Active Noise Control for Automobiles

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Abstract—Active noise control (ANC) is used to reduce unwanted sound by producing an “anti-noise” signal that cancels undesired sound, this is based on the principle of destructive interference. This project focuses on creating a cost-effective solution to reduce ambient noise inside a vehicle. The design consists of 4 microphones, an audio interface, mini-pc, amplifier, and the vehicle’s existing sound system. The ANC algorithm is run on the mini-pc and designed to cancel low frequencies in the range of 46 Hertz to 1500 Hertz by 5dB to 10dB.

Keywords-Active; noise; canceling; audio

I. INTRODUCTION

There are more drivers today than ever before. More safety measures must be in place to keep everyone safe. Constant ambient noise can cause driver fatigue. About 2.5% of fatal car crashes are a result of a fatigued driver. [2] In addition to reducing fatigue, the system is designed to make the driver more comfortable so that the driver can focus more on driving and less on the unimportant noise around him or her.

II. NOISE CANCELLATION

Sound travels in waves. During their interactions they can either increase or decrease the volume of the sound, see Figure 1. ANC systems use this property of sound to reduce the level of ambient noise. The algorithm takes the input sound filters it, and then inverts the amplitude. Systems like this are most effective in enclosed spaces where the “anti-noise” sound wave can stay near to the ambient noise source. This technology is used in phones, headphones, and automobiles.

III. COMPONENT SETUP

A. Microphone Placement

The microphones have been placed at the optimum locations to ensure the best sound detection. There are four microphones, two reference and two error mics. The reference mics are placed in the vehicle’s footwell under the dash to detect engine and tire noise. The error mics are placed near the driver’s and passenger’s heads to measure how much of the initial sound is still being heard by the occupants.

B. Necessary Connections

The microphones are connected to a USB audio interface via XLR cables. The audio interface provides phantom power to the condenser mics, and acts as a pre-amplifier for the mic signals. The audio interface is connected to the mini pc via a USB cable. This provides power to the interface and allows for data transfer. The mini pc is connected to a standard vehicle amplifier with a 3.5mm TRS jack and converts the signal to dual RCA ports. The speaker wires coming out the amplifier are wired in parallel with the vehicle’s stereo system so that the ANC system can run, or the stereo can play.
C. Speaker Placement

The speaker placement was also considered as to obtain the maximum noise cancellation through uniform sound distribution throughout the vehicle. The team chose to utilize the existing speakers in the vehicle since the automotive manufacturer has placed them fully intending the best sound of encapsulating the occupants.

A diagram of the system can be seen in Figure 2 below.

![Figure 2: Diagram of ANC System](image)

IV. ANC ALGORITHM

The ANC system operates in two domains, an acoustic domain, and an electrical domain. The acoustic domain represents the cabin space in which the noise propagates through. While the electrical domain represents the electrical path, or the path the signal undergoes in the filtering process. An ANC algorithm can represent both domains in a simple block diagram, as shown in Figure 3 below.

![Figure 3: Block Diagram of ANC System [3]](image)

Accounting for both domains is essential for functionality of the system and represented in the complete FxLMS algorithm.

V. CONCLUSION

In conclusion the designed ANC system aims to reduce physical noise with a frequency of 46 Hz to 15000 Hz by 5 dB to 10 dB inside the vehicle cabin. The ANC system is based on a FxLMS algorithm to filter the signal shifted by 180°, the signal is received by two microphones, and send it to the DSP that contains the designed algorithm and is produced by the car’s audio system to finally be updated by the microphones near the passengers.

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REFERENCES

