

Smart Attack 2: A new standard?

By Ben Piper

The future is here. Everything is smarter, faster and more efficient. We now live in 'smart cities' driven by data and algorithms. Machines now learn so that we don't have to. While these thoughts could be applied to most fields, the interest in using some of these concepts and recently developed tools has been growing in acoustics where the phrase 'smart cities' has been used as a catch-all for sensing projects that might involve some of the following:

- distributed arrays of sensors;
- low-cost sensors;
- mini-PCs;
- semi-permanent deployments;
- machine listening;
- data fusion; and
- cloud computing.

What is exciting is how fast everything is now developing. These ideas are no longer confined to universities and research laboratories, but are gaining traction with both traditional instrumentation manufacturers and agile start-ups.

This growing area of acoustics was covered by John Shelton in the March/April 2016 issue of *Acoustics Bulletin*, where some of the history, as well as thoughts on measurement quality and calibration were shared. This article will describe some of the developments and research that has occurred since, and add some further thoughts on data quality and standardisation.

Key things happening now

The amount of work in this area has increased dramatically over the past two years. There are now many more projects occurring than could be mentioned in a single article. Here just a few of

the bigger research projects will be mentioned but it should be remembered that there is much more out there.

1. Two of the larger university-led research projects were briefly mentioned in the previous article. The first is the Life DYNAMAP project, which is a collaborative EU project looking at adding temporal data to traffic noise maps generated under the European Noise Directive. The project has been very successful with the core aims achieved and demonstrated on their website (www.life-dynamap.eu). The monitoring systems deployed consisted of embedded computers connected to a cloud database. The monitors were located close to roads with the microphones mounted on the end of a short arm. The researchers conducting this project are now looking at more complex algorithms, such as their Anomalous Noise Event Detection (ANED) algorithm [1].
2. The second of these projects is Sounds Of New York City (SONYC), which is being run by the Center for Urban Science Progress (CUSP) at New York University. This project has successfully deployed a number of systems based on digital MEMS microphones and low-cost embedded computers. One of the key aims of this project is to develop machine listening algorithms, which requires a large amount of annotated data. To fulfil this need, the group has generated several annotated sound source databases, which are available for anyone to use for research, and they continue to do research in crowd sourcing sound scene annotations. One of the key outcomes of the project so far is the ability to use the machine listening algorithms to tie noise complaints to measured data within the trial area and grade the impacts [2].

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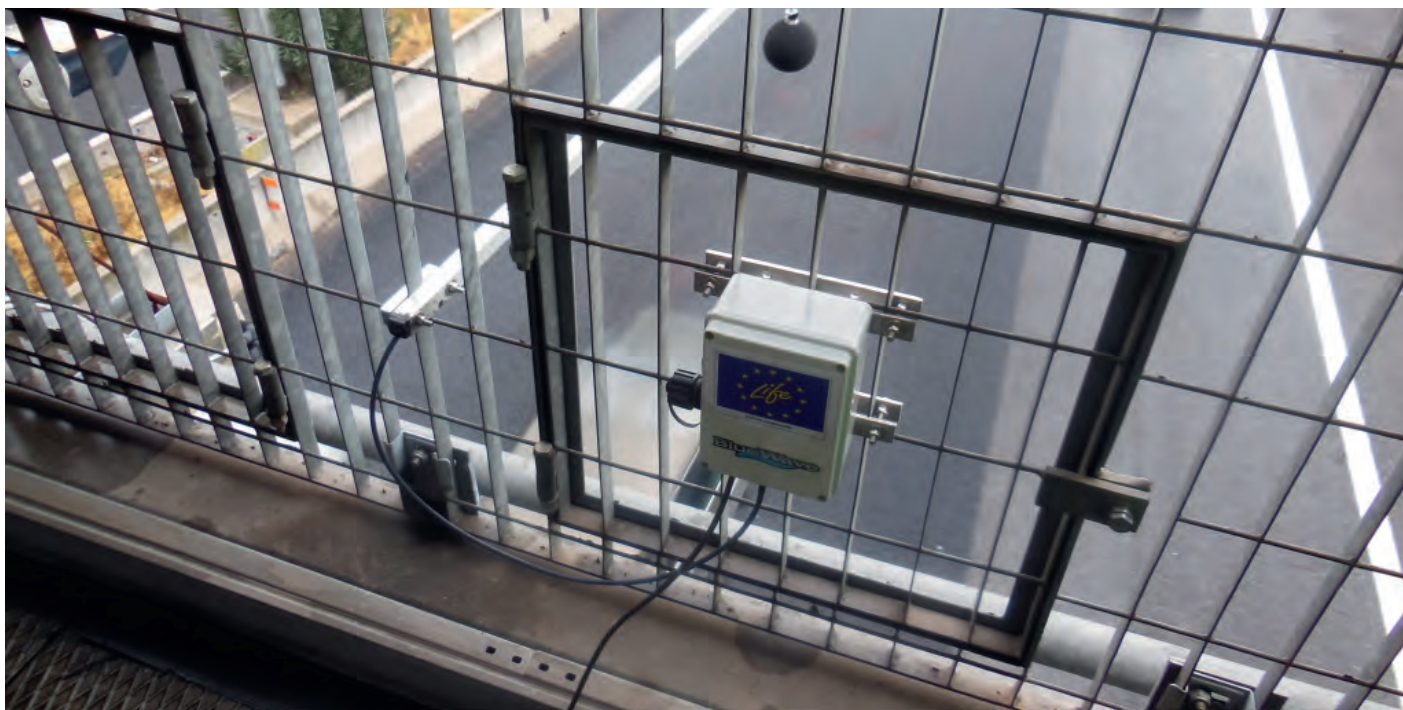


Figure 1: Dynamap system implementation (source: www.life-dynamap.eu/dynamap-system-implementation/)

Beyond these two examples there are many projects developing uses of smart city tools for acoustic measurements. Many of these are exploring the use of mobile phones as monitors, such as the work in the SP4UM project [3] and in the Vitoria-Citi-Sense project (<https://vitoria.citi-sense.eu/default.aspx>)

Rapid developments have been made by noise monitoring equipment manufacturers. Many have realised the value of providing an array of tools, which can be used to form a bespoke system that is provided as a service. This is a key change of business model from the traditional concept of selling sound level meters, but if done correctly, will certainly mean the current players will be able to pay the mortgage. In addition, a number of these systems are multi-modal with sensors for dust and air-quality included. Not only is this more efficient, but it feeds directly into some of the academic research ideas exploring the dependency between different measurands.

There is also an increasing number of start-ups and SMEs working in various aspects of smart city acoustics. These include companies that are developing new sensors systems and ways of deploying sensors, new companies and established consultancies working on new noise data analytics and companies working on how all this data can be tied to the experience of living in a city and used to improve planning. One example of the latter is Tranquil City (<https://tranquilitycity.co.uk/>) who aim to make citizens interact with cities in ways which make cities quieter and less polluted. One of their innovations is the tranquil pavement, an interactive map showing the combination of noise and air quality data using a simple rating systems. (See Figure 2.)

Thoughts on instrumentation and standardisation for noise measurements in smart cities

When it comes to selecting instrumentation, there are many options in use with varying performance characteristics and prices. This is true both of the sensors and the processing hardware. It is important to find the best one for a particular use. The philosophy taken in a lot of cases is that the trends in the data are the important feature rather than absolute levels. This allows the use of instrumentation that hasn't been through the type approval process, either for costs or technical reasons, giving a lot of flexibility.

While this opens up many more options and helps get projects off the ground there are some dangers in this. Poor quality data will always lead to weaker outcomes. When using mobile phones as measurement instruments, the risk of errors caused by orientation, user interference and unseen hardware differences is high. Conversely, a common thread in all of the most successful projects is that some attention has been given to the performance and mounting of the measurement equipment. In most of these cases, the instrument designers have aimed to meet many of the performance specifications from the appropriate sound level meter standards (IEC 61672 & ANSI S1.4).

It is unlikely that many of the instruments will go through the type approval process due to the costs and time involved and due to their modular nature. The current standards do not adequately describe these new systems either. Some sensor types simply cannot be put through the current testing protocols meaning that the costs for type approval will be even higher. What is needed, is a new standard or a new category within the current standards that allows for the modular nature of these systems and a streamlined approach to approve at least the basic performance claims. Without addressing these issues many

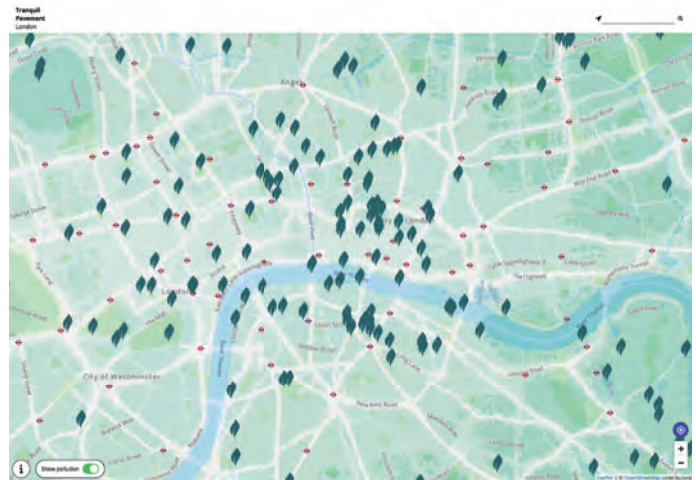



Figure 2: Example of the Tranquil Pavement (source: Tranquil City Ltd - <https://tranquilitypavement.com/>)

terabytes of data could generated by different projects without any possibility of inter-comparison. A new working group (WG24) of the IEC Technical Committee 29 (Electroacoustics) entitled 'Modular instrumentation for acoustic measurement' was convened by Mr Jes Sørensen last September to examine some of these issues.

Data accuracy

It is clear that 'smart city' ideas are changing the way noise monitoring and urban acoustics is being carried out, and these ideas are no longer confined to research groups. The immediate challenges for researchers, manufacturers and data users are:

- how data accuracy in mass data can be addressed;
- how new sensing approaches fit in with the more 'precise' traditional monitoring and how this will feed into planning and compliance;
- how to find and present meaningful outcomes from huge datasets; and
- what the dangers are of leaving the hard work to computers.

It will also be interesting to see how combining acoustic data with data from other types of sensor (air quality, traffic, light pollution, energy use, etc.) as well as human centric data, such as health effects and user experience, will give new insights. 

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