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Title:

Shaping the In-Car Listening Experience: Perceptual Insights and Dynamic Evaluation Methods for Modern Automotive Audio

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Abstract:

The rapid transition towards electric mobility and higher levels of driving automation is redefining the acoustic environment inside vehicles. As propulsion noise decreases and occupants devote less attention to driving, communication and entertainment functions gain importance, raising expectations for in-car audio performance. This paper examines automotive audio quality from both a perceptual and a measurement-oriented perspective.

A controlled listening study based on an Absolute Category Rating methodology was conducted to investigate how drivetrain type and driving conditions influence perceived playback quality and overall listening enjoyment. While the intrinsic quality of the audio system was rated similarly across electric and combustion vehicles, listening pleasure was strongly influenced by the surrounding noise environment. Electric vehicles offered a noticeably more enjoyable listening experience at low and medium speeds, whereas high-speed scenarios reduced listening satisfaction in both vehicle types.

In addition, the paper introduces dynamic measurement strategies designed to better represent realistic listening conditions. Spatially averaged frequency response measurements using a rotating artificial head and time-dependent interaural level difference (ILD) analyses with moving sources and listener motion are presented. These approaches provide perceptually meaningful insights into spectral balance and spatial rendering, supporting more effective tuning of automotive audio systems for both communication and entertainment use cases.