

20MECH5131/6031 Intro to Robotics
Homework#4 - Robot Spec and Selections (85 pts)

Student Name: Hongui Yi **Score:** _____

Answer the following questions and submit your work online in a SINGLE file.

Please use single space, 12 font size, and standard margin for formatting your submission.

1. (6 pts)

(a) Answer:

Pay load is the load capacity of a robot. It presents the weight the robot can lift, including the weight of the end effector and the weight of the product being picked. The calculation formula is
 $\text{Payload} = \text{tooling weight} + \text{part weight}$.

(b) Answer:

Because robot for material handling could not only help to cut down the labor cost, save the floor space and changeover time, but also reduce the injury for workers.

2. (10 pts)

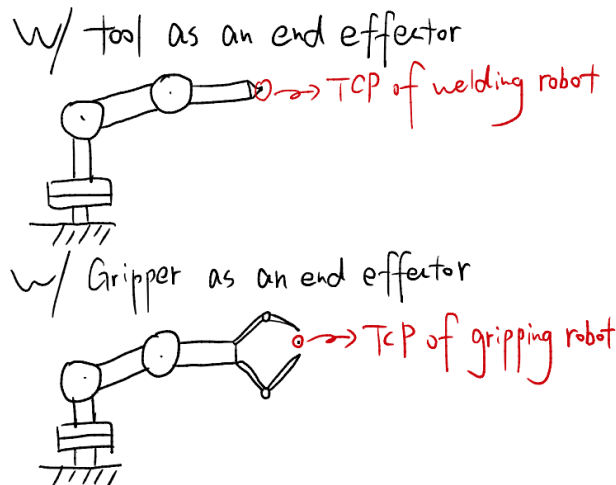
(a) Answer:

TCP is the point of action for the end effector mounted to the robot tool plate. If no tool attached to the wrist, TCP is the center of standard tool plate defined by robot manufacturer.

(b) Answer:

Offset must input into robot program to make sure the real tool center is the TCP.

(c) Answer:



3. **Answer:**

a) Accuracy: Laptop circuit board consists of many different parts. Good accuracy assure that robots could position every part in correct position so that the board can be applied.

- b) Repeatability: The same circuit will be manufactured repeatedly. High repeatability enables the robots to manufacture the circuit board again and again.
- c) Speed: There will be a large number of circuit boards to be manufactured in the assembly. High speed could confirm the efficiency.

4.

(a) Answer:

Accuracy is the ability to reach a specified point in space that defined by an x-y-z or other coordinate system.

(b) Answer:

It's determined by how close the TCP is to the point described by the program or visual system.

5. (9 pts)

(a) Answer:

It is the time needed to achieve a cycle of motion that the robot is expected to finish.

(b) Answer:

- i) Joint actuators
- ii) Overall size of the robot
- iii) Payload.

6. **Answer:**

$$\begin{aligned}
 b) R &= 360^\circ \times 4 = 1440^\circ \\
 \text{Total control points required} &= \frac{2880^\circ}{0.5^\circ} = 2880 \\
 \text{By binary digit def: } 2^n &= 2880 \Rightarrow n = \log_2 2880 = 11.49 \\
 \text{Hence, } B &= 12 \\
 \text{By checking:} \\
 CR_2 &= \frac{1440^\circ}{2^{12} - 1} = 0.35^\circ < 0.5^\circ \quad \text{satisfied} \\
 a) \text{ Repeatability} &= \pm 3\sigma = \pm 3 \times 0.25^\circ = \pm 0.75^\circ \\
 \text{Accuracy} &= \frac{CR_2}{2} + R = \frac{0.35}{2} + 0.75^\circ = 0.925^\circ
 \end{aligned}$$

7.

(a) Answer:

The robots I choose is Motoman MH24 [1], FANUC M-710ic/50 [2], ABB IRB 4600-45/2.05 [3].

Robot Parameter for Die-casting application			
Criteria	Commercial Robot Candidate 1	Commercial Robot Candidate 2	Commercial Robot Candidate 3
Manufacturere Name	Kabushiki-gaisha Yasukawa Denki	Fuji Automatic NUmerical Control	Asea Brown Boveri
Robot Model	Motoman MH24	FANUC M-710ic/50	ABB IRB 4600-45/2.05
DOF	6	6	6
Work Envelope	Spherical	Spherical	Spherical
Payload	24 KG	50 KG	45 KG
Reach	1730 MM	2050 MM	2050 MM
Repeatability	±0.06mm	±0.07mm	±0.05mm
Accuracy	0.391233211	0.43030525	0.43030525
Mass	268 KG	560 KG	425 KG
Speed of S-Axis	197 °/s (3.84 rad/s)	175 °/s (3.05 rad/s)	175 °/s (3.05 rad/s)
Speed of L-Axis	190 °/s (3.49 rad/s)	175 °/s (3.05 rad/s)	175 °/s (3.05 rad/s)
Speed of U-Axis	210 °/s (3.84 rad/s)	175 °/s (3.05 rad/s)	175 °/s (3.05 rad/s)
Speed of R-Axis	410 °/s (7.16 rad/s)	250 °/s (4.36 rad/s)	250 °/s (4.36 rad/s)
Speed of B-Axis	410 °/s (7.16 rad/s)	250 °/s (4.36 rad/s)	250 °/s (4.36 rad/s)
Speed of T-Axis	620 °/s (10.82 rad/s)	355 °/s (6.20 rad/s)	360 °/s (6.28 rad/s)
Motion range of S-Axis	180° to +180°	- 360°	- +180° to -180°
Motion range of L-Axis	-105° to +155°	- 225°	+150° to -90°
Motion range of U-Axis	-170° to +240°	- 440°	- +75° to -180°
Motion range of R-Axis	-200° to +200°	- 720°	- +400° to -400°
Motion range of B-Axis	-150° to +150°	- 250°	- +120° to -125°
Motion range of T-Axis	-455° to +455°	- 720°	- +400° to -400°

(b) Answer:

- i) Payload: The payload determines whether the selected robot can withstand the weight of four faucet knobs at the same time; the larger its value, the higher the robot's expectation of completing the task.
- ii) Accuracy: The higher the maximum reach distance, the higher the robustness of the adjustable distance between the robot and the die casting machine, quench tank and finished part conveyor.
- iii) Repeatability: The higher the repeatability, the higher the ability of the robot's wrist to move back and forth between different positions such as die casting machine, quench tank and finished part conveyor.

(c) Answer:

The one I choose is Option2: **FANUC M-710ic/50.**

Robot Comparison for Die-casting application							
TABLE-Weighted Rating Method							
Criteria	Importance Weight (%)	Robot Candidates					
		Option 1		Option 2		Option 3	
		Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
Payload	20	1	0.2	3	0.6	2	0.4
Reach	10	2	0.2	3	0.3	3	0.3
Repeatability	22	2	0.44	3	0.66	1	0.22
Mass	2	3	0.06	1	0.02	2	0.04
Accuracy	22	3	0.66	1	0.22	1	0.22
Speed of S-Axis	2	3	0.06	2	0.04	2	0.04
Speed of L-Axis	2	3	0.06	2	0.04	2	0.04
Speed of U-Axis	2	3	0.06	2	0.04	2	0.04
Speed of R-Axis	2	3	0.06	2	0.04	2	0.04
Speed of B-Axis	2	3	0.06	2	0.04	2	0.04
Speed of T-Axis	2	3	0.06	2	0.04	2	0.04
Motion range of U-Axis	2	3	0.06	3	0.06	3	0.06
Motion range of L-Axis	2	3	0.06	1	0.02	2	0.04
Motion range of U-Axis	2	2	0.04	3	0.06	1	0.02
Motion range of R-Axis	2	1	0.02	2	0.04	3	0.06
Motion range of B-Axis	2	3	0.06	2	0.04	1	0.02
Motion range of T-Axis	2	3	0.06	1	0.02	2	0.04
	100		2.22		2.28		1.66
Rating					Value		
Unsatisfactory					0		
Just tolerable					1		
Adequate					2		
Good					3		
Very Good					4		

Reference

- [1] <https://robotsdoneright.com/Motoman/MH-Series/Yaskawa-Motoman-MH24.html>
- [2] <https://robotsdoneright.com/FANUC/M-Series/FANUC-M-710ic-50.html>
- [3] <https://robotsdoneright.com/ABB/4000-Series/ABB-IRB-4600-45-2.05.html>