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DUAL SHOOTING AND EVALUATION OF HIGH-SPEED PHENOMENA

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Abstract: *The article describes the problem of dual shooting and evaluation of high-speed time varying phenomena using high-speed camera systems. It describes necessary steps for the preparation of shooting and how to set up the electronic shutter and also focuses on the processes of calibration and final evaluation of the high-speed phenomena. Dual shooting of high-speed phenomena is very modern while still remaining quite an unexplored field and is at present subject of a research at the Institute of Production Engineering ÚTB in Zlín. The published processes particularly for the Chip-Chunk test are brand new and at currently being patented in the Czech republic.*
Key words: *High-speed camera system, high-speed phenomena, dual shooting*

1. INTRODUCTION

High-speed camera systems (hereafter referred to as HSC) are well-known not only for the scientific community but also for people from the technical field. Their use has at present been extended from special applications in the military and automobile industry to the common technical practice.
The requirements to improve production process, lower costs and increase safety are continuously growing and HSC has a lot to offer in this respect. Using the high recording frequency they enable to examine the given phenomenon, stop the image in a set moment and then examine it as well as detecting the problematic sections. If we want to do this all, we first need to define the concept "speed, high-speed phenomena". They are such phenomena for the recording of which it is necessary to use the recording frequency ranging from 100 Hz to 1000 000 Hz. We also need to specify the type of phenomena. In practice they are periodic, aperiodic and stochastic phenomena, for which it is necessary to determine the time and length of shooting. Next, we have to consider the type of a HSC. At present there is a number of producers of HSC, which, however, have different configurations. It is also worth noting that the market has recently introduced digital cameras with higher speed of recording. The recording speeds range up to 100 Hz, which enable to make only very basic evaluations. In the case of professional devices we can distinguish between two basic types: It is a compact type, with a display and most control elements are integrated in the HSC and next, a modular type consisting of a number of modules and peripherals enabling the user to make a recording and evaluation according to the given requirements. The compact systems are more economical, but they are very easy in terms of their operation, setting and evaluation. The modular systems can be adjusted exactly to our requirements with the aid of connectable peripherals and methods of shooting but the setting and evaluation are rather complicated, the price very high. When shooting with the HSC there are often problems with an insufficient angle of view, which is needed to capture the phenomenon. Common lenses working at angles up to 60^0 are often not capable to capture the scene shot, on the contrary, the wide-angle lens and special lens, such as Fish Eye, which have the angle of view over 180^0 can capture the scene but with a subsequent image distortion. Hence, there are two high-speed camera systems used in practice which shoot the parallel phenomena. The two high-speed camera systems are used for parallel shooting of phenomena, which would be difficult or impossible to repeat, with lenses with the angles of view up to 60^0.

2. EXPERIMENT

The result of such shooting of one or more phenomena using a set of two camera systems are two films of the same phenomenon, or phenomena from different angles of view according to the position of lenses of the cameras.
The disadvantage is that so far no method has been developed that would combine these separate films, giving a more complex idea about the phenomenon processed. This combination can only be made subjectively in the minds of the viewers watching the films but it is clear that this way of putting images of the two films together may not be precise and sufficiently predicable. So far this process has not been objectified.
This deficiency of the present state of technology can be made up by a method of visualization of the time varying phenomena. The principle of this method is that the images created by shooting a phenomenon with a set of two camera systems or one camera system from two shooting positions (in such a way that the axis of the lenses placed in the shooting positions are in an angle ranging from 90° to 180° see Figure 1. and Figure 2.) are put together at a given time into one dual image according to a characteristic trait of the image, such as a characteristic point, edge or angle.

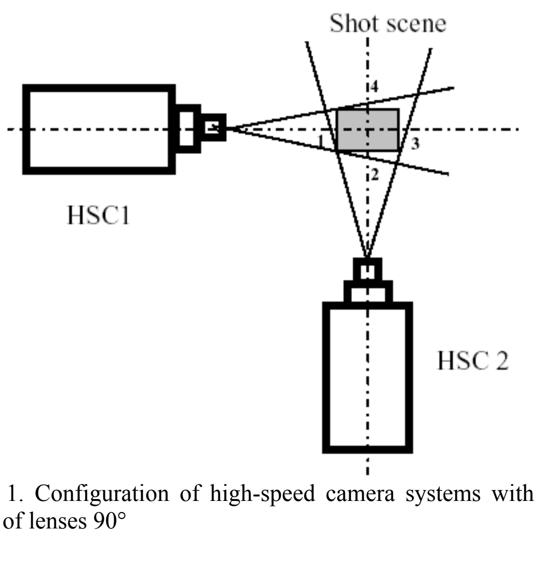

Fig. 1. Configuration of high-speed camera systems with the axis of lenses 90°

Using the two camera systems placed so the axes of the lenses form an angle ranging from 90° to 180°, see Figure 3, it is possible to shoot more phenomena independently in process on the scene being shot, and then each of the shot phenomena are made into a single film consisting of dual images.

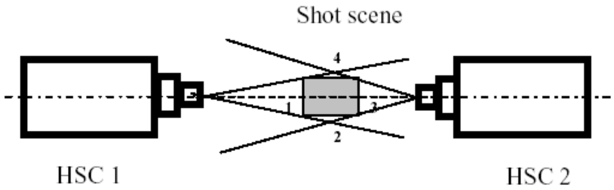

Fig. 2. Configuration of high-speed camera systems with the axis of lenses 180°

High-speed camera system or systems can be used to capture the phenomenon, or phenomena, especially camera system or systems with the angle of view up to 60°.

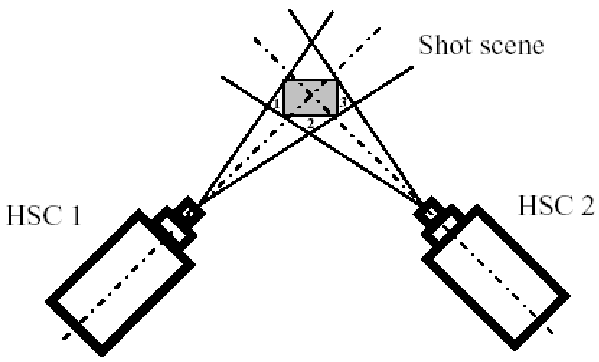

Fig. 3. Configuration of high-speed camera systems with the axes of lenses over 90° and below 180°.

3. RESULTS

The example of a practical method of visualization of time varying phenomena is shooting a phenomenon, which takes place during the wear test of rubber materials (referred to as Chip -Chunk test), see Figure 4 during which a rubber sample of cylindrical shape is penetrated by a pointed tool with defined geometry, see Figure 5.

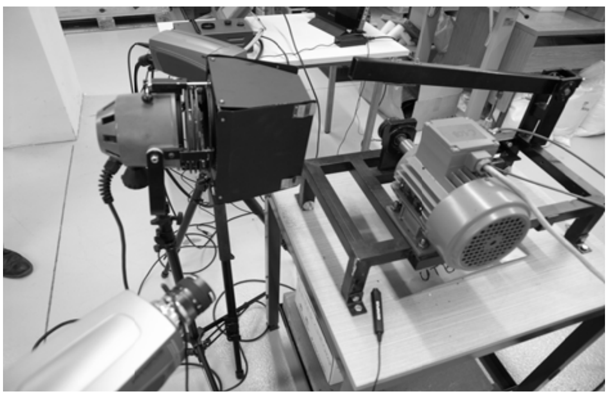

Fig. 4. Practical configuration of high-speed camera systems with axes of lenses 90°

A dual image can be created very fast and enables to immediately detect different behaviour of the left and right edges of the sample at the moment of penetration of the test tool, depth of the penetration of the tool inside the sample, speed of revolution of the sample, size and speed of the chipped parts of the rubber test sample, speed of the ceramic tool, etc. (which is one of the main requirements in practice), see Figure 6.

Fig. 5. Left and right photo obtained from high speed camera systems

Fig. 6. Final dual image

4. CONCLUSION

Dual images give us a very precise idea of the limit positions at different time intervals and if the images are arranged in a given time sequence it is possible to demonstrate a visualized dual phenomenon as a filmed scene.

5. ACKNOWLEDGEMENTS

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