PRACTICAL NO: 1

Date : 28/08/24

TITLE : Jogging of Robotic Arm.

AIM / OBJECTIVE: To Jog the robotic arm in different modes of motions by using (1) Jog window of CPRog (2) Joypad.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

Mover 4 robot arm with parallel gripper.
Pedestal
Power supply unit.
USB-CAN Adapter.
Wiring harness.
PC, CPRog software, Joypad/Joystick.

CONCEPT / THEORY OF EXPERIMENT:

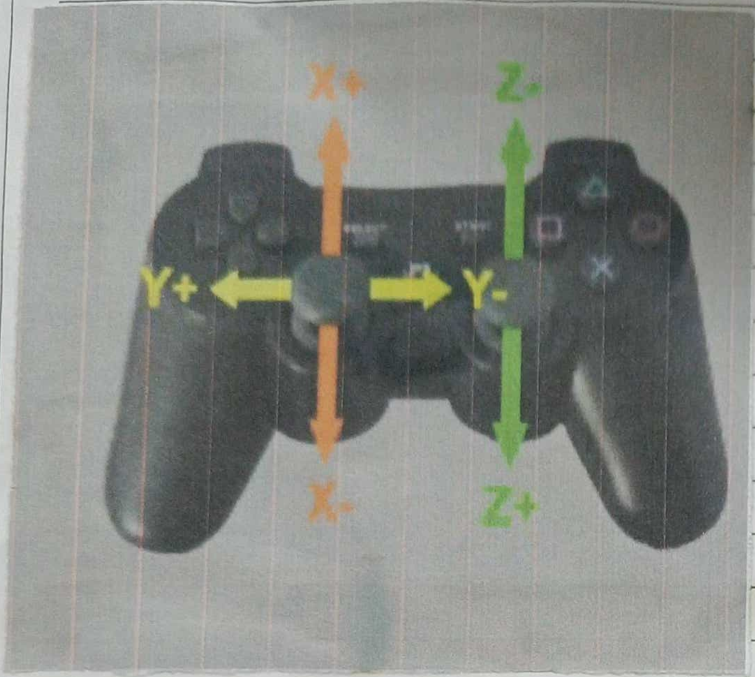
In this practical Mover 4 robot arm is being used. It's a manipulator with fixed base & 3 joints. It has 2 links. It can transverse to any position in space but it's tool can only rotate about one axis. The robot can be programmed by CPROG. This software also robot move manually and record program repeat task again & again. The are 3 mode to move robot :- 1) Joint mode 2) Cart Base mode 3) Cart Tool mode.

PROCEDURE :

A) Starting the robot:-
1) Switch the power on & unlock the emergency step.
2) Start CPRog. The status led of robot is grey.
3) Press 'connect' & the status led will turn red & it will show error, if any.
4) Press 'reset' button to acknowledge the errors.
5) Press 'enabled motor' button to enable motors & status led will turn green.
B) Moving the Robot in Joint Mode:-
1) The Joint's are acknowledge here, 1st joint as A1, 2nd as A2, likewise A3,
C) Moving the robot in cart mode:-
1) In this mode you move robot arm in X,Y,Z,B axis, do as per the need.

OBSERVATIONS

A] Cart Mode Using Joystick:-



1) Connect to Joystick.
2) The Fig. aside used cart mode to move the robot.
3) X-axis is up-word & downward.
4) Y-axis is right & left.
5) Z-axis is up & down by another button of joystick.
6) Whenever, we want to access B axis, we just press R1 and hold it and use button 1 at upward direction for B- and downward direction for B+.

B] Joint Mode Using Joystick:-

1) As per the above fig. cart mode works with axis however, joint mode works with joints of the arm robot. I have mentioned each & every joint in fig: x, y, z axis of end effector.

On Joystick, (1) Button 1

1) In upward direction it moves A2+ & downward A2-.
2) On right A1- and on left A1+.

(2) Button 2

1) In upward direction A3+ motion & downward A3- motion.
2) Whenever we want access to A4 joint, Press R1 & hold it, using buttons moves on right side so it will show motion A4- & on left A4+.

(C) Using CPRog For moving Robot:-

1) In CPRog application there are 3 modes present named joint mode, Card-Base mode; Cart-Tool mode. All modes works same I explained above for joystick & principles are also same.

CALCULATIONS :

RESULTS :

Using CPRog application and Joystick I performed the practical and moved robot using all 3 modes on both software and joystick.

CONCLUSION :

Hence, I performed this practical and did jogging of robotic arm.

PRACTICAL NO: 2

Date : 04/09/2024

TITLE : Programming movement of Robot by Graphical Editor.

AIM / OBJECTIVE: To program the movements of Mover 4 robot within the CPRog programming environment by graphical program editor

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

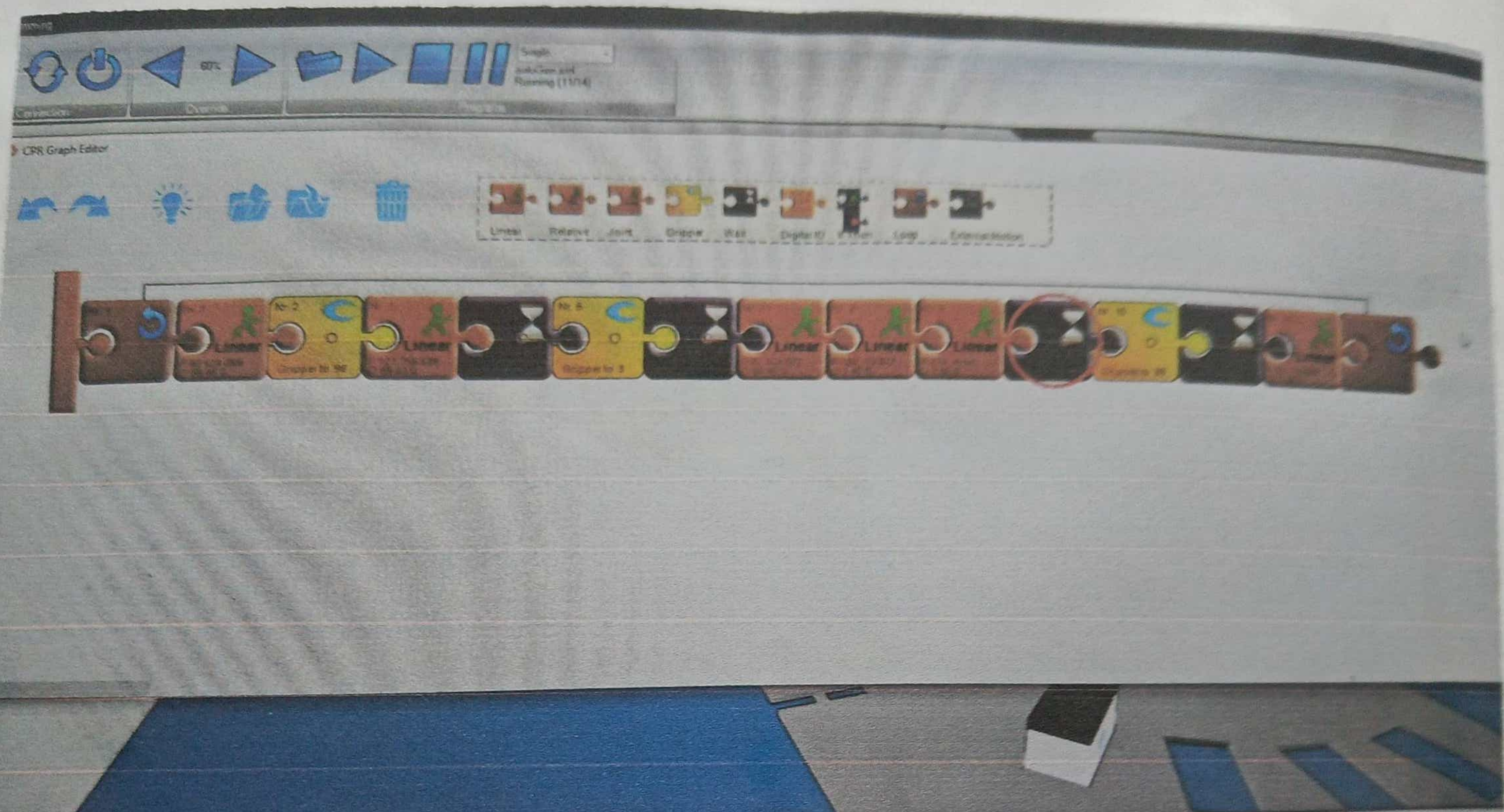
Mover 4 Robot with wiring.
PC with CPRog software.

CONCEPT / THEORY OF EXPERIMENT:

Robot movements are programmed by driving the robot to a position, & then saving this position, By graphical editor robot movements can be programmed. Graphical editor can be opened through the programming upper tab. The graphical program editor or grahedit represents & thus allows the robot program to be created by sliding and dragging.

PROCEDURE :

1) Move the robot to the desired position.
2) Drag a movement element say joint.
3) Synchronise.
4) Jog robot to some other location using tools under jog tab.
5) Click on Motion tab.
6) Select ride to 30%.
7) Activate robot, Run program.
8) observe the new location of robot, it will be at the location as per the location given in joint puzzle.
9) Similarly use linear, wait, grippers, DIO loop, puzzles one by one.
10) Observe movement of robotic arm, save program.



CPR Graph Editor
60%
Single
Running (11/14)
Linear
Relative
Joint
Gripper
Load
External Motion

Q.] Write observation of movement of robotic arm for following puzzles:

1) Joint.

→ In joint movement, the robotic arm moves each joint (A1, A2, A3, A4) to a specified position ~~and~~ independently. The motion not in a straight line but rather curved.

2) Linear.

→ In linear movement, the robotic arm moves in a straight path from one path to another, ensuring that the end effector (gripper) follows a linear trajectory. The robot itself calculates the necessary joint movement to keep the end effector path straight.

3) Wait.

→ In wait, the robotic arm stops its movement for a specified period. During, this time the arm remains stationery in its current position.

4) DIO (Digital Input/Output).

→ In DIO, The robot interacts with external devices or sensors through digital input/output signals.

In response to digital input (such as sensors), the robotic arm may perform a specified task (such as starting & stop movement). Digital output can trigger external devices, like turning on a machine or activating a light.

5) Loop.

→ In loop, the robotic arms repeat a set of instructions multiple times based on the loop conditions. The arm excecutes a series of movement repeatelly (such as picking & placing objects).

CALCULATIONS :

RESULTS :

We have performed this practical & programmed the robot to do a specified task (such as pick & place object) using graphic editor and different types of puzzle specified tasks for robot (such as linear, joint, wait, loop, Gripper, DIO).

CONCLUSION :

Hence, I have performed this practical & also make the robot do some specified ~~..~~ tasks using commands of graphic editor.

PRACTICAL NO: 5

Date : 16/10/24

TITLE : Visualization of translation and rotation of frames & homogenous transformation matrix.

AIM / OBJECTIVE: To visualize translation & rotation of frames and homogenous transformation matrix using Robo Analyzer.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

Robo Analyzer.

CONCEPT / THEORY OF EXPERIMENT:

In homogenous transformation matrix (HTM), transformation (such as translations rotations, scaling) can be applied relative to global or local axes, which affects the results depending on the order & frame of reference used. Global transformation is relative to the fixed world axes. Local transformation is relative to objects current orientation & position.

PROCEDURE :

1) Open Robo Analyzer and HTM module.
2) Solve given questions.
3) ~~The~~ Sequence - Slect down custom, Add number of rows needed to solve the questions.
4) In description select desired like 'translation' and 'rotation'.
5) In Local/ Global section select 'Local' or 'Global' transformation.
6) select the direction such as X, Y, Z and in value section given the desired value.
7) Run the simulation.

OBSERVATIONS

Q.23) A frame B is rotated 90° about the z axis, then translated 3 & 5 units relative to the n and o axis respectively, then rotated another 90° about the n axis & finally, 90° about the y axis. Find the new location and orientation of the frame.

$$B = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 0 & 0 & -1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Q.24) The frame B. Problem, 2.16 is rotated 90° about the a axis, 90° about the x-axis then translated 2 & 4 units to the x-axis - y axis respectively then rotated 90° about the n-axis. Find the new location and orientation of the frame.

$$B = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 \\ 0 & 0 & -1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

RESULTS :

For question 1 output matrix is =
$$\begin{bmatrix} 0 & -1 & 0 & 1 \\ 0 & 0 & -1 & 6 \\ 1 & 0 & 0 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

For question 2 output matrix is =
$$\begin{bmatrix} 0 & 0 & 0 & 3 \\ 0 & -1 & 1 & 5 \\ -1 & 0 & 0 & -1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

CONCLUSION :

Hence, we have performed this practical & get answer through output in Robot Analyzer.

PRACTICAL NO: 6

Date : 21/10/2024

TITLE : To find forward kinematics of a robot & validation using Robo Analyzer software.

AIM / OBJECTIVE: 1) Perform the forward kinematic of the 3-DOF robot of given DH parameter using Roboanalyzer.
2) Visualize the motion & plot the values of end effector co-ordinates and calculate the end effector position for a given set.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

Robo Analyzer.

CONCEPT / THEORY OF EXPERIMENT:

D-H parameter also known as Denavit - Hartenberg. These parameter are used to describe each joint in a robot common co-ordinate system.

PROCEDURE :

1) Animate Robot on Roboanalyzer as per given D-H parameter table.
2) Visualize D-H parameter on Robo Analyzer.
3) Visualize the motion & plot the values of the end-effector co-ordinates.
4) Calculate the end-effector position for a given set of joint values, using transformation matrices & verify with Robo analyzer.
5) Formula:

$$^{i-1}T_i = Rot(z, \alpha_i)\, Trans(z, \alpha_i)\, Trans(x, d_i)\, Rot(x, \theta_i)$$

$$\begin{bmatrix} C\theta_{n+1} & -S\theta_{n+1} C\alpha_{n+1} & S\theta_{n+1} S\alpha_{n+1} & a_{n+1} C\theta_{n+1} \\ S\theta_{n+1} & C\theta_{n+1} C\alpha_{n+1} & -C\theta_{n+1} S\alpha_{n+1} & a_{n+1} S\theta_{n+1} \\ 0 & S\alpha_{n+1} & C\alpha_{n+1} & d_{n+1} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

OBSERVATIONS

1) Visualize D-H parameter for each joint.
2) Observe the homogenous $^0T_1$, $^1T_2$, $^2T_3$, and $^0T_3$ on Roboanalyzer & verify with calculated matrices in step 3 for procedure.
3) Press on F-Kin and observe motion of each joint and end-effector on Roboanalyzer.
4) Visualize the motion & plot the values of the end effector co-ordinates.
5) Plot links position & joint value, velocity and acceleration.

Joint No.	Joint Type	Joint offset (b or d)	Joint Angle (θ in degress)	Link length (a) m	Twist angle (α in degree)	Initial value (IV) degree
1.	Revolute	0·07	Variable	0·08	90	90
2.	Prismatic	Variable	90	0·09	90	0·08
3.	Revolute	0·06	Variable	0·08	90	90

CALCULATIONS :

$$^{0}T_1 = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0.08 \\ 0 & 1 & 0 & 0.07 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$^{1}T_2 = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0.09 \\ 0 & 1 & 0 & 0.08 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$^{2}T_3 = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 0.08 \\ 0 & 1 & 0 & 0.06 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$^{0}T_3 = \begin{bmatrix} 1 & 0 & 0 & 0.16 \\ 0 & 1 & 0 & 0.14 \\ 0 & 0 & 1 & 0.16 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

RESULTS :

CONCLUSION :

PRACTICAL NO: 7

Date : ____________

TITLE : To find inverse dynamiss of a manipulator using Robo Analyzer.

AIM / OBJECTIVE: 1) To find inverse dynamic of manipulator using Robo Analyzer.
2) To plot position and joint value, velocity and acceleration and torque.

APPARATUS / TOOLS / EQUIPMENT / RESOURCES USED:

Robo Analyzer.

CONCEPT / THEORY OF EXPERIMENT:

• Inverse dynamics of a manipulator involves determining the joint torques required to achieve a desired motion of manipulator.

It is an important tool in design of control systems for precise motion control and robot trajectory planning.

PROCEDURE :

1) Open Robo Analyzer.
2) Select 3.DOF. robot.
3) May change D-H parameters.
4) May change geometry.
5) Click on FKin and then of IDyn.
6) Press Run.
7) Observe motion.
8) Go to graphs & plot position, velocity, acceleration & torque of joints.

OBSERVATIONS

3- DOF RPR Robot :-

D-H Table :-

Joint Number	Joint Type	Link length (a)m	Twist Angle (α)°	Joint offset (d)m	Joint Angle (θ)°
1.	Revolute	0·08	90	0·05	Variable
2.	Prismatic	0·075	90	Variable	80
3.	Revolute	0·08	90	0·05	Variable.

CALCULATIONS :

RESULTS :

CONCLUSION :

Hence, we were able to find inverse dynamics of a manipulator.