APPLICATION NOTE

Vibration measurement of automotive inner lining materials using Ommatidia Q2 laser Doppler vibrometer

Carmen Reina, Óscar Enríquez, Ommatidia Lidar

13/11/2025

1. Introduction

The objective of this test was to evaluate the capability of **Ommatidia's Q2 Laser Doppler vibrometer (LDV)** to detect and measure vibration signals on a black and porous material (in this case a car floor mat) with inherently low reflectivity. Manufacturers of this kind of materials who use LDV often experience signal quality issues.

The purpose was to determine whether valid measurement results could be obtained, that is, whether the Q2 laser Doppler vibrometer for Ommatidia system was able to correctly capture the vibrational response of this type of surface.

2. Q2 laser Doppler vibrometer

The equipment used for this test was the Ommatidia LiDAR Q2 Laser Doppler vibrometer based on FMCW Laser RADAR technology (*Frequency Modulated Continuous Wave*). The Q2 has two operating modes:

- **Laser Doppler vibrometer mode:** measures the velocity or displacement of a surface without contact.
- **Metrology mode:** measures the distance to the sensor and generates a point cloud

This system features multichannel coherent detection, consisting of **65 simultaneous laser beams** for signal acquisition. Thanks to the use of a dedicated photonic integrated circuit (PICs), the Q2 analyzes multiple optical channels in parallel, enabling the simultaneous three-dimensional measurement of vibrations and displacements.

The main benefits and characteristics of the Q2 are as follows:

- **High-accuracy long-range (metrology mode):** measurement range of 1.0–50 m with a precision of 20 µm + 6 µm/m.
- **Ultra-fast acquisition:** between 64 and 25,600 points per second over a 360° sweep.

- **Multi-point vibrometry:** sampling at 40 kHz across 65 simultaneous points, with a velocity range of ±15.5 mm/s.
- **Integrated accelerometer:** bandwidth of 2,000 Hz, sampling rate of 4,000 Hz, and a noise level of 22.5 μg/√Hz.
- **Pointing aid and autofocus:** Full-HD RGB camera (1920 × 1080) with automatic focusing.
- **Robust industrial design:** IP54 protection and atmospheric compensation (pressure, temperature, and humidity).
- **Comprehensive connectivity:** Gigabit Ethernet, GPS synchronization, analog I/O, and digital output.
- **Unified software:** controlled via the Ommatidia Atelier™ platform.

2. Test description

The tested sample was a car floor mat of unknown composition, though typically made up of a polypropylene or polyester felt base, a surface layer of synthetic fibers, and a foam backing providing acoustic and damping properties.

This type of material poses a challenge for optical measurement due to its low reflectivity, caused both by its **dark** color and **porous** surface.

The sample was hung with nylon fishing thread and tweezers from an aluminum frame. The sample was acoustically excited using the synthetic signal generator of the Q2 extracted through its analog output, amplified and injected into a loudspeaker placed behind the mat. The loudspeaker generated a sine acoustic signal at 100 Hz with an amplitude of 500 mV.

The Q2 was placed in front of the sample, art 1m distance (Figure 1).

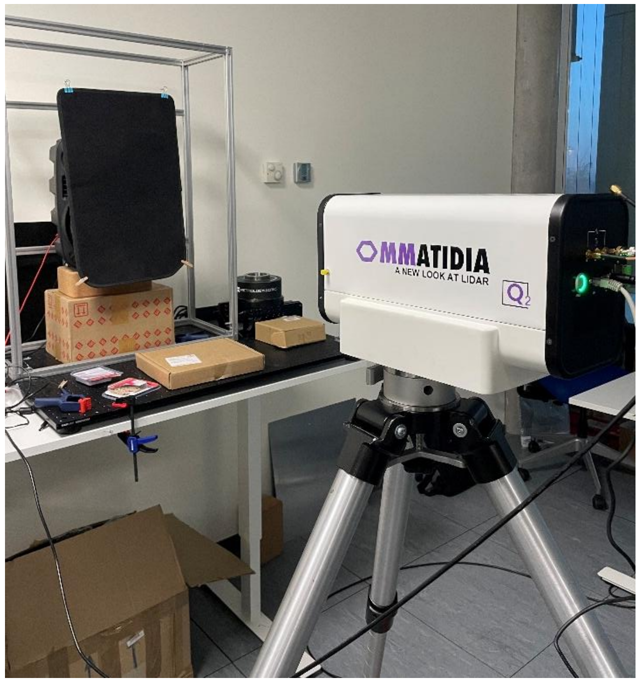

Figure 1: Experimental setup

The test was divided into several stages:

First, an **intensity scan** was performed to verify the level of reflected signal (Figure 2). The signal is considered to be strong enough is it is above 60dB, which is the case for the whole field of view.

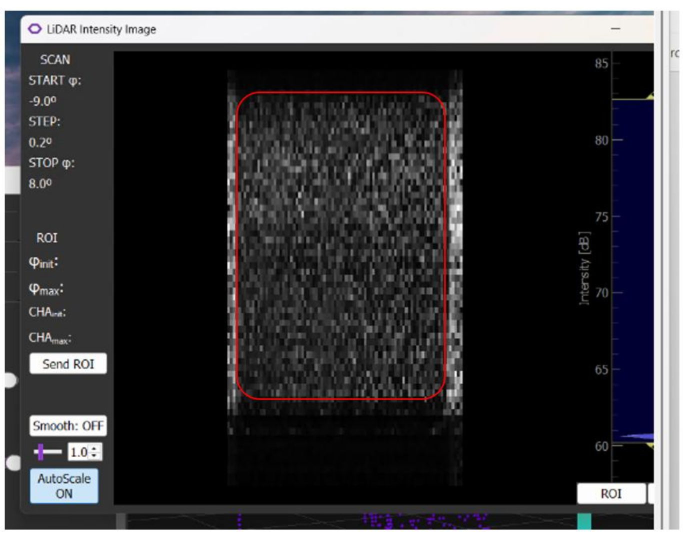

Figure 2: Result extracted from the interface after the intensity test. The area covered by the sample is inside the red frame

Once the signal quality was confirmed, data were acquired in **metrology mode** to ensure that the point cloud obtained matched the physical setup. The excitation signal was generated by the Q2 itself and extracted through its analog output and then amplified prior to injecting it to the loudspeaker.

Subsequently, a **vibrometry measurement** was conducted using a fixed excitation frequency of 100 Hz.

Vibrometry mode measurement:

A vibration measurement was taken between -9º to 8º with a step of 0.2º (65 frames) in the frequency range between 98 and 102 Hz (Figure 3).

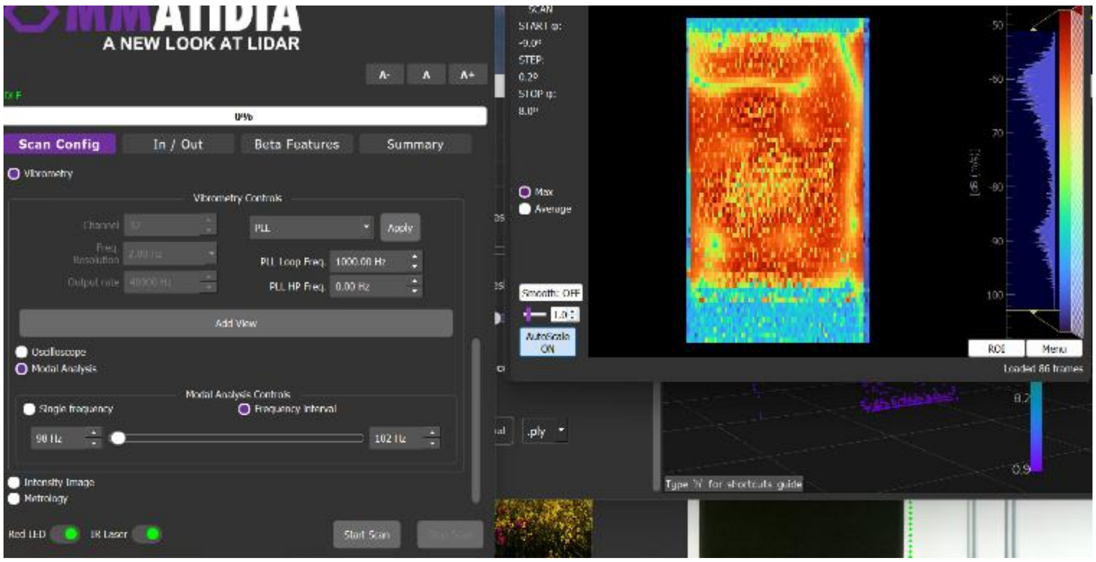

Figure 3: Result extracted from the interface after the vibrometry test

3 Results and conclusions

The result obtained from the intensity test was satisfactory: all measured return signal intensities exceeded the 60 dB threshold, and therefore are considered sufficient to ensure **good signal-to-noise ratio**.

The **uniform** intensity distribution suggests that the floor mat provided a stable and homogeneous optical response, ensuring proper conditions for subsequent measurements.

Since the mat was not tight, it did not show any membrane behaviour and one cannot extract any vibration information from these measurements. This was not however the objective of this test.

Therefore, it can be concluded that, despite the low reflectivity of the material, the **Q2 successfully recorded the vibration of the floor mat**, proving to be an effective tool for the non-invasive characterization of interior panels, upholstery, and damping components.