



UNIVERSITY OF CALIFORNIA SAN DIEGO

COURSE: MAE 204 - ROBOTICS

LAB 1 - UR3E ROBOT MANIPULATION

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1 Overview

Universal Robot 3e is a table top robot for assembly tasks. The UR3e was programmed and locally controlled using a teach pendant to perform a basic Tower of Hanoi task. Following the rules of Tower of Hanoi, the UR3e was successfully programmed. The 6 joint angles of each waypoint and the sequence of operation were recorded. The observations and the errors encountered are shown in this report.

2 Apparatus

1. UR3e robot 1.
2. Teach pendant.
3. 2 blocks big enough to fit the robot's gripper.
4. 3 designated spots to place the blocks.

3 Results

The robot performed the Tower of Hanoi task with 2 blocks. UR3e robot goes through various configurations for the tasks of going to the block coordinates, closing and opening the gripper and stacking the blocks on top of each other. Following are the joint angles based on a series of observations through trial and error of the waypoints.

3.1 Task sequence

The task sequence followed by the robot was following-

Program

Robot Program

MoveJ

Standby

Gripper Activate

Gripper Open (1)

Waypoint_1

Waypoint_2

Gripper Close (1)

Waypoint_3

Waypoint_4

Waypoint_5

Gripper Open (1)

Waypoint_18

Waypoint_6

Waypoint_7

Gripper Close (1)

Waypoint_8

Waypoint_9

Waypoint_10

Gripper Open (1)

Waypoint_11

Waypoint_12

Waypoint_13

Gripper Close (1)

Waypoint_14

Waypoint_15

Waypoint_16

Gripper Open (1)
Waypoint_17
Wait: 5.0

Notes: Use *Gripper Activate* to activate gripper first. Gripper close or open can be used only after the gripper is activated.

3.2 Joint angles

Tasks	Joint 1	Joint 2	Joint 3	Joint 4	Joint 5	Joint 6
Global Standby	-0.20835859	-1.445979805	1.458890263	-1.570404261	-1.569609467	2.937389135
Global Waypoint_1	0.04942441	-0.775000409	1.127181355	-1.909250876	-1.566847626	3.196881294
Global Waypoint_2	0.031991649	-0.710123376	1.212734048	-2.059693476	-1.567369286	3.179703236
Global Waypoint_3	0.031728767	-0.842898445	1.032461945	-1.746650835	-1.566922013	3.178842068
Global Waypoint_4	-0.623469178	-0.792330818	1.052963082	-1.820924898	-1.575839821	2.523887873
Global Waypoint_5	-0.604456727	-0.639075176	1.217287366	-2.138510366	-1.576110188	2.543504
Global Waypoint_18	-0.714533631	-1.049733595	1.143667523	-1.655134817	-1.576355282	2.432103395
Global Waypoint_6	0.030917322	-0.842185335	1.037958447	-1.752866407	-1.566887681	3.177991629
Global Waypoint_7	0.031223288	-0.641203122	1.238839928	-2.154806753	-1.567601029	3.179128647
Global Waypoint_8	0.031012822	-0.811259047	1.112112347	-1.857972284	-1.567014519	3.178319931
Global Waypoint_9	-0.331898991	-0.909154014	1.287851636	-1.936876436	-1.572238747	2.815415144
Global Waypoint_10	-0.297757928	-0.731176869	1.407957856	-2.234641214	-1.572336022	2.850123405
Global Waypoint_11	-0.298106972	-0.956110255	1.199504201	-1.801244875	-1.571530644	2.84895134
Global Waypoint_12	-0.61089975	-0.832878129	0.987272088	-1.714516302	-1.575516526	2.536292315
Global Waypoint_13	-0.610555951	-0.630922214	1.213979069	-2.143144747	-1.576284711	2.53739953
Global Waypoint_14	-0.610719506	-0.78871365	1.100520436	-1.871872088	-1.57576019	2.536688089
Global Waypoint_15	-0.300401036	-0.900984542	1.302739445	-1.959617277	-1.571835343	2.846829414
Global Waypoint_16	-0.296227757	-0.808882312	1.386087243	-2.135127684	-1.572081391	2.851418734
Global Waypoint_17	-0.296684567	-0.982732849	1.108019177	-1.68317618	-1.571428601	2.8501544

Table 1: Joint angles

4 Video link

- Robot failure 1: Failure 1
- Robot failure 2: Failure 2
- Robot success: Success

5 Conclusion

The Tower of Hanoi task was programmed and executed. The basic steps followed in programming the UR3e were as follows:

1. Setting a standby and a safe start point.
2. Activating the gripper.
3. Setting waypoints.
4. Actuating the gripper.
5. Returning back to the standby position.

5.1 Findings

1. **Failure 1:** The UR3e was programmed by setting multiple waypoints and activating the gripper at desired locations. Once the entire task was loaded onto the robot, the task was run and it was observed that the experiment failed as it crashed into one of the blocks and the emergency brake was automatically activated. This was the first failure. We resolved by changing the standby position of the robot to ensure collision free movement.
2. **Failure 2:** To pick up the block from the tower and place it at a different location. We set the initial waypoints to arrive at the location in 2 steps and activate the gripper to pick up the block. Once the block was picked, we moved the manipulator to the desired location and set a waypoint at the second location where the block had to be placed. Moving the arm the second time to pick the next block was again programmed and the block was moved to the third location. The error was not recognised at the beginning but when the program was executed, the manipulator took the shortest path to return back to pick up the second block. The gripper collided with the block and came to an emergency stop. One of the main reason for the robot's failure was our improper understanding of the waypoint coordinates. We initially assumed that the coordinated for the way point should be given after each gripper activation.
3. **Success:** Learning from the previous failures, additional waypoints were added on top of the desired block positions. This avoided the robot to take the shortest path from the initial block position to the final block position. These waypoints ensured the robot to move in a clear and concise manner. The blocks were picked and placed according to the program that was fed. The manipulator moved in 3D space with no collisions leading to a successful completion of tower of hanoi task.