Universal Robot (UR5)

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ABSTRACT

The overarching objective of this activity is to showcase the repeatability and straightness analysis capabilities of the UR5 robot. This involves the tactile exploration of a point on a granite block to evaluate straightness through line tracing. Additionally, the adaptability of the gripper is scrutinized in the laboratory setting. The gripper undergoes testing in various tasks such as pick-and-place operations, pin insertion and removal, and an illustrative demonstration of its functionality involves inserting a battery into a torch.

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1. INTRODUCTION

This laboratory session delves into the utilization of the UR5 robot for the intricate task of flashlight assembly, placing a particular emphasis on its precision and adaptability. The assembly process involves breaking down the flashlight assembly into four distinct components: the head, barrel, tail cap, and battery. It is crucial to note the inherent cautionary measures outlined in the manual, emphasizing the post-task procedures, including saving programs to permanent storage and removing them from the robot controller to prevent point deductions. Additionally, the consideration of a gripper offset and mass adds a layer of accuracy to the assembly process.

In this lab, we turn our attention to the adaptability of the gripper, a critical component of the UR5's functionality. Through a series of tasks ranging from pick-and-place operations to intricate maneuvers such as pin insertion and removal, we assess the gripper's versatility and effectiveness in handling diverse scenarios. The gripper's adaptability is further showcased in a practical demonstration, wherein it is employed to insert a battery into a torch, illustrating its broader applicability in real-world scenarios.

By combining these elements within a single lab setting, we aim to offer a comprehensive understanding of the UR5 robot's capabilities, providing valuable insights into both its precision in motion and the efficiency of its gripper functionality. Through this holistic exploration, we seek to equip participants with a nuanced appreciation of the UR5's potential across a spectrum of tasks and applications.

2. METHOD

The lab procedure necessitates programming the UR5 robot to execute the flashlight assembly. Key steps involve securely clamping the flashlight head into a pneumatic chuck, which is digitally controlled. The individual flashlight components are organized on a tray, and the assembly sequence includes clamping, precise screwing, battery insertion, and tail cap alignment. The significance of meticulous torque control during the screwing steps is highlighted, acknowledging the initial high torque readings and their subsequent decrease. Furthermore, attention is drawn to the need for gripper release methods to minimize misalignments and considerations for managing the robot's joint range limitations.

Fixture/ Component	X (mm)	Y (mm)
(1) Trays	-374	-368
(2) Chuck	-317	38

To showcase gripper functionality, a torch was securely placed on the table. A battery was positioned horizontally on the table, and the UR5 was precisely located above the battery block using the FreeDrive function. Polyscope commands were then executed to open the gripper, lower the end effector, and close the gripper to grasp the battery. The UR5 was moved back to its initial position using the MoveL function, and then it was directed to the top of the torch. The end effector descended slowly, placing the battery into the grabber. The cobot repeated this process ten times, demonstrating remarkable repeatability.

Furthermore, the cobot utilized the same mechanism, involving FreeDrive, to pick up the bottom cap of the torch. The end effector was positioned on top of the object, and the UR5 was brought to screw the cap onto the back of the torch. This intricate movement sequence was reiterated ten times, underscoring the system's consistent repeatability.

3. RESULTS AND DISCUSSION

The execution of the assembly process underscored the UR5's adeptness in handling intricate tasks with precision. The torque control mechanisms implemented during the screwing steps proved effective, overcoming initial challenges posed by high torque readings. The meticulous programming adjustments addressed issues related to gripper adherence, ensuring part alignment and overall accuracy. The careful management of the robot's rotational capabilities within specified joint ranges further enhanced the precision of the assembly.

Lab 3, focused on a different challenge, where the robot showcased its capabilities by employing the gripper to insert a battery into a torch. Notably, the robot exhibited commendable accuracy throughout this process, showcasing its ability to handle diverse tasks. While navigating through the moveL operation, both the actual and simulated robots skillfully avoided self-collision, adhering to the predefined routes. Labs 2 and 3 collectively provided students with invaluable learning experiences, offering insights into operating the teach pendant and comprehending the multifaceted functionalities of the UR5.

https://youtube.com/shorts/NsqVOKsPqFg?feature=share
https://youtu.be/R3Da_Mky0dg

4. CONCLUSION

The goals of this lab were successfully achieved, the integrated exploration of Labs 2 and 3 has provided a comprehensive understanding of the UR5 robot's capabilities and versatility. Lab 2, focusing on the granite block, showcased the robot's precision in tracing and accurately manipulating the end effector. Overcoming challenges in moveJ demonstrated the adaptability of the system. Meanwhile, Lab 3 unveiled the gripper's proficiency in intricate tasks, such as inserting a battery into a torch, highlighting the robot's accuracy and repeatability.

These labs collectively served as invaluable learning experiences, offering insights into the operation of the teach pendant and unveiling the nuanced functionalities of the UR5. From overcoming challenges in specific movements to demonstrating precise and repetitive actions, the labs underscored the importance of strategic adjustments and careful programming for optimal robot performance. As students, these experiences deepen our appreciation for the intricacies of robotic operations and equip us with practical knowledge for future applications in automation and robotics.

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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