Model-based Analysis and Evaluation of Point Sets from Optical 3D Laser Scanners

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Für Barbara und Hans-Dieter Teutsch.

Abstract

The digitalization of real-world objects is of vital importance in various application domains. This method is especially applied in industrial quality assurance to measure the geometric dimension accuracy. Furthermore, geometric models are the very foundation of contemporary three-dimensional computer graphics. In addition to create new models by using a modeling suite, the use of 3D laser scanners has recently become more and more common. To reconstruct objects from laser scan data, usually very large data sets have to be processed. In addition, the generated point clouds usually contain a considerable amount of errors. Therefore, it is necessary to optimize the data for further processing.

Compared to algorithms that interactively manipulate point clouds through an approximation with polygonal meshes, we aim to automatically correct each measurement individually and directly integrate the methods into the measurement process. In addition to traditional methods which usually assume point clouds as unstructured, this work introduces techniques for the extraction of common data structures from optical 3D scanners. Based on this information, procedures are developed to enable automatable procedures of scan data optimization and evaluation. The feasibility of the proposed methods is shown at the example of different real-world objects and industrial applications.

Zusammenfassung

Die Digitalisierung realer Objekte findet in vielen Bereichen ihre Anwendung. So wird diese Methode beispielsweise in der industriellen Qualitätssicherung zur Prüfung der geometrischen Maßhaltigkeit eingesetzt. Des Weiteren haben Digitalisierverfahren in der modernen 3D-Computergraphik Einzug gehalten. Anstelle der manuellen Modellierung von 3D-Objekten mit Hilfe von Grafiksoftware werden immer mehr 3D-Laser-Scanner eingesetzt. Für die Rekonstruktion der Objekte müssen jedoch oft sehr große Datenmengen verarbeitet werden. Zusätzlich sind diese durch verschiedene Fehler beeinflusst. Für die Weiterverarbeitung ist es daher meist erforderlich, die Daten aufzubereiten.

Herkömmliche Verfahren verarbeiten die Messdaten auf Basis polygonaler Modelle, welche zumeist eine Interaktion erfordern. Das Ziel dieser Arbeit ist es jedoch, die Punktemenge in Form der Einzelmessungen zu verarbeiten und die Methoden in den Messprozess zu integrieren. Damit sollen sowohl eine bessere Automatisierbarkeit als auch eine höhere Verarbeitungsgeschwindigkeit erreicht werden. Üblicherweise betrachtet man 3D-Messdaten als unstrukturiert. Im Unterschied dazu werden neue Techniken vorgestellt, die bereits existierende Strukturen aus den Messdaten optischer 3D-Laser-Scanner extrahieren. Diese Strukturen werden schließlich genutzt, um automatisierbare Algorithmen für die Messdatenoptimierung und -auswertung zu entwickeln. Am Beispiel verschiedener Objekte und industrieller Anwendungen wird die Praktikabilität der entwickelten Methoden gezeigt.

Preface

This dissertation is the result of my research work at the Department of Intelligent Sensor Systems at the Fraunhofer Institute for Factory Operation and Automation in Magdeburg. The work was additionally supported by the Faculty of Computer Science of the Otto-von-Guericke University Magdeburg. I was advised by Prof. Strothotte and Prof. Preim to whom I am very grateful for giving me this opportunity.

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Last but certainly not least I am very grateful for the great environment provided by the Department of Intelligent Sensor Systems. Although I was working on different industrial and research projects, they let me freely explore many ideas, concepts and algorithms.

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