

SCIENTIFIC EXPERIMENTATION AND
EVALUATION
ASSIGNMENT: 05

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1 Relevant Aspects of Experiment

1.1 Apparatus

1.1.1 Hardware

- KUKA youBot arm.
- Objects of three different sizes and weights, with ArUco markers attached to the top.
- Camera (Microsoft LifeCam).
- Two computers, one to run the robot and other for data gathering from the camera.
- A fixed container or marker on the table to ensure that the initial object position is kept constant.

1.1.2 Software and Libraries used

- KUKA youBot drivers.
- Control scripts for the arm to pick and move the objects in one of the three predefined placing poses.
- Marker pose subscribed script, to gather pose of the object.
- **LibreOffice Calc** for data management.
- **Python** for data visualization and calculations
- **Python libraries:**

1.2 Procedure

- First we run the script to get the arm in the pre-grasp position.
- We then place the object in the container, keeping the marker's orientation constant throughout the experiment.
- We then run the script to move the arm in one of the three pre-defined positions; and repeat this twenty times for each weight and pose combination. Thus, giving us 180 readings of pose coming from three different objects in three different orientations.
- Once the object is placed and the arm moves back to a stationary position, we run the subscriber script to collect pose readings of 50 frames from the camera. This is repeated after each motion.

1.3 Expected Problems and Performance

- The picking position of the arm might differ from the ground truth, because of vibrations, motion in the table and a variety of other physical conditions.
- The placement of the object in the container might not always be aligned properly.
- The marker on top of the object might move during movement and thus will lead to improper pose data.
- After placing the object, the gripper might touch it while moving away, which will introduce distortions in data.
- The light might not always be uniform, which might also cause some distortions in observation.

2 Observations and Data

2.1 Visualization

2.1.1 Data Visualization

Histograms of raw data

2.1.2 Outlier Detection and Removal

How we remove outliers

2.1.3 Pose Visualization

Plot Pose for data after removing outliers