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Real Time Measurement and Evaluation of Washer Extractor Vibrations

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Abstract: This paper shows some interesting results from vibration measurement of a washing unit realized on an industrial washer-extractor. The six inductive displacement transducers were used in the measurement with respect to the number of degrees of freedom. There were measured three washing cycles with various fillings: weights, jeans and cotton diapers. The used measurement method is accurate and makes possible relatively easy and cheap real-time capture of the current position of vibrated constructional parts.

Keywords: Measurement Method, Spatial Motion, Washer-Extractor

1. Introduction

Vibrations of constructional parts appear often practically in all branches of the machine industry. In many cases it is desirable to measure the maximal displacement magnitude under real service conditions. For the solution of this task an optical method or accelerometers are usually used. The ESPI method and the digital image correlation method are the most popular methods [1]. It is well known, that accelerometers are suitable for higher frequencies of vibrations [2] and in this case the evaluation of measurement is complicated by the necessity of displacement record integration to get time dependence of displacements. There is also methodology using sufficient number of axial displacement transducers [3]. The last possibility has been applied in this paper to the vibration measurement of an industrial washer-extractor. Results of realized experiments show good repeatability and robustness of the method for future applications.

2. Description of Measurement Method

On the basis of commission for 3D motion measurement of washing unit of a industrial washer-extractor. The main task was critical extraction speed

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determination with absolute maximum of displacement in the cases of three types of filling: weighting, jeans and cotton diapers. The used methodology has been described and verified by authors in the previous paper [3].

At least six displacement transducers are necessary to capture position of a rigid body. For illustration of the main ideas we can consider the arrangement of six displacement transducers shown at the Fig. 1. This arrangement makes possible the spatial motion measurement by the idea of capturing the position of three perpendicular planes which are coupled with the body [3].

For the evaluation of measurement the distances x_C and y_B between transducers have to be known (Fig. 1). When choosing a location of sensors, the emphasis was on the applicability for various types of industrial washing machines. Three sensors were placed at the head of the machine, two vertically and one from its side.

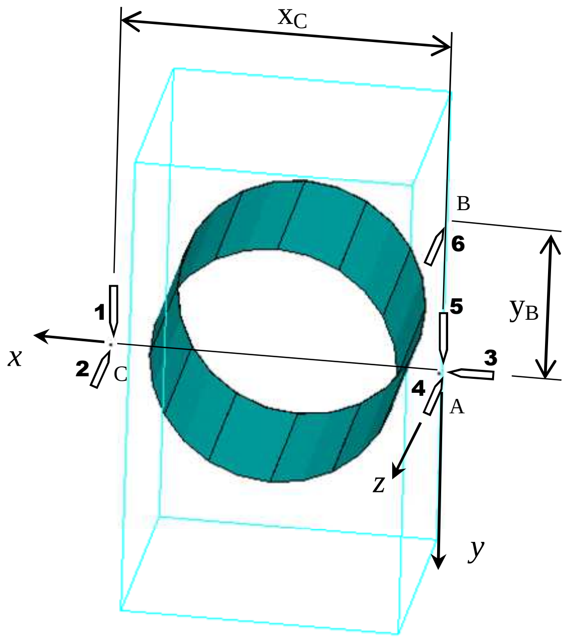

Fig. 1. Arrangement of six displacement transducers for the vibration measurement.

The inductive standard displacement transducers were used in the measurement. Three light-weight aluminium-base alloy bars have been mounted to the washing unit to create measuring places on three perpendicular planes (Fig.2). Whole washing cycle including starting and run-out of drum was measured. Data have been recorded and evaluated using LabVIEW 2011 software. Two independent virtual instruments have been created for these purposes.

Fig. 2. A photo from the measurement.

3. Main Results

All measurements were evaluated in terms of maximum deflections. They were also created space motion animations of washing unit for each measurement. The Jeans regime was measured twice.

The largest deflection 36.8 mm has been achieved in the second mode Jeans 1 (Table 1). From the comparison of measurements Jeans 1 and Jeans 2 is obvious good repeatability for the type of washing (filling 13.5 kg).

Table 1. Selected results

Measurement	Max. deflection [mm]	Point number
weighting	18.2	5
jeans 1	36.5	8
jeans 2	36.8	8
cotton diapers	35.8	9

Washing unit surveyed points correspond to points on the front and the rear face of the sphere. The result is a table which lists the coordinates of points considered, the maximum deflection and the corresponding number of the record. The actual time in seconds can be converted by dividing the sampling frequency. In the case of the "weights" measurement the maximum deflection was therefore established at point 5 on the rear face of the work units of the value of 18.2 mm, and at time t = 1181s = 9min50s (Fig.3).

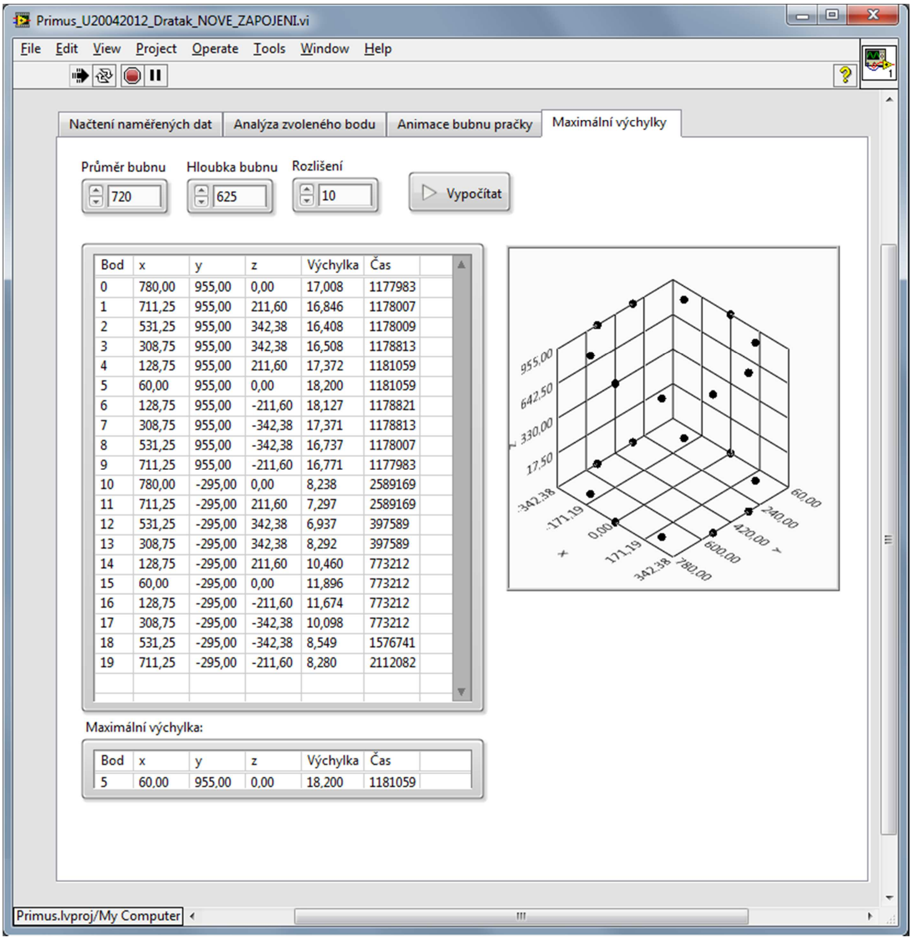

Fig. 3. Evaluation of the maximal deflection for the weights regime.

It should be noted that the initial decrease in washing unit as a result of filling water in the relative deviation is also included in the time record. This observation is not evident for the weighting regime, see Fig.4.

The trajectory of point D in the spin cycle observed by measuring the Jeans1 is given in Fig.5, where the absolute coordinates are used.

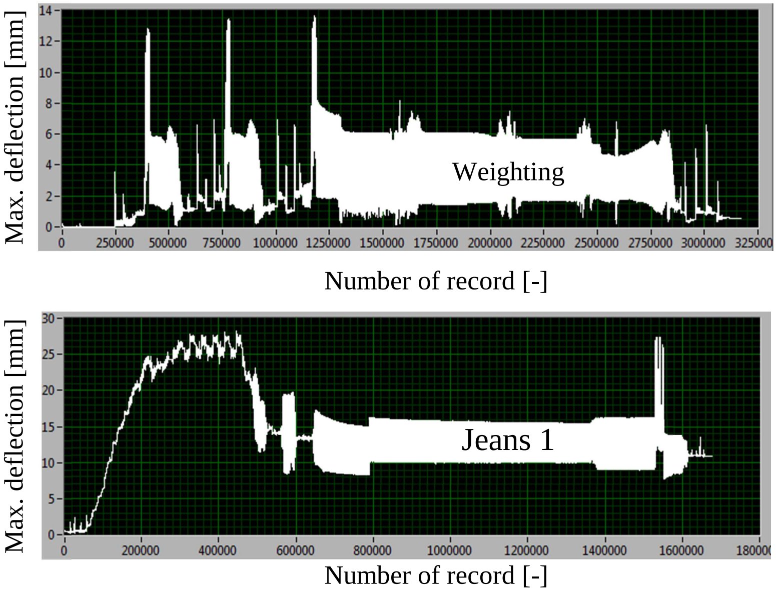

Fig. 4. Comprison of the deflection in the point D in two regimes.

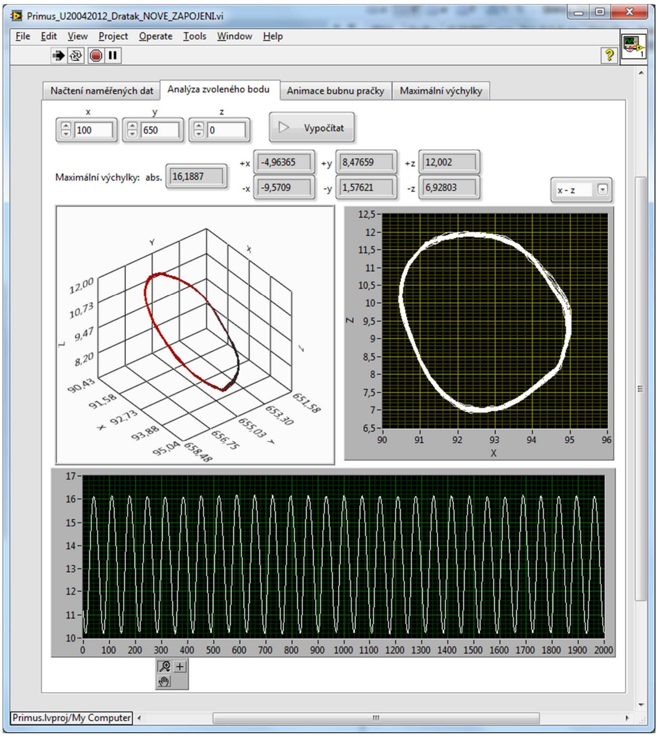

Fig. 5. Evaluation of steady state (point D, 900 revolution per minute).

4. Conclusions

This paper describes the vibration measurement of the current position of rigid mechanical parts or structures, which come from the idea of six axial displacement transducers usage. The methodology does not dependent on the type of used displacement transducers. It is possible to use standard inductive, optical or ultrasonic transducers. The benefit of the proposed method is the fact that there is the only one simplification made in the evaluation procedure. The constructional part is considered as a rigid body. The method was applied for the measurement of spatial motion of the washing unit of the industrial washer-extractor [4]. The interesting near future application will be optimization of dampers and development of active damping systems.

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References

[1] Sutton, M.A.; McNeill, S.R.; Helm, J.D. and Chao, Y.J., "Advances in Two-Dimensional and Three-Dimensional Computer Vision," in *Photomechanics*, Ascheron C.E., Kö1sch, H.J., eds. (Springer-Verlag, Berlin Heidelberg, 2000), pp. 323-372. ISBN 978-3-540-65990-7.

[2] Chapsky, V.; Portman, V.T. and Sandler, B.-Z. Single-mass 6-DOF isotropic accelerometer with segmented PSD sensors. *Sensors and Actuators A: Physical*, **135** (2) pp.558-569 (2007). ISSN 0924-4247.

[3] Halama, R., Fusek, M. and Fojtík, F. "An Industrial Application of a Method for Spatial Motion Measurement," in *Proceedings of International conference Experimental Stress Analysis 2010*, Wellness hotel Diana, Velké Losiny, Czech Republic, 31.5.-3.6.2010, p.75-80, ISBN 978-80-244-2533-7.

[4] Halama, R.; Fusek, M. and Fojtík, F. "Measurement and Evaluation of 3D Motion of Washing Unit of Industrial Washer-Extractor," in *Book of Extended Abstracts of National conference Engineering Mechanics 2007*, Zolotarev, I. (Ed.), Czech republic, Svratka, May 2007, AVČR Institute of Thermomechanics, Praha, pp. 239-240, (2007). ISBN 978-80-87012-06-2.