Aalto University
School of Science
Master's Programme in Computer, Communication and Information Sciences

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Structured light assisted real time stereo photogrammetry for robotics and automation

Novel implementation of stereo matching

Master's Thesis
Espoo, 2em

DRAFT! — February 11, 2020 — DRAFT!

Supervisors: Professor Juho Kannala, Aalto University
Professor Nicola Conci, University of Trento
Advisor: Sami Ruuskanen M.Sc. (Tech.)

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ABSTRACT OF MASTER'S THESIS

Author: Jacopo Losi

Title:
Structured light assisted real time stereo photogrammetry for robotics and automation Novel implementation of stereo matching

Date: **Pages:** v + 5

Major: Autonomous Systems **Code:**

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The abstract provides goal, motivation, background, and conclusions of the work. It has to fit to one page together with the bibliographical information.

If the thesis is in English and the language of school education is Finnish or Swedish, the abstract is written in English and in Finnish or in Swedish. If the language of school education is other than Finnish or Swedish, the abstract is written in English only.

The thesis example file (`thesis-example.tex`), all the chapter content files (`1introduction.tex` and so on), and the Aalto style file (`aalto-thesis.sty`) are commented with explanations on how the Aalto thesis works. The files also contain some examples on how to customize various details of the thesis layout, and of course the example text works as an example in itself. Please read the comments and the example text; that should get you well on your way!

In the thesis template, you can find the text of the abstract in the abstract in the `thesis-example.tex` file, together with the bibliographical information of the abstract tables. !FIXME **This is an example how to use fixme: add your abstract here.** FIXME! Fixme is a command that helps you identify parts of your thesis that still require some work. When compiled in the custom `mydraft` mode, text parts tagged with fixmes are shown in bold and with fixme tags around them. When compiled in normal mode, the fixme-tagged text is shown normally (without special formatting). The draft mode also causes the "Draft" text to appear on the front page, alongside with the document compilation date. The custom `mydraft` mode is selected by the `mydraft` option given for the package `aalto-thesis`, near the top of the `thesis-example.tex` file.

The instructions on how to compile LaTeX *.tex files to *.pdf files like this are giving in the `thesis-example.tex` file as comments and also in this pdf in a Section **??**.

Keywords: stereo vision; matching cost; census transform; hamming distance; binary pattern; semi-global matching

Language: English

Acknowledgements

I wish to thank all students who use LaTeX for formatting their theses, because theses formatted with LaTeX are just so nice.

Thank you, and keep up the good work!

Espoo, 5mm Jacopo Losi

Abbreviations and Acronyms

2k/4k/8k mode	COFDM operation modes
3GPP	3rd Generation Partnership Project
ESP	Encapsulating Security Payload; An IPsec security protocol
FLUTE	The File Delivery over Unidirectional Transport protocol
e.g.	for example (do not list here this kind of common acronymbs or abbreviations, but only those that are essential for understanding the content of your thesis.
note	Note also, that this list is not compulsory, and should be omitted if you have only few abbreviations

Contents

Chapter 1

Introduction

1.1 Problem statement

Dense and accurate disparity maps are the key factor for obtaining correct depth estimations for many computer vision applications such as autonomous driving, 3D reconstruction and robotics. In these fields fast calculations over wide images are required due to the necessity of real-time implementation. According to the current benchmark database ranks for stereo matching one of the best performing algorithms in term of calculation cost and accuracy is semi-global matching (SGM)[1]. Basically, this algorithm uses the Mutual Information (MI) as matching cost. It combines concepts of both local and global stereo matching category. Specifically, the local-based methods tend to estimate the disparity image trough a comparison of the matching cost from left and right views of the scene. In order to recover from low accuracy proper of the previous strategy, global-based methods try to calculate the disparity values by minimizing an energy function. In this context, Semi-Global Matching combines strong factors of global and local approaches allowing to obtain a good trade-off between computational cost and accuracy.
Considering the whole algorithm, it can be ideally divided in three different main parts. These are the matching cost evaluation, the directional cost calculation and the last phase regards the post-processing.
The matching cost is evaluated considering each one of the pixel in the left image and the corresponding point in the right image. Actually, the whole implementation of this part exploit two different algorithms, the Center-Symmetric Census Transform [2] and the evaluation of the Hamming Distance between correspondent pixels.

1.2 Structure of the Thesis

You should use transition in your text, meaning that you should help the reader follow the thesis outline. Here, you tell what will be in each chapter of your thesis. Often the thesis does not have as many chapters as is in this template. For example, environment and implementation can be combined as well as chapters of evaluation and discussion. The rest of this thesis is organized as follows. Chapter **??** gives the background, etc.

Bibliography

[1] H. Hirschmüller, "Stereo processing by semiglobal matching and mutual information," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 30, no. 2, pp. 328–341, 2008.

[2] R. Spangenberg, T. Langner, and R. Rojas, "Weighted semi-global matching and center-symmetric census transform for robust driver assistance," *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, vol. 8048 LNCS, no. PART 2, pp. 34–41, 2013.

Appendix A

First appendix

This is the first appendix. You could put some test images or verbose data in an appendix, if there is too much data to fit in the actual text nicely.

For now, the Aalto logo variants are shown in Figure A.1.

(a) In English

Figure A.1: Aalto logo variants