EAEC2011_ A72

DEVELOPMENT OF A PREDICTION MODEL OF ACOUSTIC DISCOMFORT IN CARS FOR ENGINE IDLE SOUNDS

13th EAEC European Automotive Congress VALENCIA EAEC 2011

Palomares, N.; Mateo, B.; Huertas-Leyva, P.; Solaz, J.; Díaz, J.; De Rosario, H.; García, C. and Laparra, J.

IBV INSTITUTO DE BIOMECÁNICA DE VALENCIA

Introduction

Sound quality has become as important as other specifications that define the vehicle (design, equipment, colour, price...). Therefore, sound quality would be considered a distinguishing factor that could contribute to the car purchase decision.

The present study is aimed to develop a methodology to obtain an acoustic comfort model capable to predict the annoyance level of the sounds of engines running on idle of compact cars by means of the psychoacoustic parameters that characterize this specific sound.

Material and methods

The sound of the engine on idle of eight compact cars was measured. Once the main acoustic parameters were calculated, jury test sessions were carried out to assess the subjective annoyance of the sounds. Finally, an acoustic comfort model was calculated.

An artificial head measurement system was used to record the interior sound of the cars running on idle. Later, the main psychoacoustic parameters (level, loudness, sharpness, roughness, fluctuation strength and tonality) were determined to objectively characterize the sounds recorded.

The jury test was carried out by users rating the sounds in a continuous scale from 0=Non-Annoying to 10=Very annoying, both ends were established with two reference sounds (0 was the sound with lowest loudness value and 10 to the sound with highest loudness value).

Artificial head placed on the driver seat

Participants during a session

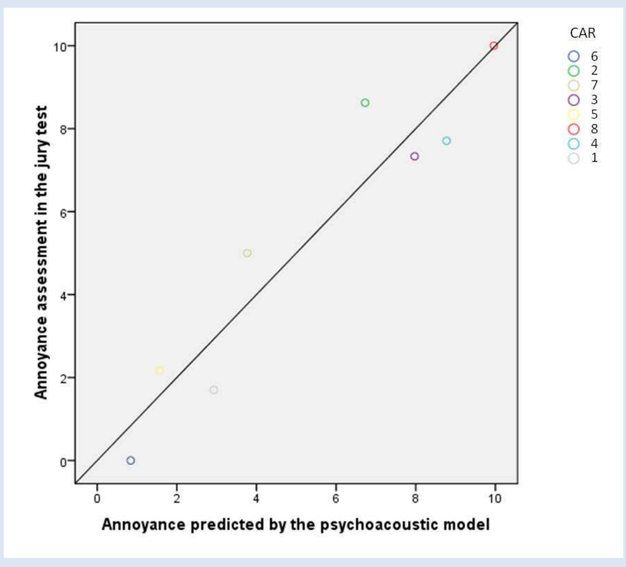
Results

The acoustic model was developed to predict the annoyance of the sounds using the psychoacoustic parameters as predictors. These potential predictors were the percentile 5, 50, and 95 and ranges (percentile 95 - percentile 5) of loudness, sharpness, roughness and level (A-weighted sound pressure level). The variable to be predicted was the average rate of the annoyance of each sound evaluated in the jury test.

The outcoming model uses as predictor variables the level (5 percentile) and the roughness (5 percentile), obtaining a high prediction capability ($R^2 = 0.86$).

Annoyance = -16.53 + 7.34·Roughness (p5) + 0.32·Level (p5)

Note: in acoustics, p5 is the level exceed for 5% of the time of the measurement duration.



Annoyance predicted by the psychoacoustic model versus the subjective assessment obtained in the jury test

Conclusions

As a result of the study, it can be concluded that the model obtained presents a high prediction capacity and it is capable to predict better the acoustic annoyance with the addition of the psychoacoustic parameters.

The main results of the study and the annoyance acoustic model will allow car designers to build vehicles with a high acoustic satisfaction level, assessing the car designed with respect to the rest of existing compact cars in the market.