STAR RATING DRIVER TRAFFIC AND SAFETY BEHAVIOR THROUGH OBD AND SMARTPHONE DATA COLLECTION

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Abstract

The objective of this paper is to demonstrate the potential for monitoring and star rating driver traffic and safety behavior, through the use of continuous data collection from the vehicle (On Board Diagnostics) and the smartphone. Current technological advances in Europe and worldwide make data collection and exploitation substantially easier and more accurate than before. The present work examines the correlation between driving behaviour and degree of exposure with traffic risk. Moreover, the impact of critical behavioural and exposure indicators on traffic risk as well as driving behavior and exposure models using the above indicators for traffic risk calculation are also examined.

Introduction

Road Safety is a typical field with high risk of important investments not bringing results. Absence of monitoring and accountability limits seriously road safety performance. Therefore there is a high need for monitoring road safety policies and performance.

Road Safety Performance Indicators (SPIs) are the measures (indicators), reflecting those operational conditions of the road traffic system, which influence the system's safety performance (Hakkert et al., 2007). SPIs aim to:

- reflect the current safety conditions of a road traffic system;
- measure the influence of various safety interventions;
- enable comparisons between different road traffic systems e.g. countries, regions, etc.).

Until recently, the high cost of real-time driving data recording systems, data programs, cloud computing services, the inability to accumulate and exploit massive data bases (Big Data) for transport and traffic management purposes (De Romph, 2013, Lee, 2014), as well as the low penetration rate of Smartphones and social networks, made it extremely hard to collect and manage real-time data and, therefore, to study the relation between driving behaviour and travel behaviour and the probability of crash involvement.

More specifically, current technological advances in Europe and worldwide make data collection and exploitation substantially easier and more accurate than before. For example, On Board Diagnostics (OBD) systems are more affordable nowadays and big data analysis is becoming more and more insightful because of the advanced tools that have been developed to exploit it. Such an example is also the Internet of Things (IoT) which comprises of several proposed developments of the Internet in which everyday objects have network connectivity, allowing them to send and receive data. Examples of the IoT application which are progressively bringing new possibilities and opportunities towards this direction are:

- wide penetration of smartphones & social networks,
- efficient data transmission (through GSM networks),
- powerful cloud computing,

It should be mentioned that research has indicated that barriers like those mentioned above can be overcome when consumers are given an incentive such as a monetary prize (Reese and Pash, 2009).

The objective of this paper is to demonstrate the potential for **monitoring and star rating driver traffic and safety behavior**, through the use of continuous data collection from the vehicle (On Board Diagnostics) and the smartphone. More specifically this research attempts to address:

- the correlation between driving behavior and degree of exposure with traffic risk
- the impact of critical behavioral and exposure indicators on traffic risk
- driving behavior and exposure models (and their combination) using the above indicators for traffic risk calculation

5. On Board Diagnostics (OBD)

OBD is referring to a vehicle's self-diagnostic and reporting capability. It provides access to data from the engine control unit (ECU). OBD systems give access to the status of the various vehicle subsystems which can be used for recording several driving characteristics (Boquete et al., 2010), (Iqbal and Lim, 2006). The installation process is easy through an existing plug in the vehicle.

Data are automatically transmitted in a central database through the mobile network of a telecom provider. The data collection from the OBD and the smartphone is much easier today since an OBD (on-board diagnostics) device can be easily installed in the vehicle at an affordable price. Moreover, this OBD integrates GSM/GPRS technology which records and transmits critical driving behavior features such as:

- mileage driven
- road network used (through gps position)
- duration and time of the day driving
- harsh braking
- harsh acceleration
- speed
- fuel consumption

6. Data Transmission and Analysis

The procedure of data transmission is continuous from the vehicle CAN bus via the OBD device and the GSM (Figure 1). This aim is feasible since:

- data collected can be continuously recorded (1 - 30 Hz frequency)
- data recorded from the vehicle sensors is transmitted in real time by GSM cards (OBD or mobile phone)
- data are stored through web clouds to remote servers and to back office databases

However an issue of general concern is whether the anonymization of the data is possible in terms of protecting privacy.

Figure1 – Continuous data transmission from the vehicle bus via the OBD device and the GSM

The highly spatially and time disaggregated data from the OBD unit and the Smartphone can be converted into useful indicators. As far as the **Big Data analysis** is concerned (De Romph, 2013), (Lee, 2014), signal processing methods (e.g. Fourier analysis) are used to clean the data, remove the "noise" and identify patterns. Moreover, data mining methods are utilized for trajectory pattern mining, clustering and classification. As a result, indicators can then be calculated by 'querying' the processed data. Such indicators may include:

- risk exposure indicators
- behavioral indicators

7. Feedback to the Driver - Indicators

The database is analysed in order to rate each driver based on his/her driving performance. This allows the development of indicators of driver risk exposure and behavior.

The outputs can be transferred through an application programming interface (API) to a user-friendly web portal or Smartphone App where the driver is able to:

- monitor his driving performance
- receive feedback on his individual driving risk
- identify behaviors that need to be improved

The delivered risk exposure indicators can be combined with other data files (road types and high risk sites, speed limits, traffic volume) by means of map matching algorithms. Such indicators may include (Tselentis et al. 2016):

- weather conditions
- traffic conditions

- number of trips
- total distance driven by the user (mileage)
- type and specific segments of the road network used (given by GPS position)
- time of the day driving and driving duration (driving during risky or rush hours)
- vehicle's safety classification

Driver behavior indicators may consist of:
- steering angle
- engine rpm and use of gear box
- speeding (driving over the speed limit)
- harsh braking (number and severity of braking)
- harsh acceleration (number and severity of accelerations)
- distraction from mobile phone use

All the above mentioned indicators are exploited either separately in a risk exposure model and a behavioral model or as a combined risk exposure and behavior model.

In more advanced setups, when sufficient amount of data is available, new additional or composite parameters might be used such as:
- seat belt use
- alcohol consumption
- vehicle maintenance
- eco-driving could also be exploited in the future as it is proved to have a significant correlation with crash risk since fuel consumption is strongly correlated with aggressive driving and speeding

8. Driver Behavior Star Rating

The calculated risk exposure and behavior indicators can be translated into star rating scales:
- driver risk exposure and behavior monitoring and star rating can be initially derived as a weighted combination of the above parameters through sophisticated data analysis and modelling
- weighting can be gradually adjusted with the cumulative dataset
- the final outcome of this modelling can be a risk indicator in the scale 0-10(0) that depicts the risks associated with the driving behavior

The driver behavior "stars" system is communicated to the driver through smartphone apps or a web portal, thus providing:
- information and monitoring on individual driving behaviour and risks
- feedback and tips on driving aspects needing improvement
- benchmarking among peers
- data on fuel consumption may also be included in the "star rating" to monitor eco performance

9. Conclusions

Technological advances worldwide and the Internet of Things (IoT) makes gradually the continuous driver assessment a feasible aim, opening a new great potential for traffic and safety behavior improvement.

This process can be used independently by the drivers in order to raise awareness and engagement on safe and environment friendly driving but also to provide feedback and support on driving performance and risks.

An innovative insurance policy could have a significant effect on safety depending on its design (Zantema et al. 2008). This can be accomplished through customized insurance schemes by correlating driving exposure and behavior with insurance premiums such as:

- pay-as-you-drive
- pay-how-you-drive

From a road safety perspective, this research concludes that a star rating driver system that is monitoring and providing feedback on driver's traffic and safety behavior could be a very good incentive for most drivers to drive in a safer manner. All the above suggest that there exist numerous and important challenges emerging on this research field which will be further investigated in the near future.

10. References

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