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ACTIVE CONTROL OF ROAD NOISE CAUSED BY TIRE CAVITY-RESONANCE IN PASSENGER CAR BASED ON OPTIMIZED WEIGHTS-FXLMS ALGORITHM

Sang-Kwon Lee[1], and Kanghyun An[1] , Inha University, Incheon, South Korea

ABSTRACT

This study proposes a new method for active noise cancellation (ANC) of cavity noise of a tire. A general method for ANC of road noise is to use several accelerometers for acquirement of reference signals. Cavity noise of tire is caused by the resonance of tire cavity mode. Resonance frequencies of tire cavity are determined by the cavity structure of tire. Therefore, harmonic sinusoidal signals related to resonance frequencies can be used for reference signals. However, resonance frequencies could be varied due to small change of tire cavity during driving of a car. For the overcome of this variation, adaptive filter of ANC system was designed and applied to the ANC of a cavity noise. It is called optimized weights filtered-x LMS algorithm (OW-FxLMS). The proposed method did not need accelerometers for the ANC of cavity noise and practically was applied to the ANC of cavity noise of a tire in a car. Tire cavity noise of a test car was attenuated to 3-5 dBA

ACTIVE NOISE CONTROL OF TIRE CAVITY NOISE

An active noise reduction device for reducing resonance was installed in the test vehicle and driving was conducted. The experimental equipment and peripheral equipment used in the experiment are as shown in Fig.1.

The test vehicle was driven at a constant speed of 50 km/h on the public road. As shown in Fig. 4(a), error microphones were installed on the left and right sides of the driver's seat head to measure indoor noise before and after active noise control. The secondary sound reproduction speaker was installed in the seat behind the driver's seat.

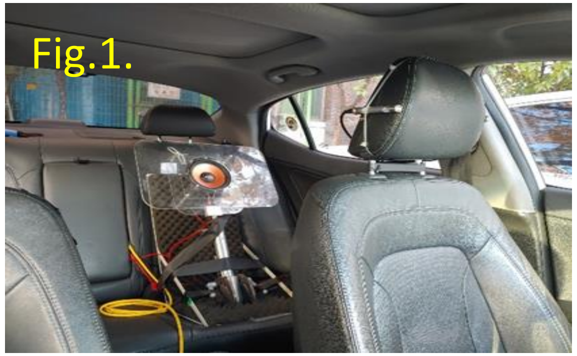

Fig.1.

Fig. 2 is a schematic flow chart of the equipment used in the active noise control system for active noise control of tire resonance used in this study. The tire resonance noise control procedure generates a sine wave harmonic signal corresponding to the measured tire resonance frequency in real time using signal processing technology in a control computer. The generated sinusoidal signal is used to create a reference signal for the FxLMS algorithm.

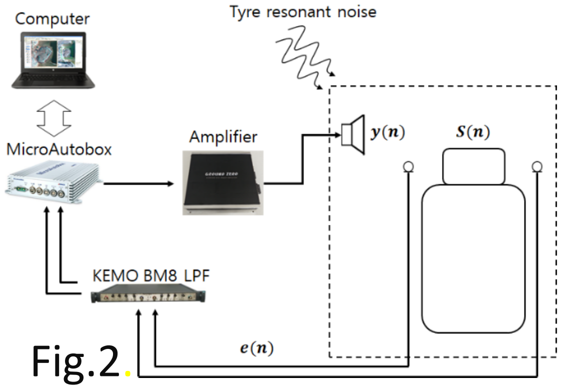

Fig.2.

Fig. 3 shows the difference in sound pressure between the applied and non-applied ANC in each driving test. It shows the degree to which the sound pressure is reduced between 210 Hz and 230 Hz corresponding to the resonance frequency band. The filter length of the algorithm was 15 and the test run was repeated 18 times. In all trials, when ANC was applied, it was confirmed that noise was reduced in the frequency band corresponding to tire resonance. When the test results were averaged, the reduction effect of 2.79 dB at 218Hz and 3.63dB at 226Hz in the case of the measurement signal of the driver's seat left microphone during ANC, and the noise reduction effect of 4.01 dB and 2.54dB at the right microphone position, respectively, were confirmed.

In addition, in order to compare the active noise control performance with the passive method, the resonance noise reduction results using the Helmholtz resonator conducted in the same vehicle and the same driving conditions were compared.

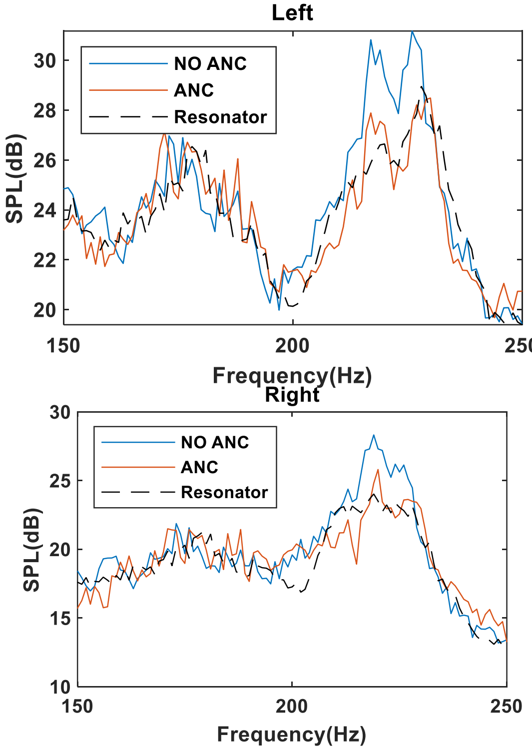

Fig.3.