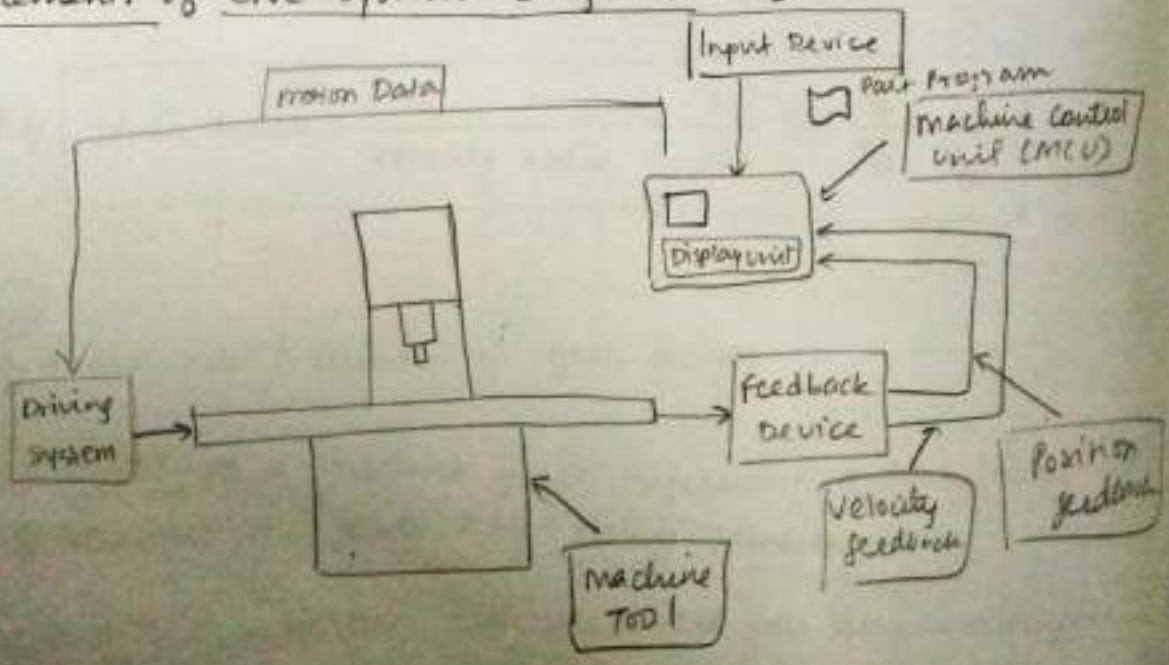
UNIT-3 : COMPUTER NUMERICAL CONTROL

→ Computer Numerical control or CNC is an advanced form of CNC systems where machine control unit is a dedicated microcomputer instead of a hardware controller.

→ Elements of a CNC system:

- Input Device.
- MCU or machine control unit
- machine Tool
- Driving system
- Feedback Devices
- Display Unit

Elements of CNC System Diagram (pg-3)



Input Devices:

Consists of -

→ USB (Universal Serial Bus) : USB flash drive transfers data to the control.

→ Serial communication: A serial comm port connects comp. system & CNC machine tool through an interface called RS-232. Through RS-232 cable, data is transferred from computer to CNC machine.

→ Ethernet communication: CNC machines are provided with ethernet card support. An ethernet cable transfers data from computer to CNC machine.

→ Conventional Programming: A built in intelligent software inside the controller enables the operator to ~~step~~ enter step-by-step data.

MCU or machine control unit.

Consists of -

- CPU (central processing unit)
  - CONTROL SECTION: that retrieves data from memory & generates signals which in turn activates all MCU components.
  - ALU (Arithmetic logic unit): that performs integer arithmetic operations & logical operations.
- Intermediate Access memory: holds the data & programs temporarily that is req. at that instant by control section.

→ CNC memory

- Main memory
  - ROM stores OS software & machine interface programs
  - RAM stores part programs
- secondary memory such as hard disks which is used to store large programs & can be used by main memory when required.

Machine Tool

→ consists of many axes (eg- X, Y, Z, A, B, C.

→ machine Tool control hardware components in the MCU control the position & velocity of each of the axes and rotational speed of the spindle.

Driving Systems

→ consists of amplifier circuits, drive motors, DC servo motors, AC servo motors, Stepper motors, linear motor, etc.

Feedback Devices

→ For the accurate operation of a CNC machine, the positional values & speed of the axes needs to be continuously updated which is done by feedback devices.

- Positional feedback devices
- Velocity feedback devices

Display Unit

Ex- monitor which displays current status of operation such as spindle RPM, running part program, etc.

Advantages of CNC machines

→ The accuracy and repeatability obtained is high.

→ Complex shaped contours can be machined.

→ Can be easily programmed to handle variety of product styles.

→ High volume production compared to conventional machines.

→ Avoids errors that were otherwise committed by humans operating conventional machines.

→ Reduces employees and costs since CNC machines can be programmed, one person can take care of multiple machines.

→ Using CNC machines results in a safer work environ

→ Can be upgraded to new tech.

Disadvantages of CNC Machines

→ Thorough programming knowledge is req. by the operators or programmers. Cost of labor can be high

→ Cost of a CNC machine is high compared to conventional machine Tools.

→ The spares of CNC are relatively costlier.

→ CNC machines require AC environment and/or a chiller unit. Thus extra costs are involved.

Q. (10M) Explain with a neat diagram elements of a CNC system.

4m - diag 6m - expl

Q. (6M) Discuss / Elaborate the adv & disadv of CNC machine

UNIT-3 : AUTOMATION IN MANUFACTURING

→ Automation is a technique that can be used to reduce costs and/or to improve quality.

→ Automation can increase manufacturing speed, while reducing costs.

→ Automation leads to products having consistent, good quality.

→ This technology includes:

- Automatic Assembly machines
- Industrial Robots
- Automatic materials handling and storage system
- Automatic inspection system and quality control.
- Feedback control and computer process control
- Computer system for planning, data collection and decision making to support manufacturing activities.

#TYPES OF AUTOMATION (10m)

→ Fixed automation

→ Programmable automation

→ Flexible automation

FIXED AUTOMATION

→ It is the automation in which the sequence of processing or assembly operations is fixed by equipment configuration.

→ In fixed automation, the sequence of operations are integrated in a piece of equipment. Therefore, it is difficult to automate changes in the design of the product.

→ It's used where high volume of production is required. Production rate of fixed automation is high.

Features:

→ High volume of production rates
→ Relatively inflexible in product variety
→ High initial investment for custom-engg. equipment
→ High production rates

Examples- Automobile Industries, machining transfer line and automated assembly machines

PROGRAMMABLE AUTOMATION

→ It is the automation in which the equipment is designed to accomodate various product config. in order to change the sequence of operations or assembly operations by means of control program.

→ Different types of programs can be loaded into the equipment to produce products with new configurations (i.e- new products)

→ It's employed for batch production of low & medium volumes.

→ For each new batch of different configured product, a new control program corresp. to the new product is loaded into the equipment. This automation is vel. economic for small batches of the prod.

Features :-

→ High investment in general purposes
→ Lower production rate than fixed automation
→ Flexibility & changes in prod. config.
→ Suitable for batch production

Examples- Industrial robot, NC machine tools

FLEXIBLE AUTOMATION

→ A computer integrated manufacturing system which is a extension of programmable automation is referred as flexible automation.

→ It's developed to minimize time loss b/w changeover of batch production from one product to another while reloading.

→ The program to produce new products and changing the physical setups i.e- it produces diff products with no loss of time.

→ This automation is more flexible in interconnecting workstations

Features:

→ High investment for a custom engg. system

→ med^m production rate

→ Flexibility to deal with prod design variation

→ Continuous prod. of

Advantages of Automation

1) High Production rates
2) dead time ↓es
3) Storing cap. ↓es
4) Human errors are eliminated.
5) Labour cost ↓es.

Disadvantage of Automation

1) Initial cost of raw material is very high.
2) High maintenance cost
3) High skilled labour req.
4) Indirect cost for R&D

ROBOTICS

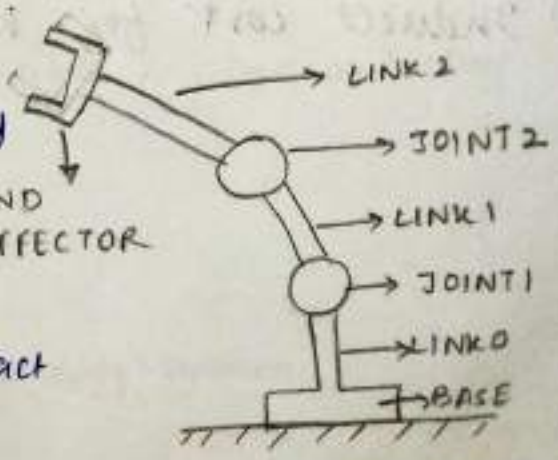
→ A robot is a reprogrammable, multifunctional manipulator designed to move materials, parts, tools or specialized devices through variable programmed motions of performance of a variety of tasks.

→ Robotics can be defined as a field of tech. that deals with the conception, design, construction, operation and applications of robots.

6M

Basic Terms Related to Industrial Robot

1) Manipulator: Arm like mechanism which is designed to manipulate / move materials, parts or tools without direct human contact



2) Joint: It's the one that integrates 2 or more links to provide controlled relative movement between input link and output link.

3) Link : It's a rigid member that connects joints. It can be input link & output link

4) Degrees of freedom : It describes robot's freedom of motion in 3-D space. (36 degrees)

5) End Effector : aka end-of-arm tool is the device at the end of the robotic arm which is shaped like a hand.

6) Base : The support of the robot arm is the base

Q: With a neat diagram, explain basic terms related to industrial robot. (6-8 marks). ↕ DIFF QNS

Q: Explain in detail elements of a robotic system. (8M)

Elements of a Robotic System

1) The Robot : consists of

- The manipulator which includes the base & arm (arm assembly)
- End of the arm tooling which is the end-effector
- Actuators which convert stored energy to movement. Common actuators include elec motors & linear actuators.
- Transmission elements such as ball screws, pulleys, belts, gears, etc.

) Control system : It generates the req. signals to co-ordinate and execute the robot movements.

The control system comprises of:

- Controls such as mech. control, hydraulic control, pneumatic control, electrical / electronic control. The control techniques can be an open-loop (non-servo) control, feedback control, feed forward control & adaptive control.
- Sensors that allows robot to collect info. about a certain measurement of the environment or internal components. Can be touch / vision sensor.
- Equipment Interfaces

3) Computer Sources : It is used to program the robots acc. to the tasks req. to be performed. The necessary software must be installed in comp to develop comp programs.

4) Power Source : It supplies electrical energy to the robot. The commonly used power source is the battery which can be a lead-acid battery or a silver-cadmium battery.

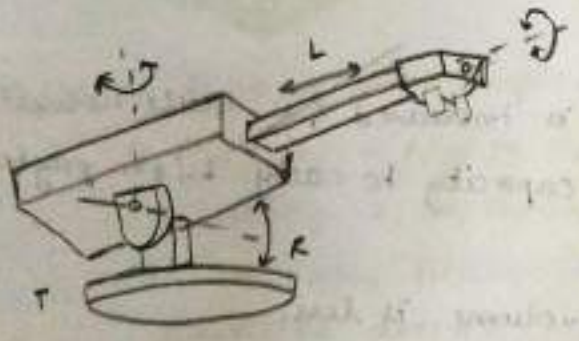
Q. With a neat sketch, explain classification & Robot config

Classification based on Robot config:

1) Polar configuration
2) Cylindrical configuration
3) Cartesian configuration
4) Joint arm configuration

Polar config / spherical config

→ consists of a sliding arm (L-joint) that is actuated relative to the body & a rotational base along with a pivot, which can rotate about a horizontal axis (R-joint) and the vertical axis (T joint)



Applications:

Die casting, forging, injection moulding, dip coating, cleaning of parts, etc.

Advantage: Long reach capability is not realised in the horizontal pos^n

Disadvantage: Vertical reach is low.

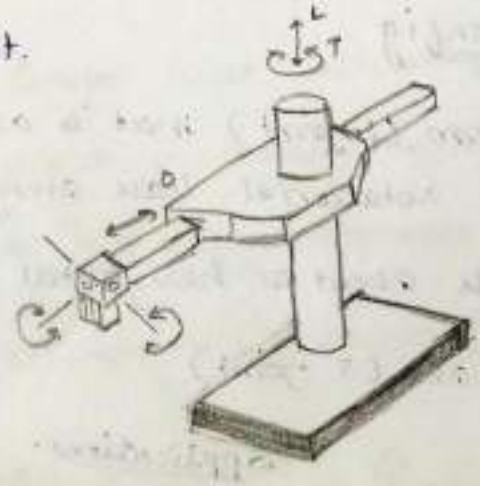
Cylindrical configuration

→ consists of a slide in the horizontal pos^n & a column in the vertical position.

→ The arm assembly moves up or down relative to the column using as L-joint.

→ The column is rotated by about its axis using the T-joint.

→ The radial movement of the arm is achieved using the O-joint.



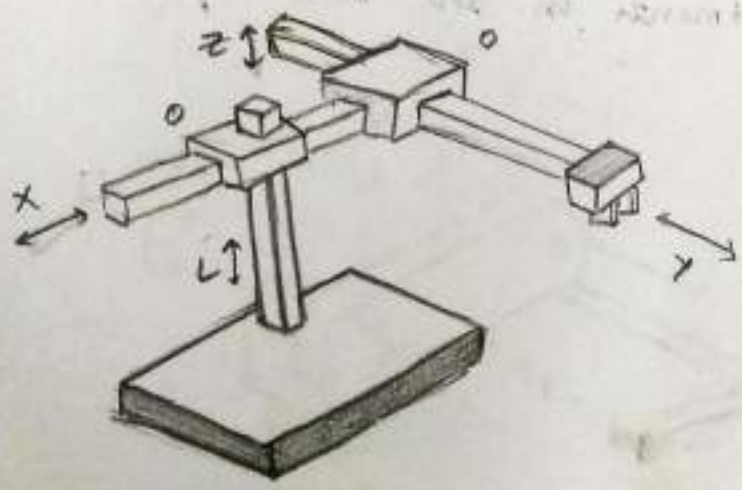
Advantages: 1. Rigidity is increased & is quite robust.
2. Has the capacity to carry high payloads.

Disadvantages: 1. Work volume is less.
2. Occupies more floor space.

Applications: Foundry & forging appl., investment casting, conveyer pallet transfers, machine loading & unloading

Cartesian Co-ordinate Robot

- aka XYZ Robot aka Rectilinear robot.
- consists of 3 sliding joints along the X, Y, Z dir^{n}s in 3-D space.
- There are 2 orthogonal joints
- Since, the movement can stop & start simultaneously along X, Y, Z axis, the motion of tool tip is smoother.



Advantages: 1. Allows for simpler controls
2. Possesses a higher degree of mech. rigidity, accuracy & repeatability
3. Can carry heavy loads & weight lifting capacity doesn't vary within work envelope.

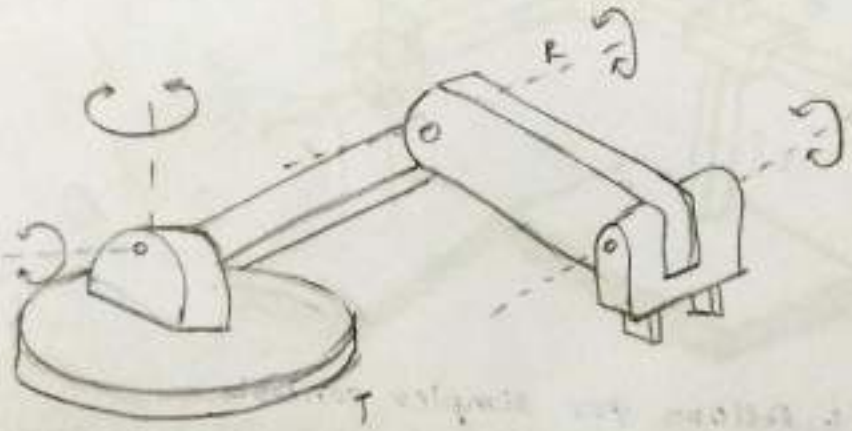
Disadvantages: 1. Limited in their movement to a small and rectangular work space
2. Reduced flexibility

Applications: To perform pick & place tasks, material handling, loading/unloading and machine operations.

Jointed - Arm Config

→ Resembles human arm where the column swivels about a base (column & base form the T-joint), the column top connects to the shoulder through a shoulder joint (which is the R-joint). and the shoulder connecting to the elbow through an elbow joint (which is also an R-joint).

→ Thus, this config. has the capability to be controlled at any adjustments in the work space.



Advantages: 1. Work volume available is large
2. Quick operation
3. Increased flexibility

Disadvantages: 1. Operating procedures are difficult.
2. Quite expensive type of configurations
3. No. of components involved are more.

Applications: To perform arc welding, spot welding and spray painting operations

Explain in detail appl. of robot.

Qn. Explain adv. of robot.

Applications of Robots