

# **A Motorcycle Riding Simulator for the Improvement of the Rider Safety**

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## **ABSTRACT**

Governments are making big effort to improve road safety, in particular the European Community wants to reduce of all road accidents by 50% by the year 2010. Statistics show that motorcycles road accidents are extremely frequent and a high percentage of them are fatal. In this contest, a motorcycle driving simulator has been developed and built at realized at DIMEG (Department of Innovation in Mechanical and Managerial Engineering) of the University of Padova. The aim is to use the riding simulator in two complementary areas: to teach and train riders and to develop and to test devices for improving the active and passive safety of the vehicle, or more generally any ADAS and IVIS system.

This paper is organized as follows: the first section the riding simulator, the second deals about rider feeling and first experiences on rider training, the third reports first experiences on virtual testing of a system for the improvement of the rider passive safety.

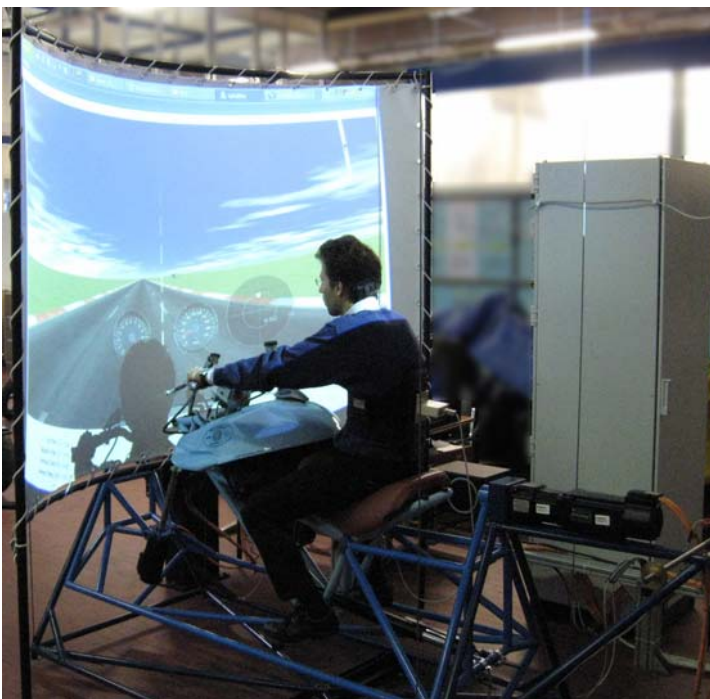
The simulator consists in five subsystems: the sensors subsystem that monitors rider's control actions, the multibody model that simulates motorcycle dynamics, the washout filter, the mock motorcycle with five degree-of-freedom that generates motion cues, and the audio/visual system. More in detail, the sensors monitor rider's handle-bars torque, body leaning, throttle, brakes, clutch and gearbox levers. These signals are the inputs of the multibody model of the motorcycle, which consists in a 12 degrees-of-freedom model, includes a realistic model of suspensions, clutch, engine, tires and 3D road, and has been optimized for real-time performances. The simulated dynamics is then converted into references for the motion and visual cues by the washout filter. Motion cues are generated by the servomotors that drive the five axes of the mock motorcycle, i.e. the roll, yaw and steer axis ( $\pm 0.3$  rad at maximum  $\pm 2$  rad/s), the pitch axis ( $\pm 0.12$  rad at maximum  $\pm 0.2$  rad/s), and the lateral motion ( $\pm 0.5$  m at maximum  $\pm 2$  m/s). The visual system consists of a 2x1 m curved screen placed in front of the rider and a projector, a speaker provide the audio cues. The forward view is presented from the rider's point of view and includes buildings and obstacles in order to improve the "riding feeling".

A simulator cannot reproduce neither the real vehicle dynamics, nor the real rider feeling. To improve simulator performances, the implemented model of the vehicle has been experimental validated successfully and it is able to reproduce motorcycle counter-steering, capsized weave and wobble instabilities, wheeling, etc. About motion, visual and acoustic cues, they are limited by hardware constraints, therefore it is essential to properly tune the washout filter in order to achieve an acceptable rider feeling. Washout tuning has been done by a trial and error procedure, finally few setups were subjectively evaluated by a group of

students, as described in section 2. Moreover, four specific scenario has been prepared and tested: test rig, downtown scenario with traffic, rural scenario and race track and rider's impressions has been collected.

The riding simulator has been used also to test an algorithm that predict motorcycle lateral falling and which is intended be used for the activation of an airbag integrated in the rider's suite. Indeed, in this case it is quite simple to replicate such accidents in various situations, without any risk for the rider. First tests shows that the algorithm work well, moreover a final validation on real motorcycle has been started.

more information on: <http://www.dinamoto.it/DINAMOTO/SafeBike/SafeBike.html>



## REFERENCES

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