CASE STUDY

Automotive Cabin Odors

Results of Evaluation of Typical Cabin Odors Considered in Mobility Use Cases

aryballe™

Cabin air quality continues to be a core focus in the automotive and mobility space—whether for shared or personal vehicles. In the case of shared car services (ie rentals, rideshare or carshare), ensuring a "clean" cabin speaks to the customer experience and ultimately overall brand trust. This is especially important as the shared mobility market becomes more crowded.

For personal vehicles, cabin malodors can indicate car system or component issues, like ventilation system fouling or mechanical wear. The impact on the consumer can range from a mere nuisance to an indicator for maintenance.

Digital olfaction offers a solution for objective in-vehicle monitoring of overall olfactive quality to both identify malodors and potential mechanical or system issues, both of which have an impact on overall driver experience.

Challenge

In many cases, the definition of a "clean smelling" vehicle cabin relies on humans to characterize the car smell. While materials testing is often done with trained human panels, cabin olfactive qualification is often done by untrained noses—such as rideshare operators, rental car detailing technicians or dealership employees. The inherent subjectivity of smell makes this practice prone to wild variations in the range of acceptable total cabin smell.

Digital olfaction offers an objective, consistent way to characterize vehicle air quality and enables service operators or car dealers to validate a car's odor with an instrument reading. These readings are only useful if we a. know what a clean car should smell like and b. the instrument can provide repeatable, objective results. To do this, we must train the solution to understand the expected odor of a clean car—and perform tests that determine the limit of detection for the device against the human nose.

Solution

Digital olfaction combines biosensors, advanced optics and machine learning to mimic the human sense of smell which can then be used for objective classification and characterization of odors.

To test against a range of expected cabin odors, we used our Standard Digital Olfaction Kit (SDOK) for automotive applications and introduced smells into an enclosed environment. The tests were performed with the SDOK alone and with our Amplifier device, which allows us to concentrate odors to increase the signal intensity.

When testing these odors, we also captured the odor intensity rating based on a typical human sense of smell scale as seen in Figure 1. The scale shows that in the case of applications for digital olfaction, the ability of the sensor to detect odors below a human smell rating of 3 are the most useful. If a sensor can only detect an odor when it is at a human rating of 5 or 6, then it is less useful for the application.

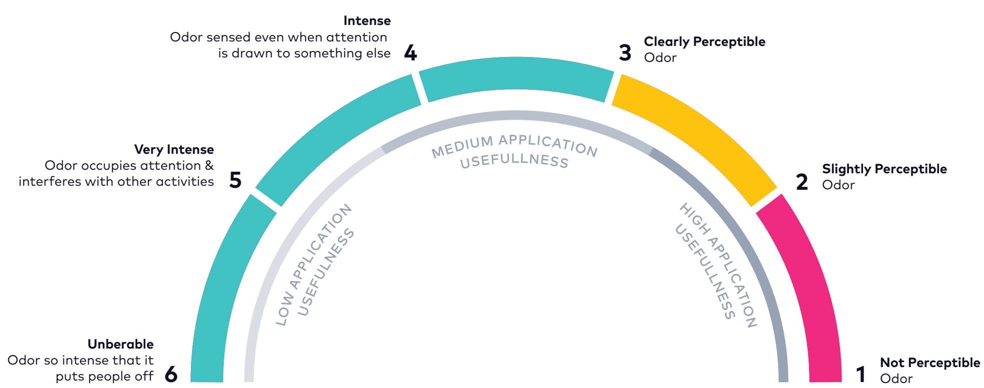

Figure 1: *Human sense of smell ratings and the related usefulness of that rating in a digital olfaction application*

The samples of new car smell and Rubber were in a vial. The samples of Cigarette odor and Cigarette post cleaning odor were 2 air sample in a bag.

Sample	Human Rating
New Car Smell	5 – Very Intense
Rubber	4 – Intense
Cigarette	2 –Slightly Perceptible
Cigarette Post Cleaning	1 – No Perceptible Odor

The new car odor was very intense for the human nose—and as expected the signal was strong for the SDOK platform alone. No Amplifier was needed to create a significant and stable signal.

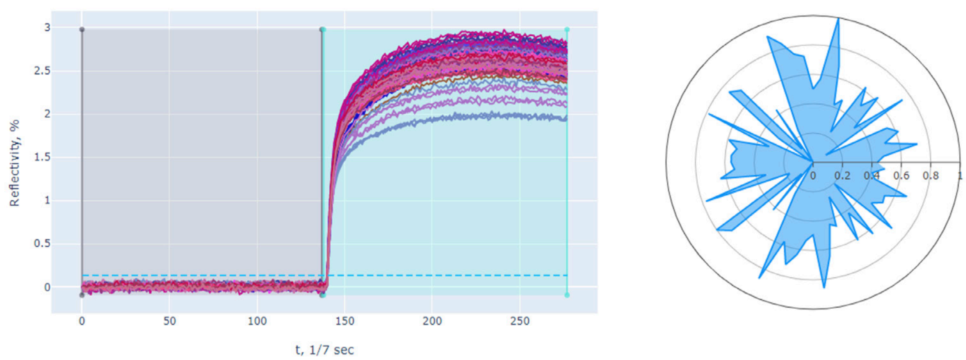

Figure 2: *The signal for the new car was above the limit of detection for the platform (A) and a stable odor signature (B) was captured using the SDOK alone.*

The second tests on rubber showed adequate signal for the SDOK alone and once again we were able to capture a distinct odor signature. However, the overall intensity was lower than the new car smell—as also witness by the human nose rating.

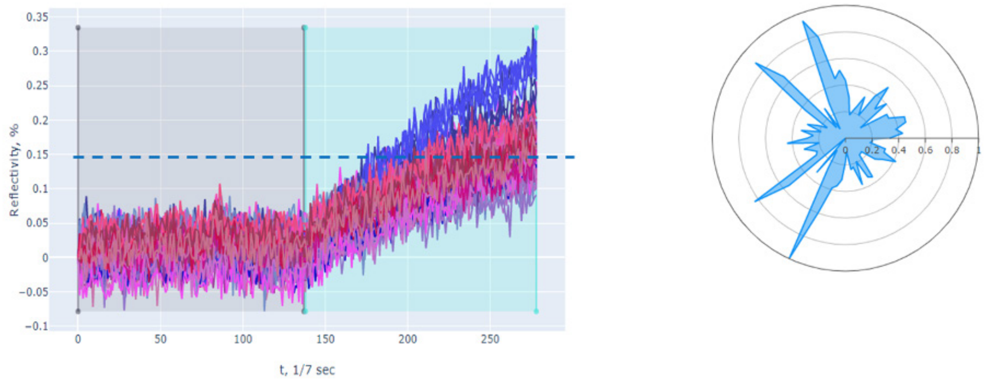

Figure 3: *Signal response for rubber was acceptably over the limit of detection for the SDOK alone (A). The response was stable over time and able to capture an odor signature (B) for rubber. This data was confirmed with the Amplifier with an improved signal.*

The cigarette odor sample was very close to the limit of detection for the SDOK and required use of the Amplifier to get a signal adequate enough to capture an odor signature, however even after 5 minutes of concentration the signal was still below the limit of detection for the device. The human rating for this particular odor was a 2, so it was only slightly perceptible to the human nose.

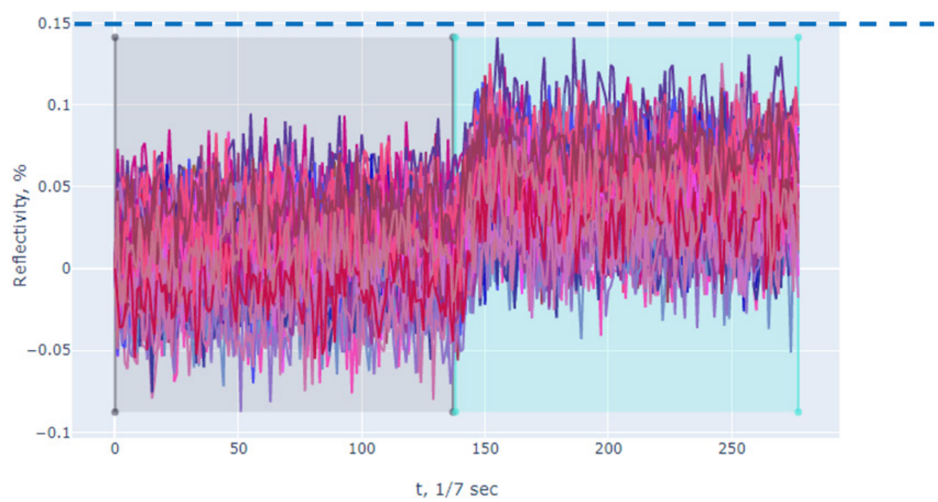

Figure 4: *Sensor response to the cigarette odor was below the limit of detection for the SDOK alone.*

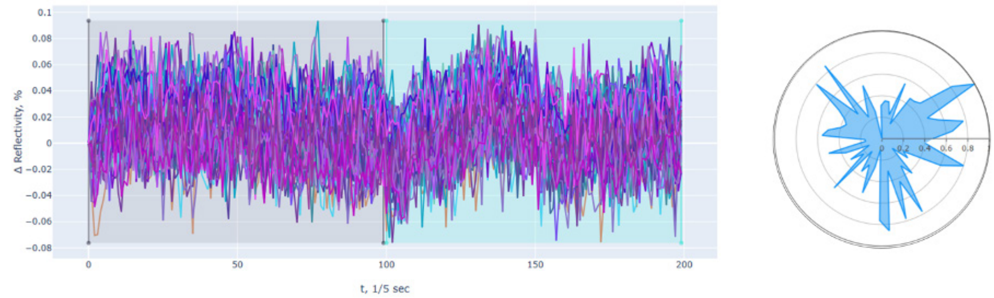

Figure 5: *After 5 minutes of concentration using the Amplifier accessory, the signal of the cigarette was still below the limit of detection for the device (A), a reproductible odor signature (B).*

The fourth sample simulated the efficiency of the cleaning process. This sample, labeled "cigarette post cleaning" had no perceptible odor to the human nose and the signal was below the limit of detection for the device both alone and with the Amplifier after 5 minutes of concentration.

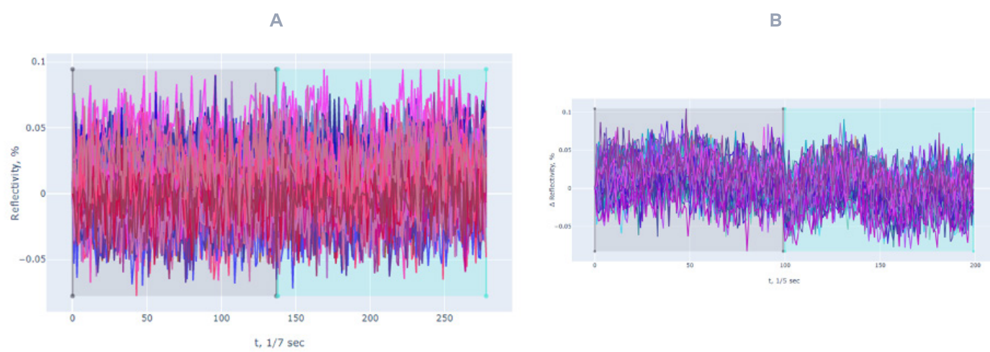

Figure 6: *The signal of both the SDOK alone (A) and after 5 minutes of concentration with the amplifier (B) were below the limit of detection for the cigarette post cleaning. We were not able to obtain an odor signature.*

Conclusion

In many of the tests performed, we were able to detect some level of signal with the SDOK device similar to the perceived intensity of the human nose, even without the use of the Amplifier. In most cases, we found that the ability for the device to detect when the human nose saw little to no perception of the odor was low.

In building the use cases for vehicle air quality, the connection between the human perception of cleanliness and the digital olfaction's ability to detect malodors is extremely important. Further tests need to be performed to establish the link between the human perception threshold and the total digital olfaction solution. However, initial tests on typical odors found in car cabins indicate that the use of an odor concentration device will be critical to establishing these limits.

About Aryballe

The best human noses can distinguish 10,000 odors. Unlike color and sound, smell does not fall along a clear spectrum, making it hard to compare various odors. But Aryballe is helping to change this by evaluating characteristics of individual scent molecules and testing them against a data-base of known smells using a combination of biochemistry, advance optics and machine learning.

Based in Grenoble, France, Aryballe develops and manufactures bio-inspired “digital nose” sensors enabling groundbreaking applications in the food, cosmetics and automotive industries. Founded in 2014, it released its first product, the digital nose NeOse Pro in early 2018. Fast, portable and sensitive to hundreds of odors, NeOse Pro is used for quality control in the cosmetic industry, new flavors development in the food & beverage industry, or materials quality monitoring in the automotive industry.

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