Robot Manipulator Planning for Multi-Robot Package Transportation

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Abstract — Manipulator robots and quadruped robots are commonly used for package relocation and transportation in warehouses. Since creating a planning strategy that would enable multi-robot collaboration for these specific robots has been a challenge due to unpredictability with the prior algorithms during the interaction process, we introduce an integrated solution that coordinates multiple robots of both types to provide a seamless package transportation pipeline. Some challenges correlated to our study are related to sensor, motion planning, and stability control. We have concentrated on developing solutions that will allow both robots to complete a single continuous package transportation pipeline in a warehouse-like environment.

Motivation

- Multi-Robot systems can be highly effective since they have the ability to collaborate and do many more tasks in far less time and effort.
- However, additional work is required to further develop several systems, such as sensor, motion planning, and control.

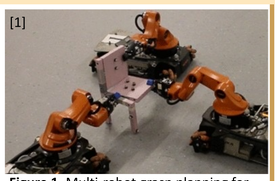
[1]

Figure 1. Multi-robot grasp planning for sequential assembly operations

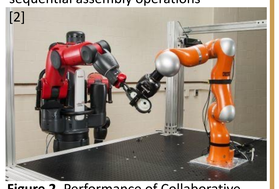
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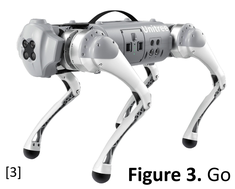
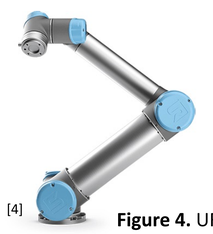
Figure 2. Performance of Collaborative Robot Systems

Introduction

- A **multi-robot system** consists of two or more robots that can collaborate to accomplish a goal.
- The **manipulator robot** (UR5) is a six-jointed and linked robot arm. In this study, UR5 collaborates with a **quadruped robot** (Go 1), which is a mobile robot with an intelligent lateral tracking system.
- Our study focuses on package transportation in warehouses, which consists of UR5 robot and Go 1 robot working together to relocate an object.


[3] **Figure 3.** Go 1


[4] **Figure 4.** UR5

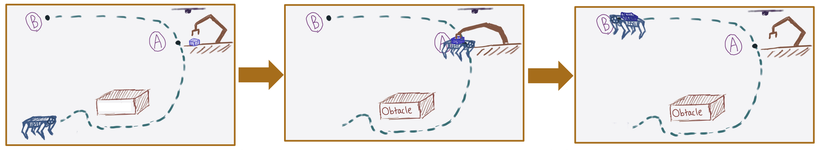
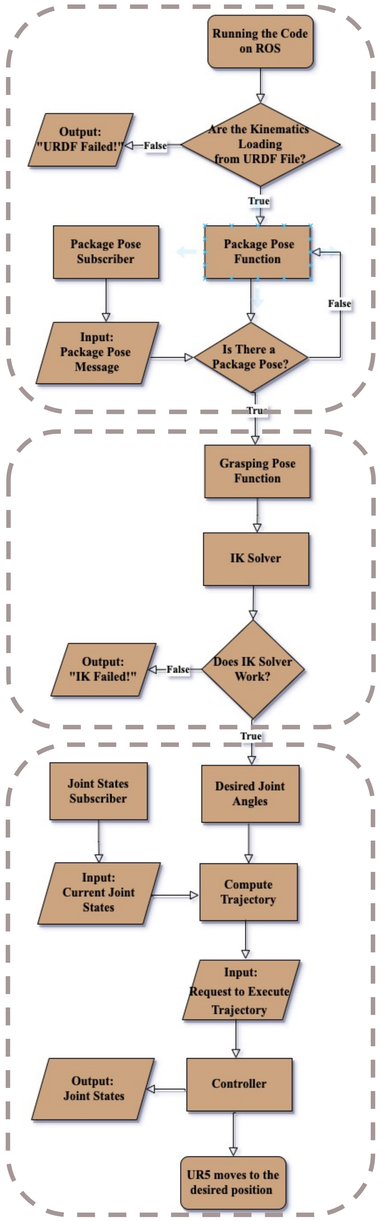


Figure 5. Theoretical package transportation pipeline with both Go 1 and UR5

Methods

- Use robot kinematics to create a motion planning process for UR5 to:
  - Move the arm into a gasping pose
- Observe and note any sources of error

Results



Waiting for Package Pose

- Robot kinematics are loaded from the URDF file
- The package pose is sent as a message by a subscriber

Working With the Inverse Kinematics

- Implement package pose to IK solver
- IK solver gives the desired joint angles

Converting Joint Angles to Joint States

- Given current joint states and desired joint angles, compute trajectory using a controller
- Controller executes the desired joint states and UR5 moves to grasping pose

Figure 6. Flowchart of UR5 moving to grasping pose

Results Continued

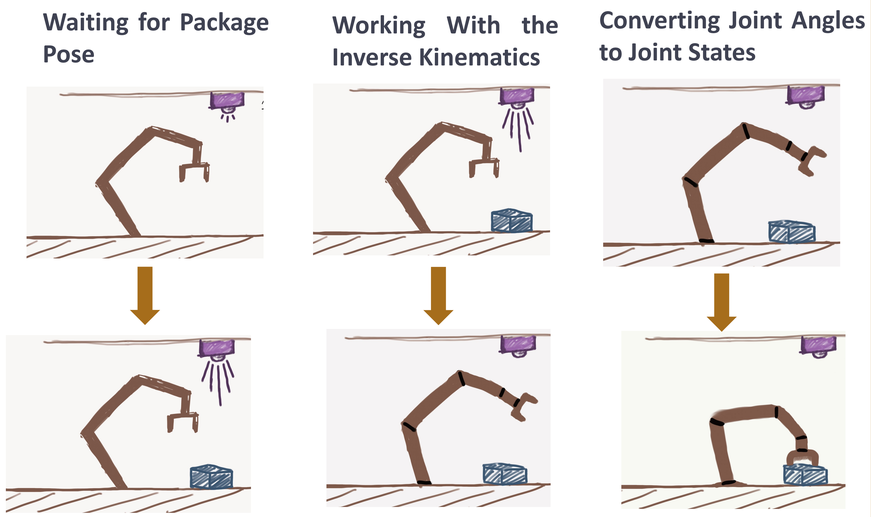


Figure 7. Illustration of the flowchart of UR5 moving to grasping pose

Conclusion and Next Step

- Our results imply that verifying that the camera sensor works and sends the correct package pose to the IK solver is critical in order for the UR5 to be able to move to the grasping pose.
- The next step of the project would be to get the robot arm to use a vacuum gripper, then carry the package and place it on the Go 1 robot.

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References

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