Some Placeholder Title

A Master Thesis

written by

Victor Melbye Staven
vista17@student.sdu.dk

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

University of Southern Denmark
The Technical Faculty

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Abstract

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

Contents

Acknowledgements

My acknowledgements

Acronyms

acronym-abbr actorym-description.
CP correspondence problem.
CV computer vision.
DL deep learning.
glossary-multi-abbr glossary-multi-long.
PE pose estimation.

Terms

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.

correspondence problem (CP) the problem within computer vision (CV) to localize the projection of the same object in 3D space in 2 or more images.

deep learning (DL) is a technique for data driven pattern recognition.

glossary term glossary term description.

glossary-multi-long (glossary-multi-abbr) glossary-multi-description.

pose estimation (PE) is a scientific picipline which deals with how computers can gain a high-level understanding from digital inputs in the form of images or videos.

Chapter 1

Example section

This document demonstrate the use of figures, references, SI units, glossary, math notation, lists, and otherwise relevant formatting specifications. Paragraphs are typically separated using `\medskip`.

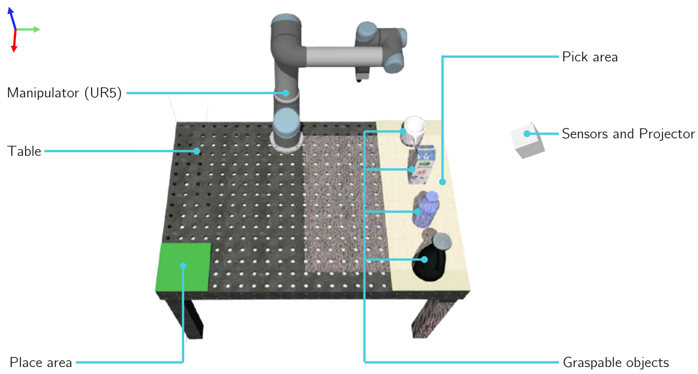

Fig. 1: An example image using actorym-description.

To exemplify math notation, consider the mapping between the joint configuration of a robot

$$\mathbf{q} = \begin{bmatrix} q_1 & q_2 & \dots & q_n \end{bmatrix}^\mathsf{T}, \tag{1}$$

and glossary term, given as a homogeneous transformation

$$\mathbf{T}_B^A = \begin{bmatrix} \mathbf{R}_B^A & \mathbf{t}_B^A \\ \mathbf{0}^{1\times3} & 1 \end{bmatrix}, \tag{2}$$

where $\mathbf{R}_B^A$ and $\mathbf{t}_B^A$ is the rotation and translation, respectively, from frame $\{A\}$ to frame $\{B\}$, denoted using a homogeneous transformation matrix $\mathbf{T}(\mathbf{q}) \in \mathbb{R}^{4\times4}$ as a function of the joint configuration in (1), as described in [**robotics-book**].

Complex table/figure hybrids with aligned captions and functioning labels can be implemented using `minipage`, as shown in Table 1 and Fig. 2. Use \cite as a placeholder for citations.

Method \ Pose	1	2	3
Linear	18.97 s	20.35 s	22.85 s
Parabolic	13.66 s	14.93 s	17.33 s

Table 1: Trajectory durations of the interpolation-based trajectory generation methods.

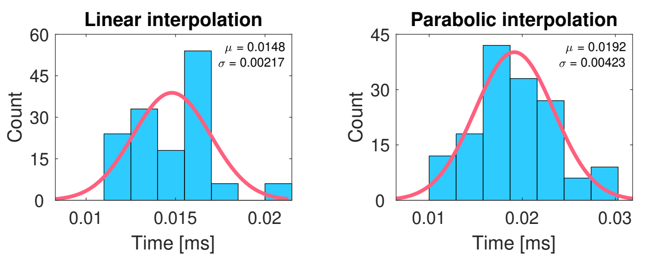

Fig. 2: Average planning time for each of the interpolation-based trajectory generation methods.

For numbers, units and ranges, the `siunitx` package is used, which allows to express a number 10, a range of 5 s to 6 s, or a SI unit of 5.73 ± 1.09 s. Inline row-vectors (with the transpose symbol) can be written as $\mathbf{a} = \begin{bmatrix} \mathbf{a}_p & \mathbf{a}_o \end{bmatrix}^\mathsf{T}$, where as parentheses can be automatically written using (a, b) or $\left\{\frac{a}{b}, c\right\}$. Also, shorthands for $\mathbf{A}^{-1}$, $\mathbf{A}^{\dagger}$and $\mathbf{A}^\mathsf{T}$.

Chapter 2

Introduction

Subject matter terms are addressed with \gls{glossary-label} like so glossary term.
Acronyms are addressed with either with their long equivalent \acrlong{gls-label} which gives actorym-description or the short equivalent \acrshort{gls-label} which gives acronym-abbr.
Subject matter terms can also be multi structure \gls{glossary-multi-label} which gives glossary-multi-long (glossary-multi-abbr) (see terms and acronyms above).

The developments in robotics as a field has over the past years provided automation solutions to execute repetitive manual tasks with high efficiency and reliability \cite. One of the most common tasks being pick and place tasks which involves picking un an object from one position and placing is in another. This is can be parted into the following subparts: Object localization, pose estimation, grasping and placing. In the solutions currently present for industrial use computer vision (CV) is used for object localization and pose estimation (PE) due to the low cost of cameras and the fields maturity. However, while these solutions may be sufficient for certain tasks they fundamentally suffer from the weaknesses introduced by vision techniques. These include a great number of outliers caused by occlusions, reflecting, transparent or homogeneous surfaces, and repetitive structures when solving the correspondence problem (CP). These problems as of the writing of this project have jet to be completely solved. In industrial settings transparency and especially reflectance become relevant since metallic parts tend to appear frequently and have this high reflectance \cite. With regards to transparency the rise of deep learning (DL) has in present time proven its worth and provides proof of concept solutions for narrow cases in pose estimation of transparent objects [1].

Chapter 3

Literature Review

3.1 Problem 1 - Tactile Perception

What is tactile perception? Why is it relevant?
How is a tactile sensor constructed [2] 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

3.2 Problem 2

3.3 Problem 3

Chapter 4

Problem 1

4.1 Introduction

Here we write the introduction for problem 1.

4.2 Related Work

Here we cite the related work by `\cite{source-label}` like this [2]

Chapter 5

Problem 2

Chapter 6

Discussion

Chapter 7

Conclusion

Bibliography

[1] Xu, Chi et al. "6DoF Pose Estimation of Transparent Object from a Single RGB-D Image". In: *Sensors* 20.23 (2020). ISSN: 1424-8220. DOI: 10.3390/s20236790. URL: https://www.mdpi.com/1424-8220/20/23/6790.

[2] Chi, Cheng et al. "Recent Progress in Technologies for Tactile Sensors". In: *Sensors* 18.4 (2018). ISSN: 1424-8220. DOI: 10.3390/s18040948. URL: https://www.mdpi.com/1424-8220/18/4/948.

Appendix A

Appendix A Title