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Speakers - as a sensor for detecting acoustic loads with Artificial Intelligent

AI-enabled earphones using speakers as sensors for accurate, low-cost hearing and audio diagnostics.

In acoustic research, two critical devices play pivotal roles: microphones and speakers. Typically, microphones are used as sensors to capture acoustic signals, while speakers act as actuators to generate sounds. However, this methodology faces several limitations, including the need for significant computational power and complex signal processing. Additionally, microphones often suffer from crosstalk and noise interference, affecting the accuracy and reliability of measurements. These limitations have prompted researchers to consider speakers, traditionally known for sound production, for their potential in monitoring ear conditions.

Speakers, as two-port electroacoustic transducers, can serve both as sensors and actuators to gather physiological data related to hearing sensitivities and changes in acoustic loads. Researchers at Purdue University have optimized this concept and combined it with an established artificial intelligence model to produce a novel earphone technology. This new technology can be used to not only produce but to measure loads attached to the speaker's output port such as a diaphragm, acting in concert with an artificial intelligence interface to achieve a more accurate sense of acoustic load. This model cuts down on the traditional requirement for expensive combinations of speakers and sensors, streamlining the research process and reducing upfront expenses. The use of AI also enables the earphone sensor to accurately synthesize and interpret the input it receives, making it a reliable tool for research and development teams. This innovative earphone technology will help speaker production companies, hearing aid manufacturers, and other related parties detect ear canal lengths and measure acoustic load in an inexpensive manner compared to traditional microphones and sensors without compromising on validity or thoroughness.

Technology Validation:

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Category
Artificial Intelligence & Machine Learning/Audio Sensing & Signal Processing
Computing/Internet of Things (IoT)/Audio & Acoustic Edge Devices
Digital Health & Medtech/Assistive & Diagnostic Audio Technologies

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Electrical impedance data were collected and pre-processed for machine learning (ML) model training. Different image forms were tested, including magnitude-only and combined magnitude-phase. Using 2100 data samples with CNN-based models (AlexNet, ResNet, DenseNet), binary and multiclass classifications achieved average accuracies of 0.9716 and 0.907, respectively.

Advantages:

-Combines microphones and speakers for a more powerful and accurate measure of acoustic load

-Utilizes artificial intelligence to process readings more quickly and accurately

-Inexpensive compared to available solutions

-Simple speaker condition and type distinguish tests without external devices

Applications:

-Speaker production companies

-Hearing research industries

-Hearing-aids

-Hearing measurement devising companies

Publications:

Noori Kim, Hui-Jun Kim, Sung-Hee Kim; Speakersâ€"Used as sensors for detecting acoustic loads with artificial intelligence. J. Acoust. Soc. Am. 1 August 2024; 156 (2): 1319â€"1323. https://doi.org/10.1121/10.0028298

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load measurement,Electroacoustic sensing,Real-time audio analysis,Intelligent transducer systems,Acoustic health monitoring,Audio system optimization,Machine learning for audio,Advanced speaker testing,Impedance-based sensing

References

1. Noori Kim, Hui-Jun Kim, Sung-Hee Kim(45505) , https://doi.org/10.1121/10.0028298, https://pubs.aip.org/asa/jasa, 156, 1319-1323