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IMPLEMENTATION OF ACOUSTIC CONTRAST CONTROL BETWEEN THE SEATS IN A CAR CABIN-LIKE ROOM USING LOUDSPEAKERS ON FLOOR

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In this study, the broadband acoustic contrast control response variation (BACC-RV) for generating a bright zone (BZ) around the driver's head (front-left) and a dark zone (DZ) around the VIP's head (rear-right) using four loudspeakers on the floor in a car cabin-like room was examined. The purpose of the study was to investigate the achievable acoustic contrast control between the zones using the usual 4 door loudspeakers in a car. The frequency range of interest was 100 ~ 3,000 Hz and the sampling rate was 16,000 Hz. Two (or four) microphones were installed around the BZ and the DZ. From the experimental results applying the BACC-RV method, although acoustic contrast (AC) between the BZ and the DZ was fluctuated over frequency, the averaged AC was about 17 and 7 dB in the cases using two and four microphones, respectively. Also, the effects of the presence of a sitter on each seat in the BACC-RV method were discussed.

Keywords: personal zone, acoustic contrast control, bright and dark zone

1. Introduction

Implementing personal sound zones inside a car is one of important research topics in car manufacturing industries. The acoustic contrast (AC) between the bright zone (BZ) at a seat and the dark zone (DZ) at another seat in a car cabin-like room generated by the broadband acoustic contrast control response variation (BACC-RV)[1, 2] technique with 4 loudspeakers on the floor of the room was investigated.

This study discusses the achieved ACs inside such a cabin-like environment. The effects of the number of microphones at each seat and the presence of persons at each seat in the room during path measurement are mainly described.

2. Algorithm and control results

The interior dimensions of the room were approximately 2000 mm (length) x 1500 mm (width) x 1900 mm (height) and its internal volume was about 5700 mm^3. Four desk chairs were arranged on the floor in the room as usual four car seats. Four mid-range loudspeakers (Tannoy mercury 7.1) were then located on the floor in the same space just beside each chair to mimic the door loudspeakers of a car. The front-left and the rear-right chairs were assumed as the driver and the VIP seats in a car to make one BZ and another DZ. Either two or four microphones were installed to measure the acoustic responses at each head position of the two seats. The distances between each microphone were about 200 mm at each seat.

The BACC-RV technique was applied to design the control filter to generate a BZ and a DZ in the room. The controlled frequency range was about 100 ~ 3,000 Hz. A dSPACE 1401 was used to implement the control filter and its sampling rate was 16,000 Hz in the control experiment.

The measured average ACs between the BZ and the DZ using the BACC-RV when the number of the microphones was 2 (solid line) or 4 (dotted line) were presented in Figure 1(a). It indicates that the achieved average AC with 2-microphones is about 10 dB greater than that with 4-microphones. This is because the 4-microphones covered a larger BZ and DZ than the 2-microphones.

In addition, Figure 1 (b) shows that the average AC when the 2-microphones were installed at each seat is influenced by the presence of a sitter during the path measurement. The average AC if the path with the sitter was applied in the control algorithm is approximately 11 dB greater than no sitter. This result implies that the improved average AC can be achieved by the measured path with the sitter is applied in the algorithm because the personal sound zone is meaningful when the seat is occupied by a passenger.

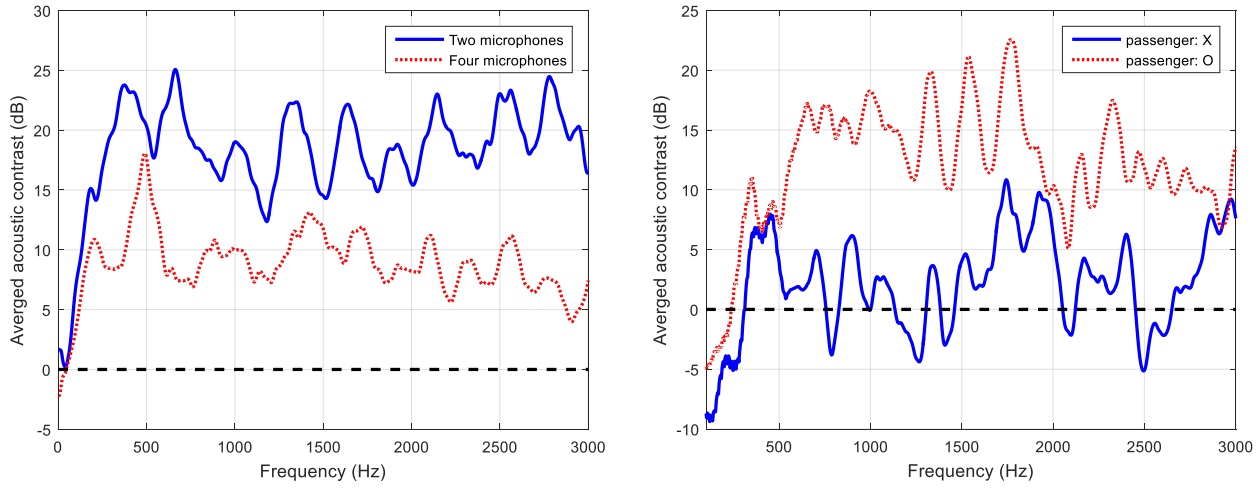

Figure 1. Comparisons of the average acoustic contrasts. (a) Effect of the number of microphones. (b) Effect of the presence of a passenger during the path measurement.

3. Conclusion

In this study, experimental investigation for generating personal sound zones at two separate seats in a car cabin-like room using the BACC-RV was performed. It is noted that AC between the BZ and the DZ in the room can be higher when less microphones are used with the BACC-RV algorithm, but the size of each zone becomes smaller. Also the presence of a sitter during path measurement affects the performance of the algorithm to achieve a higher AC.

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