MERGEABLE INDUSTRIAL ROBOTS

MASTER'S THESIS PROJECT DESCRIPTION
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Kasper A. Grøntved
kagro15@student.sdu.dk
Advanced Robotics Technology, 2018-2020
University of Southern Denmark
Odense, Denmark

Nikolaj L. Ottosen
niott15@student.sdu.dk
Advanced Robotics Technology, 2018-2020
University of Southern Denmark
Odense, Denmark

Supervisor
Anders Lyhne Christensen
andc@mmmi.sdu.dk
SDU Embodied Systems for Robotics and Learning
University of Southern Denmark
Odense, Denmark

1 Introduction

Two of the key principles behind Industry 4.0 (I4.0) are the ability of machines and devices to communicate with one another and the ability of the resulting cyber-physical system to autonomously perform tasks [2, 1]. Traditionally, industrial robots used for manufacturing are programmed for a specific task and are not able to dynamically change from one task, which for instance requires only a single robot arm, to a task which requires multiple robot arms. Setups today lack the ability to dynamically change, which is a vital, especially for SMEs who are interested in optimising their production with automation. There is thus an opportunity for flexible multi-robot systems that have the capacity to dynamically adapt to different tasks in an ad-hoc manner.

This project focuses on challenges related to decentralised coordination and local, autonomous robots in manufacturing contexts.

2 Task

The task of the project will be divided into two sub-tasks: individually autonomous robotic arms and decentralised coordination.

The individual robotic arms should be able to decide how to grasp and manipulate an object autonomously. If a task requires — or may benefit from — the use of multiple arms, the robots should rely on decentralised coordination to complete the task. The decentralised coordination comprises the robots' movement and the manipulation of objects of interest. For solving this task, artificial intelligence techniques, such as machine learning, will be studied.

For the robots to be able to locate the objects and navigate effectively, some information about the state of the environment is needed. Often, a vision system is used, but in this project, we will initially make two assumptions: Firstly, the pose of the objects are known, which makes a vision system redundant. Secondly, the scene which the object(s) is placed in will be static, meaning that it will not move, for instance, on a conveyor, but remain at a fixed location unless manipulated by the multi-robot system.

3 Project context and equipment

The project will be carried out in the newly established I4.0 lab at SDU[1]. The lab is equipped with a large number of Universal Robot arms, MiR transportation robots, an advanced object tracking infrastructure, and so on.

4 Goals

The goals of this master thesis project is split into two parts: base and extended goals. The base goals are the first to be achieved, and when completed, work on the extended goals will commence.

[1] `https://www.sdu.dk/en/om_sdu/institutter_centre/i40lab`

Base goals

- Identify grasps and implement methods to create an autonomous robotic arm for grasping simple objects.
- Implement autonomous decentralised coordination between two industrial robots.
- Simulate the implemented solutions and perform tests in I4.0 lab at SDU.

Extended goals

- Realise the solution for a specific use-case by collaboration with an industrial partner.
- Enable the autonomous system to handle dynamic tasks, such as bringing new objects, removing or manipulating objects in the scene.
- Make the system able to handle tasks with varying task parameters, such as size, configuration or shape of the object.

References

[1] Malte Brettel, Niklas Friederichsen, Michael Keller, and Marius Rosenberg. How virtualization, decentralization and network building change the manufacturing landscape: An industry 4.0 perspective. *International journal of mechanical, industrial science and engineering*, 8(1):37–44, 2014.

[2] Mario Hermann, Tobias Pentek, and Boris Otto. Design principles for industrie 4.0 scenarios. In *2016 49th Hawaii international conference on system sciences (HICSS)*, pages 3928–3937. IEEE, 2016.