

Case Study for a robot arm program

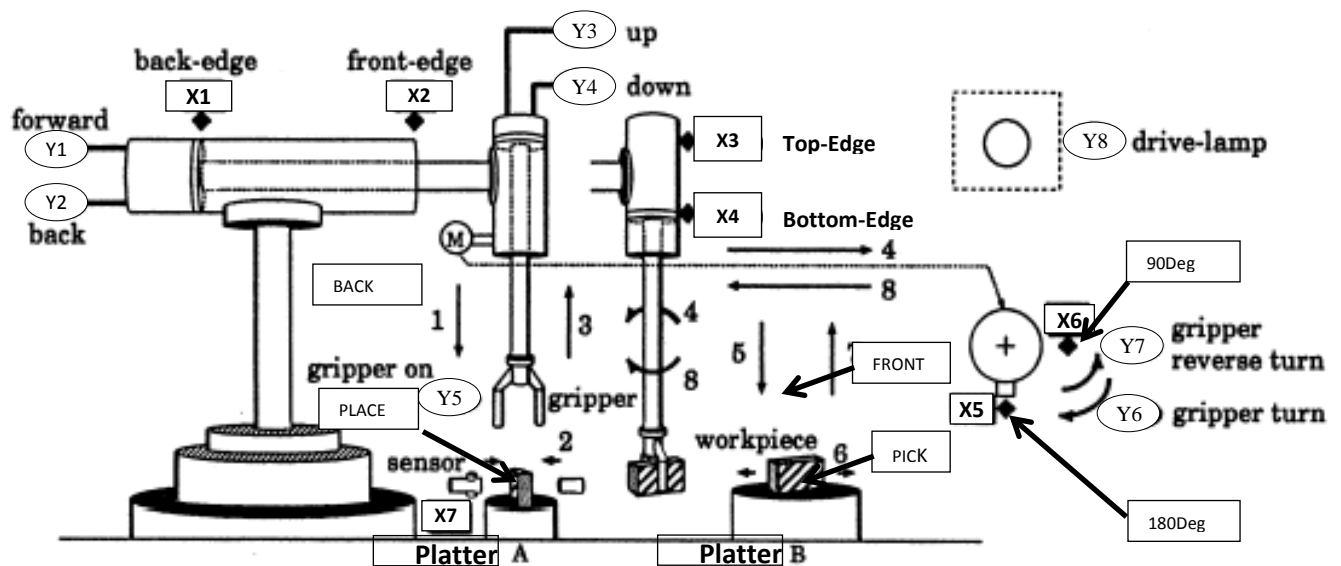


Figure 1: The Pick and Place Robot Arm

A simple robot arm is shown in figure 1. The Robot Arm has three moving parts which are the Horizontal Shaft, Vertical Shaft and Gripper. These Horizontal Shaft, Vertical Shaft and Gripper are controlled by **motor drivers** as shown in Table 1(a). Each of these **motor drivers** will determine the direction of movement of the respective Horizontal Shaft, Vertical Shaft and Gripper as specified in Table 1(a) which will determine the 2-dimension (vertical and horizontal) position where the Gripper position is. Only one of the two shafts will be moved at one time. The Gripper can be positioned at four different edge (BACK, PICK, FRONT AND PLACE) as shown in Figure 1(a) and described in Table 1(b). Sensors X1, X2, X3 and X4 in shown Figure 1(a) and described in Table 1(b) will signal if the Gripper has reached the respective specified positions which are **relative** to the position of Horizontal Shaft and Vertical Shaft.

Table 1(c) defines the configurations of ATmega32 Input/Output port with respect to the sensors and drivers. The inputs to ATmega32 port monitor the status of the respective sensor which determines the position of the Gripper. The output from ATmega32 port controls the respective drivers for motors which determine the direction of movement of the Horizontal Shaft, Vertical Shaft or Gripper. All sensors and drivers are seen as digital devices by the ATmega32 microcontroller.

Table 1(a)

Moving Part Name	Direction of Movement	Arrow # shown in Figure Q5(a)	Motor Driver Setting to control of direction of movement
Horizontal Shaft	Forward	4	Y1 activated
	Back	8	Y2 activated
Vertical Shaft	Up	1	Y3 activated
	Down	3	Y4 activated
Gripper	Grip	2	Y5 activated
	Release	6	Y5 deactivated
Gripper Rotater	Clockwise Turn	4	Y6 activated
	Anti-Clockwise Turn	6	Y7 activated

Table 1(b): Gripper's Position

Position's Name	Possible Direction of Motion to reach the respective position	Location of shaft	Sensor status (which identify the respective position)
BACK	Horizontal Shaft moved backward from front-edge or Vertical Shaft moved upward from bottom-edge	Vertical Shaft at top-edge and Horizontal Shaft at back-edge	Back-edge sensor X1 is ON, Top-edge sensor X3 is ON
PICK	Vertical Shaft moved downwards from top-edge and Horizontal Shaft static at back-edge position	Vertical Shaft at bottom-edge and Horizontal Shaft at front-edge	Back-edge sensor X1 is ON, Bottom-edge sensor X4 is ON
FRONT	Horizontal Shaft moved forward from back-edge position or Vertical Shaft moved upward from bottom-edge position	Vertical Shaft at top-edge and Horizontal Shaft at front-edge	Front-edge sensor X2 is ON, Top-edge sensor X3 is ON
PLACE	Vertical Shaft moved downward from top-edge position	Vertical Shaft at bottom-edge and Horizontal Shaft at back-edge	Front-edge sensor X2 is ON, Bottom-edge sensor X4 is ON
90Deg	Gripper turn Clockwise	Anywhere	90Deg sensor X6 ON
180Deg	Gripper turn Clockwise	Anywhere	180Deg sensor X5 ON

Table 1(c): The input-output table of the Atmega32

No.	Sensor	Detection	Input to
1	X1	Back-edge	Port A Pin 1
2	X2	Front-edge	Port A Pin 2
3	X3	Top-edge	Port A Pin 3
4	X4	Bottom-edge	Port A Pin 4
5	X5	Gripper grip	Port A Pin 5
7	X6	90Deg position	Port A Pin 6
8	X7	180Deg position	Port A Pin 7

No.	Driver	Output from
1	Y1	Port B.1
2	Y2	Port B.2
3	Y3	Port B.3
4	Y4	Port B.4
5	Y5	Port B.5
6	Y6	Port B.6
7	Y7	Port B.7

Table 1(d): Motion of Shaft/Gripper according to Process Name

Process Name	Motion of Shaft/Gripper (refer Table Q5(b) and Q5(c))
PickProcess	<ul style="list-style-type: none"> i. Assuming at Horizontal Shaft is at FRONT position, then Gripper turn Anti-clockwise until 90Deg position, the ii. Vertical Shaft will move to PICK position and iii. At PICK position Gripper grips workpiece.
PlaceProcess	<ul style="list-style-type: none"> i. When Gripper is at PICK position and is gripping workpiece, then ii. Vertical Shaft will move to FRONT position, iii. At FRONT position Horizontal Shaft will move to BACK position iv. At BACK position Gripper turn Clockwise until 180Deg position v. At BACK position Vertical Shaft will move to PLACE position vi. At PLACE position Gripper release workpiece.

Based on the specifications and descriptions given above:

- i. Draw the flow chart and
- ii. Write a program that

Perform a pick of a workpiece from Platter B which is at 90Deg position and place at Platter A after turning the workpiece at position BACK to 180Deg position.