Experiment No: 3

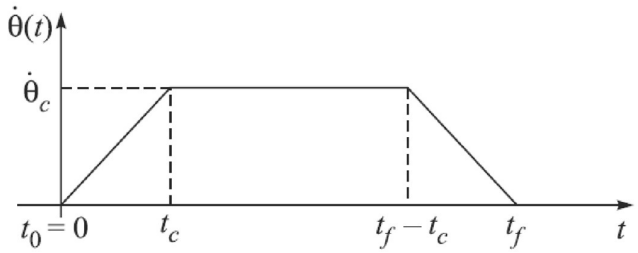
Experiment Name: Joint space trajectory planning

Objective:

It is desired to have the first axis of a 5-axis robot go from an initial angle of 30^0 to a final angle of 75^0. Verify time taken for the operation for different values of acceleration and velocity.

Theory:

Joint space trajectory generation is common usage in robotics to provide smooth, continuous motion from one set of joint angles to another, for instance, for moving between two distinct Cartesian poses for which the inverse pose solution has yielded two distinct sets of joint angles. Kinematics equations are used to compute the time theoretically.



Trapezoidal velocity profile

Procedure:

1. Set the values to the 5-axis robot arm as given in the problem definition.
2. Operate the robot and calculate the time taken from its start point to goal point using a stop watch.
3. Take about a set of five observations by repeating procedure number 2
4. Obtain these values theoretically (*refer calculation) also and compare both of the values.
5. Repeat above steps for different values of acceleration and velocity.
6. For pick and place operation do above steps for each joint of robot.

Calculation:

Sample code:

* Values if joint variables in above blockly code are not matching with the objective. The code is only for format reference.

Given

Initial point, $\theta_s = 30^0$

Final point, $\theta_f = 75^0$

Acceleration, $\ddot{\theta} = 20^0 / s^2$

Maximum velocity, $\dot{\theta}_{max} = 20^0 / s$

Initial velocity, $\dot{\theta}(0) = 0$

Final velocity, $\dot{\theta}(f) = 0$

During acceleration and deceleration, time taken is the same.

$$t_c = \frac{\dot{\theta}_{max}}{\ddot{\theta}} = \frac{20}{20} = 1\ s$$

During acceleration distance is given by

$$\theta(t_c) = \dot{\theta}(0)t + \frac{1}{2}\ddot{\theta}{t_c}^2 = \frac{1}{2} \times 20 \times 1^2 = 10$$

During deceleration, distance is given by

$$\theta(t) = 20 \times 1 - \frac{1}{2} \times 20 \times 1^2 = 10$$

Therefore, distance covered with uniform velocity = 45-10-10 = 25 °

Time taken to cover distance traveled with uniform velocity

$$= \frac{25}{\dot{\theta}_{max}} = \frac{25^0}{20^0/s} = 1.25s$$

Total time = $t_c + t_{const\ vel} + (t_f - t_c)$ = 1+1.25+1 = 3.25 s

Calculated value = 3.25s

*Practical readings noted by actual time taken by the manipulator joint to cover the angle.

Observation:

	Sl No	Time				
		J1	J2	J3	J4	J5
Practical readings	1.					
	2.					
	3.					
	4.					
	5.					
Average time						
Calculated time						

Graph:

Result: