STATE OF ART ON REAL TIME NOISE MAPPING SYSTEM AND RELATED SOFTWARE DEVELOPMENT

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Automatic noise maps calculation is an attractive tool for both infrastructures administrations which -according to END- should produce noise maps and action plans every 5 years, and for citizens who wants to know how healthy is their living place in terms of noise pollution; this last aspect has become more evident during the last years, where great efforts have been made to spread information on the long-term risk of living in a noise-polluted environment. In the last few years some approach to dynamic noise map were attempted, but the high implementation costs bordered most of those project just in research field. The article investigates the state of the art of real-time noise mapping and related software development.

1. Introduction

Exposure of citizens to noise is a widely recognized problem, which also involves important social costs for health [1][2]. For this reason citizens are interested in knowing how healthy is their living place in terms of noise pollution. Figure 1 shows a map of Europe [3] showing per-country percentage of respondents answering “*Yes*” to question “*In the immediate neighbourhood of your home do you have reason to complain about noise?*”. Above mentioned aspect, together with the high costs which infrastructures administrations has to invest for the EC/2002/49 requirement [4] for producing updated noise maps every five years, triggered the needs for cheap dynamic noise mapping system.

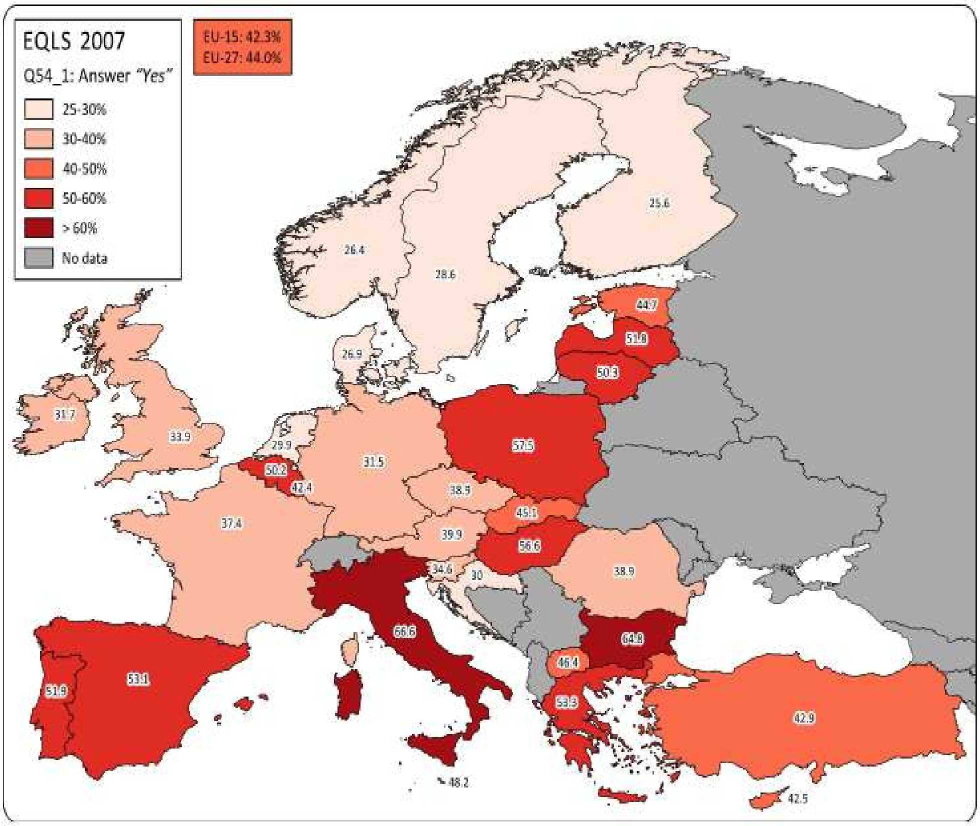

Figure 1. Map of Europe showing 'noise compliant'

2. Principle of operation of real time noise mapping

The usual approach to Real Time Noise Mapping consists in implementing a localized standard noise monitoring network, which continuously collects noise data, and transmits them to a data centre in which a noise mapping software is running. The role of the mapping software is to compute noise maps according the information coming from noise monitoring network, or to re-scale pre-computed partial noise maps taking into account to the incoming noise data, and sum them together in order to obtain the whole area updated noise map; in each case the idea is to publish results continuously on a web site. Of course it is a must that each noise monitoring terminal is influenced by only one road section to which the partial map is referred. Although during the last years the price of sound level meters has decreased and their features highly improved, noise monitoring terminals are still quite expensive, so that building up a monitoring network can be rather costly. This is one of the reasons why software manufacturers have not invested too much in developing dynamic noise mapping so far. In addition to the above mentioned approaches, some others technique were developed during last years to obtain real time dynamic noise map. In the following, main dynamic noise map approaches are discussed.

3. Approaches to real time noise mapping

The Dynamap report on the state of the art of dynamic noise mapping [5], analyzes some systems developed by various organizations during the last years. Table 1 summarize, in alphabetic order, the analyzed system and the approach on which they are based, while next sections examines more in details the implemented technologies.

Table 1. Analyzed systems

System	Type
ACCON	Scaling and sum of pre-computed maps
Datakustik	Scaling and sum of pre-computed maps
Gdansk University	On-line calculation
GEIART	Cluster analysis on traffic model
Ghent	Simplified on-line calculation
IDASC CNR	Scaling of pre-computed maps
Laermometer	Citizens contributive mobile noise mapping (smartphone)
NoiseMote	Low cost sensor system
NoiseTube	Citizens contributive mobile noise mapping (smartphone)
NPL	Low cost sensor system
SADMAM	Scaling and sum of pre-computed maps

As shown in the table, there are three major approaches to dynamic noise maps: on-line calculation, map re-scaling and sum, and citizens contributive; the system called GEIART is slightly different from the above, as it do not directly measure noise levels for updating a noise model, while it implement vehicle counting to update a traffic model which drive to updated noise maps. In addition to the above, also few low cost monitoring system are presented.

3.1 On-line calculation approach

Figure 2 shows a typical configuration of a dynamic noise mapping system. The same setup shown in the picture is used also for scale and sum approach described in the next section, but with a different role of the noise model server.

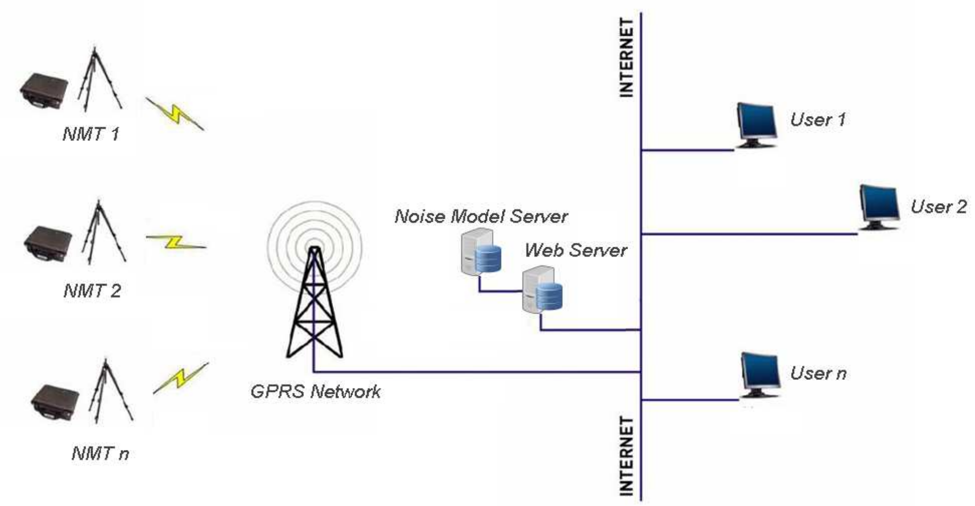

Figure 2. Typical setup for noise mapping system

In real time calculation approach, the measured values coming from noise monitoring network, are used as input data for the noise simulation software, to perform new calculation of noise maps. So, due to the fact that the role of the noise model server is to recalculate a complete noise map with continue update, in order to perform this job the noise model software should run continuously on a very powerful machine, which should make calculation as fast as possible. Gdansk university developed their system using this technology [6][7].

The use of simplified calculation algorithms can lead to fast map updating. Ghent university used this last approach to make their own system [8].

3.2 Map scaling and sum approach

This approach use a similar infrastructure as on-line calculation approach, but with a different role of the noise mapping server. In this case the new map is computed just as the sum of re-scaled pre-calculated maps, according to the measured noise levels. As all calculation toke place once at system startup, maps update rate can be very fast. This technology is implemented in systems developed by ACCON[9][10], IDASC[11], DATAKUSTIK and SADMAM [12][13].

With this technology two 'sub-approaches' are possible; the first uses a function implemented inside the noise model software for scaling and summing the partial maps, while the second one uses an external GIS software to do the job, as no any ray tracing is needed to obtain new maps.

Figure 3 shows the dynamic noise map web page of Gräfelfing community (D), which use the GIS software technique and was implemented by ACCON.

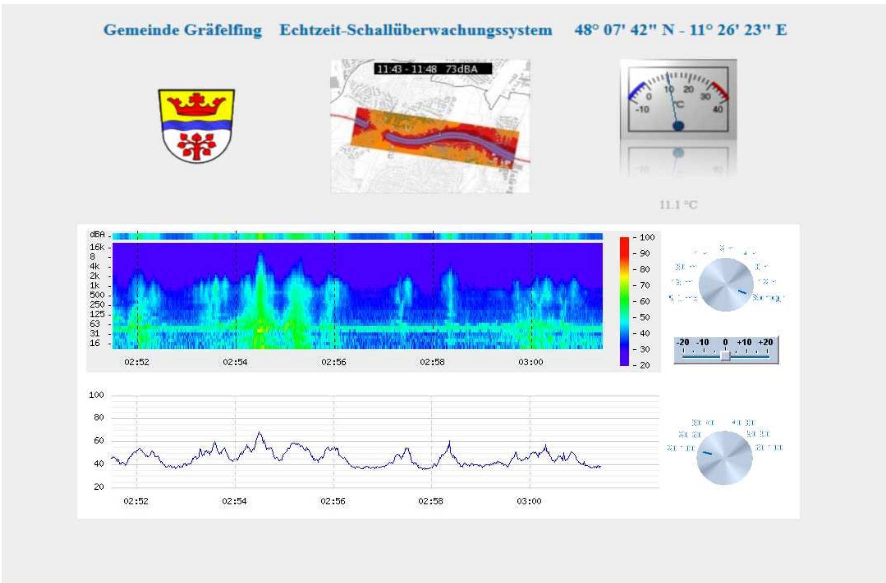

Figure 3. Gräfelfing Dynamic Noise Map page

3.3 Citizens contribution

Thanks to the high diffusion of smartphones, a new technology for dynamic noise mapping started few years ago. Main idea behind this technology is to use citizens' smartphones to take many measurements inside a city, and build up a noise map based on the acquired noise levels by citizens.

Two examples of this technology are Laermometer [14] and NoiseTube [15]. In both cases acquired noise data, together with localisation coming from smartphone embedded GPS system, are sent by cellular phone to a web server able to manage data and present them as noise maps, also directly by using Google Earth platform.

3.4 Low cost noise monitoring terminals

Between 2004 and 2007 NPL developed DREAMSys (Distributed Remote Environmental Array & Monitoring System), a low cost monitoring system based on new MEMs microphones [16][17]. DREAMSys units are capable of measuring both A-weighted and C-weighted equivalent continuous sound pressure levels, over a user-defined period from a few seconds upwards, as well as a number of statistical parameters including the maximum A-weighted level, and three percentile levels, which can also be programmed. A comprehensive database and a set of visualisation tools were produced to manage and present data.

In 2011 a project called SensablePisa started. The idea behind the project was to implement a cheap noise monitoring network for the city of Pisa, involving citizens who agreed to host developed sensors with the aim of sharing the measured values in a virtual community[18][19]. Façade noise levels were posted in real time on a dedicated website and on Facebook and Twitter social networks, while all historical noise data were collected in a central remote server. Noise map was limited to the values in measured positions. From this project, a sensor named NoiseMote was developed, and the acquired experience converged now in Dynamap project for the development of a improoved noise sensor and related network.

4. Dynamap system

Dynamap project, based on the above mentioned scaling and sum technology, consider some important aspects for obtaining cheap, fast and reliable system, to produce real time noise maps. More in details, the system involve cheap sensors capable of anomalous event recognition and cancellation [20][21][22], traffic cluster analysis for mapping optimization [23], web based GIS software for scaling and sum, and for map web presentation. In addition to the above, also a sensitivity analysis of the acoustic calculation model with respect to environmental variables inside and outside urban areas is considered [24].

5. Conclusions

Investigation results have shown that three major approaches to produce real-time noise maps are available at the time being: on-line calculation based on measured data (noise or 'noise correlate parameter'), scaling and sum of pre-computed maps according to measured data, noise monitoring networks and citizens contributive mapping.

In these terms Dynamap, confirms its peculiarity to achieve cheap and easy to use reliable real-time noise maps, by combining low-cost devices (cheap sensors = many measuring points, no needs of noise mapping software license) with clean measurements (recognition and removal of spurious noise to have reliable measurement data), and a scalable and easy to read result presentation (Realtime Noise maps on a GIS- website). Therefore, the project confirms its compliance with END requirements for both noise maps production and information to citizens.

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