CR employment exam

Manipulation

Ver1.0

Here is the specs about a SCARA type robot "Dobot M1".
We call the joints as J1, J2, J3, J4 (J1: Z-axis screw, J2: Rear arm, J3: Fore arm, J4: End-effector)

In this exam, we use right handed coordinate system, and rotation angles(rx,ry,rz) is XYZ fixed angle; roll, pitch,yaw, units are mm and deg.

Catch errors such are against the specs, and handle them appropriately showing them when they happen.

Q0. Setting up Base Coordinate

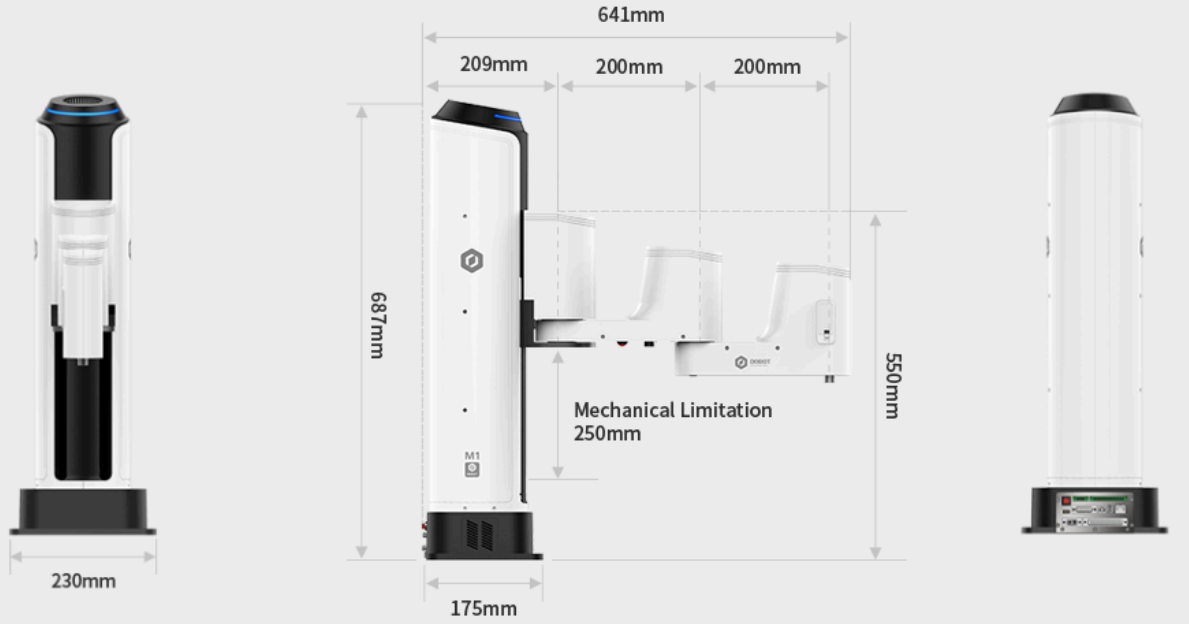
Set up base coordinate of this robot and show it visually.

Q1. Kinematics

Let displacement of Joins(j1,j2,j3,j4) and Tool offset(x,y,z,rx,ry,rz) be as inputs, and get outputs of Position and Orientation (x,y,z,rx,ry,rz) about Tool Center Point(TCP) and each joint.

Q2. Inverse Kinematics

Get outputs as displacement of joints(j1,j2,j3,j4) from Tool Offeset and TCP as inputs.



SPECIFICATIONS

Reach	400 mm		
Payload	1.5 kg		
Maximum magnitude :	Type	Mechanical limitation	Software limitation
	Rear arm	-90°- 90°	-85°- 85°
	Forearm	-140°-140°	-135°- 135°
	Z-axis screw	0mm- 250mm	10mm- 235mm
	End-effector rotation	unlimited	-360°- 360°
Maximum speed :	Joint speed of Forearm and Rear Arm and End-effector		180°/s
	Resultant speed of the Forearm and Rear Arm		2000 mm/s
	Speed of Zaxis		1000 mm/s
Repeatability :	0.02 mm		
Input Requirements of Power Adapter :	100 -240 V, 50/60 Hz		
Communication interface :	Ethernet, RS-232C		
I/O :	22 digital outputs, 24 digital inputs, 6 ADC inputs		
Software :	M1 Studio		
System :	Linux		

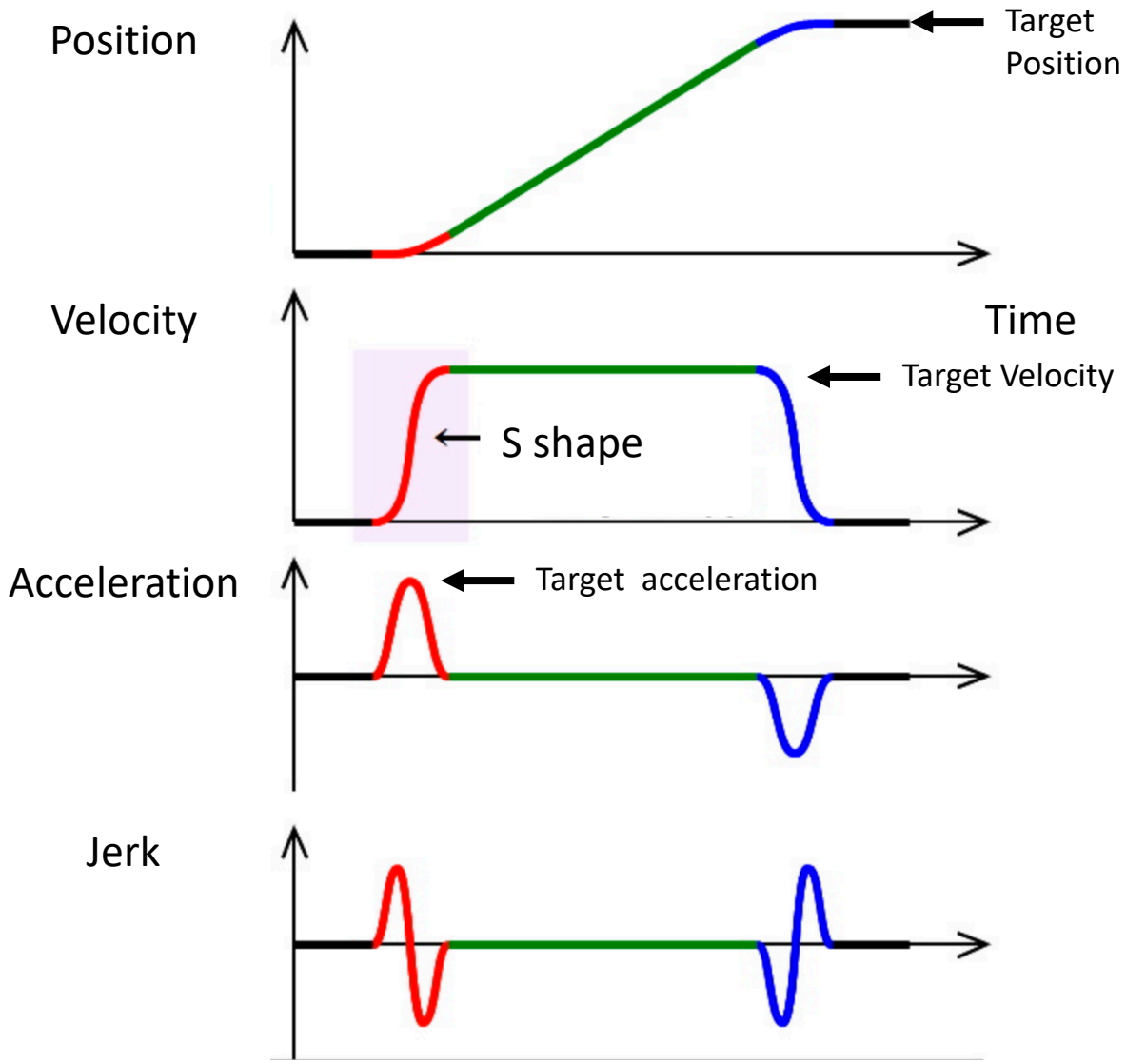
Q3. Velocity and Acceleration Profile

Let’s think about position control of a manipulator.
We’ll send a command by certain time cycle, adjusting Position, Velocity, and Acceleration according to the time sequence like right graphs.
If a target velocity exceeds the maximum, limit it at the maximum.
Now we set the time cycle as 0.01 second and make a program with such inputs and outputs.

Inputs: Target Position, Target Velocity, Maximum Velocity, Target Acceleration

Outputs: Position, Velocity, Acceleration, Jerk on each time cycle, and their graphs.

Show sample results of a set of inputs and outputs.
And enable users to test other combination.



Q4. PTP

We want to make a PTP command for Dobot M1. With this command, an user sets start location and goal location for TCP. When this command triggers each joint starts moving and joints' motion follow profiles of Q3. Each joint has to move exactly same time (some joints might not move at all). This time you don't have to think about tool offset.
In this condition, make a program with such inputs and outputs below;

Inputs:
Start location and goal location represented by (x,y,z,rx,ry,rz), and time duration for the motion.

Outputs:
Record of joints' Pos(j1,j2,j3,j4), Vel(v1,v2,v3,v4), Acc(a1,a2,a3,a4) on each time cycle(0.01s) and show them with graphs.
If the time duration makes velocity over error, limit the velocity so that this robot would not stop with error.

Show sample results of a set of inputs and outputs.
And enable users to test other combination.

Q5. CP

We want to make a CP command for Dobot M1. With this command, an user sets start location and goal location for TCP. When this command triggers TCP move along a shortest line between those two locations and TCP motion follow profiles of Q3. This time you don't have to think about tool offset.
In this condition, make a program with such inputs and outputs below;

Inputs:
Start location and goal location represented by (x,y,z,rx,ry,rz), and time duration for the motion.

Outputs:
Record of TCP's Pos(x,y,z,rx,ry,rz), Vel, Acc on each time cycle(0.01s) and show them with graphs.
If the time duration makes velocity over error, limit the velocity so that this robot would not stop with error.

Show sample results of a set of inputs and outputs.
And enable users to test other combination.

Q6. Spline

Let Dobot M1 hold a pen of 50mm length, and let it draw a curve on a paper of square 100mm on a side located at Z = 0 plain. We give some points (x,y) on this paper and want this robot to move smoothly visiting each point by drawing a curve. At the same time, TCP's motion has to have smooth change of velocity and acceleration.
In this condition, make a program with such inputs and outputs below;

Inputs:
Any number of (you can set a limit) visiting points, P1(x1,x2,), P2(x2,y2), P3(x3,y3),…
And time duration.

Outputs:
Record of TCP's Pos(x,y,z,rx,ry,rz), Vel, Acc and record of joints' Pos(j1,j2,j3,j4), Vel(v1,v2,v3,v4), Acc(a1,a2,a3,a4) on each time cycle(0.01s) and show them with graphs.
If the time duration makes velocity over error, limit the velocity so that this robot would not stop with error.

Show sample results of a set of inputs and outputs.
And enable users to test other combination.