DYNAMAP PROJECT: HARDWARE SPECIFICATIONS UPDATE

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ABSTRACT
The Dynamap Life+ project foresees the installation of low cost sound level meters in order to set up a wireless distributed noise monitoring system, aimed at automating the update process of road noise maps. In this work an update of the technical part of the project progress is given.

INTRODUCTION
The DYNAMAP project has been approved for co-financing by the European Commission through the Life+ 2013 program. DYNAMAP aims at the installation of a prototype system in the municipalities of Rome and Milan, based on a pervasive low-cost noise monitoring network. The project's goal is to develop a dynamic noise mapping system able to detect and represent in real time the acoustic impact due to road infrastructures. Scope of the project is the European Directive 2002/49/EC related to the assessment and management of environmental noise (END)[1]. In particular, the project refers to the need of updating noise maps every five years, as stated in the END. In this work a short report is given, regarding the preliminary network's design and the technical choices resulting from the analysis conducted during the preparatory activities of the project.

AN OVERVIEW OF THE DYNAMAP SYSTEM

The DYNAMAP system will be tested in two pilot areas, using 50 sensors:

1 - The first pilot area will be located in the city of Milan and will cover a significant portion of the town including different types of roads and acoustical scenarios. Roads will be classified and assigned to clusters, based on traffic characteristics. Twenty five roads representative of the clusters will be continuously monitored to provide noise levels for noise maps updating.

2 - The second pilot area will be located along a major suburban road: the ring road surrounding the city of Rome. Sensors devices will be installed in hot spots where vehicle counting devices are unavailable to feed the dynamic mapping system with real time information on noise levels. About 25 devices will be used to provide information on the noise levels caused by the ring road traffic and dynamically update noise maps.

In order to characterize road noise, the acoustic signal will be processed, excluding any relevant non road-related noise. In order to accomplish this task, at this stage of the project, the partners who have in charge the development of the sensors (Bluewave acoustics) and the implementation of the Anomalous Event Noise Detection algorithm (GTM – La Salle), agreed to evaluate the possibility of implementing this functionality on each monitoring node. The main reason was to obtain a more scalable system, because if the signal processing is distributed then the need of variable computational load at the central server (e.g. depending on the number of monitoring stations, the transmission of raw audio data or some type of acoustic parameters and its further analysis could be very complex) is avoided.

For each sensor, a classified output like this should be produced every second:

00001 – 151021113200 - 58.0 - 0

The first number is the sensor identifier, the second number is a timestamp, the third is a dB(A) level and the fourth one is an indicator standing for “road” or “non road” event. All those data will be stored in a remote web server by mean of wireless data communication system like GPRS or 3G.

Levels without spurious events will be averaged on a time period that will be defined in order to make the mapping model properly work. The magnitude order of this period should be ranging from some minutes to an hour. This time period will be the temporal base to update the map.

For each of the monitored road source and for the remaining road sources a complete noise map is calculated and saved for the entire mapping area by logarithmic sum of the single maps weighted then with measured level as shown in the scheme below. This application is nowadays extremely fast as no further recalculation of the sound propagation is required to adapt the noise map to the measured data.

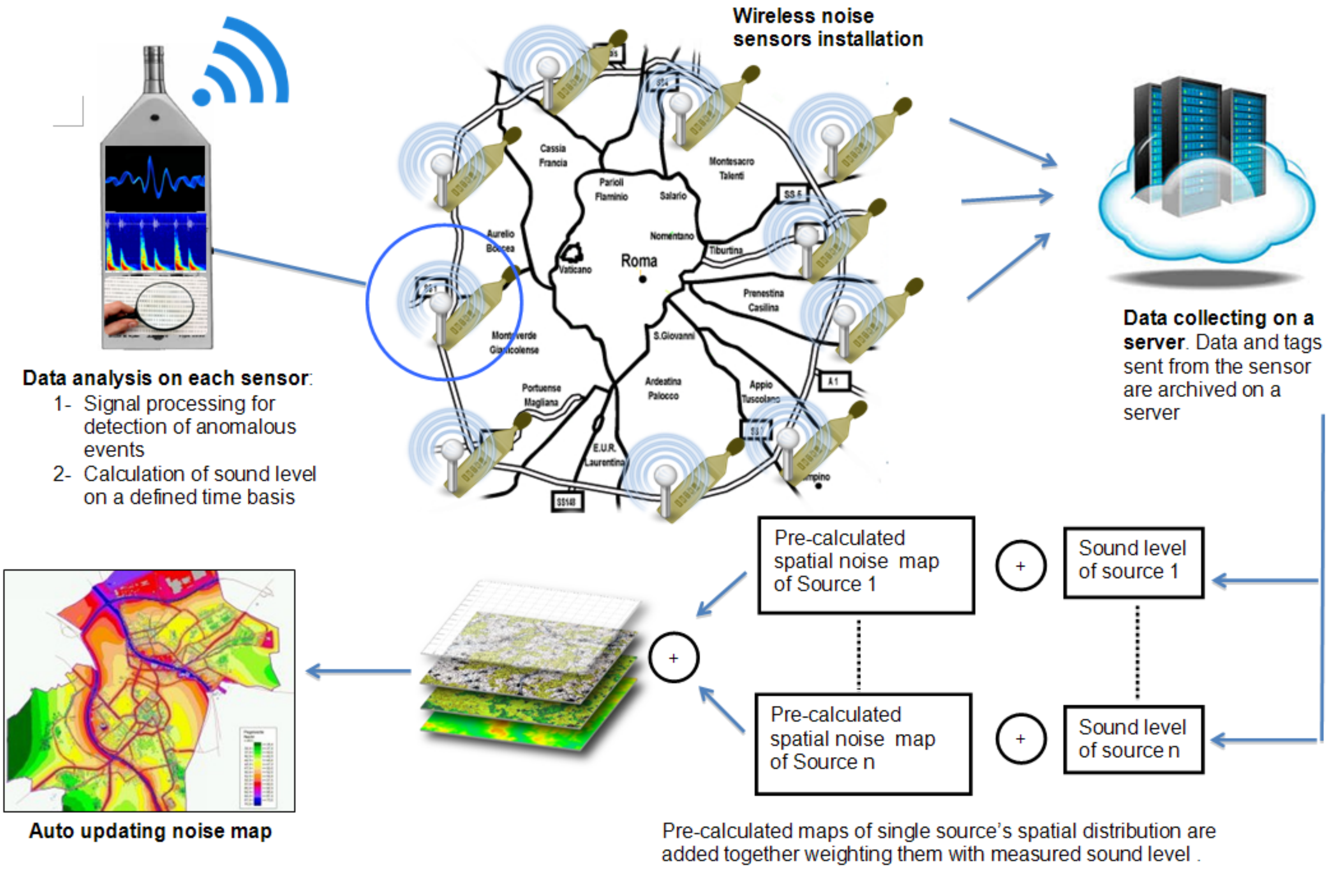

Figure 1 – DYNAMAP working principle

TYPES OF LOW COST NOISE MONITORING NETWORKS

There are many ways of classifying a sensor network (according to network topology, to transmission protocols, etc.). For the purpose of this paper, sensor networks for environmental noise monitoring can be roughly distinguished in two different groups: embedded pc based and microcontroller based. These two kind of devices are described below:

- Embedded pc monitoring systems

In the last decade, the exponential growth in computing technologies made possible to reduce a lot the computers size. Actually it is possible to find small computer boards having size less than 10x10 cm at very cheap prices, equipped with high quality sound board. Such system can be equipped with gprs/3g/4g modem or Wi-Fi connection and a signal analysis software that processes incoming data from the sound board, using a cheap microphone. These kind of system present the advantage of being low cost and they can be remotely fully updated and reprogrammed. Moreover they can be coded with specific algorithm executing particular complex tasks as noise recognition, source position tracking etc. The disadvantage of those systems is the high power consumption, that is actually at least 2-3 W, so they need direct power supply or big solar panels making difficult the application for a very pervasive monitoring using hundred of sensors.

- Microcontroller and digital signal processor systems

The main advantage of this kind of system is the possibility to implement low power applications (200 mW mean equivalent consumption or less) that permit to power these devices with solar panels or with other energy harvesting systems. The disadvantage of those systems is the reduced possibility to modify and remotely control the device in order to implement complex tasks.

Well known standard noise monitoring systems compliant to class I IEC 61672[2] (like ones like Norsonic, Bruel&Kjaer, 01dB etc.) are usually made using technology described in the second group.

TECHNICAL DETAILS OF THE MONITORING STATIONS USED IN DYNAMAP

Due to prototypal nature of the sensors network to be installed, it is advisable to use a flexible system that can be remotely accessed and programmed in order to run and calibrate specific audio processing scripts. So we abandoned the idea of using microcontroller based sensing nodes and to use instead embedded computers that offer the advantages described before. Another advantage given by this choice is the possibility to pre-process data on sensor boards to make events detection, and avoiding to send a lot of acoustic data to the central server as said before. This will also guarantee better scalability of the system, reducing the computational load on the central server if the number of sensing units is increased.

A first set of basic specifications has been defined for each monitoring station and it is listed below:

- 40-100 dB(A) broadband linearity range
- 35-115 dB working range whit acceptable THD and narrowband floor noise level
- 1 second time base Leq(A) level
- Possibility of audio recording
- Internal circular backup data storage of calculated data
- VPN connection
- GPRS/3G/WiFi connection

CONCLUSIONS

This paper lists some basic features and technical specifications of hardware devices that are meant to be used in the Dynamap project. Due to the prototypal nature of the whole system, the use of embedded computers seems to be the better solution to perform all the tasks required and to guarantee a direct control on each monitoring node. The results of this kind of implementation will pave the way for a future process of hardware optimization aimed at reducing dimensions and power consumption of the devices, in order to make possible a very wide spreading of this kind of technology.

ACKNOWLEDGMENTS

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[2] IEC 61672 (2013) Electroacoustics - Sound level meters