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Sound Quality Evaluation by SD Method for Passenger Car HVAC Noise (2nd Report)

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In our previous report, we conducted a sound quality evaluation of passenger car HVAC noise using the SD method. Then, we derived multiple regression equations by statistical analysis for subjective evaluations based on loudness and sharpness within the "Unpleasant ⇔ Pleasant" adjective pair. We also reported on the practical applicability of these findings to real car HVAC noises. In this report, we report on improving accuracy of the multiple regression equations from psychoacoustical point of view. In addition to, we similarly investigated the relationship between subjective evaluations using other adjective pairs "Calm ⇔ Sharp" as well as "Dry ⇔ Moisty" and psychoacoustic metrics. As a results, we obtained the new findings about the adjective pairs.

As shown in Figure 1, multiple regression analysis was performed for each group classified into two categories (high and low loudness) using partial sharpness filtered in the 800–3000 Hz band, and the multiple regression correlation coefficients were calculated. Figure 2 shows the correlation between partial sharpness and the "unpleasant <=> pleasant" rating.

Figure 1 shows the correlation between the predicted evaluation values obtained from this equation and the actual measured values obtained using the SD method. The correlation between the predicted subjective evaluation values and the actual measured values was high.

This suggests that the contributions of loudness and sharpness differ between air conditioning sounds with low loudness and those with high loudness; specifically, for sounds with low loudness, the perceived pitch sensitivity has a significant influence on the evaluation of "unpleasant vs. pleasant" (i.e., its contribution increases).

Based on these findings, we can demonstrate that the introduction of partial sharpness is effective in predicting subjective evaluations of air conditioning noise. We believe this can be efficiently utilized in the development and design of improved evaluation items for subjective assessments of air conditioning noise in the future.

Similarly, the partial roughness calculated in this manner was shown to have a high correlation with the "rough <=> smooth" evaluation score.

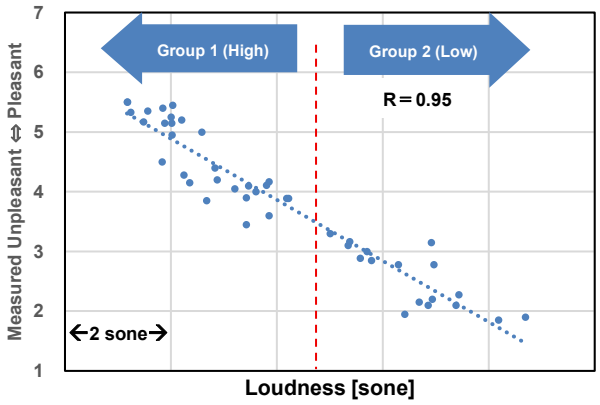

Figure 1 Relationships between score of "Unpleasant ⇔ Pleasant and Loudness of real car HAVAC noises

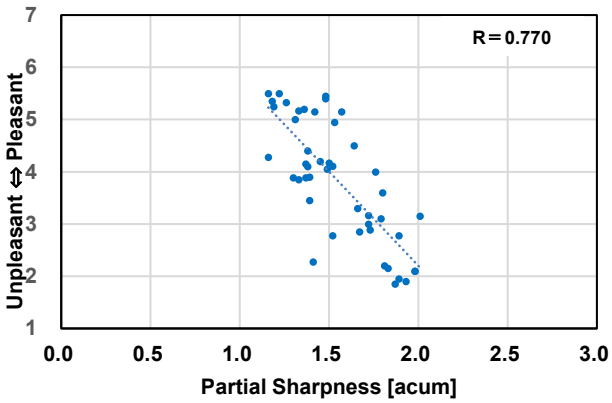

Figure 2 Relationships between Sharpness and "Unpleasant ⇔ Pleasant" evaluation with 800-3000[Hz] filtering

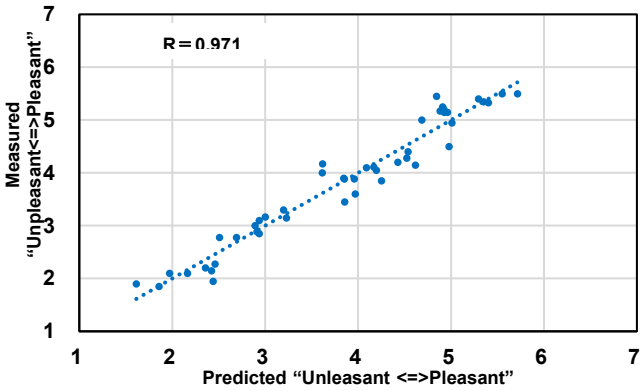

Figure 3 Relationships between predicted scores with partial sharpness in categorized loudness groups and measured score of "Unpleasant ⇔ Pleasant" for HVAC noise in real cars