

Objective Evaluation Method for Interior Sound Quality in Electric Vehicles (Second Report)

- Sound-Quality Evaluation Method for In-Cabin Sound in Electric Vehicles -

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This study investigates an objective evaluation method for the interior sound quality of electric vehicles (EVs). In the previous study, it was shown that the “prominence of tonal noise” is an important factor in evaluating the sound quality of in-cabin electric powertrain (e-PT) noise, and that EPNI is an effective metric for representing this characteristic. However, actual EV interior sound consists of not only e-PT noise, but also road noise and wind noise. Therefore, EPNI alone is not sufficient to evaluate overall interior sound quality.

In this report, subjective evaluation experiments were conducted using EV interior sounds under nine driving conditions. Fourteen noise, vibration and harshness (NVH) development experts participated in the experiments. Scheffé’s paired comparison method was used, and the participants evaluated the unpleasantness of the presented sounds on a five-point scale.

The results showed that there were individual differences in the evaluation tendencies for EV interior sound quality, and the participants could be classified into two clusters, as shown in Fig. 1. However, in both clusters, the main evaluation criteria were “perceived loudness of sound” and “prominence of tonal noise.” Furthermore, multiple regression analysis was performed using psychoacoustic metrics: Loudness, EPNI, and Sharpness, as shown in Fig.2. The results indicated that, under most driving conditions, the subjective evaluation scores could be well explained by Loudness and EPNI, as shown in Fig.3. In particular, Cluster A tended to place greater emphasis on Loudness, whereas Cluster B tended to place greater emphasis on EPNI.

These findings suggest that the combined use of Loudness and EPNI provides an effective objective evaluation method for EV interior sound quality. They also indicate that reducing both metrics is important for enhancing the sound quality of EV interiors.

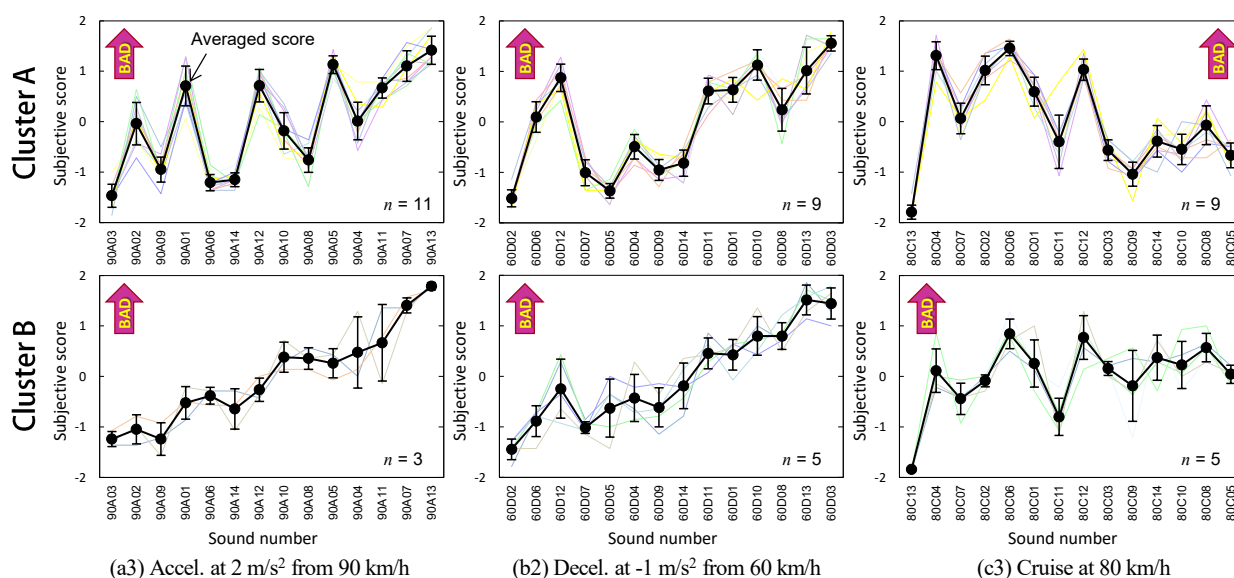


Fig. 1 Results of subjective evaluation experiments for unpleasant EV interior noise after clustering

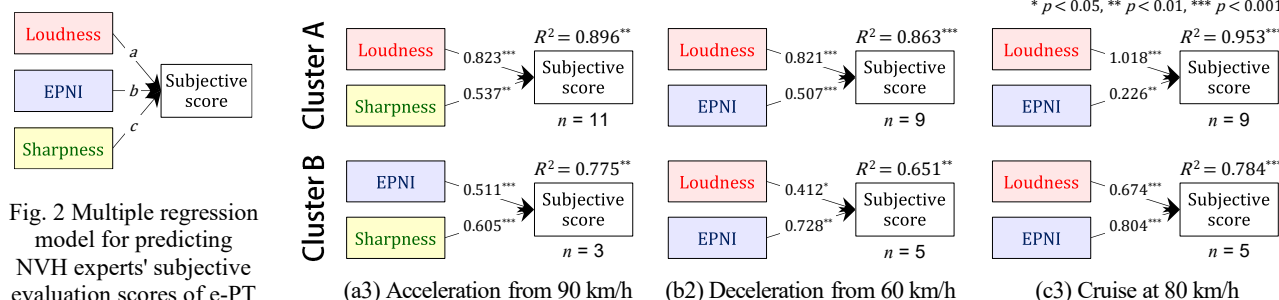


Fig. 2 Multiple regression model for predicting NVH experts' subjective evaluation scores of e-PT noise quality

Fig. 3 Results of subjective evaluation experiments for unpleasant EV interior noise after clustering