GRASP QUALITY PREDICTION USING GAUSSIAN CLASSIFICATION PROCESS

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Why we chose this problem?

• Mechanical hands were developed to give robots the ability to grasp objects of varying geometric and physical properties.
• Even though hands are designed with great dexterity, they fail to grasp object.
• This is where Grasp Quality Prediction is used to classify good and bad grasp.
What does Grasp Quality Prediction means?

- Grasp quality prediction tells us about how the robotic hand has made contact with the object it is going to grasp.
- It is very important part of grasping because it tells the operator whether the grasp the robot performed is perfect or not.
- If it is not perfect, the operator can revert the grasp and do it again before the object falls down.
How ML is used to classify a good grasp and bad grasp?

- We are using Gaussian Classification process.
- It classifies good grasp from the bad grasp based on the data provided.
- So it falls under the category of Supervised Learning.
How we approached the problem?

• Here, we used Robotiq hand which is controlled with ROS to grasp the objects.
• Robotiq hand is fitted with TakkTile sensors from which we collected the data.
• This sensors respond i.e change values when pressure is applied on them.
How we approached the problem?

• We used ROS (Robotic Operating System) and python to collect the data from the sensors.

• when the arm is closed and When ever the sensors make contact with the object, sensor shows readings.

• These reading are captured and saved for further use.
How we approached the problem?

- We conducted grasping on 4 different objects.
- We conducted 10 different grasps on each object and each grasp is repeated 10 times.
- So, we collected a data set of 400 points.
- Robotiq hand is having 4 sensors on it (left, right, middle and palm sensors).
- So the size of matrix is 400*4
How we approached the problem?

- We collected the data in 3 stages
  1. Grasp 0: sensor reading before grasp
  2. Grasp 1: sensor reading at the time of grasp
- Collecting data in this way produce more accurate results.
How we approached the problem?

• We labeled a grasp as success (1) if the object didn’t fall after the shake test.
• We labeled a grasp as a Failure (0) if the object fell off after the shake.
• We collected the data such that 30% of it is a bad grasp.
How we approached the problem?

• After collecting enough data, we divided the data into two parts i.e. 80% training and 20% testing.
• We used GPML library and MATLAB for classification.
• This data is used to train the GP for classifying good and bad grasp.
• First, we used Grasp 1 data to train GP, but due to lot of variation present in the data we were not able to differentiate good and bad grasp.
How we approached the problem?

• So, we normalized the data.

• \[ X = \text{Grasp 1} - \text{Grasp0}/ \text{Max sensor value}. \]

• After doing normalization we were able to differentiate the good and bad grasp.
How we approached the problem?

Before Normalization

After Normalization
T-test

- Even though we normalized the data, we still have some noise in data.
- So we used T-test to reduce the noise.
- T-test normally compares the mean between given sets and if the mean is same it picks only one of the give set.
- After running T-test our data is converted into 3 dimensions.
Results

- We applied PCA to reduce dimensions from 3-D to 2-D
- We also applied SVM to differentiate good and bad grasp using decision boundary
Conclusion

• We successfully able to classify good and bad grasp using Gaussian Classification Process.

Future Work

• Improve grasp quality predication such that it works well on novel objects.
• Dynamic Environment.