Automated Object Detection in a Collaborative Robot Workspace

Dario Aeschlimann

BSc in Micro- and Medical Technology | Specialisation: Robotics

Introduction

Collaborative Robots need to be flexible, easy to be reprogrammed and safe. In this work a collision avoidance system is integrated based on 3D images, in which foreign objects are detected to allow modifications of the robot's movements.

Motivation

The workspace of a collaborative robot is also a human's workspace and therefore dynamic. Objects can be added, removed or replaced. Most cobots stop when a force sensor is activated. This happens after a collision. The contact forces are dimensioned such that a collision will not harm a human. However, being as high as 150 N, collisions can still cause light or instable objects to be tipped over by the robot. Such an object could be a vessel containing toxic or otherwise dangerous fluids, thus posing a danger to the operator and the environment. This can be avoided by stopping or re-planning the robot's motion before the collision takes place, thereby improving the safety and efficiency of the robot.

Goal

The goal of this thesis is to implement a system, that detects objects inside the robot's workspace in real time. This information will then be used to adapt the robot's path to avoid a collision. If an alternative path is not found, the system shall stop the robot before a collision occurs.

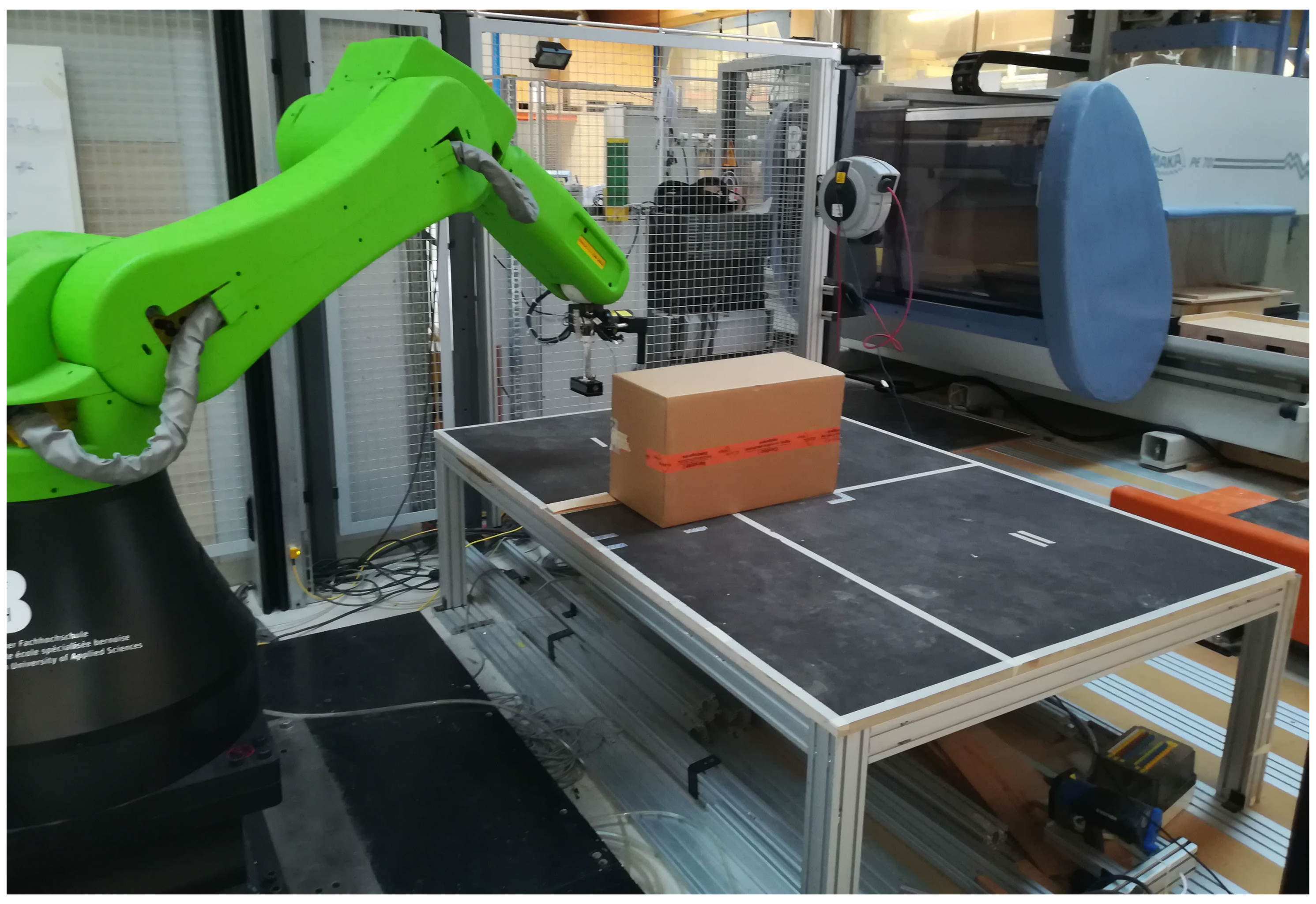

Fig 1: Fanuc CR35-iA Cobot with its workspace at the premises of the AHB.

Method

Hardware

The project is executed on a Fanuc CR35-iA cobot (Fig 1) with a R-30iB controller, which is currently one of the strongest collaborative robots on the market. The CR35-iA can lift up to 35kg, has a working range up to 1.8m and a maximum speed of 250 mm/s.

The live data of the robot workspace is captured by two Asus Xtion Pro Live RGB-D cameras (Fig.2). The cameras use the structured light technology to gather depth data

Fig 2: Asus Xtion Pro Live Camera

Software

The cameras provide data as points with XYZ coordinates and RGB color values. In order to process the so called point clouds, the point cloud library (PCL) is used. PCL provides methods to transform and merge the point clouds into a single entity and filtering unnecessary or noisy data (Fig.3).

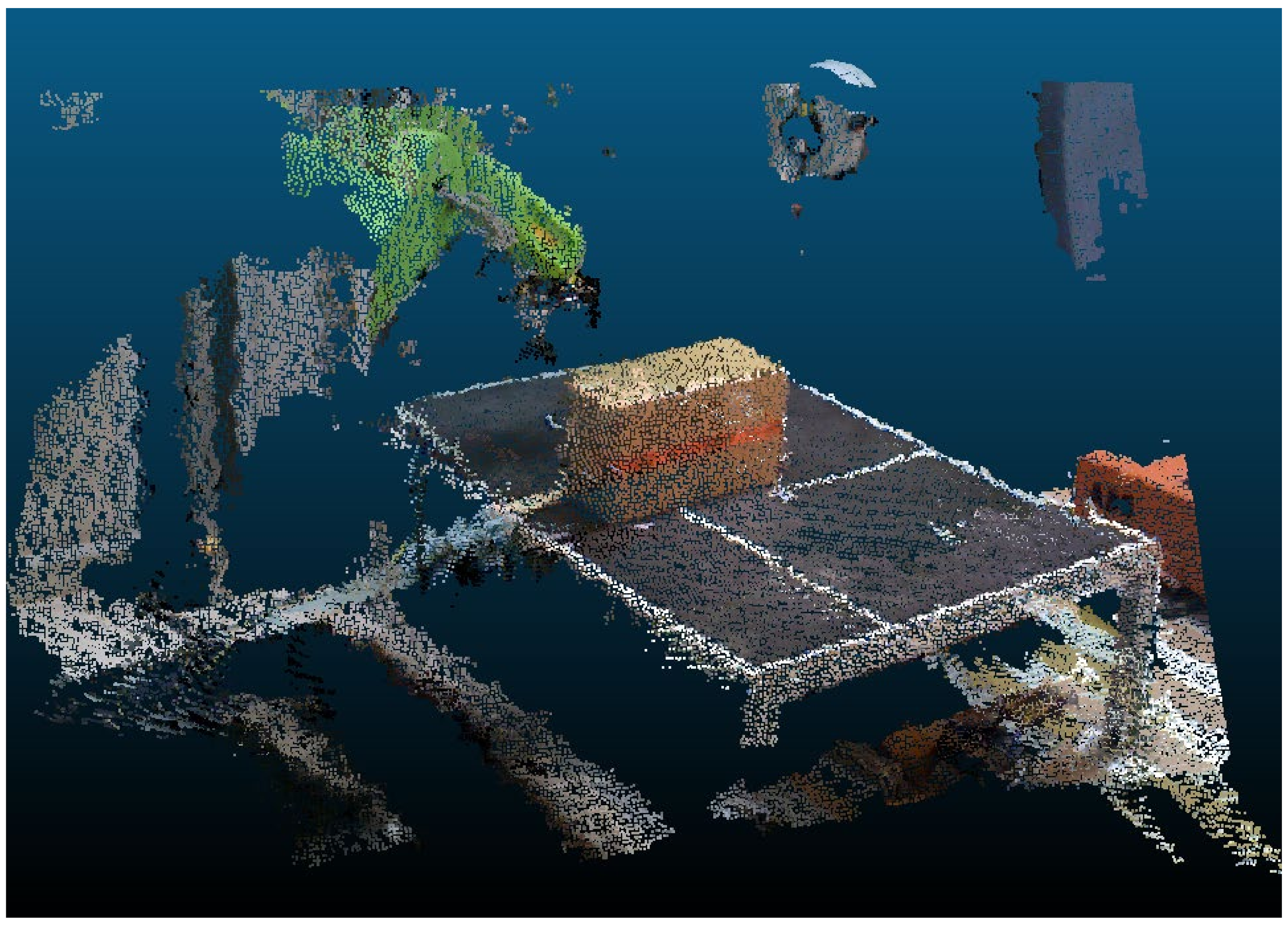

Fig 3: Data from two cameras transformed and merged into a single point cloud. Points too far away from the robot workspace are filtered out.

The point cloud data is voxelized and processed into an occupancy grid using the octomap library. Inside the occupancy grid (Fig.4), robot trajectories can be simulated and collisions with any occupied cell can be detected, thus providing the necessary data to re-plan the robot movements.

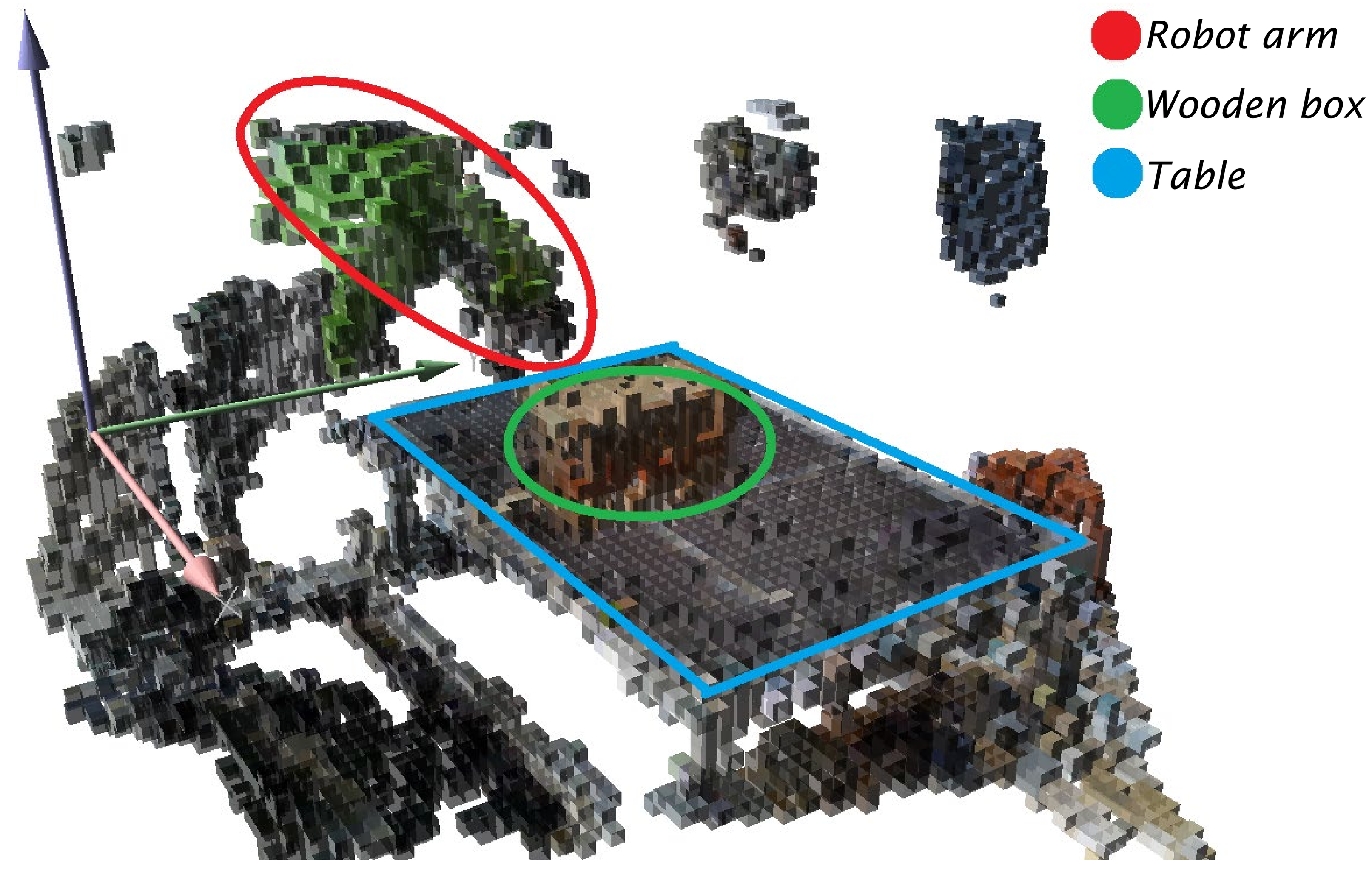

Fig 4: Occupancy grid of the robot workspace. The robot arm and different objects on the table are illustrated. The voxel size is 5cm³.

Outlook

The current collision detection only accounts for the tool center point. Collisions with the robot's body are not recognised and therefore not avoided. A collision detection for the whole robot model can be implemented. The communication with the robot is currently limited to trajectory planning. This work serves as a proof of concept and outlines the requirements and limits of robot controllers and vision systems to implement a safe and robust workspace monitoring.

Bern University of Applied Sciences

dario_aeschlimann@hotmail.ch

BFH, Department of Engineering and Information Technology
Quellgasse 21
2501 Biel

Supervisors: Prof. Dr. Gabriel Gruener, Prof. Dr. Sarah Dégallier Rochat
Expert: Dr. Nikita Aigner
Partner: BFH, Department Architecture, Wood and Civil Engineering
Solothurnstrasse 102
2500 Biel