WICHITA STATE UNIVERSITY

Introduction to Intelligent Robotics, 2022 / CS898 CA

Dr. Hongsheng He, School of Computing

Grasp Objects in Pybullet Environment

1. Project Objective

- Get familiar with 3D robot simulation
- Understand intelligent robot programming
- Apply inverse kinematics algorithm in simulated environment

2. Project Steps

1. Install pybullet with Anaconda (recommended)
    - Install Anaconda: https://www.anaconda.com/products/individual
    - Install Pybullet: https://anaconda.org/conda-forge/pybullet
2. (If you have done the first step, please ignore)

Install python3 (optional)

Setup the python3 environment on your system.

- Windows 10:
    - https://phoenixnap.com/kb/how-to-install-python-3-windows
- Mac:
    - https://docs.python-guide.org/starting/install3/osx/
- Ubuntu 16.04:
    - https://www.digitalocean.com/community/tutorials/how-to-install-python-3-and-set-up-a-local-programming-environment-on-ubuntu-16-04

3. (If you have done the first step, please ignore)

Setup Pybullet Environment:

- Run following commands in the terminal:
    - pip3 install pybullet --upgrade --user
    - python3 -m pybullet_envs.examples.enjoy_TF_AntBulletEnv_v0_2017may
    - python3 -m pybullet_envs.examples.enjoy_TF_HumanoidFlagrunHarderBulletEnv_v1_2017jul
    - python3 -m pybullet_envs.deep_mimic.testrl --arg_file run_humanoid3d_backflip_args.txt
- Pybullet Reference: https://github.com/bulletphysics/bullet3

4. Load assigned object in the environment
    - In sawyerEnv.py, change the variable *object_path* to your assigned object.
    - In main.py, update *object_path* to your assigned object.
5. Record the tray location in the environment
    - run tune_grasping.py
    - Click the GUI and Press Q on your keyboard
    - Record the tray_x and tray_y
    - update tray_x and tray_y in both sawyerEnv.py and main.py
    - Please make sure the tray and the object is not conflict.
6. Run tune_grasping.py
    - Adjust your hand position and grasp type by using the slider
    - After you have adjusted your hand position. Press Q on your keyboard
    - you can get 3 outputs
        - handIReading: the pose of the hand
        - palmPosition: arm postion
        - Orientation: arm orientation
7. Find grasping trajectory
    - Run tune_grasping.py and record parameters for each step in lines 340 – 376 in main.py
        - handIReading
            - handInitial
            - handClose
            - handOpen
        - palmPosition and orientation
            - grasp_palmPosition, grasp_orientation
            - pu_palmPosition, pu_orientation
            - final_palmPosition, final_orientation
8. Update the outputs in step 7 to main.py
9. write code for the grasping task
    - Use **Inverse Kinematics Function** in main.py to control the position and orientation of the arm
    - Use **Hand Direct Control Function** in main.py to control the hand

10. Record a video for successfully trail

3. What you need to submit

- Functional codes (30%)
- Demo illustration (30%)
  - A video that contains one trial of successfully grasping the target objects. Please share the video at OneDrive at WSU and share the link (Don't upload to Blackboard).
- Project Report (40%)
  - A project report that in academic paper format should be written for this project (IEEE conference templates) (1%).
  - The report should include:
    - Introduction (5%)
      - Background about robotic Object Recognition and Grasping (2%)
      - Procedure of the project (2%)
      - Brief Summary of the project (1%)
    - Project Descriptions (10%)
      - Describe the procedure (2%)
      - Describe the applied algorithm/methods of the project (4%)
      - Save the grasping parameters of the hand and fingers into a ".csv" file. For example, if your object is "203", save your parameters into a "203.csv" including all parameters in step 7 (3%)
      - Include a picture of the hand gesture (1%)
    - Results (10%)
      - Trajectory of the object in grasping (5%)
      - Snapshots of successful and failed grasps (if there are any) (5%)
    - Discussion of results (10%)
      - Discuss the advantages and disadvantages of the designed hand gesture in grasping the object. Why is it successful? (5%)
      - Discuss the designed trajectory of hand movement. What are the key parameters and how are the parameters are selected? (5%)
    - Conclusion (3%)
      - Conclude the report, what you have done (1%), what results you have got (1%), what worked and what did not (1%).
    - Reference (1%)