Design of system for automatic detection and classification of aircraft noise events

ABSTRACT

As the aviation sector continues to expand its share in global passenger and cargo transportation, issues related to the environmental impact of associated emissions are gaining increasing importance. Noise pollution, which affects the comfort and health of communities living near airports, is also considered a significant environmental concern. To effectively manage air traffic with the goal of reducing noise emissions in sensitive areas, such as densely populated residential zones, continuous noise monitoring is essential.

The fundamental premise of current methods for measuring aircraft noise is to determine the L_{AE} (Sound Exposure Level) for each aircraft operation within the reach of measurement equipment. A critical component of this task is the precise extraction of aircraft noise events from the unwanted signals recorded by the instruments, known as acoustic background noise. This dissertation proposes a method for analyzing measurement data that enables the automatic detection of acoustic events associated with aircraft operations and describes the implementation of this method in a real measurement system.

Based on sound level measurements of aircraft noise conducted from 2022 to 2023, accompanied by one-third octave band spectral analysis, and leveraging advances in deep learning techniques, a convolutional neural network architecture was developed. This network is capable of efficiently extracting key signal features while adhering to the constraints imposed by the measurement technique on input signal representation. The study also defined a method for interpreting the model's outputs, which allowed for the identification of acoustic events with an accuracy of 97%.

The research confirmed the potential of deep learning-based solutions in the spectral data analysis for identifying sources of acoustic signals recorded using relatively simple measurement systems. This opens up broad applications, including in smart city solutions that facilitate public transport management to ensure acoustic comfort for city residents, as well as in systems detecting objects with specific acoustic signatures that cross the boundaries of designated areas.

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