

# Preface

Intelligent autonomous acting in unstructured environments requires 3D maps with labelled 3D objects. 3D maps are necessary to avoid collisions with complex obstacles and to self-localize in six degrees of freedom ( $x$ -,  $y$ -,  $z$ -position, roll, yaw and pitch angle). Meaning becomes inevitable, if the robot has to interact with its environment. The robot is then able to reason about the objects; its knowledge becomes inspectable and communicable. These arguments lead to the necessity of automatic and fast semantic environment modelling in robotics. A revolutionary method for gaging environments are 3D scanners, which enable robots to scan objects in a non-contact way in three dimensions. The presented work examines and evaluates the algorithms needed for automatic semantic 3D map building using a 3D laser range finder and the mobile robot Kurt3D.

The first part of this book deals with the task of registering 3D scans in a common coordinate system. Correct, globally consistent models result from a 6D SLAM algorithm. Hereby 6 degrees of freedom of the robot pose are considered, closed-loops are detected and the global error is minimized. 6D SLAM is based on a very fast ICP algorithm. While initially written for the mobile robot Kurt3D, the algorithms have also been applied in many other contextes. The second part presents a wide variety of working experiments and applications, including the results of presentations, like the Kurt3D presentation at RoboCup.

In the last part semantic descriptions are derived from the 3D point model. For that purpose 3D planes are detected and interpreted in the digitalized 3D scene. After that an efficient algorithm detects objects and estimates their pose with 6 degrees of freedom.

Of course, this book is the result of my active cooperation with many researchers. I would like to express my thanks to my supervisor Joachim Hertzberg who has always supported me. I am also thankful for the joint preceding research on 3D robotic mapping with: Dorit Borrmann, Thomas Christaller, Jan Elseberg, Simone Frintrop, Dominik Giel, Matthias Hennig, Joachim Hertzberg, Achim Lilienthal, Kai Lingemann, Martin Magnusson,

Stefan Stiene, Hartmut Surmann, Sebastian Thrun, Bernardo Wagner, Oliver Wulf. Special thanks go to Alexander Loktyuhsin for proofreading the book.

My intention is that the reader of this book will use this compilation of algorithms and results to build smarter robotic systems that can cope with real world environments using 3D sensor data.

Osnabrück, Germany  
Juli 2008

Andreas Nüchter

### 3D Robotic Mapping

The Simultaneous Localization and Mapping Problem  
with Six Degrees of Freedom

Nüchter, A.

2009, XIX, 204 p., Hardcover

ISBN: 978-3-540-89883-2