Results for Natural Hearing Restoration for Encapsulating Helmets

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In the field, it is common for soldiers to be required to wear helmets. Specifically, soldiers that require protective encapsulating helmets usually have difficulty with hearing while wearing their helmets. Currently the soldiers use a communications earplug device known as the CEP. This device serves to both protect the ear from harmful noises such as a helicopter engine and provide communication with the crew. However, it has been determined that the overall effectiveness and scope of the process should be increased to include reproduction of the noises created outside the helmet. This would restore the natural hearing of the soldier. One must keep in mind that the integrity of the helmet must not be compromised because of its protective characteristics. It has been determined the best way to accomplish this design is to place a number of microphones on the outside of a helmet which then produces a signal that goes through a filter, controller and amplifier and then fed back into the helmet where the signal is reproduced for the user.

The Natural Hearing Restoration for Encapsulating Helmets project is a continuous effort to produce a working filter, controller and amplifier for use with a prototype helmet and also to find the best configuration of microphones on the surface of the helmet. The main goal for the project was to find a way for someone wearing an encapsulating helmet, such as a motorcycle helmet, to hear as if that person was not wearing a helmet. This would require certain experimentations on acoustical qualities of different materials in question such as the helmet and microphones representing an ear inside a KEMAR head (Knowles Electronics Manikin for Auditory Research). The tests performed in this project included finding transfer functions between the noise source and the KEMAR head, with and without the helmet on the body.

Results show that when the KEMAR head was facing away from the sound source the microphone representing the ear would pick up pressure waves of much less magnitude. This could be caused by a number of reasons; mainly, diffraction and reflection. The sound waves must travel a farther distance to the ear facing away from the speaker. Another reason is that the sound waves must diffract around the helmet to reach the ear. One can also see a severe dip in the frequency response at higher frequencies. This is because above a certain frequency, the pressure waves are not able to diffract around the head. This frequency is directly related to the diameter of the head. Once the wavelength of the frequency is shorter than the diameter of the head then it no longer has the ability to diffract around the helmet. For the case of the helmet, that frequency is approximately 1400 Hz.

In conclusion, we know that the pressure waves that travel near the KEMAR head are affected by the shape and direction of the ear and head. The sound can be distorted in many ways such as being reflected inside the ear canal and reflected off the torso of the mannequin. The next step in the restoration of natural hearing for encapsulating helmets project is to be able to quantify the results of what we have tested. Spatial hearing or localization testing would be an appropriate form of measurement to create quantifiable results for future comparison. The suggested method to achieve this is to test a prototype on actual human hearing.