(FCL) FUTURE CITIES LABORATORY 未来城市实验室

Singapore ETH Centre
Future Cities Laboratory

Dr. Alexander Erath
1 CREATE Way
Singapore 138602
+65-8409 8023
erath@ivt.baug.ethz.ch
www.futurecities.ethz.ch

Singapore, 21st September 2015

Task description MSc thesis Sebastian Hoerl

Multi-level evaluation of autonomous vehicle using agent-based transport simulation for the case of Singapore

Increasing numbers of autonomous vehicles are expected to have great impact on a number of factors that define the overall traffic situation in a city, such as the number of used cars, congestion in peak and off-peak hours, emissions and the availability of parking space. Recent simulation-based studies predict strong improvements in these areas, which is of great interest for policy makers and urban planning.

From a customer perspective, autonomous vehicle services are likely to show advantages over established means of transportation. They are estimated to be cheaper than owning a car or taking a taxi, while solving the last-mile-problem that is associated mainly with public transport [VTPI 2015].

While there are numerous studies aiming at abstract and artificial environments incorporating autonomous driving [ITF 2004, Fagnant 2014], less research is found on actual real-world traffic networks [Rigole 2014]. Therefore, the idea is to implement scenarios of usage and availability of autonomous vehicles in MATSim [MATSIM], which is the basis for a well-established agent-based traffic simulation of Singapore.

The first scenario will be an extension of classic car-sharing services, where, in contrast to fixed pickup stations, the customer can order an autonomous car on-demand to any arbitrary location. A second approach will involve an intelligent car positioning and scheduling strategy [Rigole 2014], allowing for groups of people, who are going in a similar direction, to share one autonomous vehicle. This resembles the advantages of public transport without being confined to specific routes through the city. Both scenarios can be grounded on existing contributions to MATSim for the simulation of car sharing and public transport [MATSIM].

Contrary to previous studies with predefined amounts of autonomous vehicles [ITF 2004, Fagnant 2014], the acceptance of AVs in MATSim will be based on a per-agent decision process, taking into account the perceived advantages and tradeoffs compared to other means of transportation. The influences covered in this process for both scenarios will be the pricing and availabilty of AVs, which are, looking at the costs of fuel and maintenance for a service provider, tightly connected by themselves.

Therefore, prior to the actual implementation, careful assumptions on an operator and distribution model, limiting factors and the quantification of perceived advantages need to be made. One interesting result of the final simulation will be how the acceptance of AVs will be constrained by the profitability of the technology. Additionally, this will lead to statistics on city-wide and locally distributed levels of access to and applicability of autonomous transportation. Moreover, it should be possible to evaluate well-established findings on the complex dependency between the amount of AVs and congestion [ITF 2004, Fagnant 2014].

Initially, the functionality of the simulation and evaluation of autonomous vehicles using MATSim will be tested using a very simple corridor scenario. Once this runs stable and produces relevant results, the routines will be applied on the MATSim Sioux Falls model for further testing before they will be implemented for the MATSim Singapore model. All models are readily available in house and will be provided, though using MATSim Singapore is subject to signing a non-disclosure agreement.

The MSc thesis will be documented in a comprehensive report. This report should be written following the guidelines presented in the „Hinweise für die Studentischen Arbeiten“ or a similar standard (see: http://www.ivt.baug.ethz.ch/allgemein/lehre_d.html). Text, programs, scripts, datasets and figures are to be handed in a well-structured digital format.

The project is carried out as a full time assignment in Singapore between Jan 2015 - Jun 2015 according to the schedule listed below.

Project schedule

1.	Kick-off	15th January 2015
2.	Meeting 1: Literature overview, familiarisation with corridor scenario	17th February, 2015
3.	Meeting 2: Definition of operational and behavioural parameters, simulation of AV with corridor scenario	14 March 2015
4.	Meeting 3: Evaluation of corridor scenario, application of AV for Sioux Falls Scenarios	11 April 2015
5.	Meeting 4 Evaluation of Sioux Falls Scenario, first draft of report, setting up AV in MATSim Singapore	9 May 2015
6.	Evaluation of AVs using MATSim Singapore	6 June 2015
7.	Full draft of thesis	17 June 2015
8.	Final thesis	30 June
9.	Kolloquium	To be defined (Singapore, connected via VC to Zurich)

The thesis will be co-supervised by Prof. Kay Axhausen (IVT), Pieter Fourie (FCL) and Dr. Alexander Erath (FCL)

Literature:

[ITF 2014] International Transport Forum: Urban Mobility: System Upgrade
http://internationaltransportforum.org/cpb/pdf/urban-mobility.pdf

[Fagnant 2014] Fagnant, Daniel; Kockelman, Kara M.: The travel and environmental implications of shared autonomous vehicles, using agent-based model scenarios
http://www.ce.utexas.edu/prof/kockelman/public_html/TRB14SAVenergy_emissions.pdf

[Rigole 2014] Rigole, Pierre-Jean: Study of a Shared Autonomous Vehicles Based Mobility Solution in Stockholm
http://kth.diva-portal.org/smash/get/diva2:746893/FULLTEXT01.pdf

[VTPI 2015] Litman, Todd: Autonomous Vehicle Implementation Predictions
http://www.vtpi.org/avip.pdf

[LTA 2014] Tan, Cheon Kheong; Tham, Kwang Sheun: Autonomous Vehicles, Next Stop: Singapore
http://www.lta.gov.sg/ltaacademy/doc/J14Nov_p05Tan_AVnextStepSingapore.pdf

[Vine, Zolfaghari, Polak 2015] Le Vine, Scott; Zolfaghari, Alireza; Polak, John: Autonomous cars: The tension between occupant experience and intersection capacity
http://www.sciencedirect.com/science/article/pii/S0968090X15000042

[KPMG 2013] KPMG: Self-driving cars: Are we ready?
http://www.kpmg.com/US/en/IssuesAndInsights/ArticlesPublications/Documents/self-driving-cars-are-we-ready.pdf

[UMTRI 2014] UMTRI: A survey of public opinion about autonomous and self-driving vehicles in the U.S., the U.K., and Australia
https://www.arrb.com.au/admin/file/content2/c7/UMTRI-2014-21%20Public%20Opinion%20Survey.pdf

[RAND 2014] RAND: Autonomous Vehicle Technology. A Guide for Policymakers
http://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR443-1/RAND_RR443-1.pdf

[MATSIM] http://ci.matsim.org:8080/view/All/job/MATSim-Book/ws/main.pdf