The 3D reconstruction of a road accident used the specialized program PC Crash 12.1

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Abstract. A modern tool used in conducting forensic and extrajudicial technical expertise is the program specialized in simulating PC-Crash road traffic accidents, which covers a multitude of different situations, as it benefits from the advantages of the latest achievements in the fields of hardware and software. The paper presents one of the possibilities of the PC Crash program for computerized reconstruction of the dynamics of a road accident, by correlating the physical possibilities of the accident, based on the laws of mechanical engineering.

1. Introduction

The obvious need to take effective action to reduce the number of road accidents is reflected in the process of real and correct assessment of their causes, in order to determine criminal /civil liability and to compensate for damages. Thus, in order to be able to carry out an objective technical expertise, in accordance with the objectives set by the research bodies, in addition to the classical methods already known by most experts such as: the use of established mathematical models, empirical methods applicable to the case, the use of modern, complex methods, which ensure superior accuracy of the results obtained. They integrate in an optimal way the mathematical models used in the specialized literature and the established empirical methods. At the same time, they involve the use of calculation tools that allow the expert (the user) to ensure the possibility of reproduction by simulation of road accidents so that at the end of the expertise to allow certain conclusions to be drawn, which otherwise would have been extremely difficult to formulate [1].

Also, many times, in order to analyses in detail the course of the accident, the experts need more information, which 2D photos cannot provide. Thus, every detail, such as traces, road markings, etc. can play a very important role in the reconstruction of the accident. The PC Crash program, developed and developed by DSD - Linz (Dr. Steffan Datentechnick) from Austria, is an accident simulation and trajectory analysis program that facilitates an efficient analysis of vehicle collisions, as well as other types of road events, being recognized and validated both at European and international level. This program processes the data using different computational models, such as a buffer model based on impulse and kinetic energy, a model based on rigidity, a kinetic model for realistic trajectory simulations and a simple kinematic model for time and space studies [2].

For high versatility, the results obtained with the help of PC-Crash can be viewed on a scale, in plan and in vertical projection, in 3D perspective, but can also be viewed in tabular and graphical form. This article presents the computer simulation of the collision between two vehicles. The section of the running track and other parameters are established in the simulation performed following the
direct determinations performed by the expert on the spot. The program also allows an analysis of the influence of the introduced parameters on the simulation results.

2. Preliminary data

The accident occurred during the day. The driver of a Renault Clio car, driving on the road with priority, signaled his intention to turn left, at which point he was hit by a Seat Leon car traveling in the same direction and whose driver initiated a maneuver to overtake the vehicles in front of him. The file provided by the investigation authorities contains the reports of a party involved in the accident. The location of the accident, shown in Figure 1, and the position of the damaged components of one of the cars are known.

![Figure 1. The scene of the accident-smartphone photo](image)

A first stage of the simulation is represented by the preparation of the road accident scene, by “adding” the accident sketch in the simulation program. The materialization of the environment in which the road accident took place in the 3 known dimensions can be done at present with the help of the specialized program Agisoft Metashape. In this program, the environment of the production of the road event is obtained by creating a "dense dot cloud" later exported to the PC Crash program. After the road accident scene, the necessary simulations are performed in order to determine the relevant quantities in order to be able to answer the questions formulated in the objectives of the expertise. Figure 2 shows the dense dot cloud obtained based on the accident site scan and photogrammetric processing using the specialized Agisoft Metashape Standard photogrammetry program [2].
3. Performing the accident simulation

For the reconstruction of the accident with the road traffic accident simulation and reconstruction program PC Crash®, version 12.1 the Point Cloud file was imported from the Agisoft MetaShape. Thus, the place of the accident, with the data taken from the file and entered in the program, scaled based on the measured width of the road, is shown in Figure 3.
Next, to perform the reconstruction by simulation of the road accident, conditions of the road were created, by defining the adhesion coefficient for the roadway for dry road $\varphi = 0.8$.

Subsequently, the dimensional and mass characteristics of the cars involved in the accident were established, by selecting them from the program database. It should be noted that the characteristics can be modified in order to reproduce as accurately as possible the correspondence with the identification documents of the vehicles involved (Figure 4).

![Figure 4. Reconstruction of the accident in 3D coordinates in the PC Crash program](image)

The Sequences dialog box was used to analyse the vehicle speed (acceleration / braking) as well as the parameters of these modes - accelerations / decelerations, braking forces on each wheel (Figure 5).

![Figure 5. Motion sequences](image)
Figure 6. Primary impact between vehicles

Figure 7. Vehicle impact - impact details

After several successive simulations, by varying the movement parameters, the impact position corresponding to the damages of the Renault Clio car was obtained. According to the obtained data, the speed of the Renault Clio car was 9-10 km/h, and the speed of the Seat Leon car was 46-47 km/h.

4. Conclusions
- With the help of the PC-Crash simulation program, accurate accident investigation can be performed using computers. Based on the terrain model, the movement sequences of the vehicles can be reconstructed exactly, and the dynamics of the accident can be displayed in a 3D simulation, which can be analysed on the computer from various perspectives. Thus, it is
possible to identify the causes of the accident under the conditions of visibility of drivers, so that the statements of the parties involved in the accident can be verified in detail.

- Due to the possibility created with the help of photogrammetry in the process of accident reconstruction, the re-creation of the place in 3D coordinates allows for judicial and extrajudicial technical expertise at a high level of accuracy and precision, involving much lower costs than using a high performance drone.
- The specialized programs PC Crash and Agisoft Metashape can be useful to research agents to improve the collection of objective data immediately after the accident. In this context, the quantitative and qualitative analysis of the factors of traffic accidents will be improved, taking into account the fact that the change of the accident scene is one of the essential elements in the reconstruction of the accident.

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