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Humanoid Robotics

Assignment 7

Discussed in Tutorial on 30.06.2026.

Object Manipulation and Trajectory Generation:

1. Uncommon Gripper Type from Literature (Total: 3 points)

In the lecture we discussed different types of grippers. Identify one gripper (or end-effector) from the robotics literature that is not a standard 2-finger parallel-jaw gripper, multi-finger (e.g. 5-finger) hand, or vacuum-based suction cup. (Tip: look for recent conference papers—examples include underactuated "soft" grippers, gecko-adhesive pads, or the ROSE-Gripper as discussed in the lecture):

Please provide:

a. **Name & Reference:** Full name of the gripper, authors, publication venue, and year.

b. **Working Principle:** How does it grasp? Describe its actuation method (e.g., rotation-based squeezing, adhesion, compliance, etc.) and key mechanical/fabrication elements.

c. **What Makes It Uncommon:** Explain why this gripper is "uncommon" compared to typical parallel-jaw or multi-finger hands. Is it the geometry, the materials, the actuation strategy, the contact model, or something else?

d. **Advantages & Limitations:**

- List at least two advantages (e.g., gentle compliance, ability to handle highly irregular shapes, reduced hardware complexity).
- List at least two limitations or challenges (e.g., limited force, sensitivity to surface conditions, speed constraints).

e. **Application Scenario:** Give one concrete scenario (pick a specific object type or manipulation task) where this gripper would outperform a standard parallel-jaw gripper, and explain why.

2. Friction Cone & Maximum Liftable Load (Total: 4 points)

Consider a simple planar (2D) parallel-jaw gripper grasping a block of mass m by pinching it on two opposite faces. Each finger applies a normal force F perpendicular to the contact surface. The contact between each finger and the block is modeled as a **hard-finger** model. Assume static friction coefficient μ between the finger pads and the block.

Consider a block of unknown mass m, gripped by a parallel-jaw gripper with each finger capable of applying F=80N. The fingertip material and the block surface together give μ=0.3. Use g=9.81m/s2.

a. Compute the half-angle θ of the friction cone in degrees.

b. Find the maximum frictional force ft,max at each finger.

c. Determine the maximum mass m_max that the gripper can lift without slipping.

d. Suppose the block's actual mass is m=2.0kg. Verify whether this gripper can lift it. If not, compute the **minimum** normal force Fmin each finger must apply (for the same μ=0.3) to just barely lift a 2.0kg block.

You can decide if you want to do this exercise in python or pen-and-paper. If you decide for the latter, please upload it as pdf to your solutions.

3. Which learning based grasp model for which scenario (Total: 3 points)

In the lecture we discussed **VGN**, **AnyGrasp** and **GPD** as three examples of learning-based grasping model for parallel jaw gripper. For each of the following scenarios, choose the most suitable model. Justify your choice based on what is presented in the lecture slides: consider factors such as sensor modality, real-time capabilities, object specificity, and task goals.

a. A mobile manipulator with a wrist-mounted RGB-D camera approaches an object that is moving on a conveyor belt. The robot must track and refine the grasp online as it aligns with the object.
b. A mobile manipulator with a wrist mounted RGB camera that is used for semantic segmentation for generating selective object masks, and LiDAR sensor that provides point clouds navigates home environments to grasp and bring specific objects to the user. The user may change the task mid-way and the robot must adapt and change its target location to grasp the new object.
c. A 7 dof manipulator arm with a depth only sensor is fixed in front of a bin with cluttered objects of the same type in a factory. The goal is to clear the bin by removing the object from the bin and placing it on a fixture as fast as possible.