Universal Robot (UR5)

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Article Info

Article history:

Received November 6, 2023
Revised November 6, 2023

Keywords:

UR5
Universal Robot
Gripper
Tracing

ABSTRACT

The overarching objective of this activity is to showcase the repeatability and straightness analysis capabilities of the UR5 robot, particularly emphasizing tactile exploration using a gauge on a granite block. The robot's repeatability is assessed through a series of precise movements, touching a single point on the block while measuring the offset of three digital indicators. Simultaneously, the straightness of the robot's programmed motion is scrutinized by tracing line segments on the granite block using a single digital indicator. These comprehensive tasks provide valuable insights into the UR5's precision, adaptability, and reliability in executing predefined motions. The inclusion of a gauge in these assessments adds a crucial element to the exploration, offering nuanced perspectives on the robot's accuracy and repeatability in real-world applications.

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1. INTRODUCTION

In this integrated laboratory exploration, our focus is on the UR5 robot, a versatile robotic system known for its precision and adaptability. The overarching goal of this combined lab endeavor is to conduct a thorough examination of the UR5's capabilities, with a specific emphasis on repeatability and straightness analysis, as well as a comprehensive assessment of its gripper functionality.

In this integrated laboratory exploration, our focus is on the UR5 robot, a versatile robotic system known for its precision and adaptability, with a specific emphasis on repeatability and straightness analysis. The overarching goal is to conduct a thorough examination of the UR5's capabilities, particularly in tasks involving a granite block. We aim to demonstrate and quantify the robot's repeatability in programmed linear motions and assess the gripper's functionality. Additionally, we will delve into the straightness of the robot's programmed linear motion through a series of experiments with a granite block.

The prelab phase emphasizes understanding the differences between accuracy and repeatability. Students are required to have ursim and RoboDK downloaded on their personal computers to facilitate the lab tasks.

2. METHOD

Task 1: Repeatability Test with Granite Block
In Task 1, the focus is on testing the repeatability of the robot by touching a single point on a granite block while measuring the offset of three digital indicators. The robot is positioned using free drive or manual controls to avoid collisions. Precise adjustments are made to ensure a specific offset, and the robot is then moved through defined waypoints, with the entire process repeated ten times. Data is recorded through either PuTTY or a popup menu, and box plots are created to analyze repeatability in different directions.

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 Pose 3 and pose 4.

Table Coordinates fed into the robot

	X (mm)	Y (mm)	Z (mm)	RX (rad)	RY (rad)	RZ (rad)
Pose 2	25.88	-360.44	169.38	1.0937	1.3504	1.2740
Pose 3	-51.53	-246.62	275.83	0.1450	1.5895	0.0580
Pose 4	-219.33	-310.16	510.30	2.1950	0.9980	0.0061

Task 2: Straightness Testing with a Granite Block

Task 2 involves creating a program to test the straightness of the robot in three directions by measuring a granite block with a single digital indicator. Faces on the granite slab are identified for tracing three straight line segments. The orientation of each face is determined by locating two points, and the robot is positioned to ensure the digital indicator displays an offset of ~5mm when pressed against the surface at both points. Linear movements are programmed, and the robot repeats this process ten times for each face, recording the position of the digital indicator.

The Robot User Interface's Polyscope Function facilitated the precise selection of points on the granite block. The gauge consistently measured a unit of 10 on the block. Subsequently, Polyscope was employed to maneuver the end effector in a rectangular pattern on the block while maintaining the 10-unit value. This process was iterated using the loop function ten times, effectively showcasing the repeatability.

3. RESULTS AND DISCUSSION

The results of both Task 1 and Task 2 will contribute to understanding the repeatability and straightness of the UR5 robot's programmed linear motion when interacting with a granite block. These detailed analyses, including the use of digital indicators in Task 1 and straightness measurements in Task 2, provide a comprehensive view of the robot's precision in various tasks.

In the context of Lab 2, which focuses on the granite block and incorporates both Task 1 and Task 2, the robot adeptly executes tasks involving the block, showcasing precision and repeatability. Challenges, such as those encountered during the moveJ operation, are addressed strategically, underscoring the adaptability of the system.
https://youtube.com/shorts/NsqVOKsPqFg?feature=share
https://youtu.be/R3Da_Mky0dg

4. CONCLUSION

The integrated exploration of Labs 2 and 3, along with Task 1 and Task 2, successfully achieves the goals of providing a comprehensive understanding of the UR5 robot's capabilities. Lab 2 showcases the robot's precision in tracing, while Task 1 and Task 2 provide additional insights into repeatability through digital indicators and straightness measurements, respectively. Lab 3 emphasizes the gripper's proficiency in intricate tasks. These labs collectively serve as invaluable learning experiences, deepening appreciation for the intricacies of robotic operations and providing practical knowledge for future applications in automation and robotics.

5. ACKNOWLEDGEMENTS

I express my gratitude to Prof Redkar, Rohit Menon, Yashaswi Ranga, and Tatwik for their invaluable explanations that helped our group comprehend the UR5 better.

6. REFERENCES

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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