Robot Programming

→ A robot Programming can be defined as a path in space to be followed by the manipulator, combined with peripheral actions that supports the work cycle.

→ There are three programing methods for programing.

(1) Lead through programming.
(2) Compulir like robot Programming.
(3) off-line programming.

(1) Lead through programming:

→ In Leadthrough programing, the task is taught to the robot by moving the manipulator through the required motion cycle, simultaneously entering the program into the Controler memory for subsequent playback.

→ There are two methods of performing the leadthrough teach Procedure (1) Powered lead through
(2) Manual lead through.

→ Powered lead through is commonly used as the Programing method for playback robots with point-to-point control. It involves the use of a teach pendent that has toggle switches and contact buttons for controlling the movement of the manipulator joints.

→ Using the toggle switches or buttons, the programmer Power drives the robot arm to the desired positions, in sequence, and records the positions into memory. During subsequent Playback, the robot moves through the sequence of positions under its own power.

→ Manual leadthrough is convenient for programming Playback robots with continuous path control where the continuous path is an irregular motion pattern such as in spray painting.

→ This programing method requires the operator to physically grasp the end-of-arm or the tool that is attached to the arm and move it through the motion sequence, recording the path into memory.

Advantages & Disadvantages:-

→ The advantage of leadthrough methods is that they can be readily learned by shop personnel.

→ It is not necessary for the robot Programmer to possess the knowledge of computer programming.

Disadvantages:-

→ Regular production must be interrupted during the leadthrough programming procedures.

→ It must be used for long production run.

→ Less decision making capability.

→ Not compatable with CAD/CAM.

Robot Programming languages :-

→ Advantages over Leadthrough:

(i) enhanced sensor capabilities, including the use of analog as well as digital inputs and outputs.

(ii) improved output capabilities for controlling external equipment

(iii) Program logic that is beyond the capabilities of Leadthrough methods.

(iv) Computations and data Processing similar to computer programing language.

(v) Communication with other computer system.

→ Motion programming:-

→ It consists of the textual statements and leadthrough techniques.

→ The textual statements are used to describe the motion, and the leadthrough methods are used to define the position and orientation of the robot during or at the end of the motion.

Basic motion statement.

MOVE P1.

* It commands the robot to move from its current Position to a position and orientation defined by the variable name P1.

* The point P1 must be defined by powered leadthrough or manual leadthrough to place the robot at the desired Point and record that point into memory.

HERE P1.

LEARN P1.

Above commands are used in the Leadthrough Procedure to indicate the variable name for the point.

→ The set of joint positions / co-ordinates are recorded in the robot's control memory.

e.g (236, 158, 65, 0, 0).

joint position. → wrist joint position.

MOVES P1.

move by using straight line interpolation.

DMOVE (4, 125).

D = Delta move / incremental move.

New position (236, 158, 65, 125, 0, 0).

APPROACH P1, 40 MM.

MOVE P1.

DEPART 40MM

→ A path in a robot program is a series of points connected together in a single move.

DEFINE PATH123 = PATH(P_1, P_2, P_3).

MOVE PATH123

SPEED 75.

SPEED 0.5MPS.

EXECUTE PROGRAM1.

indicates that the program named PROGRAM1 is to be executed by the robot at a speed of 0.5 m/sec.

Interlock and sensor commands :-

WAIT & SIGNAL.

WAIT 20, ON.

It would cause program execution to stop at this statement until the input signal coming into the robot controller at Port 20 was in an 'on' condition.

SIGNAL20, ON.

It would switch on the signal at output Port 20, perhaps to actuate the start of an automatic machine cycle.

OPEN → It cause the gripper to actuate to fully open.

CLOSE → It cause the gripper to actuate fully close.

Computation & Program Logic :-

→ Many robot languages posses capabilities for performing computations and data processing operations that are similar to computer programing languages.

GOTO 150

& IF (logical expression) GOTO 150.

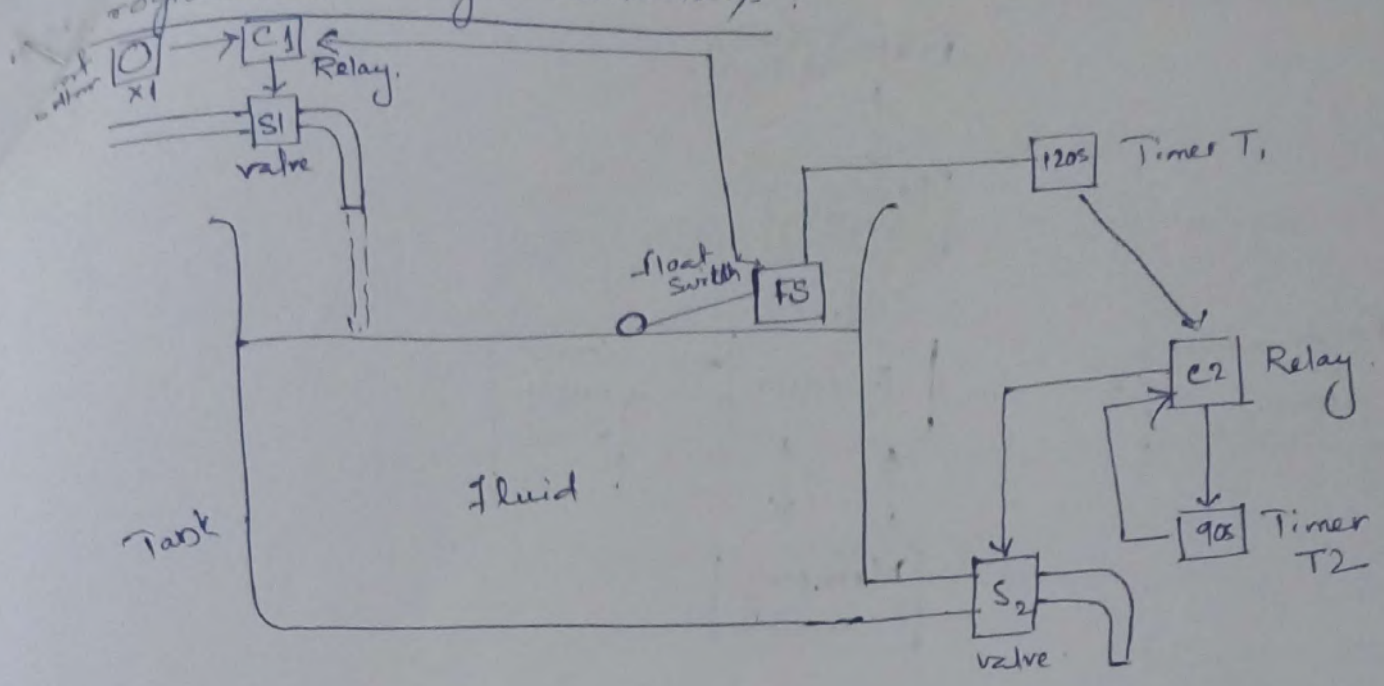
It cause the program to branch to some other statement in the program.

Off-line programming :-

→ The dis advantage of lead through and textual programming is that the robot must be taken out of production for a certain length of time to accomplish the programming.

→ Off-line programming permits the robot program to be prepared at a remote computer terminal and downloaded to the robot controller for execution without interrupting production.

Programmable Logic Controllers :-



PLC :-

→ A programmable logic controllers can be defined as a microcomputer-based controller that uses stored instructions in programmable memory to implement logic, sequencing, timing, counting for controlling machines and processes.

→ PLC applications are found in both the process industry and discrete industries to control individual machines, machine cells, transferlines, material handling equipment and automated storage system.

→ Before the PLC, hard wired controllers composed of relays, coils, counters, timers and similar components were used to implement this type of industrial control.

Advantages of PLC :-

→ Programming the PLC is easier than wiring the relay control panel.

→ PLC can be reprogrammed where as conventional controls must be rewired.

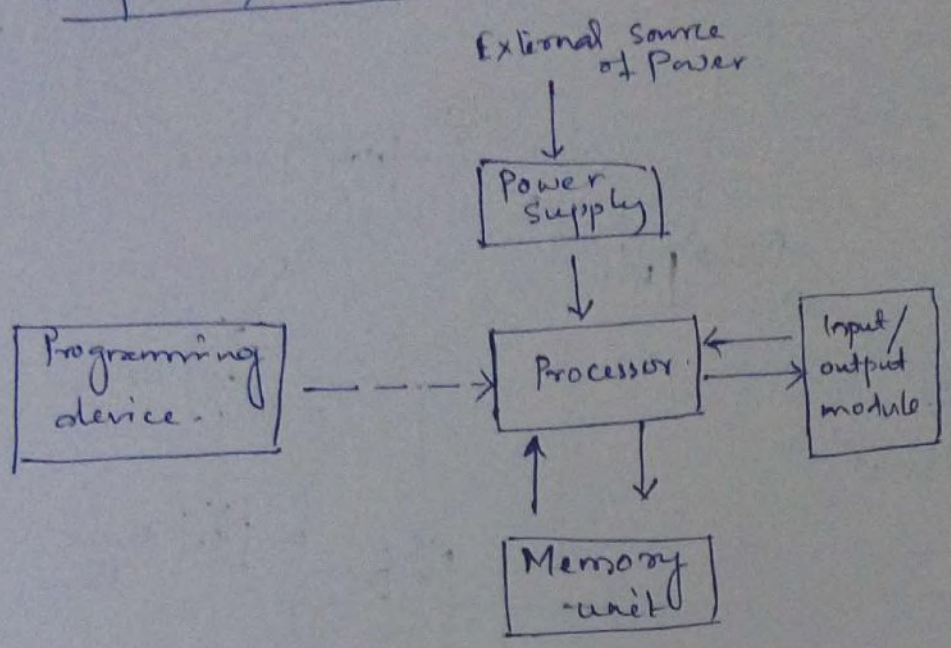
→ PLC takes less floor space than relay control panels.

→ Reliability is greater and maintenance is easier.

→ PLC can be connected to computer system more easily.

→ PLC can perform greater variety of control functions.

Components of PLC :-



(i) Processor. (ii) Memory unit (iii) Power supply (iv) I/O module (v) Programing device.

(i) **Processor** :- It is the central Processing unit (CPU) of the programmable controller. It executes the various logic and sequencing functions by operating on the PLC inputs to determine the appropriate output signals.

(ii) **Memory unit** :- It contains the Programs of logic, Sequencing and I/O operations. It also holds the data file associated with these programs including I/O status bits, counter and timer constants and other variables.

(iii) **Power Supply** :- A 115V ac is typically used to drive the PLC. The power supply converts the 115V ac into direct current (dc) voltages of ±5V.

(iv) **I/O module** :- It provides the connections to the industrial equipment or process that is to be controlled.

(v) **Programming device** :- The PLC is programmed by means of a Programing device. The Programming device is usually detachable from PLC cabinet so that it can be shared among different controller.

Material transport systems

→ **Material handling:-** It is defined as the movement, storage, protection, and control of materials throughout the manufacturing and distribution process including their consumption and disposal.

→ The handling of materials must be performed safely, efficiently, at low cost, in a timely manner, accurately and without damage to the materials.

→ The cost of material handling is around 20-25% of manufacturing cost.

→ 'Logistics' word commonly used for larger system transport system.

→ Logistics can be devided into external logistics and internal logistics

→ External logistics is concerned with transportation and related activities that occurs outside of a facility.

→ Internal logistics are popularly known as material handling, which involves the movement and storage of materials inside a given facility.

Material handling equipments:-

→ It can be classified into four catagories.

(i) Material transport equipment.
(ii) Storage system.
(iii) Unitizing equipment.
(iv) Identification and tracking system.

→ **Material transport equipment:-** Material transport equipment is used to move materials inside a factory, warehouse or other facility. The five main types of equipments are (a) Industrial trucks (b) Automated guided vehicles (c) Rail-guided vehicles (d) Conveyors (e) hoists & Cranes.

Storage System:

→ Storage methods and equipments can be classified into two major catagories (i) Conventional storage methods.
(ii) Automated storage system.
- → Automated storage / retrieval system.
- → Carousel systems.

Utilizing Equipment:

→ The term utilizing equipment refers to (i) Containers used to hold individual items during handling. (ii) Equipment used to load and Package the containers.

Containers → Pallets, boxes, baskets, barrels, pails, drums.

Identification and tracking system:

→ Material handling must include a means of keeping track of the materials being moved or stored.

→ This is usually done by affixing some kind of label to the item, carton or unit load that uniquely identifies it.

Design considerations in Material Handling:

→ Design of the system depends on the materials to be handled, quantities and distance to be moved, type of production facility served by the handling system and the budget.

→ Material characteristics:
- physical state → Solid, liquid, gas
- size → volume, length, width, height.
- weight → weight/piece, weight/unit vol.
- Shape → Long and flat, round, square
- condition → Hot, cold, wet, Dirty
- Risk of damage → fragile, brittle,
- Safety risk → Explosive, flammable, toxic, corrosive etc.

→ Flow rate, Routing & scheduling :-

(i) quantities & flow rates of materials to be moved
(ii) routing factory
(iii) scheduling of the moves.

→ Plant layout :-

→ Process layout
→ Product layout
→ fixed layout

→ Unit load principle :-

→ A unit load is simply the mass that is to be moved or otherwise handled at one time.

→ The unit load consist of only one part, a container loaded with multiple parts.

Material transport equipments :-

1. Industrial trucks (manual or powered)
2. Automated guided vehicle
3. Mono rail and other rail-guided vehicle
4. Conveyors.
5. Cranes and hoists.

1. Industrial trucks :-

→ It can be of two types → non powered / manual. → Powered.

→ The non powered types are often referred to as hand trucks because they are pushed or pulled by the human workers.

→ Quantities of material and distances traveled are relatively low.

→ Powered trucks are self-propelled to relieve the worker having to move the truck manually.

→ Common types of powered trucks
(a) walkies trucks
(b) forklift rider trucks.
(c) towing tractors.

Automated Guided vehicles:-

→ An automated guided vehicle system (AGVs) is a material handling system that uses independently operated, self-propelled vehicles guided along defined pathways.

→ The vehicles are powered by on-board batteries that allow many hours of operation (8-16 hrs).

→ AGVs are suitable for batch production and mixed production.

Types of vehicles:-

(i) Driverless trains.
(ii) Pallet trucks.
(iii) unit load carriers.

AGVs applications:-

(i) Driverless train operation.
(ii) storage & distribution
(iii) Assembly line application.
(iv) flexible manufacturing system.

Vehicle Guidance Technology:

→ The guidance system is the method by which AGVs pathways are defined and vehicles are controlled to follow the pathways.

→ There are three commercial systems

(i) imbedded guide wires

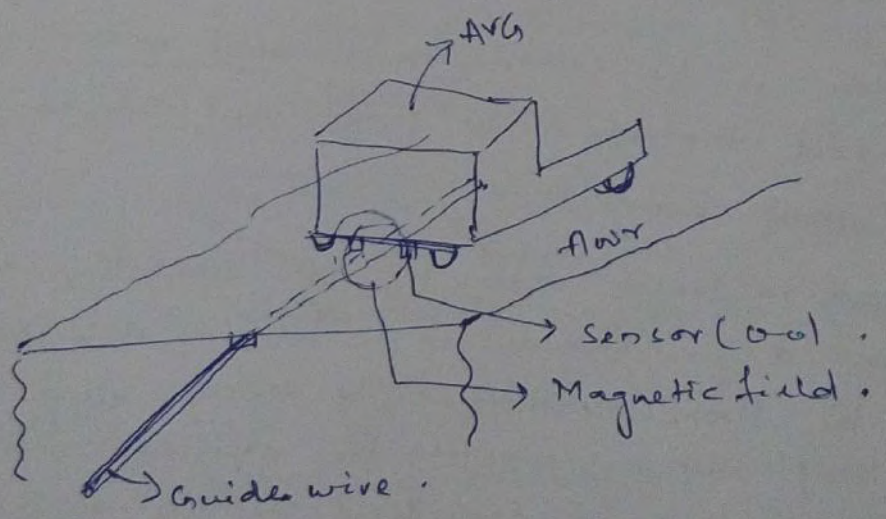
(ii) Paint strips

(iii) self-guided vehicles

→ In imbedded guide wire method, electrical wires are placed in a small channel cut into the surface of the floor.

→ The channel is typically 3-12mm wide and 13-26mm deep.

→ The guide wire is connected to a frequency generator which emits a low-voltage, low-current signal with a frequency in the range 1-15kHz. This induces a magnetic field along the pathway that can be followed by sensors on board each vehicle.



→ When the vehicle approaches a branching point where the guide path forks into two or more pathways, the vehicle must have a means of deciding which path to take.

→ There are two methods of making this decision.

(i) The frequency select method.

(ii) The path switch select method.

→ In frequency select method, the guide wires leading into the two separate path at the switch have different frequency.

→ As the vehicle enters the switch, it reads an identification code on the floor to determine its locations.

→ The path switch select method operates with a single frequency throughout the guidepath layout.

→ To control the path of a vehicle at a switch, the power is turned off in all other branches except the one that the vehicle is to travel.

→ When paint strips are used to define the pathway, the vehicle uses an optical sensor system capable of tracking the paint. The strips can be taped, sprayed or painted on the floor.

→ Self-guided vehicles (SGVs) represent the latest AGVs guidance technology. SGVs operate without continuously defined pathways.

→ They are the combination of dead reckoning and beacons located throughout the plant that can be identified by on-board sensors.

→ Dead reckoning refers to the capability of a vehicle to follow a given route in the absence of a defined pathway in the floor. Movement of the vehicle along the route is accomplished by computing the required number of wheel rotations in a sequence of specified steering angles. The computations are performed by the vehicle's on-board computer.