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Determination of physical quantities describing the movement of objects involved in a frontal-side collision of vehicles

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Abstract: The paper compares the displacement and speed courses of cars, motorbikes and motorcyclists during a road accident obtained with the use of two measurement methods. In the first method, the course of the impact recorded by a fast camera recording 1000 frames per second was used ("frame by frame" film analysis). In the second method, the courses of accelerations and angular velocities of the objects were used (numerical integration of the recorded courses). The measurements were carried out during crash tests involving a frontal-side collision of two cars or a motorcycle with a car. The results are shown in the time interval 0-0.5s. During this period, the following phases of the experiment are observed: vehicle collision and the process of their deformation, the separation of vehicles, the start of independent movement of both vehicles after the collision. The measurement results obtained with the use of both methods are burdened with errors resulting, among others, from limited data sampling frequency, offset errors, calibration errors and sensor noise, duration of the analyzed waveforms. The use of two of the above-mentioned measurement methods simultaneously allows to minimize measurement errors

Keywords: crash tests, frame-by-frame film analysis, numerical integration of acceleration and angular velocity

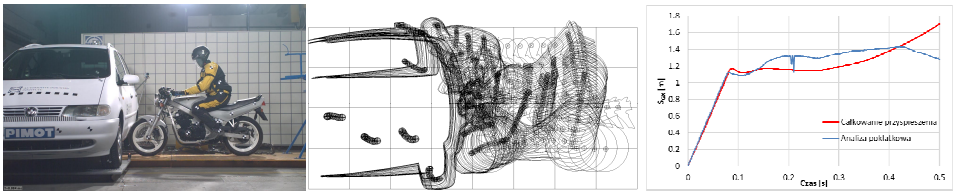
1. Introduction

Obtaining physical quantities describing the movement of vehicles and people is of interest to many entities researching: passive safety systems [1, 2], active e.g. during the modeling of autonomous lane change algorithms [3, 4], compliance of technological solutions with the applicable standard documents, e.g. LDWS (Lane Departure Warning System) or experts analyzing the records of UDS (Unfall Daten Speicher) or ADR (Accident Data Recorder) black boxes [5]. The obtained data is subject to uncertainty due to the limited frequency of data sampling, errors of offset, calibration and noise of sensors, duration of

measurements. Therefore, it seems advisable to conduct research focused on determining the uncertainty range of the obtained results of certain physical quantities describing the motion parameters with various methods. The paper compares the course of displacement and velocity of objects during the collision and immediately after the collision, determined on the basis of post-frame analysis of films and numerical integration of acceleration and angular velocity waveforms recorded during several frontal-lateral collisions of vehicles carried out in the Łukasiewicz Research Network - The Automotive Industry Institute in Warsaw.

2. Results and Discussion

Three front-side car crash tests in motion and one motorcycle-car crash test were analyzed. Fig. 1 shows as an example the test results from a crash test of a motorcycle with a passenger car.



a) b) c)

Fig. 1. Frontal-side collision of a motorcycle with a car a) location of the motorcycle and car at the time of first contact, b) frame-by-frame analysis of the collision course, c) comparison of the horizontal displacement of the rider's head determined by two methods.

3. Concluding Remarks

Research has shown that both of the measurement methods used give comparable results. However, errors in the calibration of the acceleration and angular velocity sensors must be minimized. This can be achieved by simultaneously analyzing the results obtained from two measurement methods.

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