3rd Workshop on Naturalistic Driving Data Analytics

(Tentative) Programme

19 June 2016

09:00-09:05	Welcome
09:05-09:40	Analysis of non-critical left turns at intersections and LTAP/OD crashes/near-crashes using naturalistic driving data from EuroFOT and SHRP2. Speaker: Emma Tivesten (Volvo Cars, Sweden)
09:40-10:05	Brake Response Time under Near-crash Cases with Cyclist. Authors: Mingyang Chen, Xichan Zhu, Zhixiong Ma, Lin Li, Dazhi Wang, and Junyong Liu (Tongji University and SAIC Motor Technical Center, China)
10:05-10:30	A graph database for modelling and analysis of naturalistic driving data. Speaker: Camelia Elena Ciolac (Chalmers, Sweden)
10:30-11:00	Coffee break
11:00 11:30	Driving Characteristics from NDS data – Challenges and Approaches to Manage, Extract Features, Analyze, and Predict Behaviors. Speaker: Pujitha Gunaratne (Toyota Collaborative Safety Research Center, USA)
11:30-11:55	Generating Individual Driving Behavior on Highway Curves. Speaker: Naren Bao (Nagoya University, Japan)
11:55-12:20	The Australian Naturalistic Driving Study (ANDS). Speaker: Ann Williamson (University of New South Wales, Australia)
12:20-12:30	Closing

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Analysis of non-critical left turns at intersections and LTAP/OD crashes/near-crashes using naturalistic driving data from EuroFOT and SHRP2.

Emma Tivesten

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Naturalistic driving studies (NDS) provides detailed information about the driver, vehicle and road environment in normal (non-critical) driving as well as in safety critical driving-situations leading up to a crash or a near-crash. For the vehicle industry, this opens up new opportunities to define more realistic driving scenarios, add detailed information into complete vehicle safety requirements, and to guide the development of active safety functions. This presentation includes two related analysis: 1) non-critical left turns at intersections based on EuroFOT-data, 2) left turn across path/opposite direction (LTAP/OD) crashes and near-crashes in SHRP2-data. The aim of the EuroFOT-analysis was to study the variation of non-critical left turn trajectories at four different intersections, and how these trajectories were influenced by speed and intersection design. Satellite images were used to create a 2D-representation of each intersection. Vehicle signals, forward facing video, and the 2D-representation of the intersections were used to calculate and calibrate the trajectory of each passage. In addition, variables describing the traffic scenario and contributing factors to LTAP/OD crashes and near-crashes in SHRP2 were analyzed based on the information available on the Insight webpage. This analysis included previously coded event details. In addition, more detailed coding and analysis of visual obstructions were performed based on the forward video view. The main focus of this presentation will be on the analysis methods used, lessons learned during the analysis, some of the main results from each study, and how the results has been applied in car safety development.

Brake Response Time under Near-crash Cases with Cyclist*

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In this paper, brake response time of 110 near-crash cases with cyclist is researched. Cyclists include bicyclist, electric bicyclist, motorcyclist and tricyclist. This paper refers to the time interval from the moment a collision threat appears to the moment the vehicle begins to decelerate to avoid the collision as brake response time (BRT). Values of BRT range from 0.47s to 2.13s with a mean of 1.016s and a standard deviation of 0.3875s. Influence of seven factors on BRT is analyzed using one-way Analysis of Variance and path analysis. Factors include occurrence time of near-crash, visibility, number of potential threat vehicles, intersection or not, road type, moving status and velocity of the vehicle. The results show that visibility, number of potential threat vehicles and intersection or not are significant factors. Better visibility in the darkness can significantly shorten BRT. BRT decreases with the increase of potential threat vehicles. However, when there are too many (more than three) potential threat vehicles ahead, drivers show significantly longer BRT. Drivers brake significantly slowly at intersection.

A graph database for modelling and analysis of naturalistic driving data.

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Naturalistic Driving Studies can gather large quantities of data regarding drivers' behaviour in relation to the vehicle and traffic environment, during normal driving. Such data gives possibilities for new and multi-disciplinary research on many topics, among others within traffic safety and the arising autonomous vehicles. Traditionally, the data was stored in one-dimension, with the trip as the main entity, and the data attached to a time-index instance. The measure data could be illustrated as a huge spreadsheet with hundreds of columns (measures) and billions of rows (one row per each time-index instance). New trends in the advent of Big data techniques are being explored to make the analysis more efficient and even open up possibilities for new kinds of analysis. Thus we begin to explore possibilities of using graph databases for modelling naturalistic driving data. The nature of graphs (a set of nodes connected by edges) matches the highly connected driving traces that have been collected and map data. In this talk we shall present data modelling and we'll discuss our algorithm of binding traces to map. Having implemented the prototype in a Neo4j graph database, we shall highlight some of the features (e.g. its spatial plugin) that make it suitable for this purpose. With the graph loaded, we shall explain some powerful queries in Neo4j's query language, Cypher, and thus prove how graph traversals can be employed in answering specific research questions. More precisely, we focus on analyzing behaviour in the vicinity of points of interest where by point of interest we denote a point located at some latitude,longitude pair of coordinates and with interesting semantics, e.g. pedestrian crossing, point of running over tram railways or bicycle lane, intersection with or without traffic lights. We will draw conclusions regarding the traditional approach versus the new one and highlight opportunities and challenges.

Driving Characteristics from NDS data

Challenges and Approaches to Manage, Extract Features, Analyze, and Predict Behaviors

Pujitha Gunaratne

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Surge in analysis of Naturalistic Driving data has become prominent in the past 5 years due to the extent of natural behaviors they contain of drivers and surround traffic. Such an exposure of real-world context is valuable for developing driver assistance and automated driving systems. However, due to the widespread and heterogeneous nature of naturalistic driving data, analyzing and generating inferences on natural behaviors become challenging. In this presentation, we introduce approaches to manage naturalistic driving data, develop computer vision and machine learning tools to extract features of the driver and surround traffic conditions and generate semantics of driver behaviors to produce inferences in the form of drive analysis. The presentation will feature some results of analysis based on data collected on instrumented vehicles and large-scale driving studies, such as SHRP2 in the U.S.

Prediction of Individual Driving Behavior on Highway Curves

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In order to develop driver assistance systems which can provide comfortable support for individual drivers, the systems need to learn the driver preferred driving behavior. In this paper, we present a method for predicting driving behavior of each driver during highway curve transition, by using clothoid curve fitting and neural networks. We focus on the relationship between curve geometry and driver's velocity patterns on highway curves. First, clothiod curve fitting algorithm is applied to extract the curve geometry factors from GPS data for each curve, including curvatures, angles, and curve lengths. Then drivers' preferred velocity patterns on curves are modeled using neural networks based on the time series of curve geometry factors. We conduct experiments of velocity pattern prediction for different drivers. Experimental results show that our method can successfully predict driver individual velocity patterns on highway curves for given curve geometry factors extracted from GPS data. This indicates that driver preferred velocity patterns can be predicted for any curve geometry by modeling their driving patterns using their past driving records.

The Australian Naturalistic Driving Study (ANDS)

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The Australian Naturalistic Driving Study (ANDS) involves recruitment of 360 volunteer drivers (180 from New South Wales and 180 from Victoria) and their private vehicle being equipped with our instrumentation for 4 months. The data acquisition system supplied by Virginia Transportation Technology is being used to silently record each participant's driving behaviour, the movement and operation of their vehicle and the behaviour of other road users with whom they interact on-road. Each data collection system incorporates multiple sensors (video cameras, a still camera, GPS, radar, accelerometers, etc.). In addition, drivers complete a range of assessments of visual perception, physical and psychomotor abilities, personality factors (e.g. propensity to take risks), sleep-related factors, medicines and medical conditions, and driving knowledge and history. The ANDS differs from previous naturalistic studies in other countries in focussing on ordinary, experienced drivers and including expanded vehicle/driver monitoring using Mobileye and Seeing Machines driver monitoring systems. Currently two of eight waves of data collection are complete. The data collected has the potential to answer an enormous range of research questions, but this will be limited by resources available. The ANDS project proposal laid out seven key research themes selected through consultation with all researchers and participating organisations. The themes selected were: safety at intersections, speed choice, interactions with vulnerable road users, fatigue, distraction and inattention, crashes and near-crashes, interactions with intelligent transport systems (ITS). Current analysis is focusing on exploring the available data, especially relating to describing normal driving behaviour. A data analysis group has been established to investigate strategic approaches to analysis including automation of the identification of target incidents, driver behaviours and other road users. The study will also use the various technologies (DMS, mobileye, etc.) as triggers to identify behaviours / events of interest. We plan to delegate aspects of the analysis task for specific themes to members of the Consortium with expertise in each area and are setting up analysis groups for each theme. An important part of this aspect of the project is seeking additional researchers and partners from outside this Consortium to collaborate on analysis and publication of findings.