18th International Conference
ENGINEERING MECHANICS 2012
Svratka, Czech Republic, May 14 – 17, 2012

pp. 118–119
Paper #275

# THE DETERMINATION OF THE KINEMATIC QUANTITIES BY USING THE HIGH-SPEED DIC METHOD

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**Abstract:** *A measuring of deformations and displacements of a moving object can be considered for one of the most complicated tasks in the experimental mechanics. Thanks to modern optical methods like method of digital image correlation, we are able to record displacements during the time variable actions such as dynamic loading or motion. The article deals with possibilities of using high-speed digital image correlation for determination of some kinematic quantities of rotating objects.*

**Keywords:** ***motion, kinematic quantities, digital image correlation***

## 1. Introduction

The kinematics can be integrated from theoretical aspect as part of classic physics. Its main objective is description of point/body movement or system of points/bodies but it does not deal with forces which cause this movement. For description of this movement it is necessary to find out the trajectory of this motion and also the velocity and acceleration. In practice kinematics can serve for determining a range of movement of some mechanism or for finding out velocities or accelerations of its components movement. In some cases it is convenient to use for measurement non-contact methods which do not disturb measured structure. Among modern non-contact methods which are more and more popular nowadays belongs also digital image correlation (DIC). Digital image correlation is a non-contact optical method served for identification of spatial displacements and strains of investigated object. Three-dimensional displacements are determined by correlation of digital images obtained by two high-speed CCD cameras during movement or deformation of an investigated object.

## 2. Motion analysis of an object with constant rotary movement

The investigated object was a cooling fan of an automobile Škoda Felicia powered by stabilized generator with constant voltage 5V. Since a frequency of rotation of the cooling fan was relatively high, it was necessary to perform a high-speed measurement with a sampling frequency FS=5000fps to obtain continuous displacements of rotating fan. Cameras configuration can be seen in the Fig. 1.

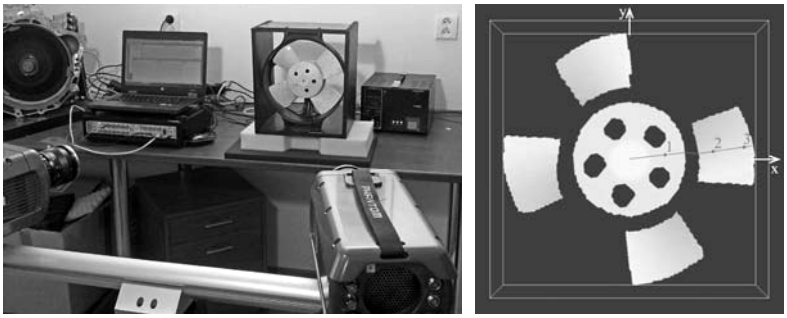

*Fig. 1: Cameras configuration (left) and reconstructed contour of cooling fan after correlation (right)*

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Displacements were investigated in three points lying in the same straight line (see Fig. 1). The time dependences of displacements of each point in *x* and *y* directions were imported into Matlab and numerically processed. Because displacements obtained by measurement represented set of discrete values it was necessary to utilize method of numerical differentiation for obtain another kinematic parameters. Some results of motion analysis are shown in following figures.

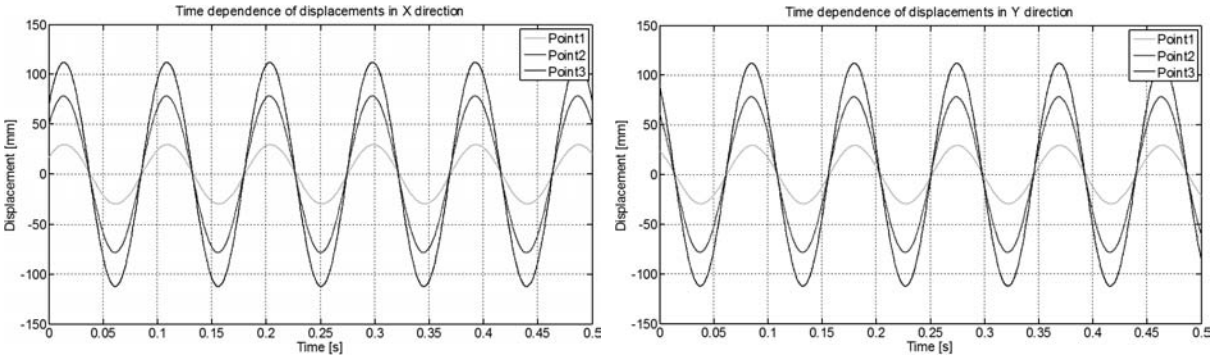


*Fig. 2: Time dependence of chosen points displacements in directions x, y*

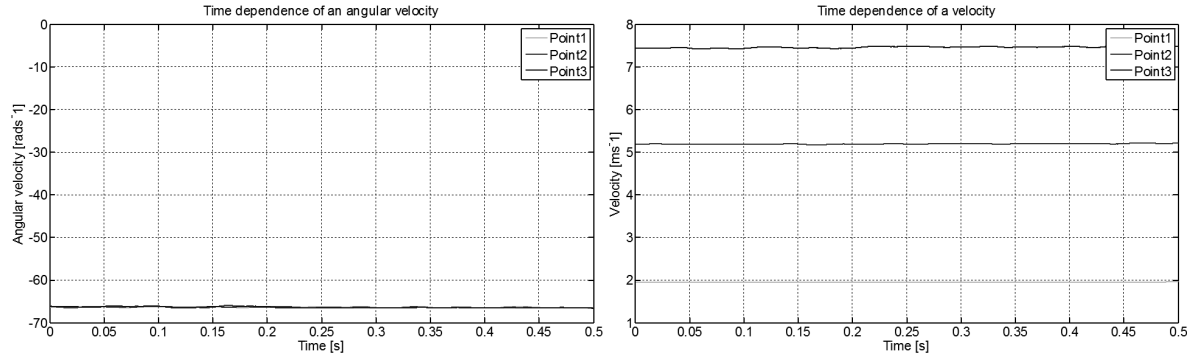


*Fig. 3: Time dependences of angular velocity (left) and velocity of chosen points (right)*

## 3. Conclusions

Using of digital image correlation method is a convenient choice to solve a lot of strength or dynamic problems of mechanics. One of the restrictions by DIC movement analysis can be a fact that investigated object has to be situated in visual field of all cameras for all the time. With respect to that correlation systems use to be mostly formed by two cameras it is possible to use them particularly for solving of flat objects. With increasing number of cameras it is not so easy to ensure illuminating conditions equal for all respective cameras. Because of that it is necessary to exclude all shadows and reflections from snapshots. By investigation of rotary object movement the correlation error is increasing due to increasing distance of investigated points from centre of rotation. This phenomenon is due to that by higher speeds is displacement of points between two particular correlated snapshots higher. Because the numerical differentiation does not work with continuous values but with discrete ones it installs certain inaccuracy to calculation. This inaccuracy obtained by higher sampling frequencies is not such strong to influence accuracy of results. The same way i.e. by sampling of displacements and their consecutive numerical processing in Matlab it is possible to perform analysis of decelerated motion. The results obtained by investigation of physical pendulum decelerated movement were verified by means of simulation in program MSC Adams/View and are described in other technical publications.

**Acknowledgement**

This contribution is the result of the project implementations: „Center for research of control of technical, environmental and human risks for permanent development of production and products in mechanical engineering“ (ITMS:26220120060) supported by the Research & Development Operational Programme funded by the ERDF and „Development of unconventional experimental methods for mechanical and mechatronic systems“ supported by Scientific Grant Agency VEGA MŠ SR (Project No. 1/0937/12).