Grasp Points Optimization in Multi-fingered Grasping

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Group# 3

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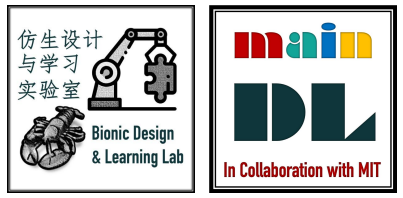

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Proposed Project Title Summary

- Summarize the whole summary in a single paragraph here, within 300~400 words, describing the following contents.
  - (20%) What is the problem that you will be investigating? Why is it interesting?
  - (20%) What reading will you examine to provide context and background?
  - (20%) What data will you use? If you are collecting new data, how will you do it?
  - (20%) What method or algorithm are you proposing? If there are existing implementations, will you use them, and how? How do you plan to improve or modify such implementations? You don't have to have an exact answer at this point, but you should have a general sense of how you will approach the problem you are working on.
  - (20%) How will you evaluate your results? Qualitatively, what kind of results do you expect (e.g., plots or figures)? Quantitatively, what kind of analysis will you use to evaluate and/or compare your results (e.g., what performance metrics or statistical tests)?

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Proposed Project Title Summary

Grasp Points Optimization in Multi-fingered Grasping

Grasp points optimization is to solve the optimal positions where forces of the gripper are applied. This optimization offers initial target points to the robot, making further manipulations possible. For most objects, they are irregular and only provide few suitable position to fetch. Consequently, it is necessary and interesting to find a solution to optimize the grasp-point by minimizing forces and torques while maximizing stability for robotics.

We shall draw upon the approach delineated in the paper titled Computation of multi-fingered grasping force with linear combination and the concept presented in the paper titled Robotic Grasp Detection using Deep Convolutional Neural Networks and Multi-view Self-supervised Deep Learning for 6D Pose Estimation in the Amazon Picking Challenge.

We plan to build a simulation environment. In this environment, we will pre configure some representative objects for the robotic arm to grip, such as cones, cylinders, etc.. In this process, we will use the known surface and position information of the object as data input, and we will determine whether our algorithm is reasonable by observing the gripping performance of the robotic arm.

Computation of multi-fingered grasping force with linear combination by CHEN Dongjin， JIANG Li and WANG Xinqing provides an efficient method to solve the optimal force distribution of grasp positions, which is usually a non-statically determined problem, using linear combination of unit external force and their unit response. Through this method, we can generate initial values for the force optimization algorithms in the point contact friction models, and improve efficiency.

Furthermore, we plan to use machine learning to help us find the best grasp-point for objects with clear known shape and position information in a simulated environment, where the initial position parameters of machine learning are the initial values obtained above. The methodology can be referred from the paper *Robotic Grasp Detection using Deep Convolutional Neural Networks.*

Quantitatively, as previously indicated, the effectiveness of our algorithm will be evaluated through the observation and analysis of the robotic arm's grasping performance. Qualitatively, we will assess the stability and time efficiency throughout the gripping process executed by the robotic arm. We intend to compile tables that succinctly delineate these performance outcomes. Additionally, we may supplement our findings with accompanying videos to substantiate our results.

We will start from 2D-2 points grasping, and we expect to offer a functioning AI to solve a 3D-N points grasping problem.

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What is the problem that you will be investigating?

Why is it interesting?

Grasp points optimization is to solve the optimal positions where forces of the gripper are applied. This optimization offers initial target points to the robot, making further manipulations possible. For most objects, they are irregular and only provide few suitable position to fetch. Consequently, it is necessary and interesting to find a solution to optimize the grasp-point by minimizing forces and torques while maximizing stability for robotics.

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What reading will you examine?

To provide context and background

We shall draw upon the approach delineated in the paper titled *Computation of multi-fingered grasping force with linear combination* and the concept presented in the paper titled *Robotic Grasp Detection using Deep Convolutional Neural Networks* and *Multi-view Self-supervised Deep Learning for 6D Pose Estimation in the Amazon Picking Challenge*.

Computation of multi-fingered grasping force with linear combination：
https://max.book118.com/html/2019/0115/6101222011002002.shtm

Multi-view Self-supervised Deep Learning for 6D Pose Estimation in the Amazon Picking Challenge：
Zeng, A., Yu, K.T., Song, S., Suo, D., Walker, E., Rodriguez, A. and Xiao, J., 2017, May. Multi-view self-supervised deep learning for 6d pose estimation in the amazon picking challenge. In 2017 IEEE international conference on robotics and automation (ICRA) (pp. 1386-1383). IEEE.

Robotic Grasp Detection using Deep Convolutional Neural Networks
S. Kumra and C. Kanan, "Robotic grasp detection using deep convolutional neural networks," 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Vancouver, BC, Canada, 2017, pp. 769-776, doi: 10.1109/IROS.2017.8202237. keywords: {Feature extraction;Robot kinematics;Machine learning;Grippers;Training}

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What data will you use?

If you are collecting new data, how will you do it?

We plan to build a simulation environment. In this environment, we will pre configure some representative objects for the robotic arm to grip, such as cones, cylinders, etc.. In this process, we will use the known surface and position information of the object as data input, and we will determine whether our algorithm is reasonable by observing the gripping performance of the robotic arm.

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What method or algorithm are you proposing?

If there are existing implementations, will you use them, and how? How do you plan to improve or modify such implementations? You don't have to have an exact answer at this point, but you should have a general sense of how you will approach the problem you are working on.

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How will you evaluate your results?

Qualitatively, what kind of results do you expect (e.g., plots or figures)? Quantitatively, what kind of analysis will you use to evaluate and/or compare your results (e.g., what performance metrics or statistical tests)?

Quantitatively, as previously indicated, the effectiveness of our algorithm will be evaluated through the observation and analysis of the robotic arm's grasping performance. Qualitatively, we will assess the stability and time efficiency throughout the gripping process executed by the robotic arm. We intend to compile tables that succinctly delineate these performance outcomes. Additionally, we may supplement our findings with accompanying videos to substantiate our results.

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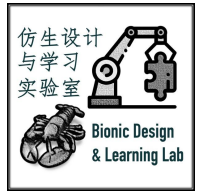

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