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Loss control detection for motorcycles during emergency braking manoeuvres using a supervised learning algorithm

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ABSTRACT

Braking is the most frequent evasive manoeuvre and one of the most complicated to perform by motorcycle riders. This complexity, makes that riders frequently loss control and fall performing braking to avoid a collision. This paper provides a method to classify unsafe loss control braking manoeuvres on a straight line before becoming irreversibly unstable to: a) support safety active systems developments; and b) improve riders' skills braking through braking training.

We performed braking manoeuvre experiments using a mock-up of an intersection conflict with a real car to reproduce a real world emergency scenario. The study comprises 165 braking trials (including 11 trials observed as *loss control*) with 13 riders representing four categories of braking skill from beginner to expert. The predictor variables of the model were identified among the parameters of the vehicle dynamics. The prediction model was defined using logistic regressions as supervised learning methods. Area under the ROC curve measured the performance of the models. The best model predicted 100% of the *loss control* and *full control* cases. The results provide a measure of the motorcycle dynamics variability in emergency braking manoeuvre associated with riders of different skill levels. The thresholds based on typical parameters characterizing the kinematics of the vehicle (maximum or RMS) to predict loss control were dependent of the rider skill levels. The study showed that expert riders may keep the stability (handle the controllability) under dynamics conditions that normally will bring to loss control or falling events to less skilled riders. The study presented provides valuable information on the stability capabilities of the riders under a braking manoeuvre close to emergency scenarios and help to understand the process and the motion conditions that lead rider to start losing control.

Keywords: motorcycle safety, braking, loss control, rider stability, supervised learning.

1 INTRODUCTION

Braking is the most frequent evasive manoeuvre and one of the most complicated to perform by motorcycle riders because of the inherent instability and the complex driving dynamics of the motorcycles. During emergency braking, considering the variations occurring in load distribution between the two wheels [1] and the tire-road adherence conditions, riders require a simultaneous optimal management of the front and rear brake to achieve the maximum deceleration. This complexity, makes that riders frequently loss control and fall performing braking to avoid a collision. In order to correct and avoid loss control events leading to fall during emergency braking, two different approaches are required: designing active systems that support the braking manoeuvre under stable conditions, and improving the braking skills of the riders. In both cases it is necessary to understand the process and the motion conditions that lead rider to start losing control. On the one hand, active systems must work in the natural range of maneuverability of the riders. On the