Master Research Proposal Nr:

# Topic: Optimizing Robotic Bin-Picking - Pushing and Grasping with Deep Reinforcement Learning

With the rapid development of e-commerce, a growing demand has surfaced for using autonomous robots in logistics. This kind of work is highly dependent on human manual workers, which is neither economical nor time efficient. In the realm of industrial automation, robotic bin-picking can play a crucial role in streamlining various logistical processes. However, traditional methods for solving pick and place task for robots often struggle in dealing with complex and cluttered environments resulting in decreased efficiency and success rate. Increasingly reinforcement learning (RL) techniques are being used to train robots in this task.

Previous RL approaches to robotic bin picking have included end to end learning from visual input [4]. Other approaches have concentrated on motion primitives based learning e.g. shifting and grasping in our case [2]. The later approaches have largely employed model free RL methods such as [3], [5] and [1]. In this thesis, we will leverage the existing robotic bin picking model free approach from [3], to develop a model for the environment and then use this model for our model based RL approach. In developing our dynamics model we want to utilize newer networks, such as Masked Auto Encoders and GANs, on our current visual input to get better generalized feature representations and predictions of the next bin scenario.

The motivation behind model-based RL in this scenario is to develop an intelligent robotic system that can optimize pushing and grasping actions through, utilizing 3D scene rendering and to enhance perception and decision-making capabilities in dynamic and unpredictable bin-picking scenarios. The utilization of model based RL should also make our approach more sample efficient. By leveraging learned models [3] of the environment, we will evaluate the robot's ability to plan and optimize its actions more efficiently, even in challenging and unseen scenarios.

The proposed work consists of the following parts:

- Literature review into different RL models for robotic bin-picking
- Developing a model for the environment using data generated from experiments with the model free approach
- Designing and implementing a model-based RL framework supported by 3D scene rendering techniques for optimal pushing and grasping in robotic bin-picking
- Evaluating the developed algorithm against the baselines on a physical Franka Emika robot using standard evaluation metrics e.g. success rate, efficiency and robustness
- Evaluating the performance of the model based RL framework against the model free RL framework for this task

The thesis will contain a detailed description of all developed and used algorithms as well as an evaluation of the results achieved. The implemented code has to be documented and provided.

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**Start – End:**

# References


[1] Abdeslam Boularias, James Bagnell, and Anthony Stentz. Learning to manipulate unknown objects in clutter by reinforcement. *Proceedings of the AAAI Conference on Artificial Intelligence*, 29(1), Feb. 2015.

[2] Mehmet Dogar and Siddhartha Srinivasa. A planning framework for non-prehensile manipulation under clutter and uncertainty. *Autonomous Robots*, 33, 10 2012.

[3] Zohar Feldman, Hanna Ziesche, Ngo Anh Vien, and Dotan Di Castro. A hybrid approach for learning to shift and grasp with elaborate motion primitives, 2021.

[4] Sergey Levine, Chelsea Finn, Trevor Darrell, and Pieter Abbeel. End-to-end training of deep visuomotor policies. *CoRR*, abs/1504.00702, 2015.

[5] Philipp Schillinger, Miroslav Gabriel, Alexander Kuss, Hanna Ziesche, and Ngo Anh Vien. Model-free grasping with multi-suction cup grippers for robotic bin picking, 2023.