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# DIGITAL IMAGE PROCESSING OF STRUCTURE RESPONSE

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**Abstract:** *This paper deals with an easily available means of vibration measurement which is the digital image processing. A method is proposed whose internal procedures are described in detail and its applications are discussed. The usability verification of the method was performed on vibration measuring of different types of experimental structures. The flow chart of the method is also given. The cases of appropriate usage are discussed.*

**Keywords:** ***Digital image processing, dynamic test, digital camera, cyclic loading.***

## 1. Introduction

Vibration is a phenomenon known in structures which are subjected to dynamic loading. Good understanding of vibration behavior can be successfully applied in a wide range of engineering fields, such as mechanical engineering. The external influences, such as earthquake (see Fig. 1), machines, traffic and other human activities are considered as the unfavorable vibration sources. The use of digital image processing, e.g. Štemberk and Kohoutková (2005), which requires a simple digital camera, a tripod, a measuring marker and a computer with proper software is the least expensive possibility for vibration measurement.

*Fig. 1 Consequences of earthquake (Murty et al. 2001)*

## 2. Proposed digital-image-processing method

The method is based on the fact that every single point in a raster image (pixel) has its own specific values and also the unique coordinates. By utilizing this reality, it is possible to work with an image like with a digital matrix. The proposed digital image processing application was created with respect to the above mentioned facts. The whole method consists of the following three steps: recording, data processing and post-processing. The first step relies on placing of the measuring markers

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and the camera fixation. In general, the camera distance ranges from 0.5 to 10 meters, which depends on the size and the resolution of the camera sensor and the lens focal length. The data are subsequently processed (see Fig. 2) and the results post-processed, which includes numerical differentiation and plotting.

The recorded series of images, or a movie, is split into single images that are uploaded one-by-one in the software application. Then, the dynamic threshold dependent on the brightest and the darkest place of the image is determined. The threshold is used when the original image is converted into a binary image. The binary image contains only zeros (black) and ones (white). The second step consists of searching for a continuous area composed of ones only. Then, the center of gravity of the area which contains only the ones is calculated and its coordinates are stored. The next images are automatically loaded and processed in the same manner. The last step consists of determination of the measuring point pixel size because it is necessary to multiply the results (pixels) by a ratio of the actual size to the pixel size.

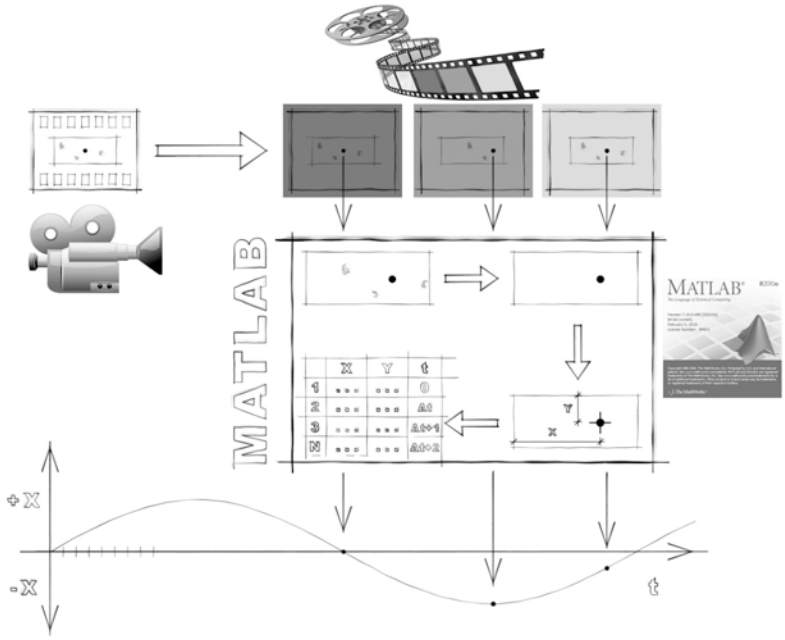


*Fig. 2: Flow chart of proposed digital image processing method*

## 3. Conclusions

It was shown that it is possible to apply digital image processing in measuring the displacement of cyclically loaded structures. This however assumes that certain rules and conditions, such as a sufficient measuring point resolution, the ratio of the vibration frequency to the video frequency and proper camera fixation, are satisfied. The proposed method is essentially wireless and also reasonably priced. On the other hand, using this method requires certain discipline and certain amount of experience with digital processing. The flow chart of the method and its inner steps were given. The procedure of measuring was discussed.

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**References**

Murty, C.V.R. et al. (2001) *The Seismic Performance of Reinforced Concrete Frame Buildings with Masonry Infill Walls*. New York: McGraw-Hill Professional.

Štemberk P. and Kohoutková A. (2005) Image-analysis-based measuring of lateral deformation of hardening concrete. *Materials Science* (Medžiagotyra), vol. 11(3), p. 292-296.