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SIMULATION OF ACOUSTIC NOISE ELIMINATION OF AN AUDIO PROFILE GENERATED BY URBAN ENVIRONMENTS IN TIRANA, ALBANIA
Modeling via Matlab / Simulink

Jozef Bushati
University of Shkodër "Luigj Gurakuqi"
Sheshi 2 Prilli, Shkodër
Albania

Virtyt Lesha
Polytechnic University of Tirana
Sheshi Nënë Tereza, Tirana
Albania

Darko Petković
University of Zenica, Faculty of Mechanical Engineering
Fakultetska 1, Zenica
Bosnia and Herzegovina

Diana Karuović
University of Novi Sad, Technical Faculty "Mihajlo Pupin"
Zrenjanin
Serbia

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ABSTRACT
Urban environments are subject to various pollutions where, among other things, acoustic pollution. Consequently, the study of acoustic pollution is an issue that is addressed in several aspects: economic, political and scientific / research.
In this paper we propose a simulation model through the Matlab / Simulink software that shows the effect of eliminating the sound noise from a sample taken from the noisy urban environment in the city of Tirana, Albania.
The noisy signal is sampled near the city center of Tirana, during mid-day, when the acoustic pollution levels are expected to be relatively high. Further, the sample of the received signal is placed as an input on the simulation model. The simulation model in question consisted in standard Quadrature Amplitude Modulation (QAM) algorithm and was considered to eliminate the signal noise that is input to this algorithm; the output expectancy is noise output minimized by about 80% of the noise at the input signal.

The outputs generated by this model meet the expectations and is consistent with the performance of the algorithm in question. The noise minimization through the standard QAM algorithm is up to 78.3% of noise elimination from the sampling signal. However, the limitations of this proposal include minimization that can be improved in higher percentages of the noise signals through other QAM modulation constellations such as: 16-QAM, 32-QAM, 64-QAM, etc. This proposal intends to serve as model for analytical studies of acoustic pollution for taking objective politics in reducing the level of acoustic pollution in urban environments.

1. INTRODUCTION

The acoustic pollution is a type of environmental pollution and is ascertained as such by the different standards that determine its levels in dB. Different countries have different standards of noise level determination to take into account the nature of acoustic pollution [16]. The European Union, in the context of the effects of acoustic pollution on human health, has generated some norms that have set acceptable noise limits in urban environments and measures to be taken to prevent the effects in question. According to "Noise Legislation, Section 9" and "Directive 2002/49/EC on the assessment of environmental noise; July 2016", the main focus of the European Union's noise policy is to reduce noise abatement through the use of mandatory technical standards for products. The most important legal instruments consist of a set of directives establishing noise emission limits for certain products: motor vehicles, motorcycles, tires, airplanes, household appliances and outdoor equipment [7, 10, 14, 15].

Following the progress of the European Union's policies, a number of scientific research were developed in order to extract various information on the effects of acoustic pollution, simulations that make it possible to reflect on technical aspects of acoustic pollution and the creation of applications or devices that measure the noise in urban environments. The research in question includes different fields of study such as health, mathematical simulations, development of electronic devices, and so on [13, 6, 2].

Regardless of the European Union's norms and guidelines on acoustic pollution, patterns of research conducted in the context of simulations are always in development and provide different approaches to acoustic pollution analysis; more specifically, simulation models have been developed in a variety of ways, such as: measuring acoustic pollution for aerospace facilities subject to aircraft acoustic noise, measuring acoustic environments in urban environments by cars, trucks, motorcycles, etc. [5].

Simulations of acoustic pollution analysis include different models and environments such as Matlab / Simulink, Facsimile, Galatea, GNU Octave, NetLogo, etc. These simulation programs have the relevant parameters and therefore give the respective performance on the modeling in question. One of the best performing programs for acoustic pollution simulation includes, Matlab / Simulink and GNU Octave [16].

One of the elements to consider for the simulation of acoustic pollution is cleaning of the noise for different uses, using different mathematical models such as amplitude modulation. In the present study, discus acoustic pollution issues were based on the simulation through the Matlab R2017a program. Matlab R2017 was accessed to obtain audio sample samples which were processed through standard QAM modulation and at the output of the algorithm in question results in an audio model against which the noise caused by the urban environment was minimized according to a performance factor which has let space for further modulation methods to minimize noise to an audio signal.

2. METHODOLY

The study consisted in creating a simulation model which as input has an audio signal received from the urban environments of Tirana, Albania. The sampling is carried out through a noise-level meter presented in the Figure 1, which had the following cross-reference Figure 1:

- Cirrus – CR:306
- Applicable Standards
  a) *IEC 61672:2002-1 Class*
  b) *IEC 60651:1979 Type 2 I*
  c) *ANSI S.1.4*
- Measurement Range
  a) *35 dB to 130 dB(A)*
  b) *40 dB to 130 dB(C)*
- FrequencyWeighting
  a) *dB(A) & dB(C)*
  b) *to IEC 61672:2002 – 1 Class*
- Outputs
  a) *AC Out Max Output = 2 V*
- Microphone
  b) *½ pre-polarized electret condenser (Typically Typw MK:268)*

Figure 1. The presentation of a noise level meter that is used to measure the noise level in Tirana

The geographic points in which the measurements are made to determine the noise level in question are as given in the Table 1:

Table 1. The points where the noise level measurements are performed and the respective coordinates

Location	Coordinates
Sheshi “Skenderbej”	41° 19′ 42″ N 19° 49′ 6″ E
Sheshi “Nene Tereza”	41.3179° N, 19.8213 °E
Kryqezimi “21 Dhjetori”	41.3268° N, 19.8060° E
Laprake	41.3416° N, 19.7874° E
Piramida	41.3232° N, 19.8216° E
Hotel “The Plaza Tirana”	41.3276° N, 19.8218° E

The measurements are carried out on February 15, 2013 from 12:00-13:30 in the points of Tirana city shown in Figure 2. The measurements are made considering that the points in mention hold the highest level of sound as well as supposing that the time of the measurements are considered as the time when urban noises were the highest.

The Figure 2 shows the map obtained from www.earth.google.com which gives the positions where the measurements are made.

Figure 2. The obtained from www.earth.google.com map shows the points where noise measurements are performed

After the noise level extraction, these data were recorded and passed to the second phase of the research in question.
Initially, an arithmetic average is obtained that outputs the average level data in dB and this audio signal is set as input in the algorithm developed in Matlab R2017a. The simulation is

performed through the Matlab R2017a which required a terminal equipped with at least 6 10^9 Bytes RAM memory and processor over $2.2*10^9$ Hz because Matlab R2017a program included simulations that are off video nature.
The algorithm used in the environment of the Matlab R2017a performed the function of reading the audio file and through its structure outputs a signal that was subjected to noise clearing; the algorithm in question is based on the constellation of the QAM module 8. Thus, in the output of algorithm, the visual representation of the constellation according to QAM 8 and the error margin ascertained in this method are presented [4]. Based on the methodology in question and in the context of the use of amplitude modulation for noise minimization in urban environments, the hypothesis we are building consists in the assumption that minimization should be at the level of 73% -84%. This rank was related to the fact that the modulation was a standard one with the 8 (8 QAM) constellation. Larger constellations were expected to be minimized by higher levels and by smaller errors and this assumption opened up further possibilities for higher noise minimization results.

3. THE RESULTS

The points, where the reflected noise levels are extracted, are processed to project an equivalent signal as shown in the Figure below. The following Figure shows two graphs:

1. Noisy signal graph,
2. Noise-canceled graph (graphs resulting from application of algorithm 8 - QAM),

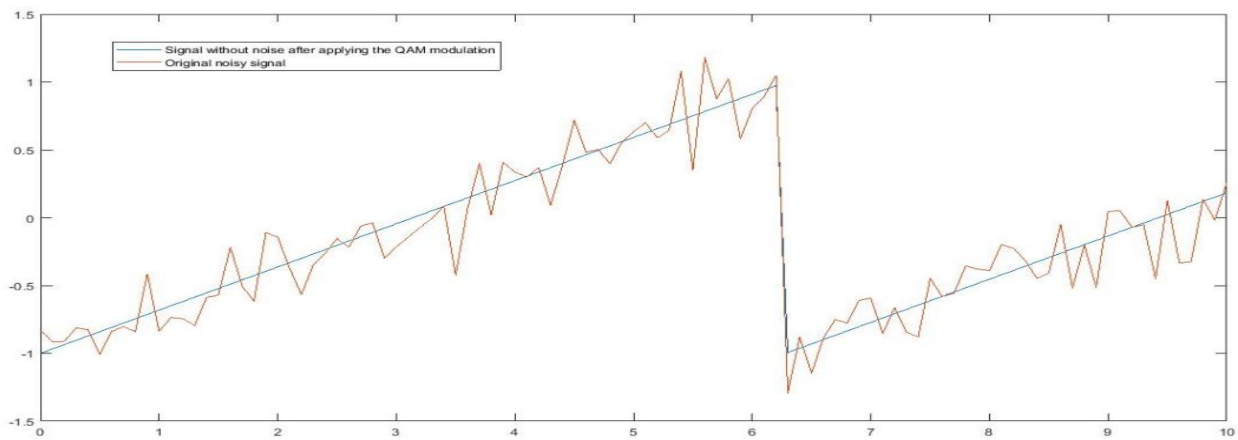

Figure 3. The noisy and clear signals

The used algorithm was 8-QAM constellation. Initially, we transmitted and received data using a nonrectangular 8-ary constellation in the presence of Gaussian noise. Then, the scatter plot is shown; this scatter estimated the noisy constellation and the symbol error rate (SER) for two different signal-to-noise ratios. Consequently, random symbols are generated and we have modulated the data by using the general functions. General QAM modulation was necessary because the custom constellation was not rectangular. The signal is passed through an Add White Gaussian Noise (AWGN) channel having a 20 dB signal-to-noise ratio (SNR). In the Figure 4, we have displayed a scatter plot of the received signal and the reference constellation.

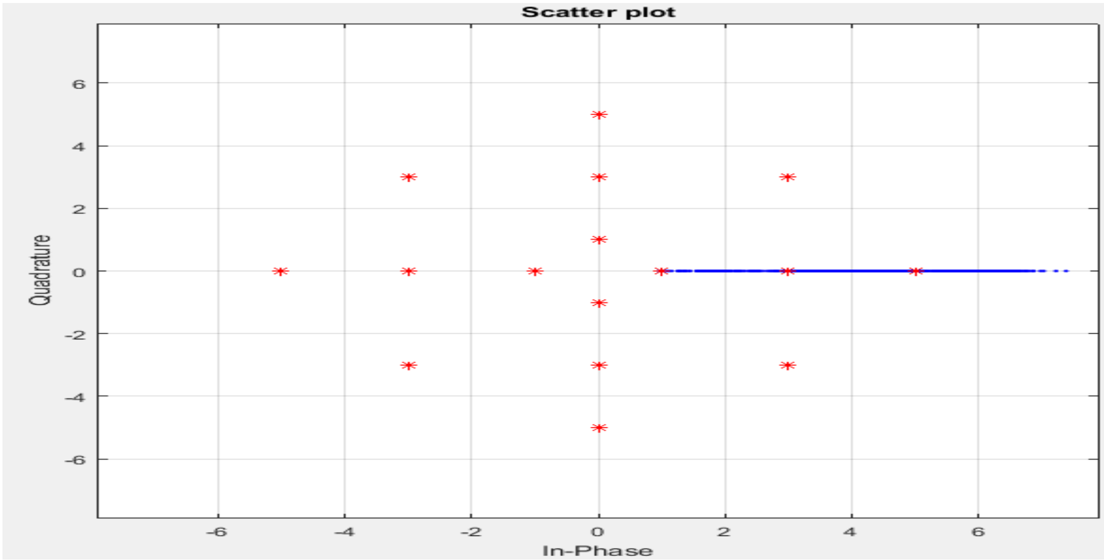

Figure 4. The results of 8-constellation QAM

Then we have determined the number of symbol errors and the symbol error ratio and repeated the transmission and demodulation process with an AWGN channel having a 10 dB SNR. As expected, the performance was degraded when the SNR was decreased and the minimization of the noise was by 78.3% which is conform with our hypothesis.

4. CONCLUSIONS

In this paper, we discussed acoustic pollution issues in the context of technical handling and simulation aspects. The noise pollution is subject to the development of protection policies against it and research of various fields because it is a very influential aspect in human life [11].
The European Union has issued laws and norms that describe the policies of minimizing the effects of acoustic pollution and issues standards that are followed by procedural and reporting approach by public and private entities [7].
In our study, we developed a simulation model in Matlab R2017a which reflected a noise reduction study method. The simulation model used the 8-QAM algorithm that minimized noise at such a level that in our case was within the expectations assumed by the hypothesis [3].
At the entrance to the algorithm, an input was a signal under the effect of the random noise which was an average signal taken from the measurement at different points of the city of Tirana, Albania. Measurement of noise levels in Tirana is carried out at points and at such moments that the ambient noise expectations are much higher than in other cases [1].
This averaged signal was put in Matlab R2017a which had the QAM algorithm environment and the output were the initial noisy signal and the clear one; also, the relevant design of the 8-QAM modulation constellation was represented as output [12].
This study is limited and simultaneously open in the context of further research that uses QAM modulations of higher-level constellations or other modulation methods used to minimize noise on a given audio signal [8, 9].

5. NOMENCLATURE

- AC - Alternative Current
- ANSI S.1.4 - International Standard for Sound Level Meters
- AWGN - Additive white Gaussian noise
- B - Bytes
- CR:306 - Class 2 Sound Level Meter
- dB - Decibels
- Hz - Hertz
- IEC 60651:1979 Type 2 I - International Standard for Sound Level Meters
- IEC 61672:2002-1 Class – International Standard for Sound Level Meters
- MK:268 – Type of Condenser Tool Kit
- QAM - Quadrature Amplitude Modulation
- SER - Symbol error rate
- SNR – Signal to Noise Ration
- V – Volt

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