Teaching materials

Deliverable 1. Grasping with a robotic hand

MISCE project

Mechatronics for Improving and Standardizing Competences in Engineering

Competence: Robotics

Workgroup: Universidad de Castilla-La Mancha

Universitat Politècnica de València

This document corresponds to the first deliverable for the competence 'Robotics' using the 'hand platform'

Version: 1.0

Date: October 5th, 2023

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1 Introduction

This section introduces a collaborative hands-on activity focused on the execution and analysis of grasping strategies using a robotic hand mounted on an industrial robot. The goal is to reinforce core robotics skills such as robot programming, end-effector orientation, grasp selection, workspace awareness, and operational safety.

Unlike theoretical simulation-based practices, this activity emphasizes real-world interaction and teamwork. Students will plan and execute pick-and-place operations involving different objects, selecting grasp types and robot configurations that ensure success and reliability. Each group member will participate in both object placement and robot control, ensuring full engagement with the robotic system and the learning objectives.

2 Task description

In this activity, students are required to program the robot to pick up three different objects from predefined locations and place them at specific target positions on the worktable. The robotic hand, already mounted on the robot wrist, will execute the selected grasp gesture in coordination with the robot's movement.

The student must plan and implement a robot program that includes:

- Selection of the appropriate grasp gesture using the MATLAB app.
- Positioning the robot end-effector in an appropriate orientation and pose to perform the grasp.
- Sending a digital signal to the Arduino to trigger the grasp gesture.
- Waiting for the confirmation signal from the Arduino before proceeding with the pick-and-place movement.
- Transporting the object to its destination position safely.
- Opening the hand and returning to a standby or initial pose.

Throughout the task, students must:

- Consider the geometry and physical properties of each object.
- Evaluate the reachability and limitations of the robot's kinematics.
- Ensure safe and collision-free movement at all stages.

This task encourages the understanding and application of robotic concepts such as trajectory planning, inverse kinematics, system programming, and safe operation, in line with the Robotics competence goals.

3 Procedure

The activity will be carried out in groups of three students. Each student will take turns as the robot operator, while the other two students act as object placers. Each round follows this procedure:

1. **Object placement**: Two students select one of the three objects and place it anywhere within the defined starting zone on the table.
2. **Robot program execution:** The third student programs the robot to:
   - Reach the object considering its position and orientation.

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- Select an appropriate grasp gesture from the MATLAB app.
- Trigger the grasp via a digital signal and wait for the confirmation.
- Move the object safely to a fixed destination location, shown in the guide with an image reference.
- Open the hand and return to a neutral pose.

3. **Rotation:** Once the object is placed at its destination, it is removed from the table and students rotate roles. The process repeats until each student has completed at least one full pick-and-place task. If there are more than three students, objects can be reused in new positions.

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4 Report

Each student must complete an individual activity report during their turn as the robot operator. This report will be provided as a fillable PDF form, where students will be able to insert images and type their responses directly.

Take two photos during your turn as robot operator:

- Photo 1: Photograph the object in its initial position before it is grasped.
- Photo 2: Photograph the robot and the hand at the exact moment of grasping.

Insert both photos into the corresponding boxes in the PDF form.

Photo 1. Object in its initial position before being picked	Photo 2. Robot and hand at the grasping moment

Select the gesture you used to grasp the object. Write the name of the selected gesture from the MATLAB app in the box below:

Explain why you chose that gesture to grasp the object. Consider the object's shape, size, and position:

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Describe how the robot approached the object. Mention the orientation of the end-effector and the movement path you programmed.

Did you have any difficulties during the task? Briefly describe any issues such as reachability problems, unstable grasp, or misalignment.

Was the task successful? Explain if the object was picked and placed correctly, and whether it remained stable during transport.