Some Placeholder Title

A Master Thesis

written by

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The code for this project is available at
`https://github.com/vmstavens/in_hand_pose_estimation`

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Abstract

Some abstract text explaining the goal, methods and conclusion of the project.

Contents

Acknowledgements

My acknowledgements

Acronyms

cobots collaborative robots.

CV computer vision.

EE end effector.

PNP pick-and-place.

Terms

collaborative robots (cobots) [some description].

computer vision (CV) is a scientific field which deals with how computers can gain a high-level understanding from digital inputs in the form of images or videos.

end effector (EE) [some description].

manipulator , [a manipulator description].

pick-and-place (PNP) [some description].

Chapter 1

Introduction

1.1 Context

As of 2022 humanity has developed tools for unprecedented growth in wealth and technology on a global scale \cite. In such times a great deal of consumerism and interconnection is present with people needing product produced faster and more consistently than ever \cite. As one would expect, this creates a high demand for manufacturers to reliably and consistently being able to provide products, while also remaining flexible, as the demand for different product change rapidly. In order to provide great volumes of products, manual labor has is essential as assembly, transport and manipulation processes rely on these. Due to these types of manual labor being largely done by unskilled workers, automation alternatives are being adopted which provides benefits. These include for the employer: Avoid having to pay monthly salaries to unskilled labored individuals doing manual tasks, here the automation solution only requires electrical energy and potential supervision by a qualified individual. Potential risks are also involved when hiring humans as the workforce can be inconsistent due to human error\cite or left out due to illness etc. Considerations with regards workers rights such as working conditions and wage also needs not to be considered. These cause production limitations in the form of stand still hours, such as bathroom and lunch breaks along with after work hours and holidays. This replacement of manual labor also benefits the employee, as boring and physically wearing work is automated, enabling the employees to take on different and less wearing roles. While the issue of labor unemployment becomes apparent solutions which provide support to already hired workers have been developed, such as collaborative robots (cobots)\cite.

When implementing automation of production lines using robotics, certain categories of problems are revealed. These include: Assembly, alteration and pick-and-place (PNP), the last being the one of interest in this project.

1.2 Problem Description

Pick and place manipulators are used in a wide variety of different fields such as sorting of waste [1] handling of food [2][3] and factory bin picking [4] [5] [6]. The solutions in these industries are examples of subcategories under the pick and place problem, namely sorting and bin picking. Since both of these are sub categories of the pick and place problem, they fundamentally follow the same sequential four phases from start to end. These steps being pre-grasping, grasping, transport, and placement [5] for traditional . The pre-grasp phase involves localizing the object(s), potentially estimating their pose and executing the trajectory to move the end effectors grasp, collision free to said object(s). Here different potential grasp can be considered in order to determine the best pose for the end effector. In the grasping phase the end effector gasps the object in such a manner that the object's entire weight is supported by the end effector (EE), and ends when the object no longer is in contact with the environment, which often is the container holding the object. The transportation phase involves the motion of the manipulator to move from the pose achieved after the grasping phase, to a pose ready for placement of the object in the desired placing area or fixture. Here considerations may be needed with regards to how much force and torque the EE can tolerate without losing the object. Finally the goal of the placing phase is to place the object within the placing area or fixture in a desired end pose. Here the constraints on the end pose might differ significantly based on the application, as the pose of greens in a crate might need less precision than if the manipulator hands a bolt to the next robotics system in the pipeline.

While these phases make up a traditional PNP systems, certain assumptions are made regarding the objects of interest in order for this pipeline to function. Specifically the localization and pose estimation of the pre-grasp phase are assumed possible due to computer vision (CV) often being the sensory system for such tasks. Due to CV techniques mimicking the human eye the field's maturity has generated a wide range solution proposals to these problems.
solutions to computer vision: classical,old fashion, deep learning based
deep learning on transparent objects and reflective objects, shown less than ideal results
classical approaches
vision has been used for many years \cite

1.3 Thesis Overview

Chapter 2

State of the Art

2.1 Problem 1 - Tactile Perception

What is tactile perception? Why is it relevant?
How is a tactile sensor constructed [7] what different types exist and which one is present in the model provided.
"Representations of tactile data are commonly either inspired by machine vision feature descriptors"
often used in computer vision context, where each tactile image
Addressing the problem

2.2 Problem 2 - Pose Estimation

2.3 Problem 3 - In-Hand Manipulation

Chapter 3

Tactile Perception

3.1 Introduction

Here we write the introduction for problem 1.

3.2 Related Work

Here we cite the related work by `\cite{source-label}` like this [7]

Chapter 4

Pose Estimation

4.1 Introduction

Here we write the introduction for problem 2.

4.2 Related Work

Here we cite the related work by `\cite{source-label}` like this [7]

Chapter 5

In-Hand Manipulation

5.1 Introduction

Here we write the introduction for problem 3.

5.2 Related Work

Here we cite the related work by `\cite{source-label}` like this [7]

Chapter 6

System Integration

6.1 Introduction

Here we write the introduction for the system integration.

Chapter 7

Discussion

Chapter 8

Conclusion

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Appendix A

Appendix A Title