

A practical methodology using in-depth crash data to support the assessment of new motorcycle safety technologies

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Abstract

Current knowledge on safety technologies developed for passenger cars represents great potential for translatable solutions that may also reduce the number and the severity of casualties among motorcyclists. However, the translation of a safety system conceived for a four-wheeled vehicle to a motorcycle is not straightforward due to the different characteristics in the vehicle dynamics and in common real world crash scenarios. In this paper, we present a methodology to exploit in-depth motorcycle crash data for the purposes of a subsequent assessment of the potential benefits of a promising safety technology for motorcycles: autonomous emergency braking (AEB). The in-depth crash data used in this study involved motorcyclists who were seriously injured following a crash on a public road within 150 km of Melbourne, Victoria. From the subset of cases available for this activity, a set of 20 multi-vehicle crashes in which AEB was considered as “possibly applicable” were identified using a dedicated rating algorithm. For each selected case, the trajectories of the host motorcycle and the other vehicle prior to the crash were estimated using the available in-depth data and reconstructed via 2-dimensional simulations. Finally a panel of investigators reviewed each case until agreement was reached on the accuracy of the reconstruction. In further steps of this research, AEB will also be modelled in the numerical environment. Simulations with and without assistance of AEB will be run to predict the effects that this safety technology may have produced in the reconstructed cases.

Introduction

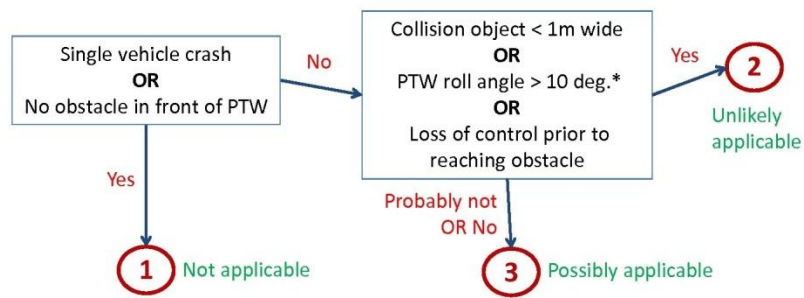
Recent vehicle-based safety technologies developed for passenger cars show great potential for reducing serious injury crashes. These technologies may also offer significant safety benefits when applied to motorcycles. However, the translation of a safety system conceived for a four-wheeled vehicle to a motorcycle is not straightforward due to the different characteristics in the vehicle dynamics and differences in common real world crash scenarios. There is currently limited information available on the potential benefit of these safety technologies if applied to powered two-wheelers.

One of the most promising vehicle safety technologies is autonomous emergency braking (AEB) (Budd et al., 2015). In this paper, we present a methodology to exploit in-depth data from real-world motorcycle crashes for the purposes of a subsequent assessment of the potential benefits of this safety technology for motorcycles. The methodology presented hereafter is an important part of the assessment methodology previously presented by the authors (Savino et al., 2014).

Methods

The in-depth crash data used in this preliminary study were extracted from a recent case-control study. Cases were motorcyclists who were seriously injured following a crash on a public road within 150km of Melbourne, Victoria (Day et al, 2013). Recruited riders participated in an interview-based questionnaire. This was followed up with an investigation of the crash site and motorcycle. From the subset of cases available for this activity, a set of 20 crashes in which AEB

was considered as “possibly applicable” were identified using a dedicated rating algorithm (Figure 1).



(* only when PTW travelling along a curve – do not consider last second swerve manoeuvres)

Figure 1: Algorithm for the evaluating MAEB applicability

For each selected case, the trajectories of the case motorcycle and the other vehicle prior to the crash were reconstructed via numerical, 2-dimensional simulations.

Initial speeds, vehicle headings, and modelling of the manoeuvres involved in the trajectories were estimated using the available in-depth data. Finally a panel of investigators reviewed each case until agreement was reached on the accuracy of the reconstruction.

An example case applicable to MAEB is summarized in the textbox below (see also Figure 2). The example shown was the most frequent reported scenario (defined by VicRoads DCA code) from the full series of recruited cases, which involves another vehicle turning right across the path of a motorcyclist travelling from opposite direction through an intersection.

CASE #129 (example)**Basic Crash Scenario (Rider questionnaire/self-report)**

- M/cycle approaching traffic controlled intersection (middle lane)
- Lights began to change to red. Rider states intersection too close to stop on wet road
- Car travelling in opposite direction commenced right turn into the path of m/cycle
- Rider applied front brakes only, then swerved to avoid vehicle
- Rider struck vehicle, catapulting off car onto footpath (25m – site inspection)
- Visual obstructions: No (rider perspective)
- Weather conditions: Light rain, wet road
- Lighting conditions: Dusk/dark, Street lights ON
- Road Surface: Wet (confirmed)

Basic Crash Details (Site & Bike Inspection)

- DCA code 121 – ‘right through’ crash, motorcyclist as ‘through’ vehicle
- Est. travel speed of motorcycle (approaching int): 55-67 km/hr (70% confidence)
- Excessive use of brake: No
- Anti-lock brakes fitted: No (from bike inspection)

Basic Simulation details

- Initial PTW assumed: 61 km/h.
- Other vehicle (car) speed assumed: 30 km/h, decreasing to 12 km/h (accel. 0.2 g)
- Car turning radius = 16m

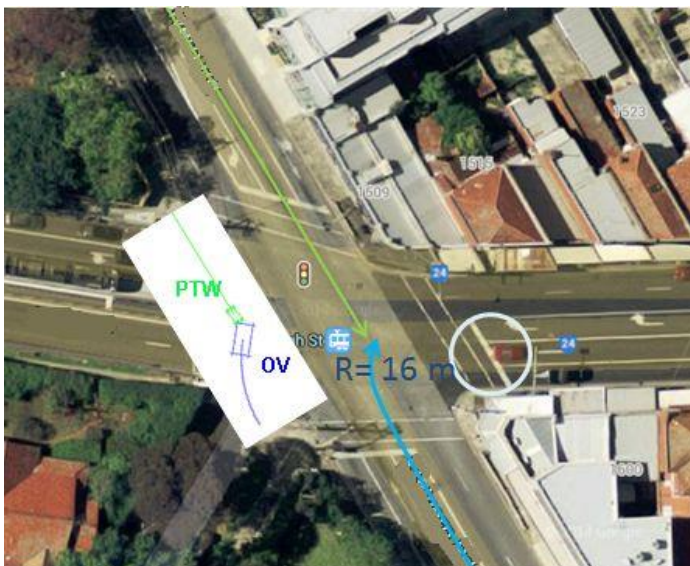


Figure 2: Example crash scenario (left) and photo of case motorcycle (right) used to assess the potential of AEB on crash likelihood or impact speed

Discussion

Kinematical and dynamical reconstructions of real-world road crashes are common activity and typically involve dedicated software. These reconstructions typically require many details including information from all vehicles involved regarding estimated initial speed, final position, and impact

damage. In this study we applied a different approach, using a simple but very flexible software that we developed to focus on geometrical trajectories of the approaching vehicles, i.e. their time variant relative heading and speed. These are in fact the fundamental elements required to evaluate whether an obstacle detection system will detect an approaching vehicle, and the possibility for a triggering algorithm to compute the deployment of a given safety system. This approach, combined with the Monte Carlo methodology presented in Savino et al. (2014), should also allow coping with a lack of detail in a crash investigation, such as the exact final position of the vehicles involved or even any detail about one of the vehicles.

For these purposes, we believe that the information from the 20 selected cases (questionnaire and site inspection) together with the input of the crash investigator in panel discussions, were typically sufficient to model the crash scenarios for the purposes of assessing AEB. In fact, clear incongruences in the final trajectories and the crash report data were not reported in the process, and the team was able to reach reasonable agreement on each of the reconstructions.

Some limitations exist with this approach. Errors in the trajectory reconstructions may have occurred, especially in the cases with a very low level of detail available from the crash site, missing information in the questionnaire, or unfaithful responses. In some of these cases, the team may have misjudged the precipitating or primary factors involved in the crash, thus potentially leading to wrong decisions in the definition of the pre-crash trajectories or actions (both quantitative, but also qualitative errors). This is something to keep into account when moving on to the next step of evaluating the potential of AEB. However, the method proposed by Savino et al. (2014) is especially designed to handle quantitative uncertainty in the reconstructed pre-crash trajectories.

In further steps of this research, AEB will also be modeled in the numerical environment. Simulations with and without assistance of AEB will be run to predict the effects that this safety technology may have produced in the reconstructed cases, including any changes in crash likelihood or impact speeds.

References

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