Identification of critical ride comfort sections with a validated vehicle model in Monte Carlo simulations

MASTER'S THESIS

submitted in partial fulfillment of the requirements for the degree of

Master of Science

in

Civil Engineering and Water Management

by

Alexander Genser

to the Institute of Applied Statistics and Computing

University of Natural Resources and Life Sciences Vienna

Advisor: Univ.Prof. Dipl.-Ing. Dr.techn. Friedrich Leisch
Assistance: Philippe Nitsche, PhD, MSc

Declaration of Authorship

I hereby declare that I have written this Master Thesis independently, that I have completely specified the utilized sources and resources and that I have definitely marked all parts of the work - including tables, maps and figures - which belong to other works or to the internet, literally or extracted, by referencing the source as borrowed.

Vienna, 27th September, 2018

Alexander Genser

Acknowledgements

A lot of people contributed to this work with their helpful advice and comments throughout long talks and supervising sessions. I would like to thank my supervisor Prof. Friedrich Leisch for guiding me through this thesis and the food for thoughts on scientific working and mathematical problems. Further, I would like to thank Dr. Philippe Nitsche who opened the doors for the opportunity of doing a Master thesis at the Austrian Institute of Technology. I really enjoyed the Friday afternoon sessions discussing new approaches, trying out new things and making progress, no matter if we were talking about AIT projects or my Master thesis.
I also would like to thank my colleagues at AIT that helped me out with their expert knowledge: Roland Spielhofer for the advice with OpenCRG, Andreas Hula for the help with mathematical problems, Martin Czuka and Karoline Alten for helping me out with the fundamentals of signal processing.

I would like to thank my friends for all the support, all the pieces of advice, discussions we had and all the fun nights out throughout these years. Without you, this period of life would not have been the same.
My biggest gratitude goes to my parents and my brother Andreas, who made all of this possible. No matter if it was a thoughtful chat on the phone or a nice talk in the time we barely see each other. Without you I would not be standing where I am today - Thank you so much!

Vienna/Austria
September 2018

Alexander Genser

Abstract

With the goal to make road traffic safer and to mitigate crashes and conflicts, various assistive systems have been developed in the last decades. Besides these developments, the Autonomous Vehicle (AV) should contribute significantly to a safer and more efficient mobility of the future. With the deployment of AVs, the role of the driver changes from taking active actions in the driving process to a passive passenger, such as in public transportation. Hence, the necessity of making driving as comfortable as possible and to prevent negative effects, such as poor ride comfort, arises. A way to enhance the acceptance of autonomous vehicles on the market and to improve the imitation of a human driving style is to include the concept of ride comfort into motion planning. The gained data can be used to complement a high-precision digital map for road foresight. This thesis provides a simulation framework, capable of producing ride comfort estimates and merging that data with the national transport network graph. Within the framework, road surface data is imported to the sub-microscopic environment Carmaker. With real-world measurement data, a model optimization is done and Monte Carlo simulations are performed, for a statistically representative identification of vehicle dynamics data. The output is applied to a frequency-weighted assessment method for ride comfort determination suggested by the ISO-2631 guideline. Consequently, this thesis provides a toolchain for the enhancement of digital maps and, with that, the improvement of motion planning of AVs.

Keywords: Autonomous vehicles, Ride comfort, OpenCRG, Model Optimization, Monte Carlo simulations, Simulation framework, Motion planning enhancement.

Kurzfassung

Mit dem Ziel den Straßenverkehr sicherer zu machen und damit Unfälle und Konfliktsituationen zu verringern, wurden in den letzten Jahrzehnten eine große Menge an Sicherheitssystemen entwickelt. Neben diesen entwickelten Systemen, soll das autonome Fahrzeug einen wesentlichen Beitrag zu einer sicheren Mobilität der Zukunft leisten. Mit der Einführung von autonomen Fahrzeugen ändert sich die Rolle des Fahrzeuglenkers erheblich. Dieser greift nicht mehr aktiv in das Fahrverhalten ein, sondern wird viel mehr zum Fahrgast. Damit ergibt sich die Notwendigkeit die Fahrt so angenehm wie möglich zu gestalten und mögliche negative Effekte, wie unangenehmen Fahrkomfort, ausklammern zu können. Um diesem Anspruch gerecht zu werden, sollen Fahrkomfortdaten a priori in einer digitalen Karte verfügbar sein, um eine möglichst effiziente Fahrmanöverplanung bewerkstelligen zu können.
In dieser Arbeit wird ein Simulationsframework entwickelt, das es ermöglicht Fahrkomfortdaten zu generieren und mit einem offen verfügbaren Verkehrsgraphen zu verbinden. Dabei werden Straßendaten in eine Simulationsumgebung immigriert und daraus produzierte Fahrzeugdynamikdaten mit realen Testdaten abgeglichen. Um eine fundierte Datengrundlage für die Fahrkomfortauswertung zu generieren, wird eine Modelloptimierung und eine statistisch repräsentative Monte Carlo Simulation durchgeführt. Outputdaten werden folglich auf Basis der ISO2631-Richtlinie frequenzgewichtet und anhand vorgeschlagener Bewertungsmethoden prozessiert. Die vorgelegte Arbeit stellt damit eine Werkzeugkette zur Verfügung, die zur Erweiterung von digitalen Karten und damit zur sicheren und komfortablen Manöverplanung beiträgt.

Stichwörter: Autonome Fahrzeuge, Fahrkomfort, OpenCRG, Modelloptimierung, Monte Carlo Simulationen, Simulationsframework, Fahrmanöverplanung.

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