Norsonic Acoustic Camera

Pinpointing low level sanitary noise in apartment building

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Measurements in apartment building in Oslo, Norway, April 2015

These recordings were made with the Nor848A-0.4 40 cm acoustic camera with 128 microphones, now replaced with Nor848B acoustic camera system.

Problem

A newly built apartment building consists of several floors with multiple apartments on each floor. One of the ground floor apartments is disturbed by sanitary noise from the apartment above, which is heard whenever the toilets in the top apartment are being flushed. The sanitary noise is heard in several rooms, and the level was measured to be around 30 to 35 dB, which is above the noise criteria set in the regulations. The culprit was thought to be embedded pipelines in one of the corners of the living room, and several measures were made on this area. Although increased insulation improved the noise dampening capabilities of the embedded pipelines, the noise was still heard. Also the improvements could not explain the fact that the noise was also heard in two bedrooms, one of which was not adjacent to the living room.

After the construction of the apartment complex was finished, the contractor in charge of piping had gone bankrupt, and also there existed no documentation or blueprints on the actual position of the piping system. Since the first measures did not produce the desired outcome and had little overall effect, it was quite certain that the problem was also located elsewhere. Given that the measured sound pressure levels were so low, it was very difficult to detect any real change in sound pressure level from different measurement positions. Also trying to locate the origin by hearing in different positions proved to be futile when trying to determine source position. In addition to hearing the noise in several rooms, it was also heard in the hallway and it was uncertainty whether there existed a single source location or several.

Measurements

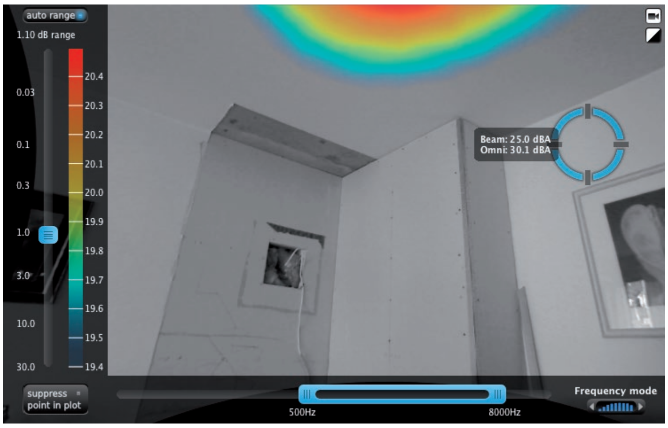
The 40 cm Nor848A-0.4 acoustic camera with 128 microphones was used for the measurements. Although the external battery pack could have been used for extra mobility, the easy access to power outlets meant that the camera could be plugged in directly in the wall outlet in the different measurement rooms.

The light weight and small size of the array ensured easy portability and also great flexibility in measurement positions. The camera could be set up on the tripod, but also positioned on the floor, in a bed, on a couch or just hold it by hand all based on what part of the room one would like to listen to and get the acoustic image from. The 40 cm camera proved to be very handy in a measurement situation where it was not given beforehand exactly where the source of interest was positioned. In that way the camera could easily be used to scan around different parts of different rooms.

To actually get a recording of the sanitary noise, one person was positioned in the apartment above and told when to flush via cellphone from the apartment below. This was repeated several times, with recording time around 20 seconds each time to cover the entire event duration.

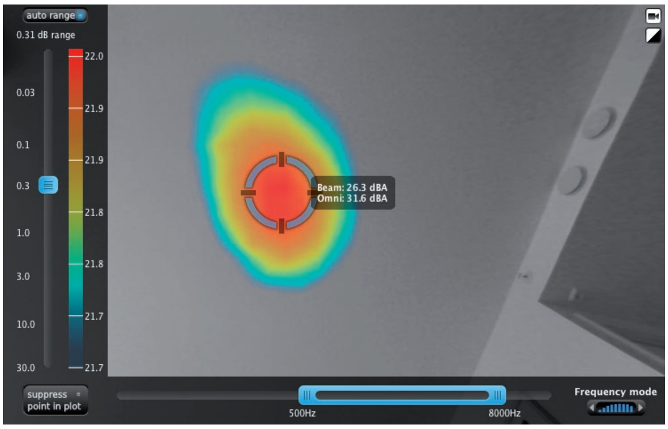
Results

The first recording of the flushing event did not produce the desired result. The source colouring was on a wall adjacent to the embedded pipes, but no pipes were in that part of the building, and it was impossible that the noise could originate from that position. By looking at the recording and listening to the center of the colouring on the video, one could quickly realise what was happening. Because of the very low noise levels, the camera was picking up the strongest source in the room, which in this case was a reflection on the wall from the noise of the cooling fan of the Macbook that was being used for the recordings. This was solved by placing the Macbook in a different room and closing the door. The ethernet cable from Macbook to the acoustic camera was small enough in diameter that the

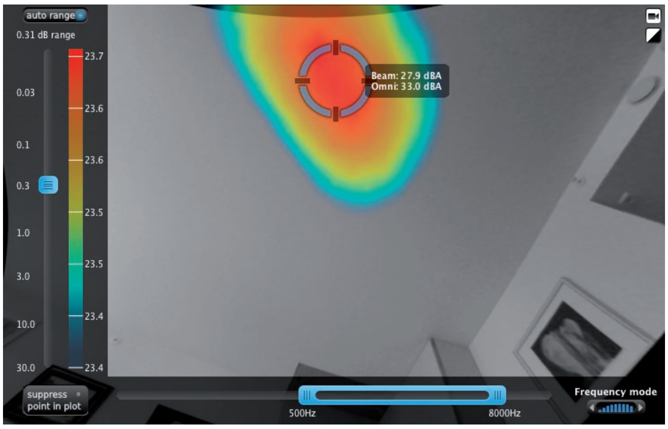


person doing the recordings could sit virtually anywhere he or she pleased, as long as the cable was long enough. On the second try one could clearly hear the sanitary noise for a period of around 8 to 10 seconds. When filming at the location of the encased pipes in the corner of the living room, the acoustic camera did not pick up any energy at that position, but rather the colouring was upwards towards the roof and outside the field of view of the camera at that measurement position. This was a very strong indication that the origin of the noise was in fact located somewhere else, and the camera was directed accordingly for the subsecuent measurements.

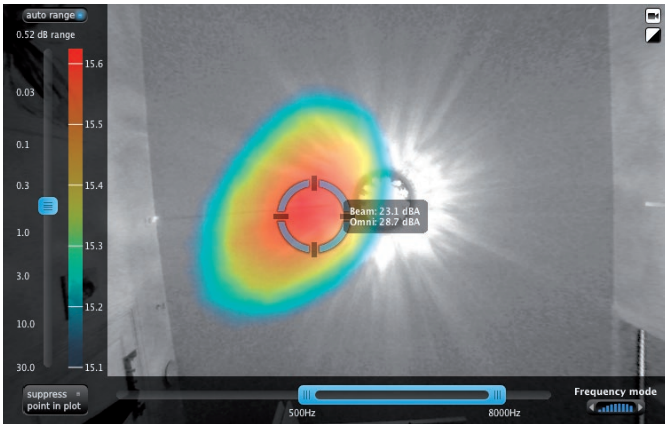
When pointing the camera towards the ceiling it became apparent that the source was at this position. No other spots, either from the embedded pipes in the corner of the living room, or from the hallway, had any visible colouring, and could be excluded as the likely position of the origin of the source.

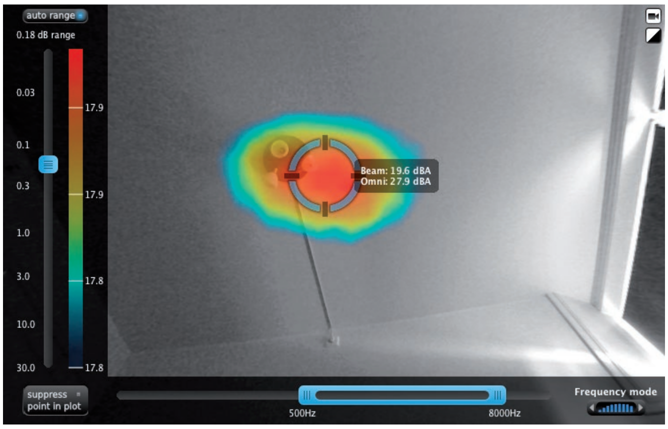


By using the virtual microphone, which enables the user to listen to a specific position in both real time and in a recording, one could clearly hear the sanitary noise from the recorded position at the roof. Also by enabling the bandpass filter one could further be able to filter out background noise and very clearly hear the sanitary noise from the piping. Based on these measurements one could deduct that the water pipes in were in fact not positioned as previously thought.



In addition to measurements in the living room subsequent measurements were also made in the two bedrooms. These measurements displayed the same result, the energy of the noise did not come from the walls, but were confined to the roof. All in all this was a very strong indication that the problem was piping located in separating floors between apartments.





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.

Hextile - lightweight and portable

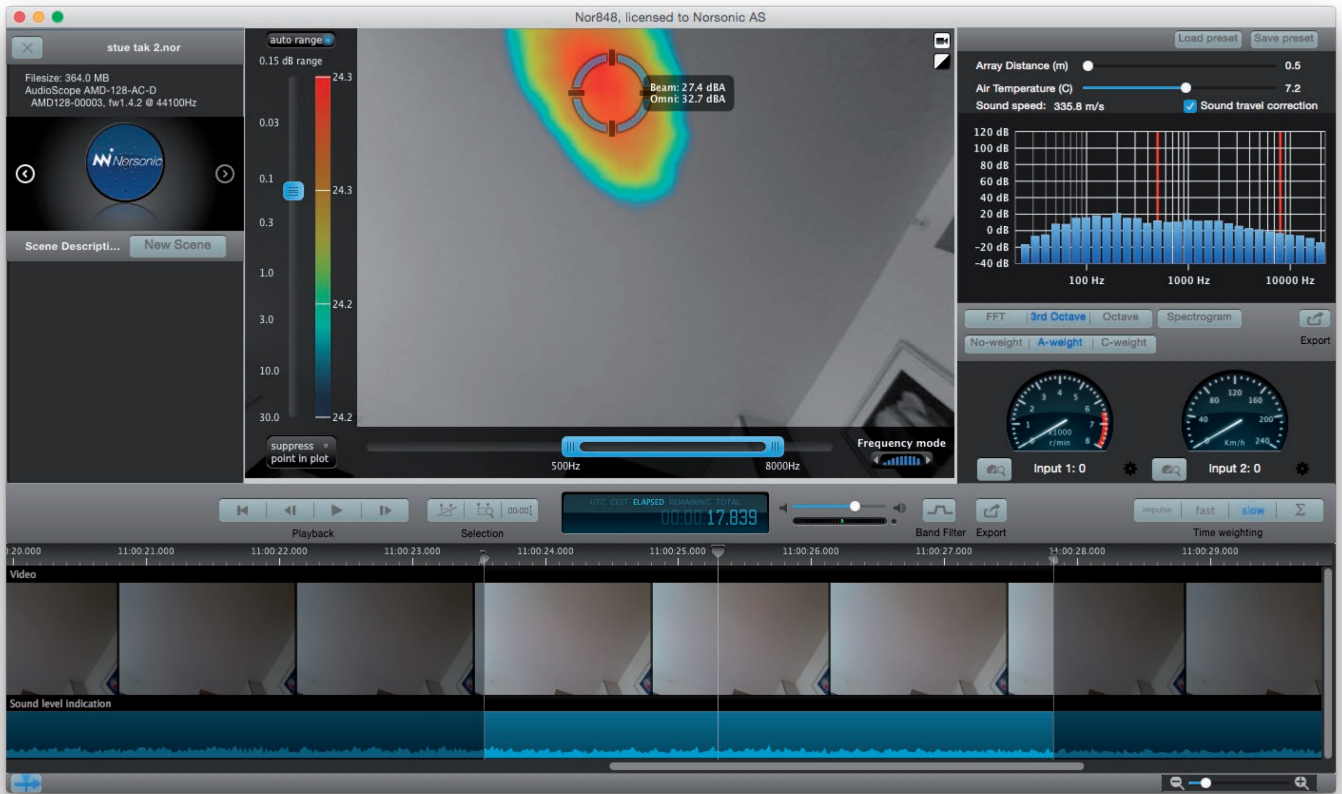
With a single Hextile, the user has a small, portable and lightweight acoustic camera that can be used for a wide range of measurement situations. The Hextile is a USB based acoustic camera, with a single USB cable for both power and data transfer – no extra battery cable needed. The array is made from 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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