UNIVERSITÄT ZU LÜBECK
INSTITUT FÜR
THEORETISCHE INFORMATIK

Sensorfusion Design und Evaluation für Eigenbewegungsschätzung eines Roboters in unebenen Geländes

Sensor Fusion Design and Evaluation for Robot Motion Estimation in Uneven Terrain

Bachelorarbeit

verfasst am
Institute for Electrical Engineering in Medicine

im Rahmen des Studiengangs
Robotik und Autonome Systeme
der Universität zu Lübeck

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Martin Rolfs

Zusammenfassung

Es ist nicht leicht, eine Abschlussarbeit so zu schreiben, dass sie nicht nur inhaltlich gut ist, sondern es auch eine Freude ist, sie zu lesen. Diese Freude ist aber wichtig: Wenn die Person, die die Arbeit benoten soll, wenig Gefallen am Lesen der Arbeit findet, so wird sie auch wenig Gefallen an einer guten Note finden. Glücklicherweise gibt es einige Kniffe, gut lesbare Arbeiten zu schreiben. Am wichtigsten ist zweifelsohne, dass die Arbeit in gutem Deutsch oder Englisch verfasst wurde mit klarem Satzbau und gutem Sprachrhythmus, dass keine Rechtschreib- oder Grammatikfehlern im Text auftauchen und dass die Argumente der Autorin oder des Autors klar, logisch, verständlich und gut veranschaulicht dargestellt werden. Daneben sind aber auch gut lesbare Schriftbilder und ein angenehmes Layout hilfreich. Die Nutzung dieser LaTeX-Vorlage hilft der Schreiberin oder dem Schreiber dabei zumindest bei Letzterem: Sie umfasst gute, sofort nutzbare Designs und sie kümmert sich um viele typographische Details.

Abstract

It is not easy to write a thesis that does not only advance science, but that is also a pleasure to read. While the scientific contribution of a thesis is undoubtedly of greater importance, the impact of *writing well* should not be underestimated: If the person who grades a thesis finds no pleasure in the reading, that person are also unlikely to find pleasure in giving outstanding grades. A well-written text uses good German or English phrasing with a clear and correct sentence structure and language rhythm, there are no spelling mistakes and the author's arguments are presented in a clear, logical and understandable manner using well-chosen examples and explanations. In addition, a nice-to-read font and a pleasing layout are also helpful. The LaTeX class presented in this document helps with the latter: It contains a number of ready-to-use designs and takes care of many small typographical chores.

Acknowledgements

This is the place where you can thank people and institutions, do not try to do this on the title page. The only exception is in case you wrote your thesis while working or staying at a company or abroad. Then you should use the `Weitere␣Unterstützung` key to provide a text (in German) that acknowledges the company or foreign institute. For instance, you could use texts like »Die Arbeit ist im Rahmen einer Tätigkeit bei der Firma Muster GmbH entstanden« or »Die Arbeit ist im Rahmen eines Forschungsaufenthalts beim Institut für Dieses und Jenes an der Universität Entenhausen entstanden«. Do not name and thank individual persons from the company or foreign institute on the title page, do that here.

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Introduction

1.1 Motivation and Related Work

The topic of motion estimation in robotics is not new. There are alot of research projects concerning the issue of estimating a motion state of a robot. Most of the research effort in this field is spent on vehicles moving in controlled environments such as ideal road conditions. The task of estimating the motion of mobile wheeled robot is significantly more difficult if done in rough terrain or even on a road with bumps and potholes.

The systems that were used in a lot of works trying to estimate a robots motion in uneven terrain make use of rather expensive hardware such as doppler radars or LIDAR. This work differs from a lot of other related works in that sense, that only very basic sensory was used combined with a robot platform using an Ackermann steering geometry [1] that was build for rought terrain.

Making good estimations of a motion state of a vehicle in uneven terrain has considerable applications. Possibly the most predominant application of this would be an agriculteral vehicle. But more applications such as exploration rovers in dangerous or remote environments can be easily thought of.

1.2 Contributions of this Thesis

1.3 Structure of this Thesis

This Thesis consists of three parts. The first part describes the applied sensorfusion from a technical standpoint and explains the methods used. This part outlines the fundamentals that are needed to understand the workings of the algorithm aswell as the used hardware. Following this, the software that encapsulates the algorithm is briefly presented. This is kept rather brief as it is not strictly relevant for the underlying problem. Thirdly, the evaluated results are presented, but also the process of the evaluation itself.

[1] The Ackermann steering geometry describes the geometry of a steering system used in most modern cars.

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Design of the Sensorfusion

Sensorfusion describes the process of combining sensor data so that the resulting information can desribe the environment with less uncertainty and more accuracy than each individual sensor alone. The combination of sensor data expands the cability to sense different physical properties from the environment. The extraction of similar information such as position from these different sources can differentiate a lot. If similar information can be extracted from different sensors redundancy is implied, as the quality of one sensor might not effect the quality of another that senses a different physical property. Therefore through sensorfusion a much more accurate estimation of the motion of a robot can be made.

The implementation of the sensorfusion is kept modifiable to allow adjustments. If the quality of one sensor is not satisfactory its effect on the final estimation can be neglected as its output is suppressed. A consequence of this is that the parameterization of the algorithm is more complex as the parameter space is rather large.

At the heart of the sensorfusion is the ZED stereo camera from Stereolabs. [2]This camera utilizes visual odometry to track its position and orientation. The use of visual odometry is very popular among researchers when trying to estimate its pose. The quality of the visual odometry depends on a lot of different factors. The goal of this work was to aid the camera when the quality of its provided information was not adequate. This is done through the use of several Kalman Filters. The following diagram shows an overview of the interaction of all the components of the sensorfusion.

2.1 The Hardware

In Order to understand the functionality of the algorithm it is necessary to explain the underlying hardware. Not only is the sensor technology of importance but also the functionality of the actuators.

[2] The functionality of this camera is detailed in the next section.

Figure 2.1: The logo of the University of Lübeck. It consists...

The Robot

The underlying robotic platform is a converted electric quad for children. Therefore it performs excellent in outdoors scenarios and on rough terrain.

2.2 Kinematics

lol

3

The Software

4

Evaluation of the Results

5

Conclusion

This template document got much longer than I had initially intended with more and more hints and comments becoming part of the text. The reason is, of course, that writing a thesis is not easy since there are a *lot* of things to consider. However, you have six months to write your thesis, so you stand a decent chance to get most things right.

Do some great scientific research now and report on it in a thesis that is a pleasure to read.