6-DOF Grasp Planning using Transformer-based Neural Networks

Description

With the rapid advancement in robotics, effective and efficient grasp planning in high degrees of freedom (DOF) environments is becoming a critical challenge. Grasp planning involves determining how a robotic manipulator should approach, position, and apply force to an object, often within dynamic and unstructured environments. Traditional approaches often rely on predefined heuristics or control algorithms, which may not generalize well to complex environments.

This project aims to explore the use of transformer-based neural networks to address 6-DOF grasp planning problems. Transformer models have recently demonstrated significant success in a variety of domains, particularly in natural language processing and vision tasks, due to their ability to capture long-range dependencies and process sequential information efficiently. This proposal suggests extending the transformer architecture to the domain of grasp planning, utilizing its strengths to predict feasible grasps for a robotic manipulator in environments with variable object types, orientations, and uncertainties.

Tasks

As a thesis student, you will work closely with our team to investigate the use of transformer-based models in 6-DOF grasp planning. You will be responsible for the following tasks:

- Develop a transformer-based neural network architecture (we have a basic version) tailored to 6-DOF grasp planning, incorporating object features and spatial information.
- Train the network using large-scale datasets (e.g. ACRONYM) containing 3D object representations, grasp annotations, and pose data.
- Benchmark the performance of the transformer model against other deep learning-based and traditional approaches for grasp planning, measuring grasp success rate, computational efficiency, and real-time feasibility.
- Implement and test the model on a 6-DOF robotic manipulator in a physical or simulated environment, analyzing its performance in real-world scenarios.

This project will provide you with hands-on experience in applying state-of-the-art deep learning techniques to robotic control systems, specifically focusing on grasp planning tasks. You will also gain practical knowledge in ROS, robotic manipulation, and the integration of machine learning models with robotic systems.

Technische Universität München

TUM School of Computation, Information and Technology

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Supervisor:
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Advisor:
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Research project:
MANNHEIM-CeCaS

Type:
SA/MA

Research area:
Grasp Planning, Robotics, Neural Networks, Deep Learning, Autonomous Systems

Programming language:
Python, C++

Required skills:
Programming skills in Python or C++ (must have); Experience with deep learning frameworks (TensorFlow/PyTorch) (must have); Knowledge of Robot Operating System (ROS) and 6-DOF manipulator control (nice to have).

Language:
English

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