Universal Robot (UR5)

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ABSTRACT

The goal of the entire exercise is to familiarize oneself with the UR5 robot and its programming environments by performing specific tasks. By moving the robot through specified poses in both Cartesian and joint space, and tracing a virtual cube, the objective is to gain hands-on experience and understanding of the robot's capabilities. This exercise enables users to develop proficiency in controlling the robot's movements, executing precise trajectories, and manipulating objects, ultimately facilitating the utilization of the UR5 robot for various applications that require accuracy and versatility in robotic operations.

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1. INTRODUCTION

The UR5 robot, renowned for its payload capability of up to 5 kilograms, offers a wide range of applications in industries such as manufacturing, logistics, and research. In this exercise, we explore the capabilities of the UR5 robot by performing various tasks. Firstly, we move the robot through a set of poses in both Cartesian and joint space using the PolyScope programming environment accessed through a tablet connected to the robot. This allows for precise control and manipulation of the robot's movements, enabling complex tasks that require accurate positioning.

Additionally, we demonstrate the UR5 robot's repeatability by utilizing its programming capabilities to draw multiple cubes in Cartesian space. By programming the robot to follow specific trajectories, it accurately traces the edges of each cube, showcasing its ability to consistently reproduce movements and positions. This demonstrates the robot's precision and reliability in executing complex paths, making it an ideal solution for applications that demand precise and repeatable movements.

Through this exercise, we gain hands-on experience with the UR5 robot and its programming environments, allowing us to develop proficiency in controlling its movements and executing precise trajectories. By exploring its payload capability, utilizing the teaching pendant, and employing the graphical programming environment, we harness the full potential of the UR5 robot for various automation tasks.

2. METHOD

To control the UR5 robot and perform the desired tasks, the following method was employed. The pose of the robot's tool or end effector, which includes its position and orientation, was described in the robot manual. The programming environment utilized was PolyScope, a visual programming interface specifically designed for the UR5 robot.

The process began by accessing the PolyScope Robot User Interface page and selecting "Program Robot." Then, an empty program was created by pressing "Empty Program." Navigating to the "Structure" tab, the "Move" option was chosen. Within the robot program, "MoveJ → Waypoint" was clicked, followed by pressing "Set this waypoint" to specify the Tool Center Point (TCP) as Pose 1. This procedure was repeated for Pose 2 and Pose 3.

Table Coordinates fed into the robot

	X(mm)	Y(mm)	Z(mm)	RX(Rad)	RY(Rad)	RZ (rad)
Pose 1	-575	-350	300	2.10	1.11	0.63
Pose 2	-240	-445	650	1.57	-1.57	-1.57
Pose 3	400	-400	200	2.79	-0.16	0

To ensure accurate positioning, the free drive function of PolyScope was utilized by manually guiding the robot to the required coordinates. Horizontal lines in the cubes were traced using the "movel" command, which allows for smooth and controlled motion. This process was repeated in a loop to test the repeatability of the robot's movements.

To verify the robot's performance, the "Graphics" tab was accessed in PolyScope's move robot interface. By selecting the "Simulation" mode and pressing "Play," the robot's actions were observed to ensure they aligned with expectations. Finally, the "Real Robot" option was chosen in the "Graphics" tab, and the robot performed the task while being monitored.

3. RESULTS AND DISCUSSION

As illustrated in the table, the robot effectively accomplished Task 1 by reaching the three specified destinations. It demonstrated the desired accuracy was capable to move the end effector without any issues. Nonetheless, there were complications with moveJ, as the robot collided with its own linkages and came to a halt. The issue was rectified by adjusting the robot's home position and moving it more efficiently. In the case of moveL, both the actual and the simulated robot avoided self-collision as they adhered to the pre-set routes. Task 1 served as a valuable learning tool for us students, providing insights into operating the teach pendant and understanding the basics of UR5 robot programming. https://youtube.com/shorts/WuZaSwZJDT8?feature=share

The cube's outline was drawn using the UR5's freedrive function, which traced the necessary points in Cartesian space. The Polyscope was utilized to guide the robot in straight lines, thereby accurately tracing the shape of the cube. This process effectively demonstrated the robot's repeatability.
https://www.youtube.com/shorts/5EuH1M09cLE

4. CONCLUSION

The goals of this lab were successfully achieved, with the UR5 robot demonstrating its capabilities by navigating through all the necessary waypoints. The task of tracing the cube in Cartesian space was also carried out effectively. Additionally, the exercise served to familiarize us with the UR5 interface.

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Holmes Joseph, currently a Masters student at Arizona State University, brings a rich background in project development, specifically in the realms of Embedded Software and Hardware, have honed skills in multiple communication protocols and have a track record of successfully integrating a variety of sensors and actuators into microcontroller environments. And the proficiency extends to the field of Machine Learning and its applications, particularly in Robotics and Data Science. A passion for Artificial Intelligence is evident and fuels their aspiration to be a part of the rapidly expanding Robotics industry. And I also foresee this industry as a major driver of change in the future. Through diverse experiences, cultivated a high level of adaptability, allowing to navigate and excel in various work environments. Email:hjoseph6@asu.edu