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NOISE SOURCE VISUALIZATION OF CONVEYOR SYSTEMS ON THE POSTAL PACKAGING SORTING LINE

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Abstract:
Sound visualization tools are now used for the identification and localization of noise sources. This paper is aimed to locate and quantify noise sources on a packet sorting line using an acoustic camera and then propose noise reduction measures. Localization of noise sources was performed using an acoustic camera with a microphone ring array. The result of these measurements and analyses was to sort the individual noise sources from less noisy to the noisiest, which gives a good assumption for better planning of spending on the implementation of noise reduction measures. The outputs of these measurements also give information on the character and frequency composition of the sound of individual sources, which will help out in the design of specific measures for noise reduction.

Key words:
Noise sources, sound visualization, noise location, conveyor systems

1 INTRODUCTION

Belt conveyors are automated facilities, which are used in production lines, during sorting of postal items, or at airports, are specific and diverse (Mikušová a Millo, 2017). The reliable operation of these types of equipment is a key factor in the efficient operation of company logistics (Surtees, 1996). Several ways of monitoring belt conveyors are described in the publications (Wang et al., 2010; Lu, Wang a Zhuang, 2012). Monitoring, from the point of view of its execution, is quite a difficult process. The difficulty lies in the need to monitor several parameters which can be complicated due to the length of the transport route and volume of the monitored data (Garbacz et al., 2015). The issues of online monitoring of belt conveyors were also described by Molnár et al. (Molnár et al., 2016; 2017). Within their research, benchmarking and evaluation standards, which support decision-making processes in online monitoring, were considered.

Monitoring and evaluating operation modes are needed from the point of view of obtaining device status information and predicting failures. Currently, the methods which can

be used to monitor and diagnose conveyor belts involve acoustic visualization. The advantage of these methods is the ability to monitor the devices remotely without any interference in them, sensor mounting, etc.

Before proposing technical measures to reduce noise from machinery and equipment, it is necessary to know the frequency spectrum components of the sound. Currently, acoustic visualization techniques are one of the ways to obtain relevant machine and equipment status data. Authors (Döbler a Heilmann, 2015) discussed the perspective of using acoustic cameras. Acoustic cameras that work on the Beamforming principle and concepts, techniques, and problems associated with their use are described in works (Johnson a Dudgeon, 1993; Fischer a Simmer, 1996; Gauthier et al., 2011).

Another important step for obtaining information from the data measured through acoustic cameras is the correct analysis of mechanical and electrical equipment components. Such analyses use the various approaches and methods discussed in the publications (Helzner et al., 2005; Urbanek et al., 2012; Opocenska a Hammer, 2017; Márton et al., 2018).

2 METHODS AND METHODOLOGY

The workplace of the post where the measurements were carried out is aimed at sorting postal items. The acoustic camera, which consists of a ring antenna with 48 microphones and a camera itself, was used for the realization of the measurements. This acoustic camera works on the beamforming principle, which is a signal-processing technique used in sensor arrays for directional signal transmission or reception. The simplest beamforming architecture is described as the Delay-Sum and is illustrated in Fig. 1.

The measurement time record was set at 8 seconds. Data analysis was realized with the NoiseImage™ program, which is designed for the processing of measured data. The outputs were generated as time sound record, spectrum, spectrogram, and sound images.

A digital camera takes an image of the noise-emitting object. At the same time, an exactly computed array of microphones acquires and records the sound waves emitted by the object. A specially developed software calculates a sound map and combines the acoustical and optical images of the sound source. The Acoustic Camera can extend the time and frequency selectivity and add a location-selective component.

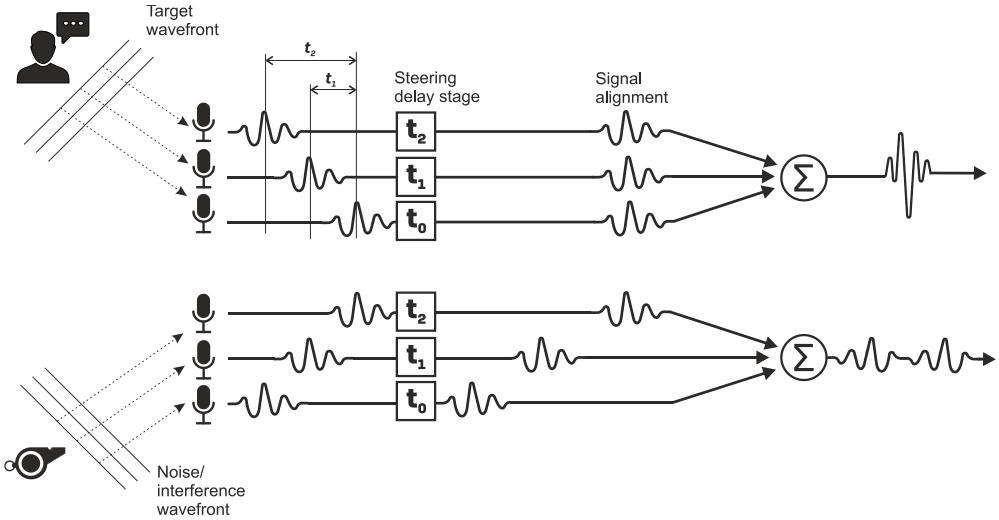

Fig.1 *Delay-Sum architecture*

3 RESULTS

The measured audio records of selected devices were corrected by the weighting filter A; frequency spectrum and acoustic images were subsequently generated in the NoiseImage™ software. Fig. 2 shows the acoustic image of the sorting line scanner. Fig. 3 presents the A-weighted frequency spectrum. From the resulting frequency spectrum, the sound character of the recorded device with its typical frequencies, namely 390 Hz, 530 Hz, and 660 Hz, can be seen.

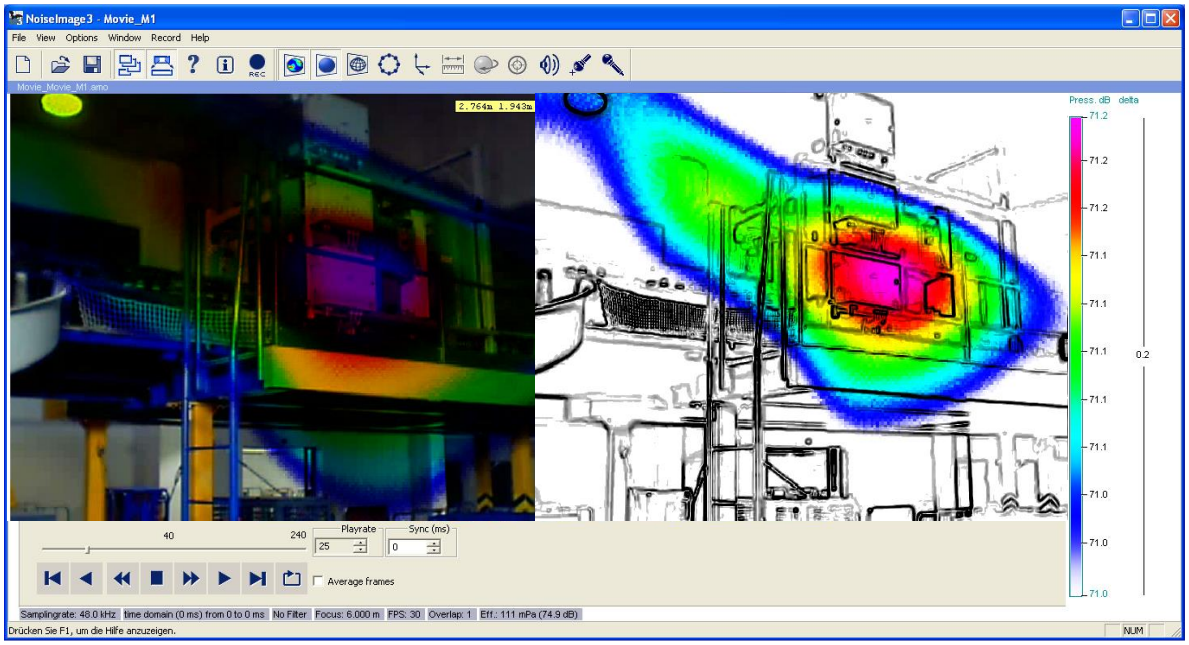

Fig.2 *The acoustic image with localization of the prevailing sound source*

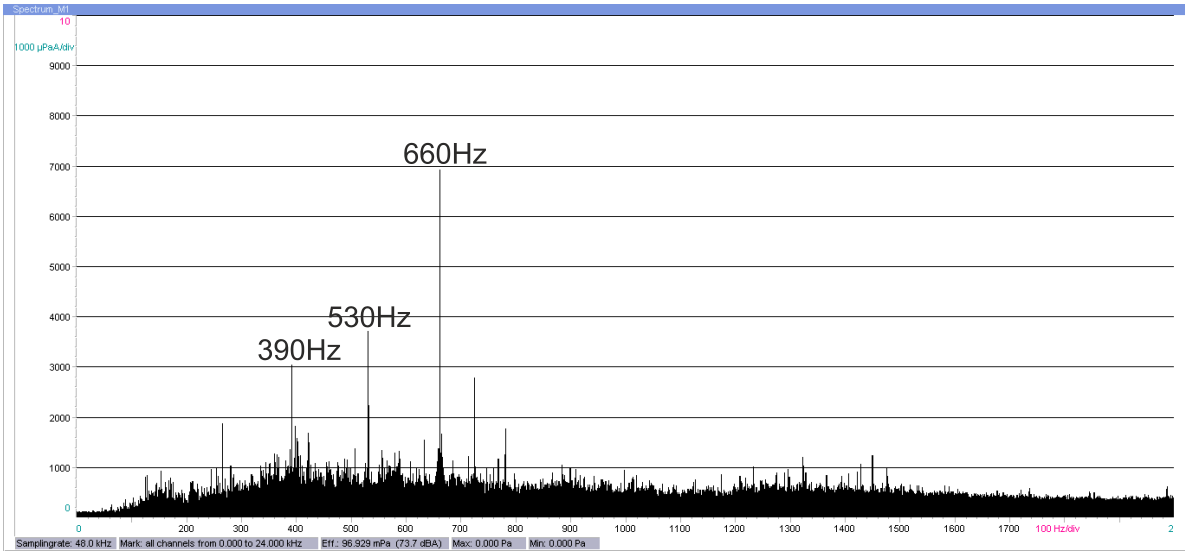

Fig.3 *A-weighted frequency spectrum*

Fig. 4 shows the acoustic image of the emitting noise of an electric engine with chain drive which serves to drive the transport tubs of the sorting line. Fig. 5 presents the A-weighted frequency spectrum. From the resulting frequency spectrum, the sound character of the recorded device with its typical frequencies, namely 390 Hz, 420 Hz, and 660 Hz, can be seen.

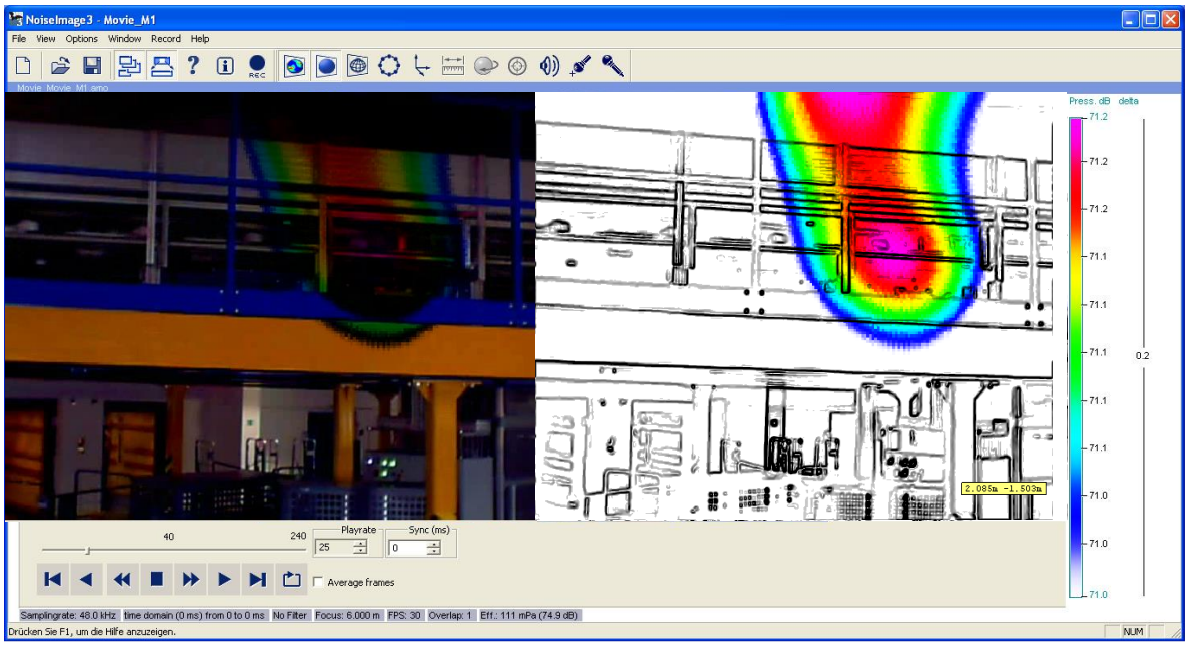

Fig.4 *The acoustic image with localization of the prevailing sound source*

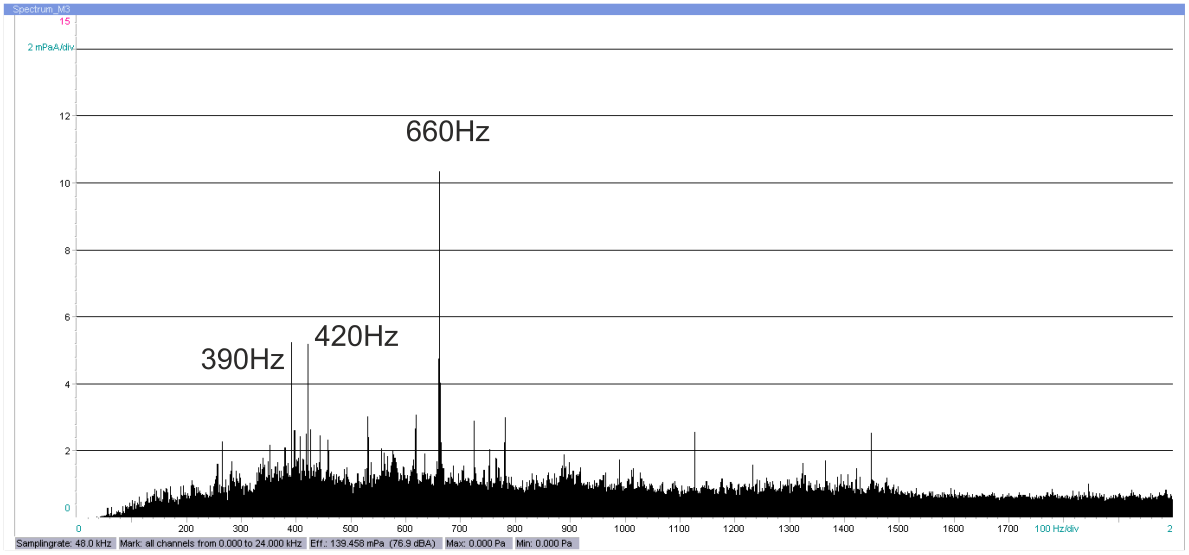

Fig.5 *A-weighted frequency spectrum*

Fig. 6 depicts an acoustic image of the emitted noise by an electric engine with a wedge belt which serves to drive the conveyor belt of the sorting line. Fig. 7 shows the A-weighted frequency spectrum. From the resulting frequency spectrum, the sound character of the recorded device with its typical frequencies, namely 340 Hz, 400 Hz, 530 Hz, 1230 Hz, and 1430 Hz, can be seen.

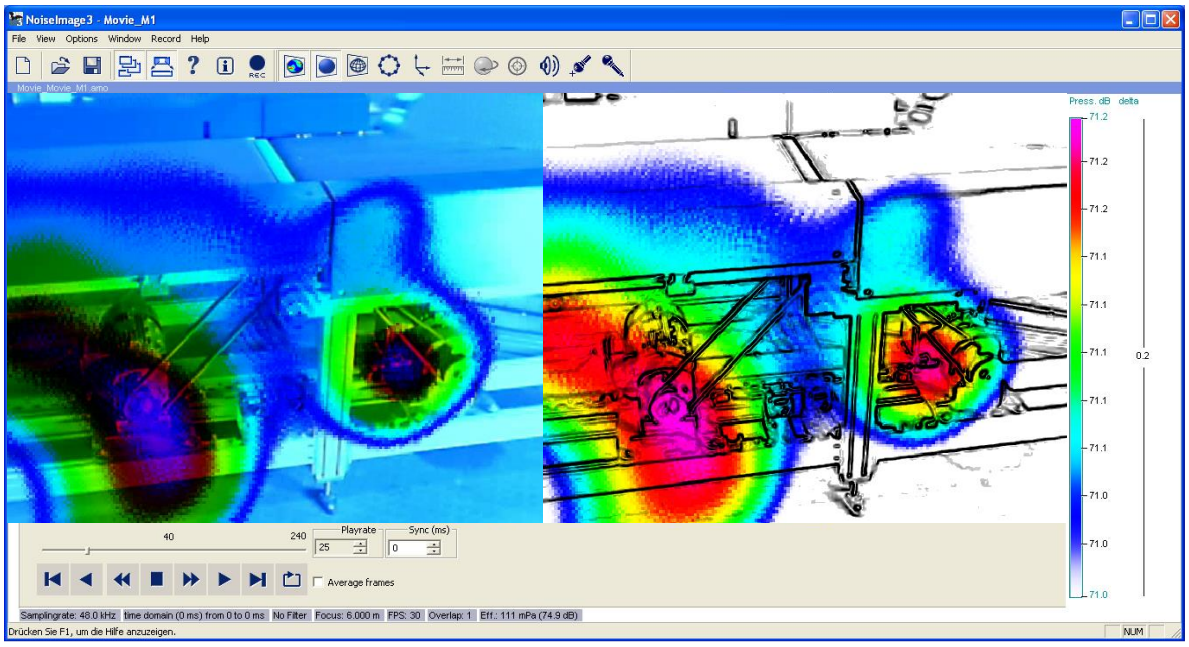

Fig.6 *The acoustic image with localization of the prevailing sound source*

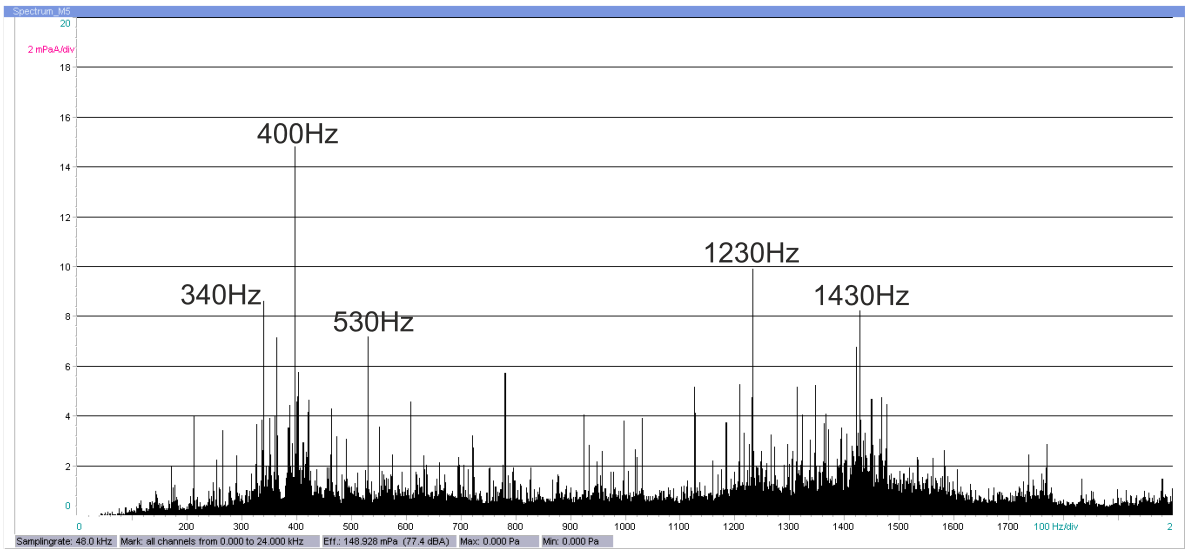

Fig.7 *A-weighted frequency spectrum*

4 CONCLUSIONS

The presented work was focused on the solution of noise sources in the working environment. From the point of view of reducing noise at the specific post-workplace, it is necessary to focus mainly on the dominant sources of noise, in this case – the electric drives and their transmissions. Appropriate ways of reducing the noise levels in the workplace can be described as follows:

- targeted and repeated maintenance of the drive components,
- partial or full coverage of devices with access during repairs, maintenance, and revisions.

Other possibilities are to introduce regular vibroacoustic measurements to quickly identify undesirable phenomena and machine and device failures, followed by a report on the

status of the device. In addition, it is suitable for future planning of funds for the maintenance or replacement of machinery and devices.

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