ABSTRACT

Active noise control (ANC) systems mitigate noise by detecting incoming noise and generating an anti-noise signal to attenuate it with destructive interference. While commercial systems (e.g. noise-cancelling headphones) excel at mitigating low-frequency noise, they are typically supplemented with passive noise control (PNC), such as earmuffs, to attenuate high-frequency noise. However, the PNC solutions may block out sound indiscriminately, which can hinder communication and situational awareness. This project proposes a potentially more effective ANC system, implementing an external array of microphones located around the user to estimate the noise path and increase the distance between the sensors and the user. The increased distance will afford the ANC system more time to calculate and generate anti-noise signals, thereby improving high-frequency cancellation. The system also can detect noise from any direction, and can be implemented to only cancel noise from outside the system, allowing the user to wear open-back headphones to facilitate communication with others within the array. The microphone array is designed to determine the locations of each microphone, the user, and the noise sources using a time delay of arrival (TDOA) algorithm. By tracking the user and noise in real-time, the noise paths can be estimated for the feed-forward Filtered-x Least Mean Squared (FxLMS) algorithm, which adjusts the weights of the controller based on the TDOA instead of an error microphone and feedback loop. The simulated results of the proposed ANC system were compared to that of a system using impulse responses (IRs) to determine the noise path and a traditional FxLMS adaptive algorithm. As expected, the ANC system with IR measurements had the lowest root means square (RMS) error of -50.16 dB, followed by the proposed ANC system using TDOA with an RMS error of -33.76 dB, and the adaptive FxLMS with an RMS error of -22.73 ± 0.66 dB.