MID TERM EXAM REVIEW SOLUTION

Answer the following questions in your own words.

Q1. What are the key elements of robotic manipulator that are used to define the basic configurations of robots? Why do we need a manipulator of different configurations? [5]

The basic configuration of a robot manipulator depends on the following elements:

Degrees of freedom: Independent movement of each joint or link

Type of joint: linear, revolute, spherical, and cylindrical

Number of links: total number of links (generally, each robot has 3-6 links)

Length of the link: determine the reaching area or the size of the work envelop

Permissible Coordinate system: Allow the motion of each link in different axes

Each configuration of robots because of its unique characteristics is very useful to address the large range of industrial applications such as pick and place, assembly, welding, machining, tool handling, painting etc.

Q2. How many types of robotic configuration are available in the industries (choose any four)? Write down the industrial applications (at least 03) of each configuration? [5]

Revolute configuration: The robot performs in an irregularly shaped work envelope and has a long, flexible reach. This configuration also becomes less stable as the arm approaches its maximum reach. Some applications are: pick and place, handling of tool, Assembly operation.

Cartesian configuration: Movement can start and stop simultaneously along all three axes, resulting in smoother motion of the tool tip. The robot can carry heavy loads, but it is generally limited in movement to a small, rectangular work space. Some applications are: Assembly operation, handling of machine tools, Palletizing

Cylindrical configuration: This configuration produces a larger work envelope than a Cartesian configuration. Overall mechanical rigidity is reduced. Typical industrial applications are: pick and place, assembly, handling machine tools

Spherical configuration: This configuration provides a larger work envelope than the Cartesian or cylindrical configurations. The design is simple and provides good weight lifting capabilities. Vertical movement is limited. Some applications are: Glass handling, part handling, dip coating etc.

Q3. Why do we prefer the high-level programming language for robots and how can we convert the high-level programming language to machine language? List the names of some common Robotic Programming languages (any 05). [5]

High-level languages are programming languages that more closely resemble Standard English than other programming languages. It makes them easier for people to use. High-level languages are translated into machine code that computers can understand by means of a program called a compiler. Some common robot programming languages

1. Karel (Fanuc Programming)
2. PAC (Denso Programming)
3. VAL (Variable Assembly Language)
4. MCL (Manufacturing Control Language)
5. SAIL (Stanford Artificial Intelligence Language)

Q4. Define task level programming and give some of the advantages of task level programming? Give some examples (at least 03) of task level Functions of your third round's Robot. [5]

In task-level programming the user specifies the goals of each task rather than the motions required to achieve those goals. Instructions are entered using simple English-like terms. Many activities are programmed automatically by the computer. Task-level programming is a highly efficient method that replaces hundreds, even thousands, of lines of programming code with a small number of statements selected from menus. The need for programming knowledge is reduced. Programming software has become so user-friendly that even inexperienced programmers can program a robot.

Some Task Level Functions are

Robot Movement (MOVE)

Calling other program (CALL)

Repeating program (Loop)

Palletizing

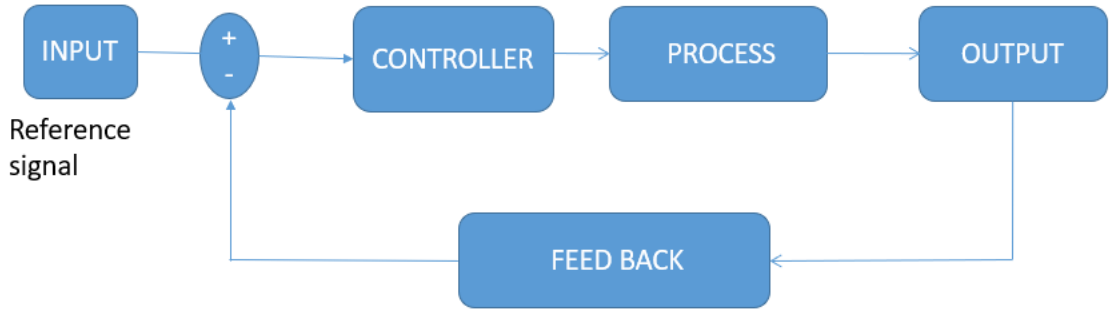
Q5. What are the two types of control systems? Give at least 03 examples of each system. What is the main difference between non-servo and servo robotic control system? [5]

There are two type of control system: Open loop control and close loop control system.

Open loop control system:

In an open loop control the output is independent and not connected with the input. Open loop depends on time slice in which each action is divided in set of times to produce the desire results. Examples are automated washing machine, Electric Dryer, Microwave etc.

Open loop control system can be converted in to closed loop control system by providing a feedback.

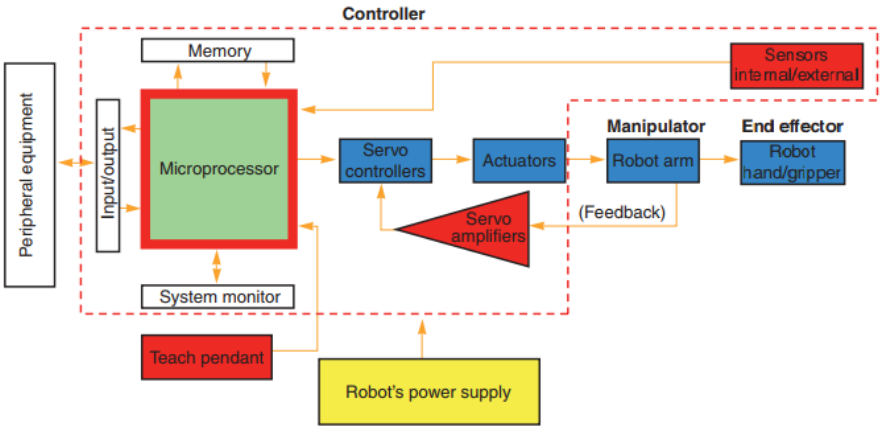


Feedback system takes the information from the output and feeds to the controller for necessary change to achieve the desired output.

Robots may use one of two control systems: non-servo and servo. Non-servo robots use an open loop system in which no feedback mechanism is used to compare programmed positions to actual positions. Servo robots use a closed-loop system that allows feedback to affect the output of the robot.

Q6. Explain the servo robot and servomechanism. Show the components of servomechanism and explain it briefly. [5]

Servo robots are considered closed-loop systems. In a servo robot system, the feedback signal is sent to the servo amplifier affects the output of the system. Servo amplifiers are used in motion control systems where precise control of position or velocity is necessary. Errors in positioning and movement are detected and corrected in each cycle.



Components of servomechanisms are:

Microprocessor: manage the process and gives input instruction to the servo controller

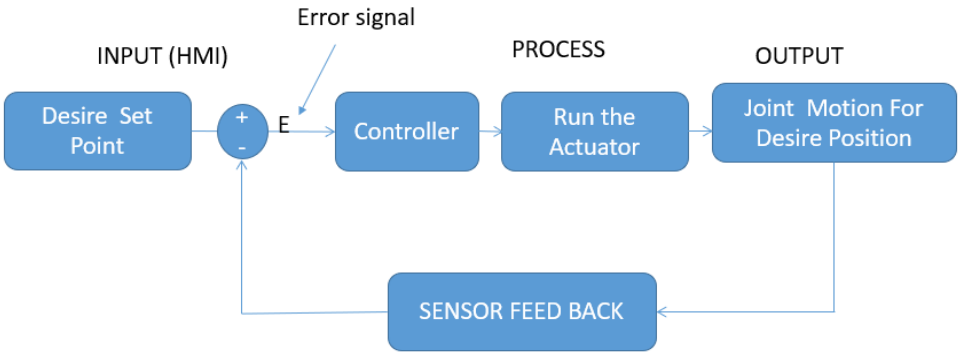
Servo Controller: Receive an input signals from the microprocessor and compare it with a servo amplifier signal and send a resultant signal to the actuators

Servo Amplifiers: A servo amplifier receive the feedback signals and translates the signals into motor voltage and current signals.

Actuator: Receive the signals from the controller to produce motion linearly or rotary

Sensors: Incremental encoder generate electrical pulses in correspondence to the displacement and speed of the motor.

Q7. Sketch the diagram of a robotic arm close loop system, identify the key elements and briefly explain the controlled process. [5]



Closed-loop system has automatic correction control system. System allows the interaction between the system output and input. The key elements are:

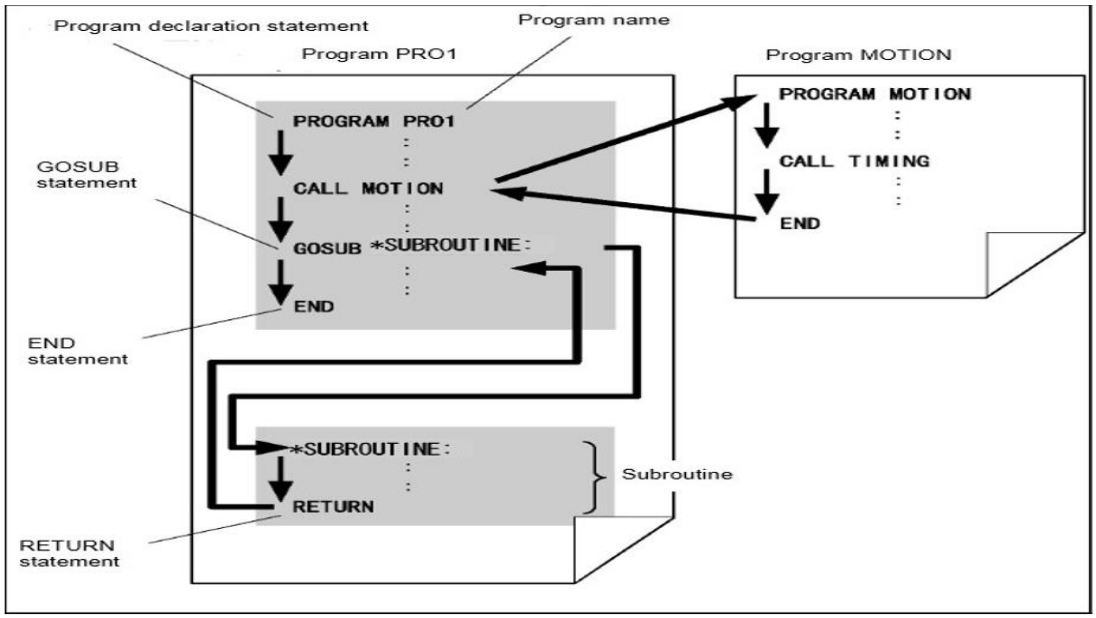
Input : Desired set point or position
Comparator (+/-): compares feedback signal to an input signal and send an error signal to control unit
Controller: Receive an error signal and actuate an actuator according to the error signals
Actuator: Any actuator generally electric motor to move the joints
Output: Achieved position or current position
Feedback: provides information using sensors (encoders) about the actuator position and speed
E: Error signal (difference between the desired position and the current position)

Q8. Differentiate between subroutines and sub procedures. Give one example of using subroutine and one example of using sub procedure based on the lab robot.

[3]

Subprogram is a separate program which is called inside the main program. Subroutines is the set of codes or program instructions which is written inside the main program under the name of a subroutine. All subroutines must have return statement.

Following example is showing the difference between sub procedure and subroutines (Note: student will use their own program example)



Q9. Differentiate between joint coordinate system and world coordinate system. Which coordinate system is more feasible for teaching the robot? Which coordinate system support MOVEJ motion? [3]

Joint coordinate system allows independent movement of each joint. Joint coordinate is used to achieve the precise position in each axis of the movement.

In world coordinate system the position of the tool is defined by the values of the three Cartesian coordinates X,Y and Z. The changing of values of one of these coordinates (X, Y or Z) causes the robot to move several of its joints at the same time. The world coordinate system is more feasible for teaching the robot because its move the tool in any specific direction (x, y or z).

MOVEJ command is the type of controlled motion which is available in both coordinate system

Q10. Describe different type of robotic motions (MOVE J, MOVE L, MOVE C and reduced accuracy)? Which type of motion is fast but less accurate? [4]

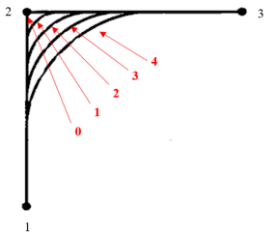
MOVE J: Controlled, Point to point but not precise, path is not accurate

MOVELL: Controlled, Linear movement, very precise.

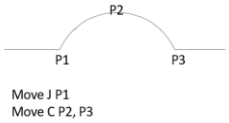
MOVEC: Controlled circular motion

Reduced accuracy: controlled, cut the corner or reduced accuracy

MOVEJ motion is fast but less accurate.



Reduced Accuracy



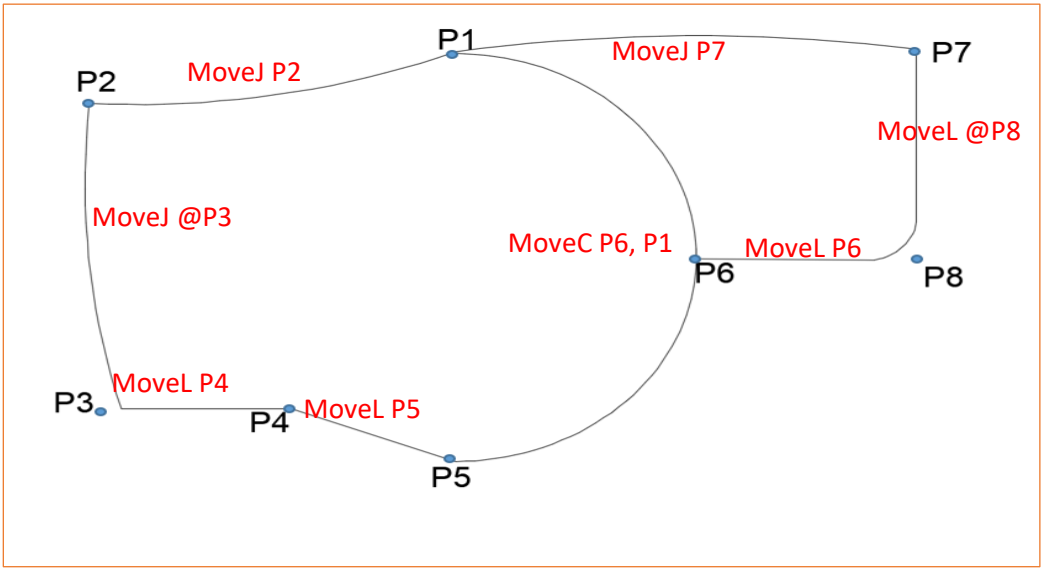
Circular

Linear

Point to Point (MoveJ)

Q11. Assume your robot is tracing the following positions as shown below. Choose the correct type of motion for each point (P1-P8). [5]

For Denso Robot



Good Luck

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