Norsonic Acoustic Camera

Wall leakage testing in the lab with acoustic camera

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

Problem

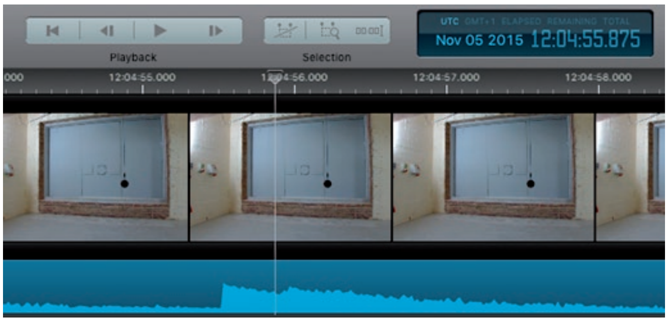
Facade insulation testing is usually performed by using a loudspeaker in the sending room, and record the sound pressure level (SPL) with microphones in both the sending and receiving room. The difference in SPL adjusted for the size of the dividing wall element will then give an estimate of the sound reduction quality of that element. However these measurements will not say anything on where any potential weaknesses, or cracks and gaps, exist in the wall element under inspection.

Measurements

An acoustic lab is set up with two reverberant rooms acting as sending and receiving room. In the sending room an impulse sound is used as the source. The Nor848A-10 1.0 m acoustic camera with 256 microphones was placed in the receiving room pointed at the wall element under inspection. It was thought that any weaknesses would be displayed as small sound sources on the wall element at the position of the weakness, as the SPL from these spots would be slightly louder.

One uncertainty was also how a very reverberant receiving room would influence the recordings, and if this method would only work in a receiving room with lots of absorption or close to anechoic.

In the acoustic camera software it is possible to either look at a recording in live-mode view, which is the view when the recording is running, or to stop the recording at an arbitrary point in time to get a high-resolution plot. As seen in the picture below, the analysis was performed by stopping the recording just after an impulse sound had occured.



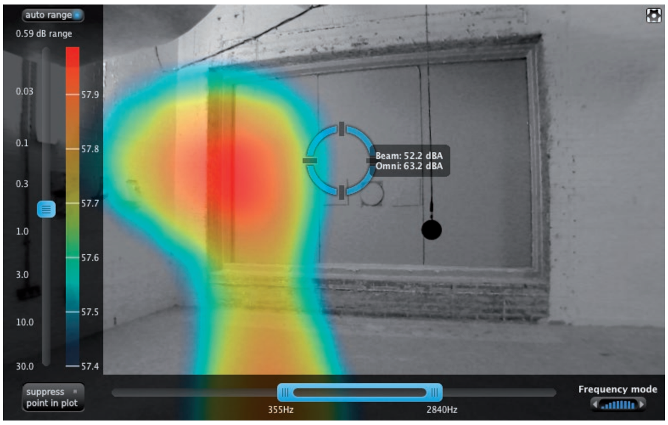
The coloring of sources is also influenced by the time weighting used, and the selected frequency band. As resolution for acoustic camera is also a function of frequency, where higher frequencies give better resolution, it is usually best to filter higher in frequency. For the results presented in this paper the default frequency filtering from 355 Hz to 2840 Hz was used, in addition to SLOW time weighting, which is the mean value over a second.

Results

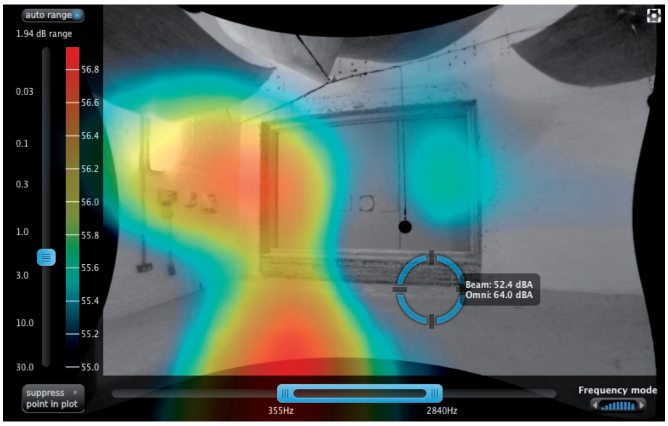
When stopping the recording just after the impulse sound, and using the frequency filtering and time weighting as described above, the first image that appeared was the one seen below which indicated a weakness on the left hand side of the wall element.

For this image however the dynamic range is set very low, so if we increase the dynamic range we are able to see more than just the strongest source in the room.

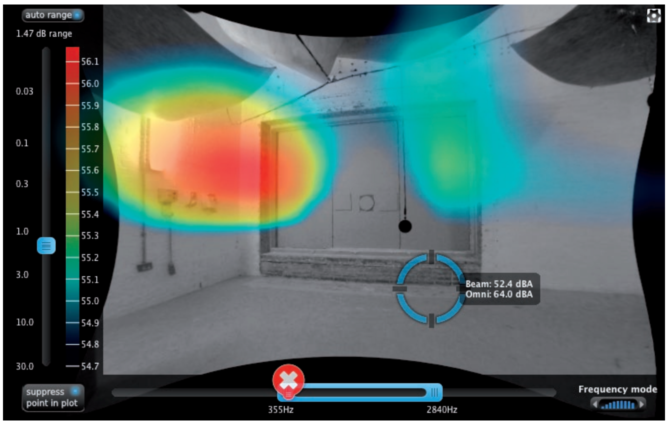
Increasing the dynamic range produced the picture below where we can also see the reflection from the floor. Depending on where the measurement was stopped, the situation could also have been reversed, so that the reflection from the floor would be the strongest source, and the leakage from the wall would be the second strongest source and only appear after the dynamic range is adjusted.



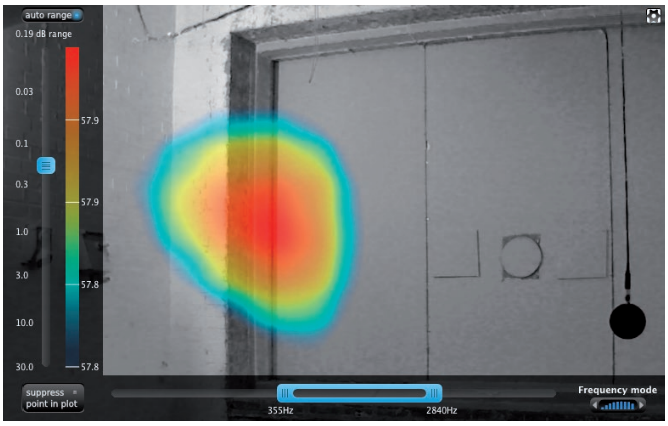
By further adjusting the dynamic range we are able to pick out the third strongest source and so on. Seen below is the image when increasing the dynamic range further, and we are now able to see a very faint third source on the right hand side of the wall element.

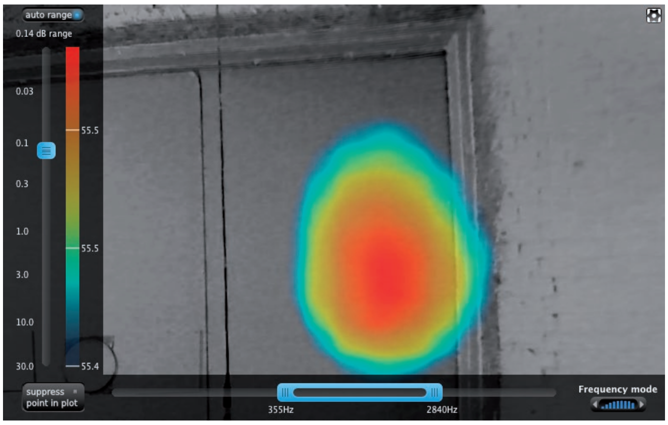


However the result is a bit obscured by the strong reflection from the floor. This could either be solved by adding some absorption materials in the receiving room such as a rug or similar, or zoom in in the image. But we also have the possibility to use the acoustic eraser in the software. The acoustic eraser removes a source in the image based on the position you place it. Seen in the image below, the acoustic eraser is seen as a red circle with a white cross on it. When placed on top of the position of the reflection, the reflection is removed from the image, and we can see the two sources from the wall element more clearly. Judging from this image it seems we have the strongest weakness on the left hand side of the wall, but also a second weakness on the right hand side that isn't as powerful as the first source.



Now it is possible to zoom in on the regions of interest to further increase the resolution. The images on the next page show the zoomed in results when looking at the left hand side and right hand side of the wall element.





For the results presented in this paper an impulse sound was used as noise source in the receiving room, and this worked well. However any type of source can be used, and often the best results are obtained when using a stationary white noise source in the sending room. In that case one is not dependent on stopping the recording at the correct time to obtain meaningful results, but could also do the analysis in the live-view mode. Also the virtual microphone, that enables the user to listen to the sound from only a specific direction, can be used in this situation to scan and hear along the edges or similarof the wall element. Often doing analysis by listening gives additional vital feedback that may not be obvious from the coloring alone.

The recordings in this paper were done with the acoustic camera connected directly to the MacBook also placed in the receiving room. Often in acoustic labs one would use a main control room where technicians can start and stop a measurement without having to physically be in the sending or receiving room. The transmission of data and communication between the acoustic camera and MacBook happens by ethernet cable over a fixed IP address. This means that it is also possible to use the LAN network of the lab to transmit data. In this case the MacBook could be located in the control room, and the camera in the receiving room with an arbitrary distance between them, as long as they are connected by cable on the same network.

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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