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Development of a Signal Analysis Technique for Aircraft Identification by Converting Audio Signals using Fourier Transforms

Hypothesis

The audio signal of an aircraft in flight creates a unique signature that can be used to identify it.

Purpose of Study

The purpose of this project was to apply Fourier analysis to aircraft sound patterns to analyze their digital identity.

Rationale and Significance

Security agencies such as the CIA, DOD, FBI, or NSA could use the passive Fourier analysis technique described in the study to identify lost aircraft or monitor aircraft suspected of engaging in illegal activities that might not be found using air traffic control, radar, and daylight cameras. This technique could also be useful in the implementation of “no-fly” zones in areas of conflict or for enforcing border security against aircraft that attempt to smuggle contraband into the nation. Energy companies could also use this technique to locate sources of geothermal energy while weather agencies could utilize active Fourier analysis to identify the location of earthquakes or volcanic activity.

Method

A preliminary review of literature on sound analysis revealed a study of a violinist using Fourier transform analysis to compare recordings. This research provided the grounds and inspiration to test whether this technique could be used to include identifying particular aircraft by their sound.

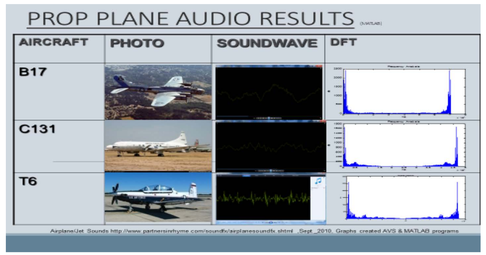
A microphone and portable sound recorder placed outside a fence midfield on a runway captured 5-10 second audio signals of a variety of aircraft as they took flight. Analog signals were digitized as MP3 files, then converted to WAV files for analysis by MATLAB (MathWorks). A frequency vs. amplitude plot yielded sound signatures for each aircraft that was tested.

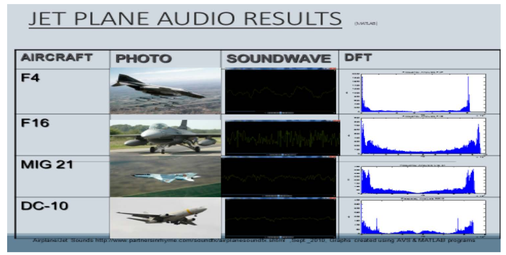
Fourier transform analysis revealed the frequency spectra for each signal. GNU (gnu.org) Octave sound processing software created a difference plot between same, similar, and different aircraft types to determine the reliability of repeatable evidence and whether the researcher could distinguish aircraft types using sound spectra.

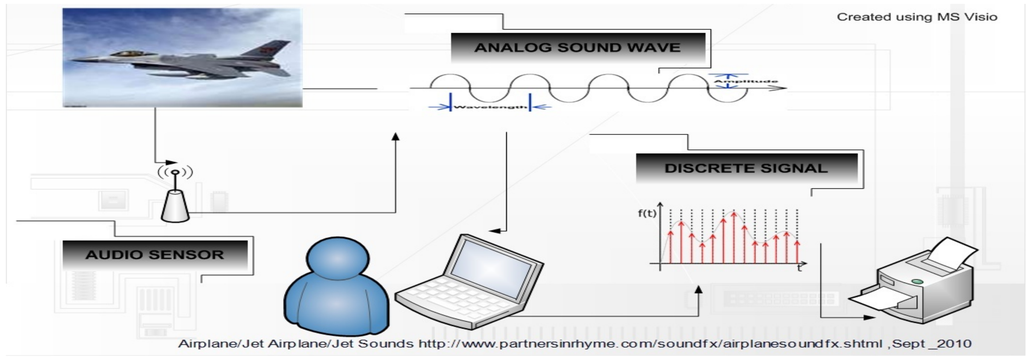
Findings

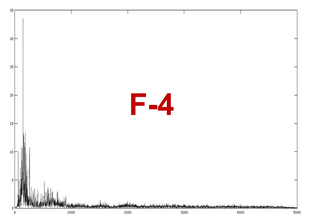
Fourier transform and comparative analysis of digitized aircraft sound spectra showed distinctive visual differences among aircraft types. The researcher was able to accurately identify aircraft types from their digital sound signatures.

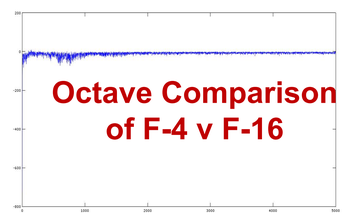
Aircraft DFT Results

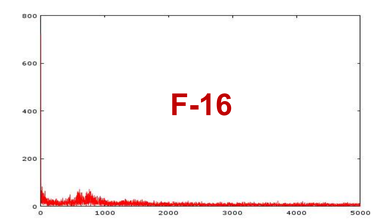


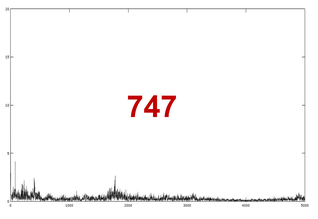


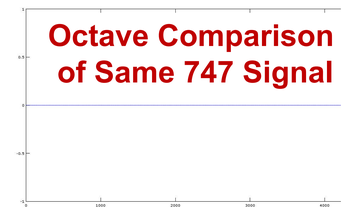


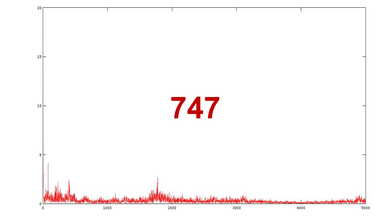












Conclusion

There is appropriate evidence to support the hypothesis that the audio signal of an aircraft in flight creates a unique signature that can be used to identify it.