# Norsonic Acoustic Camera

## Identifying short time high pitch squeak noise from electric window in car door

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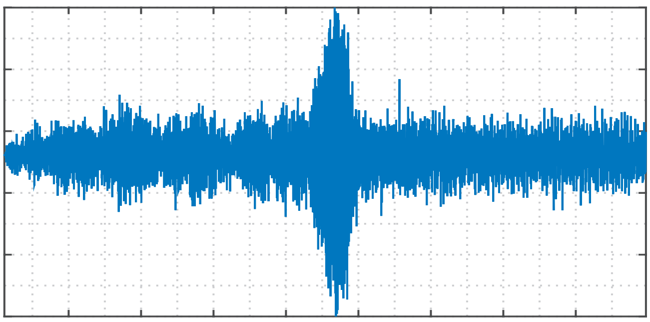
### Measurements in car factory, Korea, July 2015

*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 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.

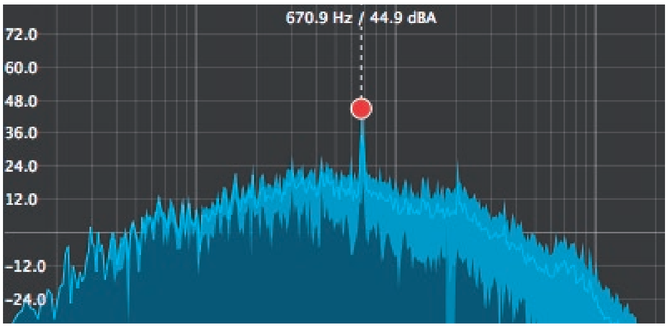


### Measurements

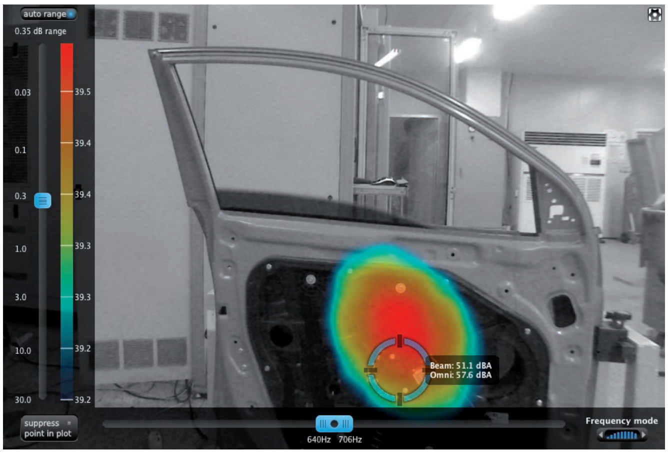
The camera was positioned at a distance of 2.0 m from the car door, with the front-end of the camera pointed straight at the door. The recording consisted of an event of the car window going up whilst being driven by the electric engine.

### Results

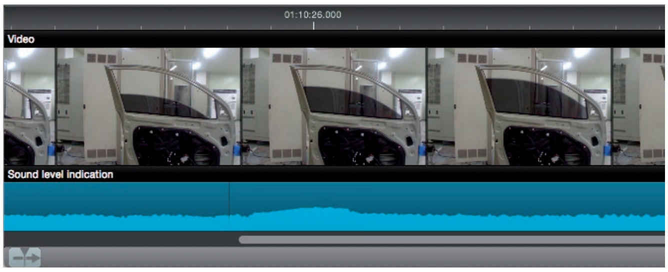
In addition to the high pitch squeak noise, sound from the electric engine could also be heard which was around 670 Hz as seen below. Since this sound was present during the entire recording, it could be easy to misinterpret the results and pinpoint the source of the high pitch noise to the wrong location without doing proper analysis.



As seen in the image below, the location of the electric engine was in the middle of the door.

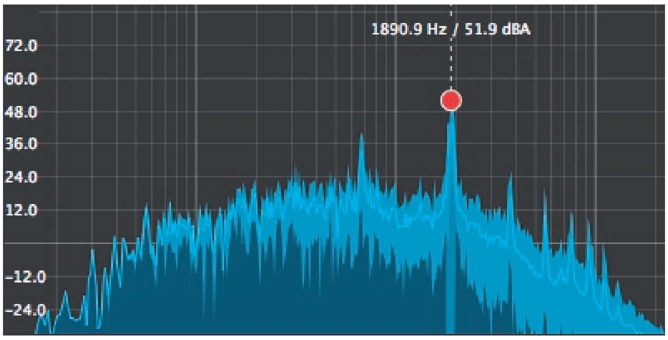



As opposed to the stationary sound from the electric engine, the high pitch squeak noise was only happening for a brief period of time, around 300 ms. By defining a scene in the sound level indicator pane of the acoustic camera software, it was then possible to analyse events happening only within the 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.

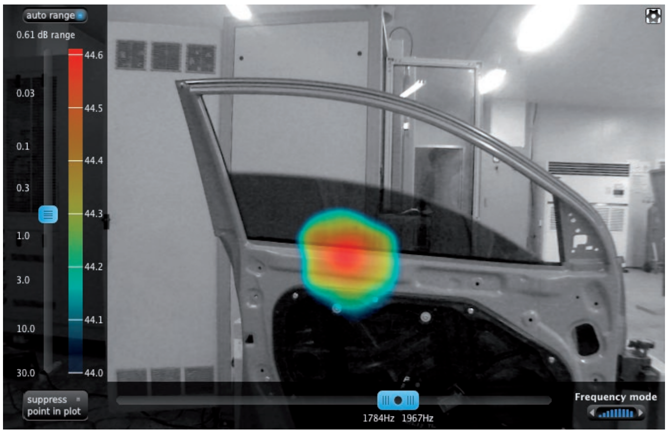




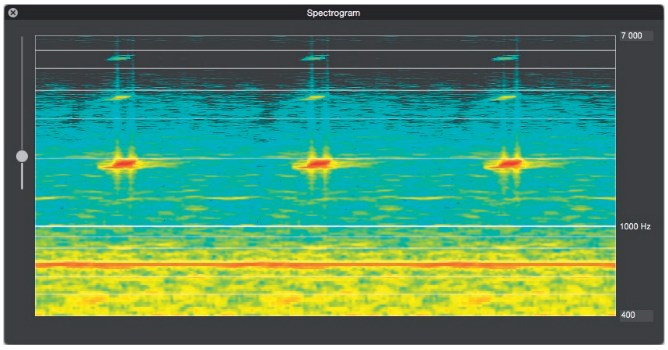
Now by calculating the average spectral density over that part of the recording, it was easy to see that in addition to the noise from the electric motor around 670 Hz, a high pitch tonal noise with a fundamental frequency around 1890 Hz could also be seen in the frequency spectrum. In addition harmonics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



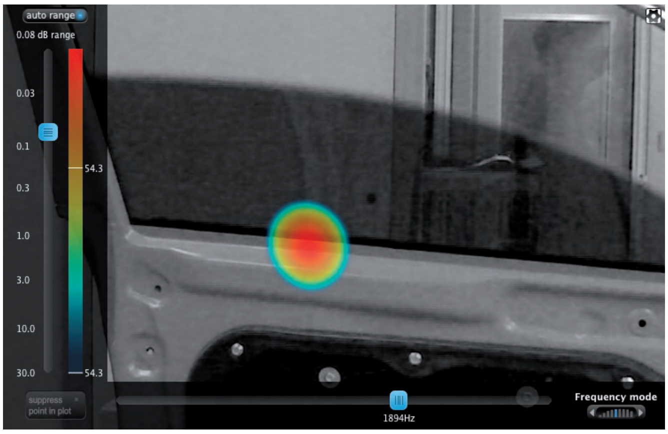

Now by filtering the frequency content of interest around the fundamental frequency, it was possible to get a clearer indication of the position of the source of the high pitch squeak noise as seen below.




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.

## 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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