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VALIDATION OF SIMULATION AND OPTIMIZATION RECONSTRUCTION IN PC CRASH WITH VIDEO RECORDED SAMPLE

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Abstract: *In many cases we have to estimate the speed of the vehicles involved in an accident. The aim of this paper is to make a brief presentation of some cases solved on the question of speed and dynamics using different methods and presenting the estimated error obtained. So in the paper it will be taken into account the indication of tachograph diagram with pro and contra arguments assuming that this indication is only informative as far as the tachograph is not specially designed as an accident recorder device. In the paper it will be included the reconstruction of the accident using PC Crash facility in optimization method to reduce the error regarding the trajectory and rest position. For validation of this analysis we will provide also a video surveillance camera film high resolution versus simulation of the accident.*

Keywords: *accident reconstruction, simulation, optimization*

1. INTRODUCTION

Methods for estimating and reducing simulation errors for the reconstruction of road accidents

Artificial intelligence at work in favor of finding an optimal solution, this is the target of optimization process. Such could be defined genetic algorithm optimization; the optimization technique appeared with works of John Holland. "Survive the one that is best suited," says genetics principle enunciated by Charles Darwin, hence the idea of optimal. Thus we can say that the genetic algorithm combines these principles in solving heuristic search optimization solutions based on a mechanism determined by the biological process of evolution, in our case the development in the form of real parameters.

In other words, the issue is based on the genetic algorithm to optimize conditions to which are added to a part of the experience of previous tests and on the other hand similar to the decision that may be taken by a specialist after the estimation results. In fact the algorithm leads to the minimization of relative errors to the criteria optimization always taking into account a real balance between the parameters which are subject to optimization process based on the weight required. This can be affected by the imposition of a share or ignoring less relevant process parameters.

These optimization processes have been successfully implemented with the advent of multiprocessor systems in which the calculations may be performed in parallel in different tasks and the results then can be compared to reprocessed at a rate multiplied by the number of available processors. Thus we find that the processes running on a system with an Intel © Core ™ i7 have available a number of 8 Core processor technology can drive every two processes simultaneously. In these conditions optimization process can be

supported and the duration for processing cycle about 120-180 iterations is about 30-120 s.

To optimize, the conditions have to be imposed by the user. Based on this optimization process under the conditions imposed, will seek a minimum of relative error to the criteria weights or ignoring the results to be expected.

To lead such a process must first determine the parameters to be optimized and course optimization criteria.

In practice the reconstruction of road accidents optimized values are relate specifically to impact velocities, the impact, the height of the impact point, the orientation of the contact plane, directions of vehicles before the collision, vehicle positions, the coefficient of restitution, coefficient of friction of impact bodies, etc. To optimize these criteria, are included in optimization the end positions and relative to those the post-collision trajectories and all angles relative to the trajectories followed. These latter criteria may be weighted or ignored by a percentage in the criterion of their importance versus ignore possibilities.

The process is difficult to be optimize because of the number of parameters in the optimize process. From experience these processes must run an average of three parameters. After obtaining a solution the process may be repeated with another set of three parameters to minimize the error. Finally after obtaining a solution close to the minimum relative error, optimization criteria can resume the process by assessing all parameters optimization, but it is not sure that the minimum error is expected to be. If the error is increasing of course the system returns to the previous solution obtained in the simulation process.

To optimize an accident reconstruction simulation parameters are always related determinant by the impact speed. This parameter is an important part in changing the output quantities that the final position of the vehicles and their trajectories, are dictated by the optimization criteria.

2. CASE STUDY

This is a typical case of priority violation but the main characteristic of this accident was that for documentation we have also a video sample as prove.

In this case we have the tachoghraph diagram which indicates a speed as in the next figure (Fig.1):

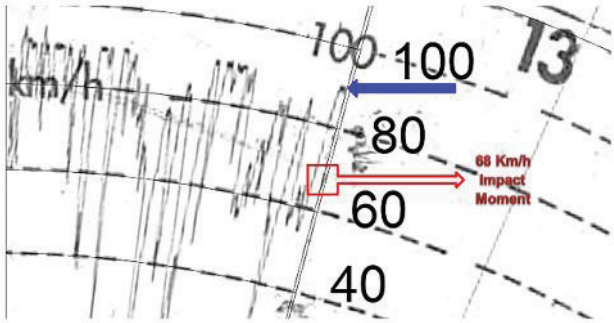

Fig. 1

As we can estimated from this diagram the speed of the truck was around 90 km/h before the impact and after a normal break the impact moment can be found on this diagram at around 68 km/h.

Fig. 2

Fig. 3.

In this case it was estimated that before the accident the speed was decreased from around 90 Km/h to 70 Km/h in a space corresponding

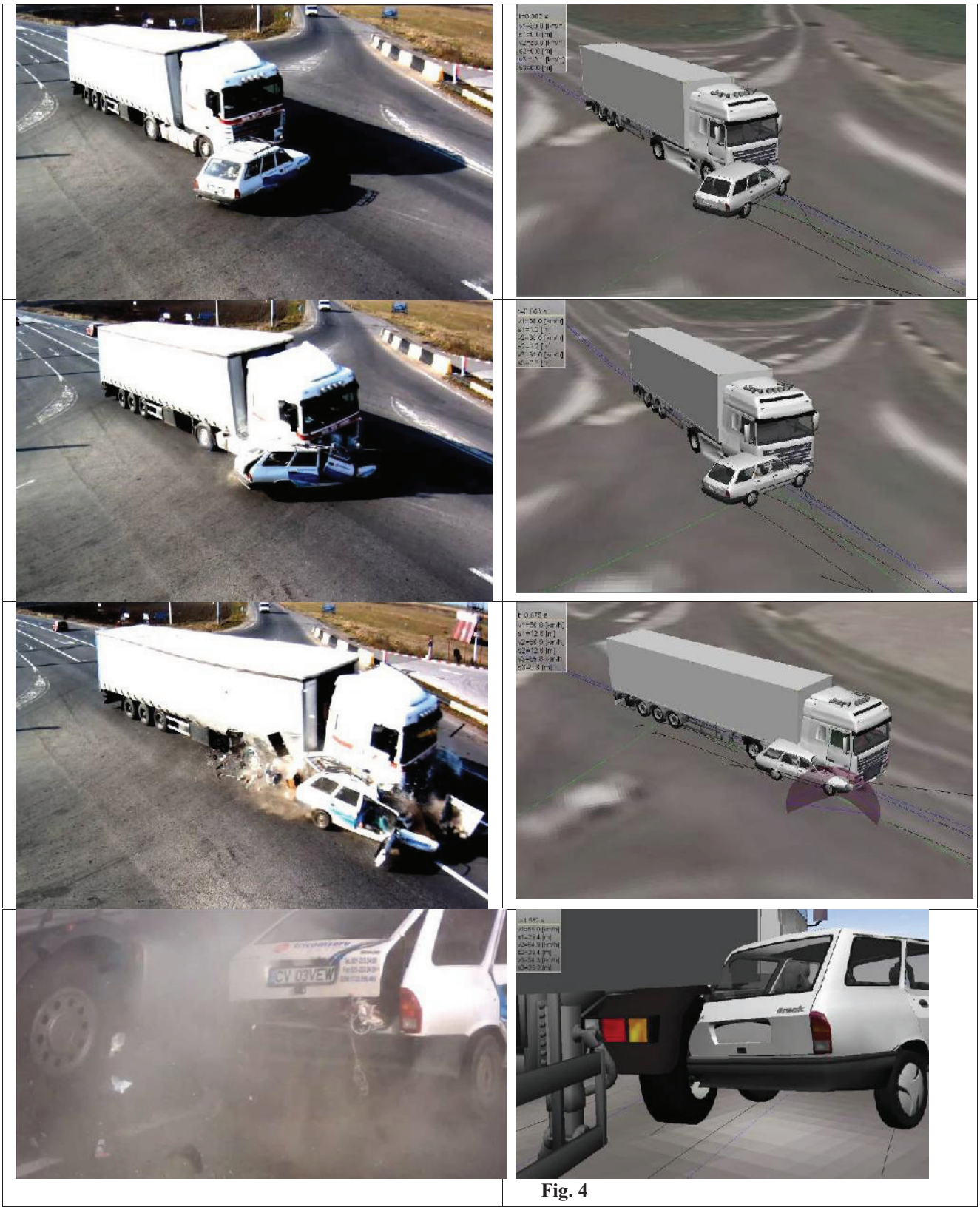

Fig. 4

to the slope discovered on the diagram of around 90-100 m before the point of impact with a constant deceleration

Different from the first two cases at this point we have also a record from a high quality surveillance camera designed for identification of the registration number in connection with the road tax paid.

With the preliminary information a simulation in PC Crash was realized and the result was com-pared with the images provided by surveillance camera (fig4).

As can be seen in Fig. 4, the simulation is well represented compared with the video capture and the speed of the impact determinated after an optimization procedure was 69 Km/h for the truck and trailer and 13 Km/h for Dacia car, result which is in accordance also with the tachograph diagram indication. A detail on the impact position can be observed below (Fig. 5), together with the position of the second impact with the back of the car (as can be seen in the film the last position): Dacia station wagon left rear corner:

Fig. 5.

Fig. 6.

This secondary impact (Fig. 6) was also proved due to a second camera mounted on the same pole at a different height for registration of the license plate.

Analysis of the impact was achieved as a result of a process of optimization that took into ac-count the film unwinding road event surprised by the traffic surveillance cameras in the area concerned.

The optimization process was achieved in successive iterations in which relative error at the final positions and trajectories were minimized to an acceptable error of 2.5%.

In the process of simulation the minor impact with the chariot on the opposite side has been ignored due to low share in relation to its mass relative to the mass of the road train and also due to the fact that in relation to this there was not a frontal impacts but only a minor side impact. Statistical error analysis is presented below (Fig.7).

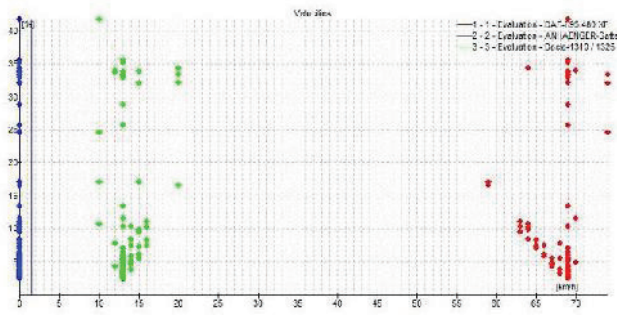

Fig.7.

Thus, one can conclude that the impact velocity was determined with the highest probability (minimum error related to final position and trajectories) to 69 km/h for the truck with trailer and 13 km/h for the car: Dacia station wagon.

Another method that we intended to use to appreciate the speed for this case was to reconstruct the accident with scale reduced vehicles. Normally this procedure is very close to a game because in fact we can use toys like models. But in laboratory we try to simulate the real accident by modifying the toys and the surface to be closer but scale reduced in what concerning the mass, adhesion coefficient, acceleration and braking.

The main disadvantage in using this method is that cannot simulate the real deformation, nor estimate the EES values for this models.

Even with the assumption of these errors the results in what concern the impact and the trajectory after collision till the end position was quite well estimated (Fig. 8).

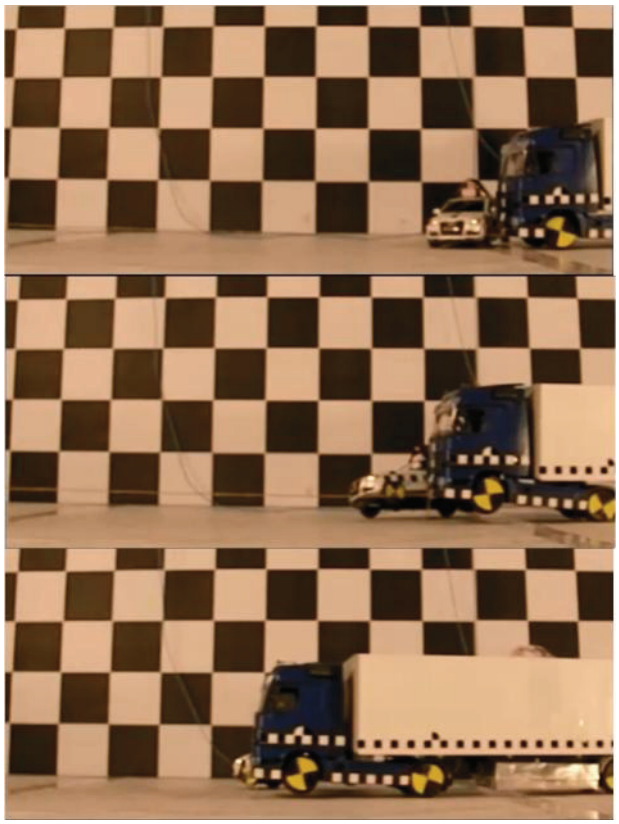

Fig. 8.

All the methods used conducted to almost the same value of speed, obtained with the high precision by simulation and optimization realized with PC Crash. As a conclusion for this analysis we can say that the simulation was the fast and most precisely method, and also not expensive.

REAL CAUSE OF THE ACCIDENT

Analyzing these three cases we can take a conclusion in what concern the speed of the vehicles involved.

In a kinematic analysis we discovered that the danger situation appears for the truck driver un-der his reaction time. But this is only a theoretical estimation, in assumption of a theoretical reaction time and lag time.

Due to the good resolution of the film we have observed even the driver position (Fig. 13). From these pictures, looking to the position of the arms of the truck driver, it can be seen that he did not have a real reaction in time.

The main reason that we concluded for this absence of reaction was that because of the low speed of the car, intersecting his trajectory, the truck driver did not realize that the car driver will not stop at the limit.

Fig. 9.

Another observation regarding the way in which the car enters in the intersection was that the driver did not break at all: he was entered in the intersection with a low speed, almost constantly.

As a conclusion we can say that the low speed of the car did not represent a real danger for the truck driver, situation in which he did not have any reaction.

4. CONCLUSION

For a good appreciation of the impact speed it is always necessary to verify the calculation with at least two methods. First step can be an analytical appreciation of the speed but also a good simulation can give an appropriate value.

The second step is to compare this information with other sources.

The comparison method it is as precise as the source of information come from real crash tests in which the speed is measured and controlled.

The third phase is to try to make a statistical error estimation to evaluate the global error of the speed value determined.

Not always, but very offen in the last period in the area of the accident can be found a surveillance camera, in which images provided by the owners you can find important information about the speed, but also for the point of impact and contact plane.

One of the important issues for using this kind of prove is to have together with the film also some information from the camera operating system such as the fps and interlaced factor.

The simulation with little models did not give a good estimation of the values of the speed and even for the real post collision trajectories the errors are considerable, as far as the models are not very well represented.

The information taken from the surveillance camera are very important not only for the speed confirmation but also for small details which can be essential for solving the reconstruction of the accident.

5. ACKNOWLEDGEMENT

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