Medusa: a new approach for noise management and control in urban environment

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Summary

Five years ago, Bruitparif conducted a study in some lively districts of Paris, using standard noise monitoring stations. One of the difficulties encountered was the inability to assign a noise to a particular source, which greatly invalidated the possibility of setting up autoregulation or penalization. Classical approaches using automated audio analysis were not possible due to lack of power and CPU. Anyway, they would have been of moderate help because of the complexity of urban noise mixtures.
In order to build the opposable evidence of the origin of disturbance, Bruitparif designed and patented a noise monitoring device that combines four microphones and two optical systems in a way that it is now possible to represent noise levels on a 360° image of the environment. By doing so, noise origin can now be considered as an evidence, replacing the complexity of answering the question “what kind of noise is it?” by the question “where does the dominant noise comes from?”. A companion mobile application completes the device and enables people to examine noise spatial distribution at a given location during a given period of time.
This new device called “Medusa” due to its typical shape, opens new perspectives for the management and control of noise in the urban environment, by giving the authorities an opposable evidence criteria on which to rely on.

1. Introduction

Over the last ten years, conflicts over the use of public spaces have multiplied in so-called festive neighbourhoods, in particular because of the ban on smoking in public places. Relations between local residents and owners of restaurants, late-night bars or musical places are sometimes very tense, which leads to a strong solicitation of the district town halls and the police forces with a major difficulty for them: how to have for a long time objective data allowing not only to evaluate the nuisance but also to provide proof that the alleged offender is indeed in question.

This problem can be transposed to many other cases, such as construction site monitoring, aircraft noise monitoring and multi-exposure contexts.

Five years ago, Bruitparif conducted a study in some lively districts of Paris, using standard noise monitoring stations [1]. One of the difficulties encountered was the inability to assign a noise to a particular source, which greatly invalidated the possibility of setting up autoregulation or penalization.

The sensors deployed provide an overall noise level at the time step of the second, and possibly a spectral distribution per third octave band, the analysis of which makes it possible to have first response elements as to the nature of the measured noise, but which in reality proved to be insufficient to assert as opposable proof.

Other classical approaches using automated audio analysis were not possible due to lack of power and CPU. Anyway, they would have been of moderate help because of the complexity of urban noise mixtures.

In order to build the opposable evidence of the origin of disturbance, Bruitparif decided to design and patent a new noise monitoring device.

2. Description

In 2016 Bruitparif started the development of a new type of sensor, called "medusa" because of its shape, which adds crucial information to the data

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usually measured: the source of the noise. The goal is to go further in the analysis and understanding of noise.

The “medusa” sensor (see Figure 1) is an acoustic antenna composed of four microphones arranged in a regular tetrahedron.

Figure 1: View of the "medusa" sensor developed by Bruitparif.

This multiplicity of microphones makes it possible to detect small time shifts when noise arrives, sufficient to allow the direction of the dominant noise to be reconstructed several times per second with no need of classical beamforming algorithms.

By then projecting these "geolocated noise levels" on a 360 ° view of the environment, it becomes possible to "see the noise" (see Figure 2). The visualizations produced by the system are based on fixed images made periodically, which make it possible to give an overall account of a situation. The sound levels from each direction are then represented as colored hexagons. The color code used makes it possible to intuitively account for the intensity of the sound levels.

The "medusa" technology of Bruitparif is the subject of a patent application.

Figure 2: One of the images from one of the "medusa" sensor deployed at the Grand Paris Express construction site in Clamart. It shows that two thirds of the sound energy emitted towards this sensor, during two hours between 15h30 and 17h30 on November 14, 2017, comes from a precise place of the construction site (in red). The noise level observed at the sensor is 74 dB(A).

3. Use cases

The “medusa” sensor is currently being tested in various urban contexts in Paris and in the Ile-de-France region (see Figures 3 to 5).

This tool should eventually make it possible to better monitor the behaviour of certain noise sources by real automatic screening of measurements. From there, it becomes simpler to construct a truly representative indicator from which the setting of quality objectives or even sound management thresholds can follow quite naturally.

Figure 3: Noise at the Grand Paris Express construction site at Clamart

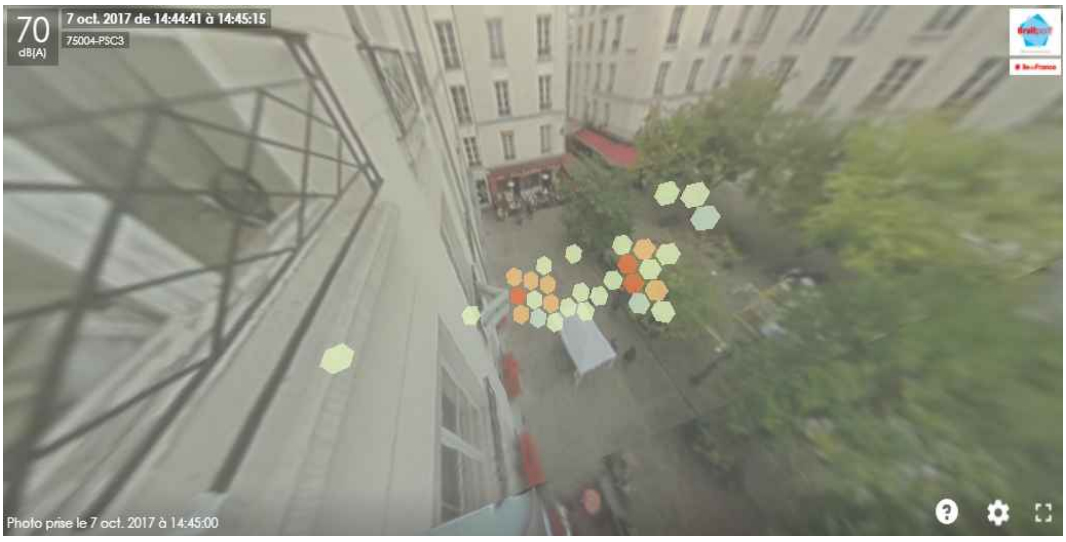

Figure 4: Noise on restaurant terrace, Place Sainte-Catherine in Paris

Figure 5: Road cleaning machine in Paris

Regular data analysis, through periodic reporting, will provide long-term monitoring of changes in the situation and compliance with quality objectives. The possibility of having real-time monitoring indicators available within an operational platform also facilitates regulation within the instrumented sectors, since any deterioration detected can give rise to appropriate alerts being sent to the authorities in charge of noise nuisance management.

4. Conclusion

Beyond the simple representation of the sound environment, this new approach now certifies that a dominant noise comes from a particular area. It makes possible to answer an essential question: where did the noise mainly come from during such a time interval?

It then becomes possible to construct objective indicators specifying the contribution of this area, which finally opens the door to the establishment of regulatory mechanisms to limit nuisance where possible.

References

[1] Noise generated by late-night establishments: a new monitoring and management tool, Bruitparif, Internoise 2013