# Introduction

All commercial aircraft are subjected to rigorous testing before certification by government regulatory agencies such as the FAA in the USA or the European Aviation Safety Agency in the European Union as defined the regulations of each agency. A part of the certification testing requires that the noise levels of the aircraft are measured and do not exceed the levels set in the regulations. The noise certification testing requires flying the aircraft in a set of prescribed airframe configurations (landing gear up or down, slats and flaps deployed or retracted) and engine power settings over a prescribed array of microphones installed on the ground near the end of a runway. The test procedure has the pilots set the aircraft one of the prescribed configurations on approach to the test site. When the aircraft reaches the test site threshold the microphone signals are recorded until the aircraft leaves the test zone. The noise data is then processed to compute the perceived noise levels (REF) for each configuration and compared against the allowable limits. The noise certification tests require enormous effort and resources by the aircraft companies of the aircraft to plan, execute, and report out on and a failure to comply any part of the regulations, including required noise levels, could result in a failed certification which would prohibit the sale of aircraft or non-compliance with levels guaranteed to potential customers.

To ensure the best possible data for the noise certification tests, aircraft companies seek test sites with low background or ambient noise levels (REF). In addition, personal may be assigned to monitor the microphone signals for noise contamination that would increase the measured and recorded noise levels of the aircraft. Typical examples of noise contamination are road and vehicle traffic noise, other aircraft in the vicinity, insect noises, bird calls, and wildlife and livestock vocalizations. The noise monitors can alert testing staff to presences of the noise contamination such that corrective action can be taken such as voiding the condition and requesting a repeat run, requesting a delay in the arrival of the test aircraft, and proactive remove of biological sources. This approach is costly due to:

* Travel costs for the monitors.
* Specialized workstation computers and software for the monitoring workstations.
* Storage, shipping, setup, and networking support for the workstation computers.
* Validation and testing of the analysis applications, especially the communications with other data acquisition systems at the test.

Also, human monitors can be subjected to:

* Mental fatigue of the monitors from the repetitive menial task, resulting in a reduction of the quality and consistency of the classification over time.
* Inconsistencies and subjectivities of the classification from monitor to monitor.
* Limited ability or knowledge to accurately account for noise contamination corrections available to analysis staff at post-acquisition data reduction.
* Limited post-test review opportunities for training and enhancements.

This work proposes to create an automated environmental noise contamination detector, particularly biological noise contamination, using machine learning methodologies. Eventually, this automated system would remove the need for the multiple work stations and staff providing significant cost reductions for the community noise fly-over capability. The automated system also would provide increased accuracy and consistency of the classification thus increased efficacy of the test for further significant cost reductions. The detector should alert community noise test crews of the presence of environmental noise contamination continually, in real-time, thus allowing them to respond by either removing the sources from the measurement area before the arrival of the airplane or by declaring the on-condition recording out of tolerance and requesting a repeat of the condition.

The remainder of this paper is outlined as follows. The next section describes overall process of creating a machine learning algorithm for detection and outlines the implementation into a real-time system. This is followed by a description of processing applied to an example set of data and evaluates the performance of the various techniques investigated. Finally, this paper finishes with a discussion of conclusions of the results and recommendations for additional work.

Background

(including previous work)

training

Acquire signals with known provenance

Prediction (offline or streaming)

Acquire signal

Segment signal as done for training data

Run each segment through trained classifier to make predicted class (clean vs contaminated)

Raise alert and log data if contaminated

# References

Code of Federal Regulations. (2016). Title 14, Part 36, Noise Standards: Aircraft Type and Airworthiness Certification. Washington, D.C.: Federal Aviation Administration.

International Civil Aviation Organization. (2014). Standards and Recommended Practices, Annex 16. *Vol. 1, Aircraft Noise, 7th*. Montreal, Canada: International Civil Aviation Organization.

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