Norsonic Acoustic Camera

Filming low-frequency structure born noise with acoustic camera

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Measurements in apartment building, Oslo, Norway, September 2015

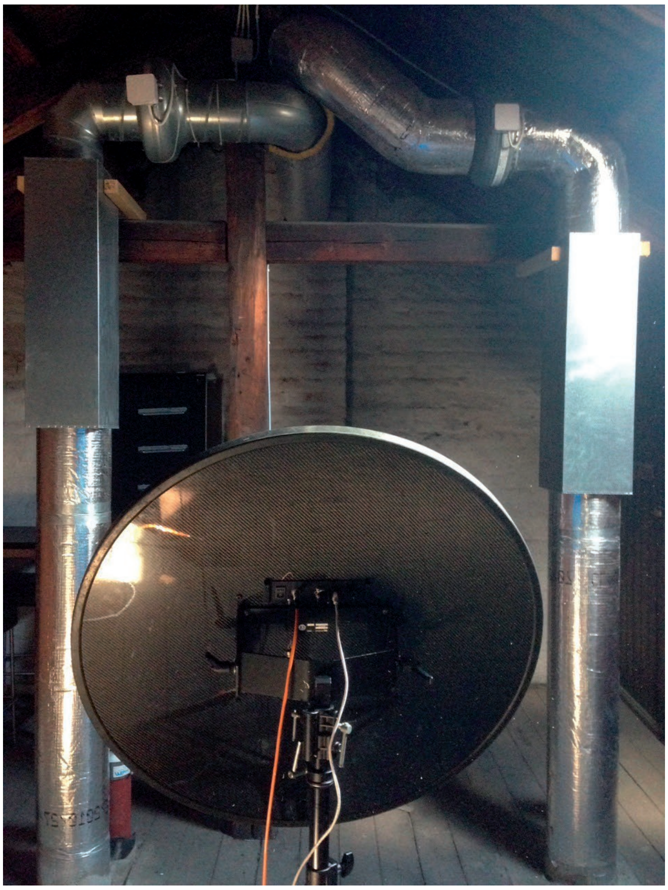
These recordings were made with the Nor848A-10 1.0 m acoustic camera system with 256 microphones, now replaced with Nor848B acoustic camera system.

Problem

An apartment complex consists of five floors, with several apartments over four floors, and an attic on the top floor. In the attic an air circulation system is installed to provide circulation in the bathroms of all the apartments in the building. The circulation system is driven by an air fan distributing air through pipes going to all apartments. The air pipes are cemented in to the structure of the building itself, and in some apartments a low frequency structure born noise with the same frequency content as the frequency of the air fan can be heard.

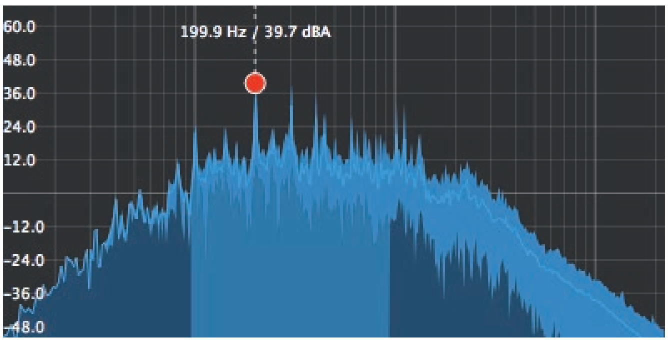
Measurements

The Norsonic Nor848A-10 1.0m acoustic camera with 256 microphones was used for the recordings. The camera was plugged into an external battery pack for easy transportation and mobility. Measurements were made both in the attic at the source location, and also in the bedroom and bathroom of one of the apartments three floors below. The Nor848A-10 was chosen for the recordings over the more compact and mobile 40 cm and 128 microphone Nor848A-4, mainly due to the low-frequency nature of the noise. An array that is larger in size will have better resolution for all frequencies, and will also be able to go lower in frequency content. Even though the Nor848A-10 has a diameter of 1.0 meter, it weighs in at only 11 kg with tripod mounting brackets, and could easily be mounted on a tripod for inspection of the air fan in the attic, or laid down on the floor, or a bed or similar for inspection of the roof in the bedroom and bathroom of the apartment.



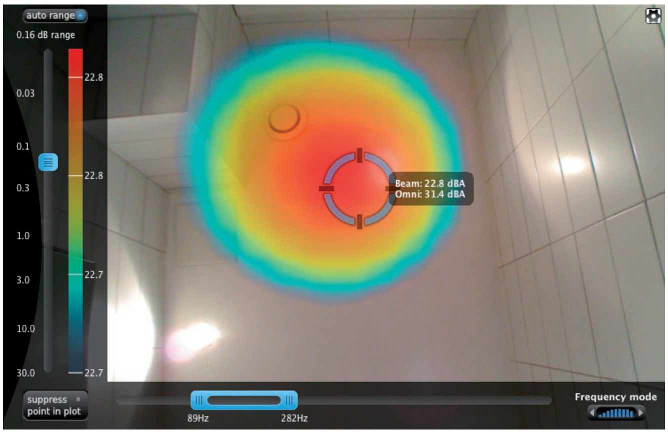
Results

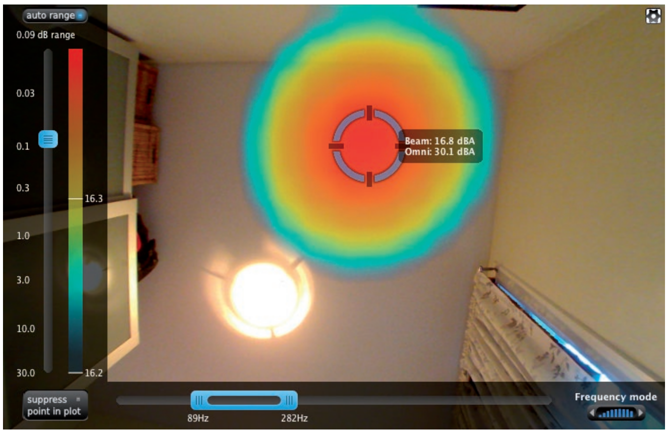
Looking at the recordings from the attic, it was clear that the intake fan was the main culprit having a dominating fundamental frequency at 200 Hz. Also several harmonics of the fundamental frequency could be seen in the frequency spectrum. Since the distance between the attic and the measurement apartment was several floors, and the sound pressure level of the fan noise in the attic was around 40-50 dB, it would have been impossible for the noise in the apartment to be anything other than structure born noise. By inspecting the pipes it was seen that they were cemented in place to the building structure itself without any form of vibration damping measures in place.

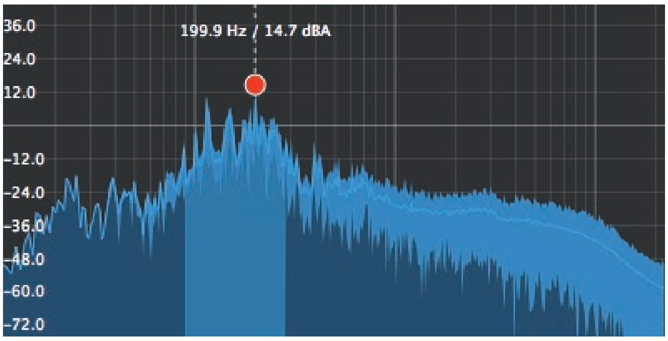


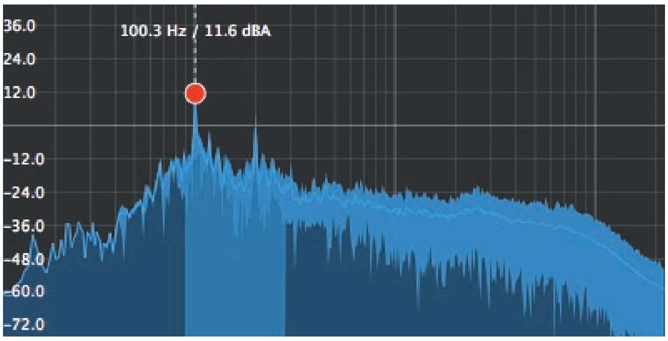
The air flows through the pipes and enters the bathroom in the measurement apartment through an air valve in the roof. By positioning the camera so that the measurement direction is straight up at the roof, it was possible to film the structure born noise and get images as seen below. Also by looking at the frequency spectrum one could se how the frequency content of the obtained noise in the bathroom had the same characteristics as the frequency spectrum in the attic. However now more sub harmonics below 200 Hz were seen in the spectrum as seen from the image below.

Recordings were also made in the bedroom of the apartment. The camera was placed on the bed with measurement direction up towards the roof. As was the case in the bathroom, the frequency spectrum also showed tonal tendencies, however here the sub harmonic at 100 Hz was the most dominant frequency. For both bathroom and bedroom the measured sound pressure level was around 30 dB.









Nor848B Acoustic camera

The Norsonic acoustic camera is a module based approach to acoustic camera that gives the user both portability and great resolution for a wide range of measurement situations. The array dish is based on a hexagon shape, given it both its name, and the ability to combine several tiles into larger systems.

Acoustic beamforming arrays, commonly known as acoustic cameras, enable the user to visualise different sound sources at different frequencies and source strengths. The resolution and ability to resolve sound sources spaced closely apart, and at lower frequencies, is mainly decided by overall size and number of microphones of the equipment being used. Although image manipulation and deconvolution techniques on the beamformed results might give added resolution, in practise the properties of the array still influence the results. This size versus resolution criteria is the crux of the acoustic camera market. Users want something that is small, light weight, and portable, while at the same time having excellent resolution, and the ability to go low in frequency. This has been an impossible demand for a single system – until now.

Hextile - lightweight and portable

With a single Hextile, the user has a small, portable and lightweight acoustic camera that can be used for a wide range of measurement situations. The Hextile is a USB based acoustic camera, with a single USB cable for both power and data transfer – no extra battery cable needed. The array is made from robust and lightweight aluminium, has 128 MEMS microphones, and is less than 3 kg in weight while having a maximum diameter of 46 cm. The low frequency limit for the Hextile is 410 Hz.

Multitile - great solution

For users that require better resolution both in lower frequencies and overall, three single Hextiles can be combined to a larger Multitile system, consisting of 384 microphones with a maximum diameter of 96 cm. The low frequency limit for the Multitile is 220 Hz.

Multitile (LF mode) - low frequency measurements

For special low frequency applications below 1 kHz, it is also possible to utilise the Multitile in the low frequency configuration as the Multitile (LF mode). By placing the individual Hextiles further away, the maximum diameter of the complete array system is increased to 1.46 m, making it ideal for low frequency measurements. The Multitile (LF mode) is for low frequency measurements below 1 kHz, with a lowest frequency limit of 120 Hz.

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