Accelerometer-based Safety Surrogate Measures

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Abstract

A literature review was conducted to identify telematics-detected accelerometer-based safety surrogate measures (SSMs) used in peer-reviewed, published road safety studies. Five types of SSMs were identified, including: longitudinal deceleration, longitudinal acceleration, lateral acceleration, jerk and yaw. Findings for each measure were categorised into those associated with crashes and near-crashes (CNCs) and/or incidents, and those used as SSMs. This presentation will describe these SSMs; discuss the aims, methodology and results of the literature review; and make recommendations for potential SSM definitions and thresholds, and methods for data validation and reduction for use in future on-road driving studies.

Introduction

Crash frequency and severity are direct measures of road safety (Tarko, Davis, Sunier, Sayed, & Washington, 2009), but are relatively 'rare' events. Due to sample size limitations, near-crashes are often analysed with crashes to assess road safety. However, identification of CNCs require long periods of driving and data collection using costly equipment and data reduction procedures (e.g. the use of video cameras requiring manual review of footage).

CNCs can be used to develop and validate SSMs, which have the advantage of allowing the evaluation of road safety at a reduced financial and time cost. However, no standards exist for researchers for definitions or minimum thresholds for telematics-detected, accelerometer-based SSMs. Therefore, the aim of this research was (i) to identify what accelerometer-based SSMs and associated thresholds have been used in peer-reviewed, published road safety studies, (ii) examine the validity of these SSMs and thresholds in identifying CNC, and (iii) make recommendations for potential outcome measures based on these findings.

Method

Relevant literature was identified through academic databases and search engines using key search terms. Papers were reviewed if they documented (i) the development and validation of accelerometer-based measures associated with CNCs and/or incidents, or (ii) the use of these measures as SSMs in road safety studies.

Results

Five types of SSMs were examined: longitudinal deceleration, longitudinal acceleration, lateral acceleration, jerk and yaw. Several studies used common datasets, with three naturalistic driving studies (NDS) datasets used in four or more individual studies. These included: the 100-Car Study (Dingus et al., 2006), the Teenage NDS (Simons-Morton et al., 2011), and the Second Strategic Highway Research Program NDS (Kluger et al., 2016).

Each type of accelerometer-based SSM and brief results of the literature review are described here:

Longitudinal deceleration and acceleration (measured on the x-axis) refer to movement in a straight line in either a forward or backward direction, and deceleration and acceleration refer to the rate of change of velocity (speed in a given direction) per unit of time. Thirty studies employed

longitudinal deceleration measures with thresholds ranging from 0.10g to 0.75g. Nineteen studies employed longitudinal acceleration measures with thresholds ranging from 0.10g to 0.75g.

Lateral acceleration describes acceleration measured on the y-axis (sideways). Seventeen studies were reviewed which employed lateral acceleration measures with thresholds ranging from 0.30g to 0.75g

Jerk refers to the rate of change of acceleration or deceleration per unit of time. Nine studies employed various measures of jerk, including jerk deceleration, jerk acceleration, and peak-to-peak jerk.

Yaw refers to the oscillation (twisting) of the vehicle around a vertical axis (measured on the z-axis). When used as a kinematic threshold, the angle of rotation is specified within a defined timeframe. Twelve studies reviewed employed measures of yaw with a wide variety in the degree and rate of yaw thresholds.

Conclusion

Based on the findings of this literature review, we will present recommendations for thresholds for each type of accelerometer-based SSM to detect CNC. It is envisaged these recommendations will inform government, industry and academic stakeholders planning on-road driving studies, particularly in cases where large datasets are involved and video footage from participant vehicles may not be available.

References

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