Master Thesis

Czech
Technical
University
in Prague

F3

Faculty of Electrical Engineering

Part localization for robotic manipulation

César Sinchiguano

Supervisor: Dr Gaël Pierre Écorchard.
May 2019

Acknowledgements

I would like to express my sincere gratitude to my supervisor, Dr Gaël Pierre Écorchard for his patient guidance and good predisposition to help me with my thesis.

Declaration

I hereby declare that the presented work was developed independently and that I have listed all sources of information used within it in accordance with methodical instructions for observing the ethical principles in the preparation of university theses. Prague, . May 2019

Abstract

The new generation of the collaborative robots allow the use of small robot arms working in an asynchronous or synchronous fashion with human workers. Such an example of the collaborative robot is the YuMi robot, dual 7-DOF robot arms designed for precise manipulation of small parts better known in computer vision as rigid body. For further acceptance of such robots in the industry, some methods and sensors systems have to be developed to allow them to pick parts without the position of the part being known in advance, just as humans do. This thesis is focused on the implementation of an algorithm for determing the positition of the known parts. We first deal with a robot-camera calibration, then we propose a method to obtain the ground truth position of known parts. As step in between a 3D model of the known part needs to be created.

Keywords: manual, degree project, LaTeX

Supervisor: Dr Gaël Pierre Écorchard.
Czech Institute of Informatics, Robotics, and Cybernetics, Office
B-323,Jugoslávských partyzánů 3, 160 00
Prague 6

Abstrakt

Nová generace takzvaných spolupracujících robotů umožňuje použití malých robotických zbraní bez toho, aby byli izolováni od lidských pracovníků. Takovým příkladem spolupracujícího robota je robot YuMi, dvojitý 7-osý robot robotů určený pro přesnou manipulaci s malými částmi a dostupný v laboratoři Inteligentní a mobilní robotika CIIRC. Pro další přijetí takových robotů v průmyslu je třeba vyvinout některé metody a systémy snímačů, které by jim umožnily vybírat části bez předchozího znát umístění části, stejně jako lidé. Práce je zaměřena na implementaci algoritmu pro lokalizaci známých částí. Vedle lokalizace se část práce skládá z kalibrace kamery relativeley k robotovým a devolopingovým metodám pro získání pozemské pravdivé pozici dílů. . . .

Klíčová slova: manuál, závěrečnná práce, LaTeX

Contents

Figures

Tables

Chapter 1

Introduction

Within this chapter, the reader receives an outline of the general context which surrounds this thesis. Starting with the motivation section and the ultimate goal to be accomplished, and a summary of the thesis' structure follow.

1.1 Motivation

For years. The industrial robot has undergoes through enormous development. Robot nowadays not only receives command from the computer. But also has the ability to make decision itself. Such abilities are well known in the world of the computer vision as recognizing and determining 6D pose of a rigid body (3D translation and 3D rotation). However, finding the object of interest or determining its pose in either 2D or 3D scenes is still a challenging task for computer vision. There are many researchers working on it with method that goes from state-of-the-art to deep learning means where the object is usually represented with a CAD model or object's 3D reconstruction and typical task is detection of this particular object in the scene captured with RBGD or depth camera. Detection consider determining the location of the object in the input image. This is typical in robotics and machine vision applications where the robot usually does task like pick and place objects. However, localization and pose estimation is much more challenging task due to the high dimensionality of the search in the workspace. In addition, the object of interest is usually sought in cluttered scenes under occlusion with requirement of real-time performance which make the the whole task even much more harder.

1.2 Goal

We attempt to provide an algorithm for determining the pose of a known parts similar to following pipeline "6D object pose estimation using RGBD data" [3]. In addition, a robot-camera calibration needs to be done, and a main requirement a 3D object model needed.

1.3 Thesis structure

The thesis consists of 5 chapters, **??** and **??**. The current chapter briefly describes the motivation and the goal for the part localization which we refer from here on through the whole thesis as 6D pose estimation of a rigid body in order to fit to the nomenclature giving in the perception field. Chapter 2 gives a background to camera calibration, openCV, open3D, ROS, prepossessing algorithm for segmenting the 3D image and related work about 6D pose estimation of the rigid body on which this work is building on. Chapter 3 describes the algorithms and the implementation for creating and collective ground data. Chapter 4 metric pair with the ground truth data. Chapter 5 concludes the thesis and showcase possible future works.

Chapter 2

Background

This chapter presents a briefly theoretical background that is needed in order to understand the thesis. To fully understand any topic, the reader should refer to the reference.

2.1 ROS: Robotic Operating System

ROS is a flexible framework for writing robot software. It is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behaviour across a wide variety of robotic platforms. It is based on the concepts of nodes, topics, messages and services. A node is an executable program that performs computation. Nodes need to communicate with each other to complete the whole task. The communicated data are called messages. ROS provides an easy way for passing messages and establishing communication links between nodes, which are running independently. They pass these messages to each other over a Topic, which is a simple string. However, topics are asynchronous, synchronous communication is provided by services. Services act in a call-response manner where one node requests that another node execute a one-time computation and provide a response. For more details about ROS, the reader can refer to [5].

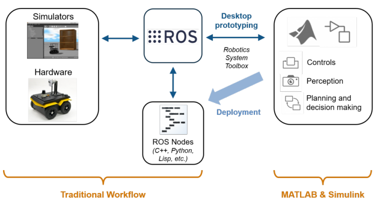

Figure 2.1: A ROS Overview

Lorep ipsum [2]

Bibliography

[1] J. Doe. *Book on foobar.* Publisher X, 2300.

[2] J. Doe. *Book on foobar.* Publisher X, 2300.

[3] J. Doe. *Book on foobar.* Publisher X, 2300.

[4] J. Doe. *Book on foobar.* Publisher X, 2300.

[5] Quigley, Morgan., Conley, Ken., Gerkey, Brian P.., Faust, Josh., Foote, Tully., Leibs, “ROS: an open-source Robot Operating System” in: Conference Paper; 2009. `http://www.willowgarage.com/papers/ros-open-source-robot-operating-system`

[6] J. Doe. *Book on foobar.* Publisher X, 2300.