Nor848A Acoustic camera

Filming Low-Frequency Structure Born Noise With Acoustic Camera

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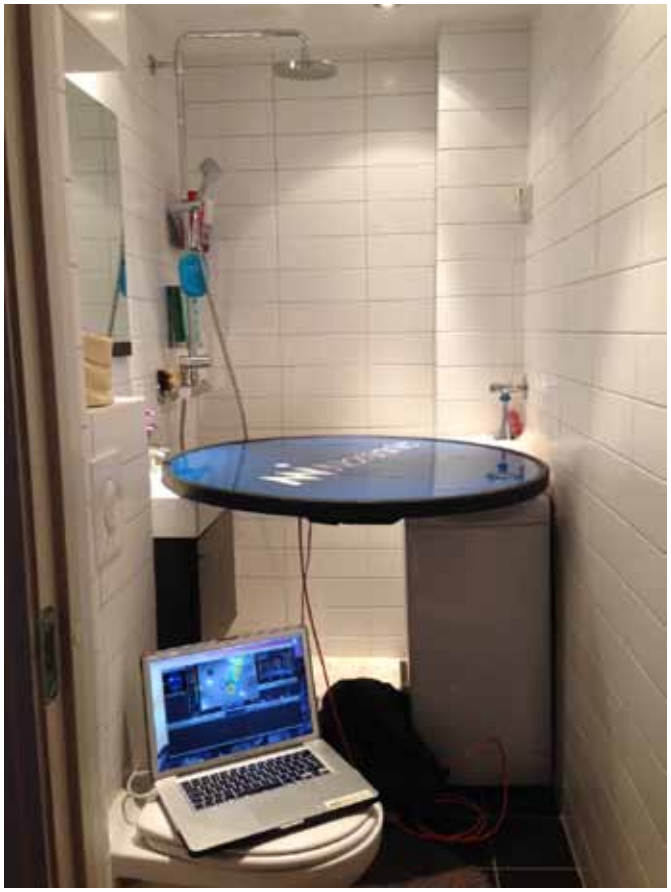
Measurements in apartment building Oslo, Norway, September 2015

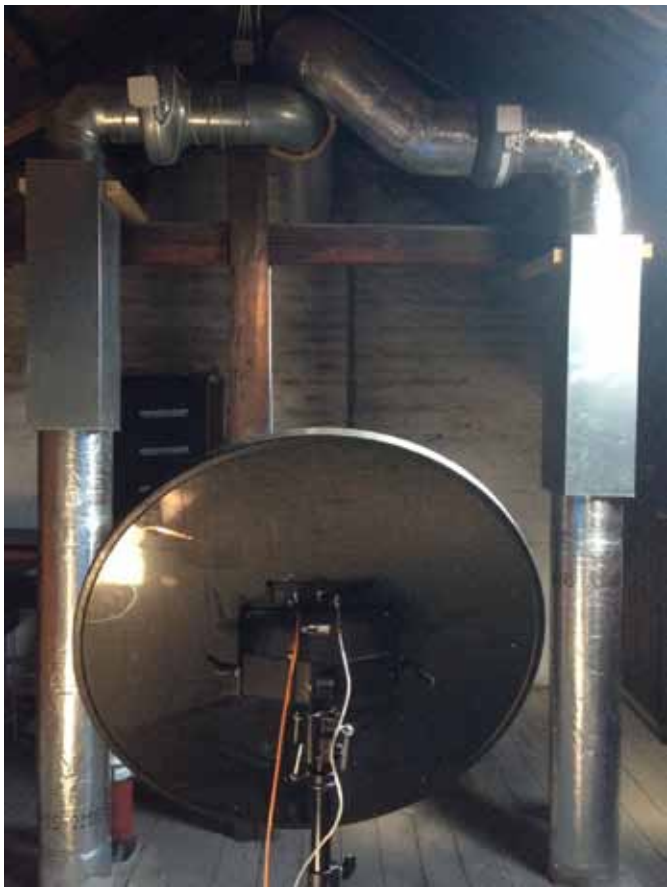
Problem

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

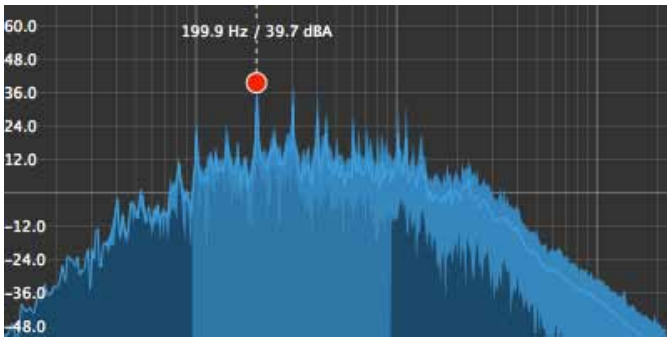




larger in size will have better resolution for all frequencies, and will also be able to go lower in frequency content. Even though the Nor848A-10 has a diameter of 1.0 meter, it weighs in at only 11 kg with tripod mounting brackets, and could easily be mounted on a tripod for inspection of the air fan 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.

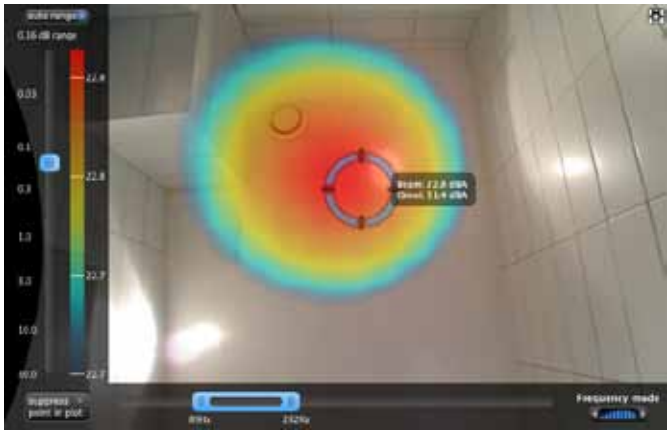
Results

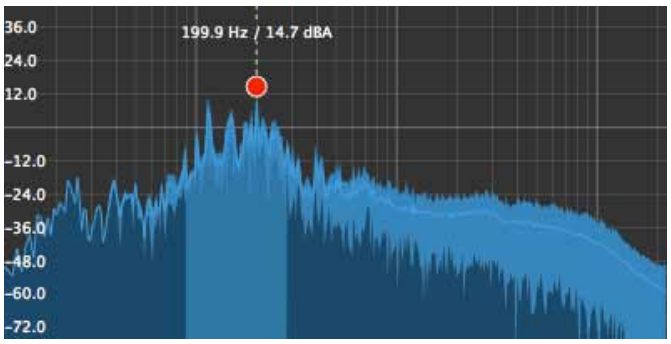
Looking at the recordings from the attic, it was clear that the intake fan was the main culprit having a dominating fundamental frequency at 200 Hz. Also several harmonics of the fundamental frequency could be seen in the frequency spectrum. Since the distance between the attic and the measurement apartment was several floors, and



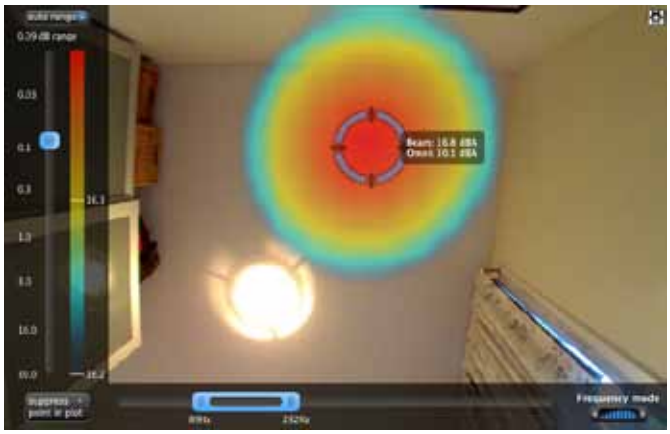
the sound pressure level of the fan noise in the attic was around 40-50 dB, it would have been impossible for the noise in the apartment to be anything other than structure born noise. By inspecting the pipes it was seen that they were cemented in place to the building structure itself without any form of vibration damping measures in place.

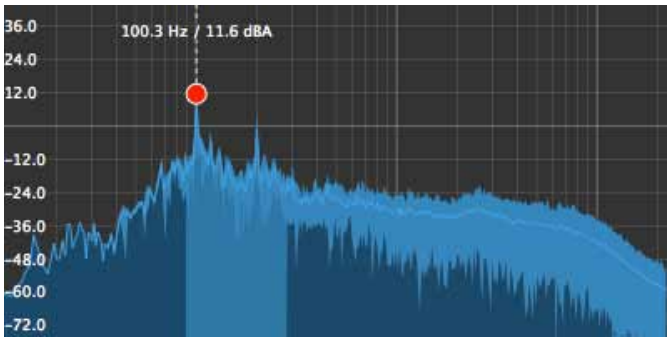
The air flows through the pipes and enters the bathroom in the measurement apartment through an air valve in the roof. By positioning the camera so that the measurement direction is straight up at the roof, it was possible to film the structure born noise and get images as seen below. Also by looking 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.





Nor848A Acoustic camera

The Norsonic Nor848A acoustic cameras sets a new standard for acoustical cameras. The large number of microphones eliminates the problems of ghost-spots, compared to traditional acoustical cameras where the relatively low number of microphones increases the side lobe effect, resulting in the so called ghost- spot effect: You “measure” a non-existing source.

The Nor848A software is extremely intuitive and easy to use. Just after a few minutes of training, the user is able to operate the system and do real measurements. Three camera frontends are available, all varying in number of microphone sensors and size, where a larger array size ensures better resolution for lower frequencies: A 0.4 meter array holding 128 microphones, a 1.0 meter array holding 256 microphones and a 1.6 meter array with 384 microphones.

The digital microphone elements are protected behind a disc-shaped carbon fibre enclosure, and a dust and water repellent mesh is protecting the microphones from dust and moisture. The robust and sturdy construction also ensures that all microphones are kept in the correct position – important for field applications. The small distance between the microphones in the inner circle is important for low spatial aliasing at higher frequencies. The large number of microphones also contributes to the wide measurement range and the low self-noise. The signal in the selected direction is based on the weighted average of all microphones and is therefore far below the self-noise from a single microphone.

The system enables the user to perform noise analysis with a clear view of where the different noise sources are located in real time. The system is ready to measure in just a few minutes after entering the site. By moving the cursor in the picture you may analyze and listen to the sound in the selected directions while doing the measurements. This enables the user to identify the problem, whether it is an annoying sound, a leakage or other difficult noise problems in just a fraction of time compared to traditional methods.

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