

Experimental study of out-of-position motorcycle rider in crashes without loss of control before the accident

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I. INTRODUCTION

Motorcycle rider fatalities are overrepresented in Europe relative to their fleet [1]. During these accidents the rider is usually performing an avoidance maneuver before the impact. As it was found in the MAIDS report [2] these manoeuvres were braking, swerving and no action and their occurrence is presented in figure 1. However, in the ISO 13232:2005 [3], the current standard for motorcycle crash tests, the positioning of the MATD helmeted dummy is only studied in a normal seating position on an upright motorcycle. Previous studies with volunteers were used for the creation of the MATD dummy posture [4] and have compared the normal riding posture of volunteers to the one used by the standard [5]. Further in the literature there are studies of the rider postures during braking and swerving in laboratory conditions [6-7]. In this paper an experimental study of the braking and swerving maneuver with volunteers is presented in real riding conditions.

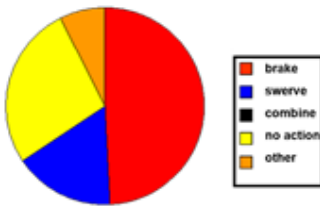


Figure 1 MAIDS avoidance manoeuvres

II. METHODS

An experiment was performed with eight male volunteers with an instrumented motorcycle. The motorcycle instrumentation included the measurement of the steering angle with a rotational optical encoder, the measurement of the displacement of the front suspension with a Time of Flight sensor, the measurement of the motorcycle speed through the OBD2 vehicle plug and the 3 axis accelerations and rotational velocities of the motorcycle. The kinematics measurement of the rider was performed with three infrared cameras (resolution: 0.8Mp, frame rate 100Hz) that were rigidly fixed over the top case of the motorcycle. Targets with Infrared LEDs in square configuration were placed on the helmet and the back of the rider.



Figure 2 The targets placed on the torso and head of the rider, the rotational encoder and the ToF sensors placed on the front suspension

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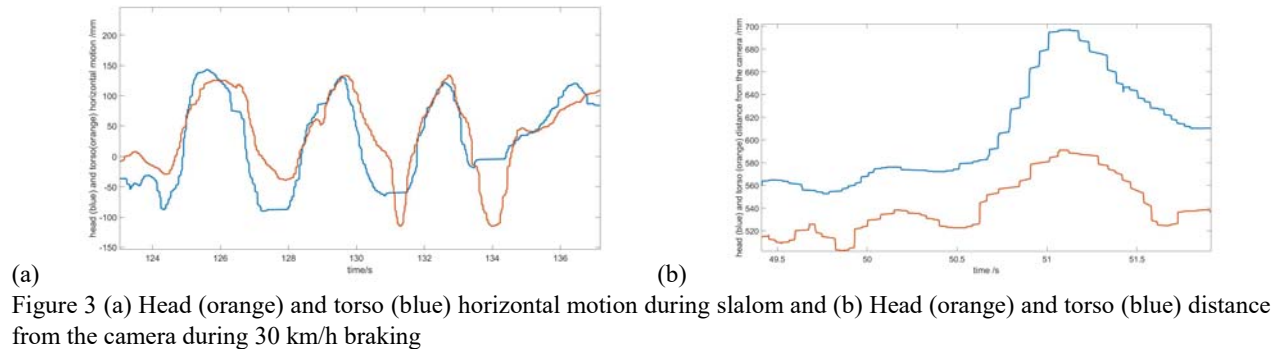
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The experiment protocol was approved from the ethics committee of CERTH and included the following:

1. Free ride: the volunteer rode the motorcycle in order to get familiar with the vehicle.
2. Path following: the volunteer followed a predefined path marked on the street (slalom).
3. Braking: the volunteers was asked to brake from the speed of 20, 30 and 40 km/h
4. Swerving: the volunteer was asked to swerve at a certain point.

III. INITIAL FINDINGS

The rider kinematics for volunteer one during the slalom test and braking are presented below.



During the slalom test a horizontal displacement of 10 cm, on each side, for the head and torso was noted, while during braking at 30km/h, which is a very low speed for motorcycle riding, the forward displacement of the head was 15 cm.

IV. DISCUSSION

If the above measurements are combined with the motorcycle lean angle during the slalom as well as the motorcycle pitch during braking, the out of position rider posture relative to normal sitting posture with an upright motorcycle become important. This out of position posture can significantly influence the outcomes, in case of a motorcycle crash, due to the different impact points of the head and torso. The above field test for capturing the rider kinematics in braking and swerving manoeuvres allows the simulation of accidents with the rider in these postures which are often closer to the real pre-crash reaction of a rider according to accident studies [1]. These simulations will allow better understating of injury mechanics in accident reconstructions as well as the development of more effective PPE that can be assessed with simulations that include riders' evasive manoeuvres.

V. ACKNOWLEDGMENT

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