Norsonic Acoustic Camera

Using acoustic camera inside caravan car to find squeak and rattle noise

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Measurements in caravan car, Lier, Norway, October 2015

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

Problem

When driving a caravan car, the driver could hear annoying noises from behind the driver's cab in the living compartment. Even though the noises could be heard clearly, it was very difficult to discover the exact location and cause of the various annoying sounds due to overwhelming background noise.

When the car was standing still with the engine running, no extra noises could be heard, but especially two distinctive sounds that were different from ordinary engine and wheel noise were heard when the caravan was driving. The first sound had the characteristics of a loose screw sliding back and forth on a hard surface, so whenever the vehicle was turning, what sounded like a small piece of metal rolling from one side to the other on a hard surface could be heard. This was only heard when the caravan was in a turn, and not when driving straight. The second noise sounded like squeaking and creaking of wood, which made sense since a lot of the interior consisted of wood. This sound also appeared when the caravan was driving straight, and not only when turning. Since there were several pieces of the interior that consisted of wood, including the floor, it was not know what specific piece of interior made the noise. Based on previous listening experiments when the car was driving, it was thought that the indoor fridge which was positioned next to the entrance door might be root of of both noises.

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. Although the 40 cm Nor848A-0.4 acoustic camera would have been more mobile, at the time of the measurements it was unavailable. Nevertheless there was more than enough room in the caravan car to use the Nor848A-10.

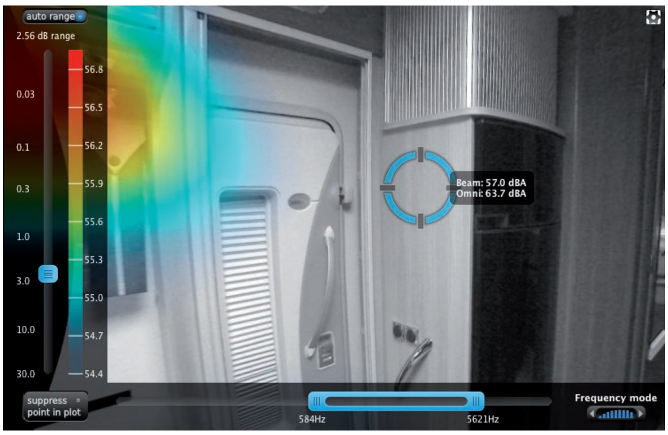
The measurements were done with one person driving the caravan, and another placing the camera dish on a table and performing the measurements. As the array dish itself weighs in at only 11 kg, it was easy to control it with one arm, and starting and stopping a measurement in the software on the MacBook with the other arm. No tripod was used or needed for the measurements.

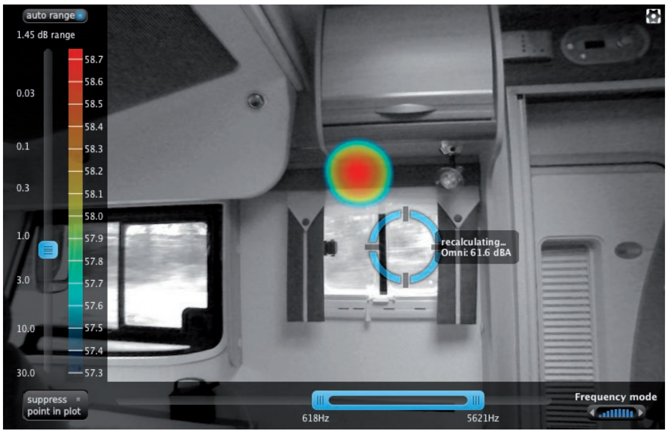
Results

Initially the camera was pointed towards the fridge in the center of the living compartment of the caravan and measurements were made as this was thought to be the origin of the sources, In addition to looking at the coloring of the sources, it was also very useful to use the virtual microphone to listen to the sound field from a specific

direction. In addition it worked very well to enable the band pass filter when listening in order to filter out background noise such as engine noise and wheel noise.

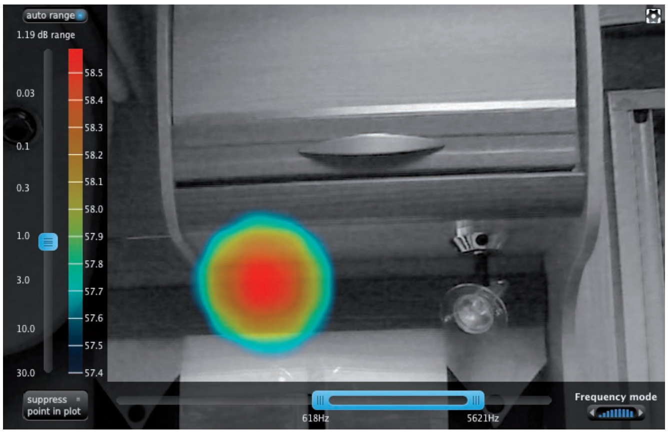
Seen in the image below is the inital result when filming at the fridge in the living compartment of the caravan with the caravan driving and turning, and when the distinct metal rolling sound was heard. As seen from the image there was no indication whatsoever that the sound originated from the fridge in the middle of the picture. Instead the coloring indicated that the sound originated from a different location. Also listening with the virtual microphone could more or less rule out the possibility that the fridge was the source origin. Instead the camera was positioned to aim to the left of the fridge where the coloring indicated a source. The position of the true source was seen more or less



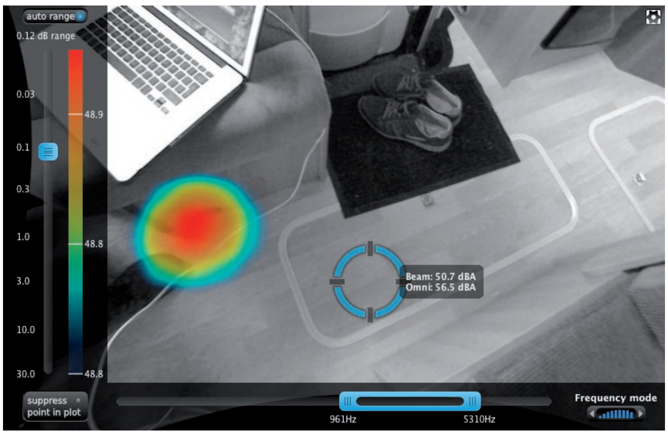


instantly to be inside a cabinet positioned on the wall of the car. This true source location was also confirmed when listening with the virtual microphone on a recording, and even when holding the ear into the cabinet when driving.

Finding the second noise source proved to be a trivial case



after the fridge had already been ruled out as the source. Since most of the interior floor was wooden, is was thought that the creaking might originate from here, and this was the first position the camera was aimed at. Both coloring and listening with the virtual microphone confirmed this.



Normally using acoustic cameras in the interior of cars will often provide poor results, due to high background noise, and a very reverbant noise field. This means that sounds and signals will arrive multiple times at the array at different times, thus making it very difficult to determine the true source location. In this case study it is demonstrated how ordinary beamforming can provide accurate results even in such a situation. This could be thanks to the added space of the interior compartment of the caravan van, in addition to various soft furniture and so on that may help in reducing reverberation effects. In addition the Nor848A-10 1.0 m camera was used that has higher resolution than smaller cameras, in addition to excellent side lobe level suppression.

In addition to being able to locate the various sources correctly by looking at the coloring, also using the virtual microphone in combination with the band pass filter to filter out background noise proved valuable.

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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