Nor848A Acoustic camera

Identifying Short Time High Pitch Squeak Noise from Electric Window in Car Door

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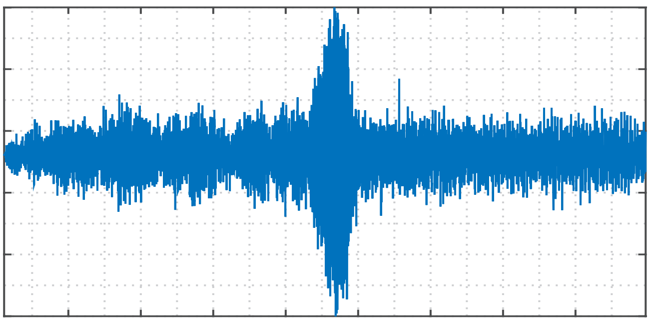
Measurements in car factory Korea, July 2015

Problem

A well known car manufacturer in Korea were testing an automatic car door window intended for one of their new car models. The window is driven by an electric engine positioned in the middle of the car door that drives the window up and down. When the window was driven up by the electric motor, a short timed high pitch squeak noise could be heard as seen from the level versus time plot below. The squeak noise was obviously connected to the window and the car door, but the localisation of the source of the problem proved difficult.

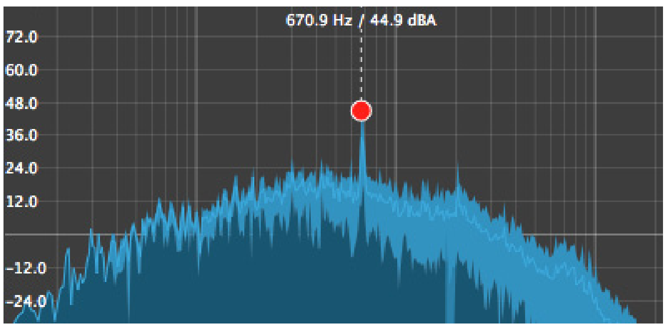


Measurements

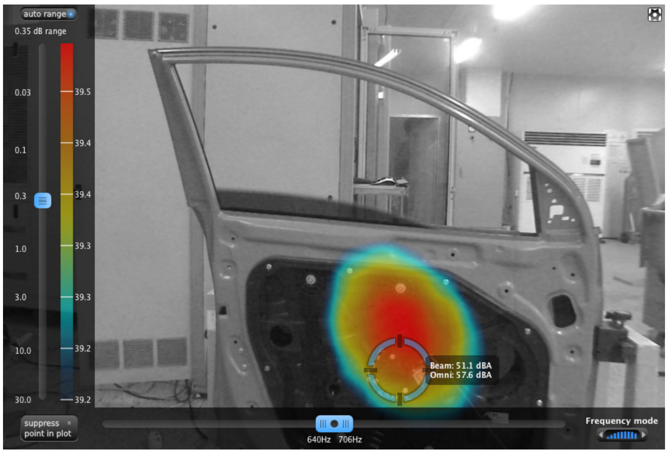
The Nor848A-0.4 40 cm camera with 128 microphones was used for the recordings. The camera was positioned at a distance of 2.0 m from the car door, with the front-end of the camera pointed straight at the door. The recording consisted of an event of the car window going up whilst being driven by the electric engine.

Results

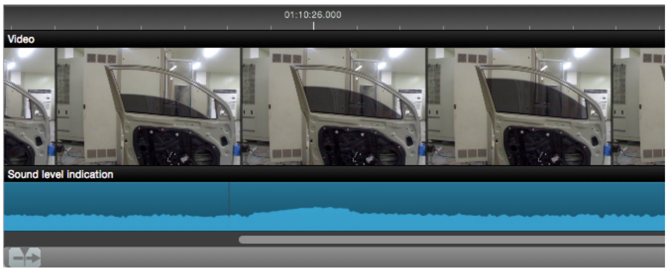
In addition to the high pitch squeak noise, sound from the electric engine could also be heard which was around 670 Hz as seen below. Since this sound was present during the entire recording, it could be easy to misinterpret the



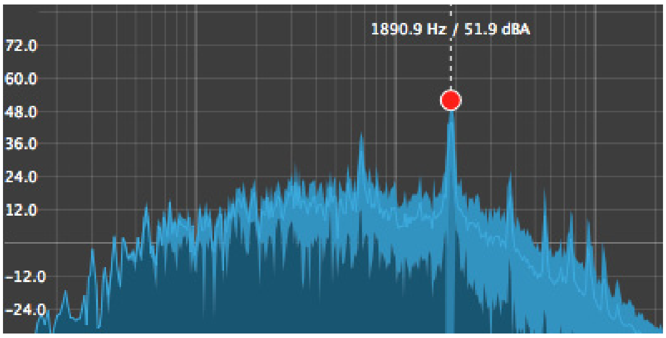
results and pinpoint the source of the high pitch noise to the wrong location without doing proper analysis. As seen in the image below, the location of the electric engine was in the middle of the door.



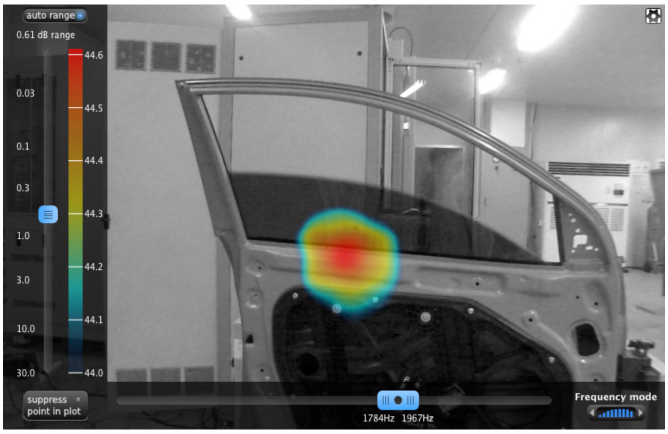
As opposed to the stationary sound from the electric engine, the high pitch squeak noise was only happening for a brief period of time, around 300 ms. By defining a scene in the sound level indicator pane of the acoustic camera software, it was then possible to analyse events happening only within the time frame of the extent of the scene. The scene is made by simply dragging the cursor over the region of interest in the software as seen below.



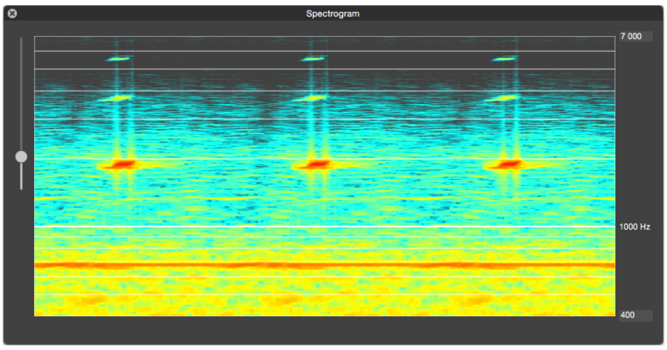
Now by calculating the average spectral density over that part of the recording, it was easy to see that in addition to the noise from the electric motor around 670 Hz, a high pitch tonal noise with a fundamental frequency around 1890 Hz could also be seen in the frequency spectrum. In addition harmonics of the fundamental frequency up to the 7th harmonic was visible in the spectrum.



Now by filtering the frequency content of interest around the fundamental frequency, it was possible to get a clearer indication of the position of the source of the high pitch squeak noise as seen below.

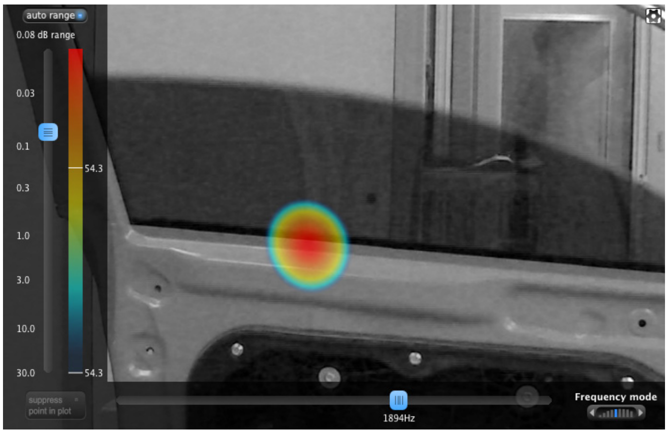


In the software the so called virual microphone can be used, which makes it possible to listen to and analyse sounds from a given point in the image. By positioning the virtual microphone on top of the indicated position of the squeak source, and looping the scene over and over again, it was also possible to look at the spectrogram for that scene and that position. Clearly in addition to the stationary sound coming from the electric engine, bursts of energy at higher frequencies made by the source of the squeak noise were also seen.



Lastly, due to the tonal nature of the noise it was possible to switch from the ordinary, robust wideband algorithm, to the adaptive algorithm for narrowband applications.

This further helped in pinpointing the exact location of the problem. Higher resolution could also be achieved by zooming further in in the image.



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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