ANCCAR: Active Noise Cancelling System for a Automobiles

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***Abstract*—Modern vehicles aim to provide supreme comfort to daily drivers using a variety of methods such as panel insulation, improved tire treads, and suspension design. However, these systems wear down over time and often fall short of optimal noise reduction within the cabin. This project aims to alleviate the noise pollution within the cabin of a vehicle using a non-invasive system to actively measure noise within the vehicle and produce an inverted output to create a true noise cancellation. The system targets the driver and passenger inside the vehicle by uses two microphones and two speakers,an audio box, microcomputer and amplifier to process the undesired noise. The non-invasive installation is created by using 3D printed housing components for all the electronics, such that panel retainers readily available within the vehicle can be substituted for the provided screws. This prevents the need for any drilling or threading of any surfaces of the vehicle. Power is supplied through the vehicle battery and into a fuse box and power converter to control the operating and steady state voltage and amperages.**

I. Introduction

Over 200 million Americans drive their vehicle to and from work on a daily basis, often times at highway speeds [1]. The droning noise from the vehicles engine and tires contacting the road surface can be both annoying and lulling to many drivers. The majority of daily commuters are in a vehicle over five years of age. This indicates that the vehicles are worn in many ways which often leads to greater noise pollution passing through the cabin of the vehicle. Modern vehicles attempt to combat this noise pollution by adding insulation to the inner frame of the vehicle, however this tends to be very costly and adds a large amount of weight to the vehicle. As a result, drivers sacrifice fuel economy for peace and quiet. Since the automotive industry is not fully vested in electric vehicles, some form of noise cancellation must be available, especially for older vehicles since they dominate the majority of roadways.

Previous active noise cancelling systems utilize a collection of inertial sensors as well as multiple microphones to capture vehicle motion data, process it through an algorithm, and output the cancellation throughout the vehicle cabin. The primary downside of such kind of system is the excessive cost, difficulty of installation, and limitation of compatible vehicles. The ANCCAR system tackles all these challenges in one effective solution and is affordable and feasible for nearly all vehicles.

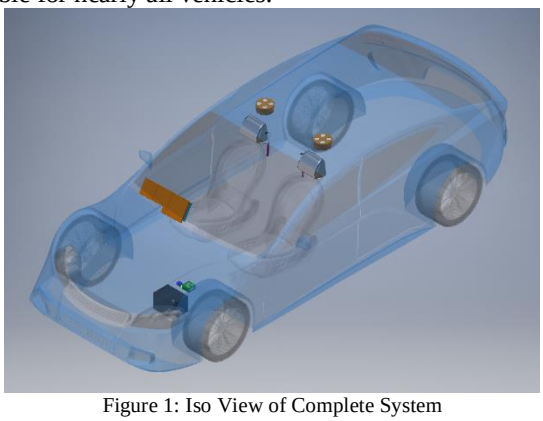

Figure 1: Iso View of Complete System

The ANCCAR system is one third the price of currently available noise cancelling systems, as well as 15 times lighter than traditional noise dampening butyl rubber inserts.

II. Mechanical Design

The ANCCAR system uses a set of 3D printed housings to secure each electrical component to the vehicle in a safe, non-invasive, and spacing limiting method. The system consists of two speaker housings printed in SLA, a control board printed in FDM, as well as a housing for an amplifier, a microcomputer, and an audio box which is printed in SLA.

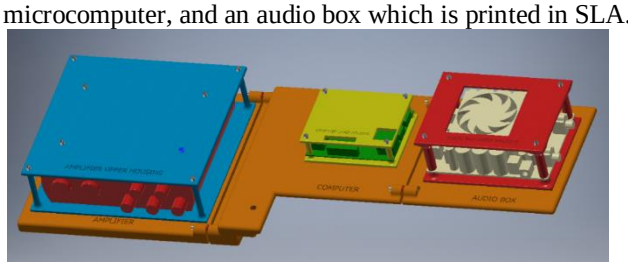

Figure 2: Computer Control Rack Assembly

The speaker assemblies come preassembled and are suspended from the roof of the vehicle's cabin via four

neodymium magnets. The placement of the speakers should be placed behind the driver and passenger's head to prevent blocking driving visibility. The neodymium magnets generate a net vertical pull force of over 80 pounds. This ensures that the speaker assembly (weighting approximately 1.5 pounds) will not detach from the cabin roof from any large shock load or vibration which the vehicle will undergo. Each electrical housing as well as the control board are easily assembled using the provided machine screws. These screws are set into helical inserts which prevent them from backing out due to vibration. Additionally, the use of helical inserts eliminates the need for users to have additional tools beyond the provided 2.5mm hex key. Furthermore, a double flip safety switch is attached to the inside panel of the driver side center console via a Velcro strip. This eliminates the need for fastening the switch to the body panel yet creating an easy use on/off switch for the driver to control the operation of the system. In most vehicles the control board will be placed underneath the passenger side glove box. This is both beneficial for not interfering passenger space and creating a discrete wiring path. The provided microphones come with a clasping mechanism that allows them to be securely placed on the inside bar of the head rest.

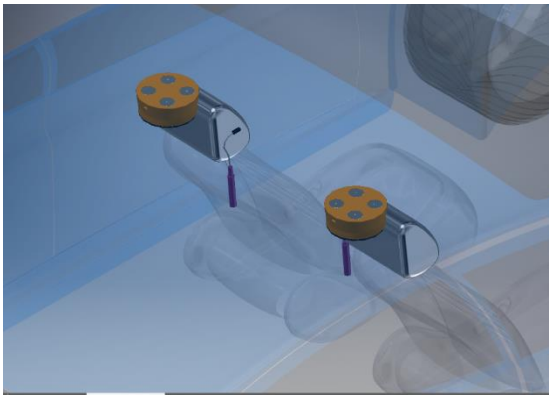

Figure 3: Microphone placement

Once more these microphones are positioned such that they fall within one inch of the head rest so that they do not interfere with the driver's vision. In the event the vehicle does not have a detachable head rest, an alternative mounting solution can be made readily available.

III. Electrical Design

A. Computing System

The main processing power for the ANCCAR comes from the LattePanda but is not actually the microcomputer inside, it is the Arduino Leonardo that is imbedded on the back side of the board. This board uses an ATmega32u4 chip with 32KB of memory and 2.5KB of ram. This allows a code be uploaded from the microcomputer to the Arduino for daily operation and signal p-processing.

B. Operating

Normal operation uses two compact microphones with an audio interface to create an analog signal. This signal is processed though the Arduino Leonardo which outputs a corrected analog signal. This signal is sent to a compact 2 channel amplifier that powers two low-profile speakers behind both of the front seats.

The noise inside the cabin of a vehicle is collected and corrected through actively sampling and filtering in real-time fashion. This system uses many types of filters in order to achieve approximately half of the engine noise while leaving many high frequency sounds unattenuated. The output is limited in its magnitude to make sure the system is stable.

C. Power System

The system is powered with the stock electrical system of the vehicle. A fuse block and power converter are located in the engine bay to provide safe fused 12 volt and 5-volt sources to power all of the components. A 12 volt connect is wired to the amplifier and a 5-volt connection is powered the LattePanda. The LattePanda power rail is connected to the USB ports, the Arduino Leonardo board, and the microcomputer screen port. This allows all components power instantly whether the microcomputer is on or off.

IV. Abbreviations and Acronyms

FDM: Fused Deposition Modeling
SLA: Stereolithography
ANC: Active Noise Control

V. .Conclusion

The ANCCAR system allows common road and engine noise to be collected, analyzed, and inverted to cancel most of the noise pollution within the vehicle's cabin. The system is intended for a user friendly, noninvasive installation method. This system will provide optimal noise cancellation without hindering the weight and fuel economy of the vehicle. Moreover, the system does not break the bank into parts and it is a cost effective manufacturing method. The reduction of noise pollution in the vehicle will make for a much more comfortable ride for the driver as well as allowing them to have more focus and less irritability on longer drives.

Acknowledgment

This work was done with the support and guidance of Dr. Lichuan Liu, Dr. Nicholas Pohlman, and Sonali Rawat.

References

[1] Wagner, I. "Number of Drivers Licensed in the U.S. 2018." *Statista*, I. Wagner, 9 Jan. 2020.