Noise Pollution in Urban Environment by Some Natural Phenomena

I.S. Ivanov*, T. Trifonov** and É. Hajnal ***

*National Military University "Vasil Levski"/Department of Communication and Information Systems, Veliko Tarnovo, Bulgaria
** St. Cyril and St. Methodius University of Veliko Tarnovo /Department of Computer Systems and Technologies, Veliko Tarnovo, Bulgaria
*** Óbuda university / Alba Regia Technical Faculty, Székesfehérvár, Hungary

e-mail:*tihomirtrifonov@ieee.org*, *ivanov_ivan@nvu.bg*, *hajnal.eva@amk.uni-obuda.hu*

***Abstract*—: In the submitted work the noise characteristics of some natural phenomena in urban environment are analyzed. It is shown, that the infrasound component has very strong influence on noise energy. Wavelet analysis is used for signal processing. For acceleration of calculations the opportunity of parallel algorithms application is considered.**

I. Introduction

One of the most common mathematical and physical model of the Earth's atmosphere is based on a layered structure. The parameters of the atmospheric boundary layer (whose height is up to about 2000 meters above the ground) are strongly dependent on the turbulence and other chaotic phenomena.

Traditionally, it is known that the basic phenomena, associated with the propagation of the sound, have been well studied, but recently some new researches contribute new facts and circumstances which change the concept [1, 2, 3]. They are mainly associated with the distribution and identification of the lowest frequencies, and especially infrasonic waves. This interest is founded on both reasons: the inability of a human hearing to detect the infrasound components and occurrence of a new tools and methods for analysis.

The sounds, generated by various natural phenomena, are attractive not only as new models, but also as a revision of old concepts how deep is their impact on human beings and on human activities in general.

The goal of this paper is to analyze some of the spectral characteristics of natural phenomena such as hail and other anomaly weather phenomena that are important to people.

II. Hail noise in urban area

Our measurements were made in an urban environment. This is important remark, because of initiated in this case noise and the noise in natural environment (without building areas) have different characteristics. Moreover, the modern urbanization leads to a concentration of large masses of people in the cities [4].

The experimental setup has the unique characteristics, for example, its bandwidth start from 0.1Hz and dynamic range exceed the 160dB, [5]. In Fig. 1 measuring conditions in concrete urban environments are presented. The pressure-field microphone type 4193 Brüel&Kjær (sensitivity: 12.5mV/Pa) was fixed on a balcony of about 7 meters height above the asphalt road.

Figure 1. The location of measurements – urban built environment

The record of noise of hail (dimensions 0.5-0,7mm) plus noise of auto alarms as array in workspace in MatLab

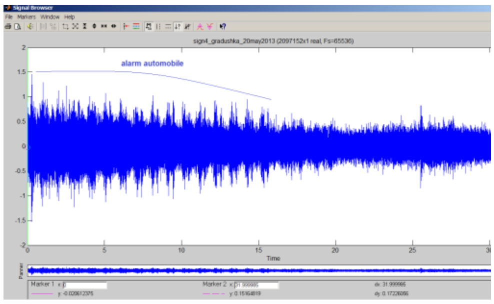

Figure 2. Part of registered noise of hail plus auto alarms. 2097152 samples, sample frequency Fs = 65536Hz, microphone 4193 and PULSE data acquisition unit 3560B Brüel & Kjær; 03 July 2012., 17:58. EEST, air temperature 23.2°C; GPS: 43.072078, 25.60695.

is shown in Fig. 2. This signal is collected by microphone 4193 and PULSE data acquisition unit 3560B Brüel & Kjær, [4]. It consist 2^{19} samples, with sample frequency Fs = 2^{16} samples per sec.

Some parts of signal from Fig. 2 in time domain are illustrated in Fig. 3.

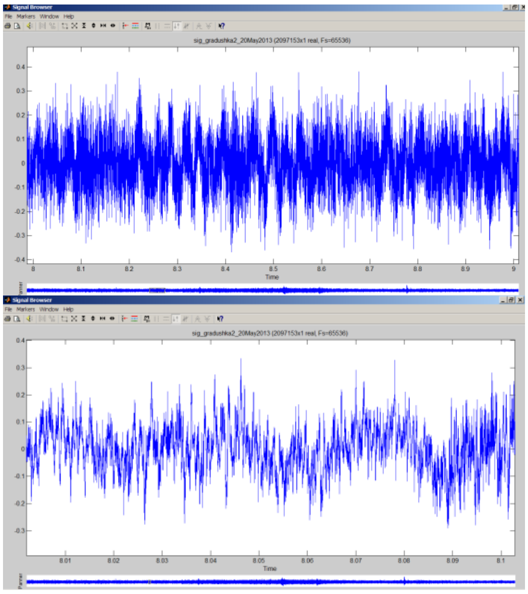

Figure 3. Spectral components in bandwidth from 10 Hz to 20000 Hz for noise of hail, DFT for 2^{19} samples, sample frequency Fs = 2^{16} Hz.

Estimation of components of power spectrum density (PSD) of sample of signal with 4 sec. duration, is made in MatLab with nonparametric method Discrete Fourier Transform (DFT),[6] with Fast Fourier Transform(FFT) are illustrated on Fig. 4.

The same part of signal's PSD after using Welch method with the traditional Hamming window is presented on Fig. 5.

As a result of estimation it was found that the spectral power density contains relatively equal components in the range from 100 Hz to 10000 Hz.

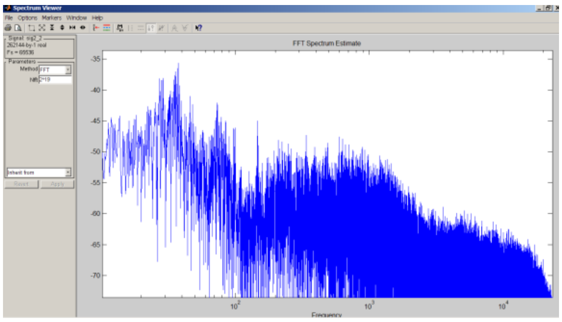

Figure 4. Parts of signal in time domain - 1 sec and 0.1 sec.

In infrasound band (below 50 Hz) the strong components are concentrated in the interval from 20 to 40 Hz, Figure 4, 5. It is supposed that this result depends on the properties of the propagation medium, in which resonated sound waves present, see Figure 1, and it can be seen that the strong harmonics are in this interval, 20…40 Hz. They are generated because of occurrence of standing acoustic waves with a length of 8 to 16 m (if the assumed velocity of a sound waves is v=330 m/s). The attenuation of high frequency components over 20000Hz turns out because of the maximum operating frequency of sensor.

In the Figure 6 is presented the scalograms for the same 4 sec. duration noise of hail, the result of continuous wavelet transform, [6] (respectively 4 sec., 0.04 sec. and 0.004 sec.).."

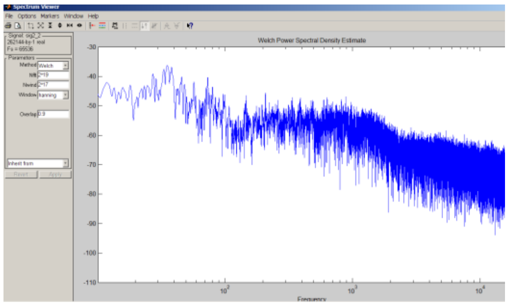

Figure 5. The smoother spectral components in bandwidth 10 Hz …20000 Hz for noise of hail. DFT with Hanning window, Welch method) for 2^{19} samples, sample freq. Fs = 2^{16}Hz.

From these scalograms can be seen that the hail noise have multiple local singularities, both in the low scales and in the high scales.

III. Conclusions and Future Works

The results of researches obtain, that at some natural phenomena there is a high level of infrasound component. High density of building in addition worsens an acoustic situation. In opinion of the authors this problem will be more and more urgent in connection with climatic changes.

For obtaining of system of attributes of specific noises, the authors will use methods of eye identification (for example, 2-D Haar transformation). For acceleration of searching in the large databases the method of hierarchical clusterization of scalograms space will be used.

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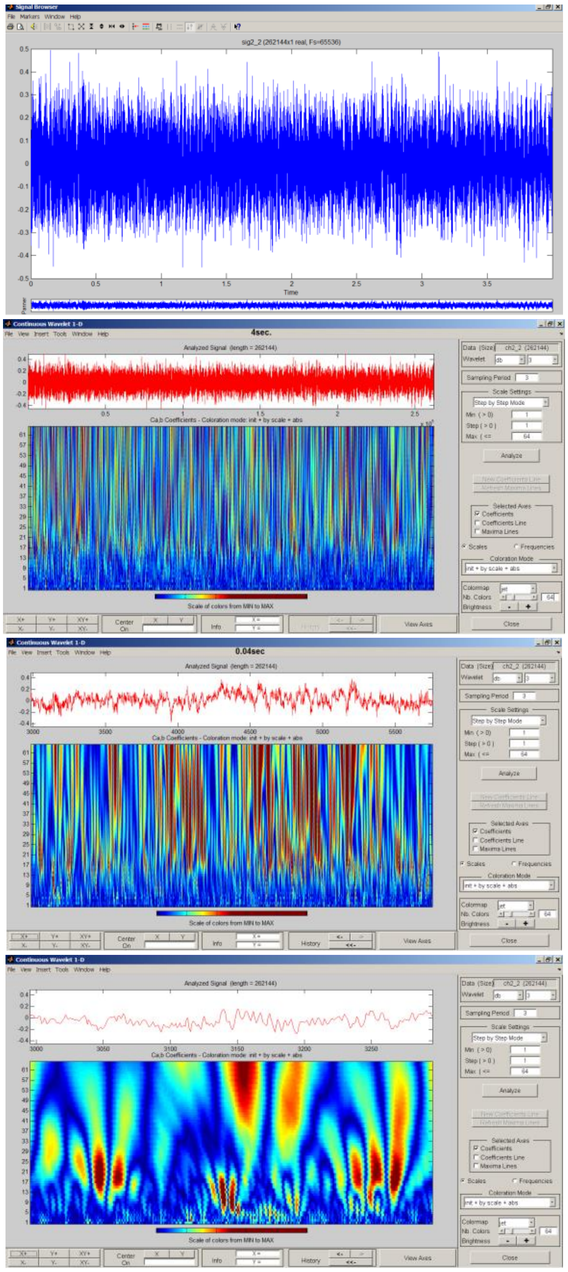

Figure 6. The smoother spectral components in bandwidth 10 Hz …20000 Hz for noise of hail. DFT with Hanning window, Welch method) for 219 samples, sample freq. Fs = 216Hz