Research Journal of Applied Sciences, Engineering and Technology 5(14): 3732-3735, 2013
DOI:10.19026/rjaset.5.4517
ISSN: 2040-7459; e-ISSN: 2040-7467

Submitted: July 27, 2012 Accepted: September 17, 2012 Published: April 20, 2013

Research Article

The Aircraft Sonic Feature Extraction Based on the Wavelet Analysis

Nuan Song, Shuang Xu, Jun Li and Jingyuan Shi
Air Force Aviation University, Chang Chun 130022, China

Abstract: The aircraft passive sonic detects and identification technology as a traditional means of reconnaissance is an important component of airborne early-warning system. Using the sound wave what the acoustic targets produces in the rate process, to identify the targets is the basic task of passive acoustic detection system. This study using modern signal processing method studies the wavelet transform feature information extraction method of target audio signals. Based on the two kinds of battlefields targets about the audio spectrum characteristics, using the characteristic pick-up arithmetic of the wavelet decomposition measure detail signal domain energy which is based on wavelet theorystudy using this algorithm obtains lower-dimensional feature vector.

Keywords: Aircraft, audio features, pattern recognition, wavelet analysis

INTRODUCTION

The aircraft sonic feature target recognition belongs to the category of pattern recognition, as shown in Fig. 1, which shows, pattern recognition system mainly divided into data acquisition, pretreatment, feature extraction and selection, classification and decision-making four parts. In the aircraft passive sonic feature recognition system, target recognition is key to the feature extraction and classifier design. Among them, the feature extraction was more key, it had decided the classifier classification effect quality. The more information contained in the category from the eigenvector from feature extraction, the less information will be interfered, the effect of classification will be better. Paul and Newberg (2006) study the Andrew new berg. Artificial neural network classifier for the diagnosis of Parkinson's disease using trodat-1 and spect. Physics in medicine and bid logy. Al-Taani (2003) has a research of the efficient feature extraction algorithm for the recognition of handwritten Arabic digits. Zhu and Abeer (2003) have a research of the non-linear feature extraction for robust speech recognition in stationary and non-stationary noise. Blumenstein *et al.* (2003) analyze the novel feature extraction technique for the recognition of segmented handwritten characters. Jeffrey and Raymond (2006) have a research of the Wavelet-based functional mixed models.

This study using modern signal processing method studies the wavelet transform feature information extraction method of target audio signals. Based on the two kinds of battlefields targets about the audio spectrum characteristics, using the characteristic pick-up arithmetic of the wavelet decomposition measure detail signal domain energy which is based on wavelet theorystudy using this algorithm obtains lower-dimensional feature vector.

INTRODUCTION AIRCRAF AUDIO CHARACTERISTIC ANALYSIS

The armed helicopter target audio characteristic analysis: The causes of the armed helicopter noise are very complicated. The noise characteristics of the armed helicopter mainly consist of three parts, namely the rotor noise, tail rotor noise and engine noise. Among them, the engine noise is a broadband high-frequency noise, it is different from the main rotor and the tail rotor noise, it must be treated separately. Because of its energy partial collection in high frequencies, in the far field air attenuated fast, this study does not consider the impact. So the rotor noise (including tail rotor) became the main noise source of detection system. The tail rotor noise generating mechanism and estimation methods is the basic same as the main rotor. From the analysis of the results look: the noise spectrum of the helicopter from discrete spectrum and broadband spectrum composition, it is a typical noise spectrum which on the basis of the broadband spectrum superimposed a series of discrete spectrum.

The rotor noise includes spin noise and broadband noise. The rotor spin noise is caused by the load periodic disturbance and blades thickness. When role in the lift of the blades and resistance with blades in different position and cyclical change, the surrounding air force with blades rotate together and presents to periodic disturbance. Thickness noise is caused by the thickness of the blades. Through the blades rotate, the thickness of the blades forced displacement periodic filling the volume of a gas around, from this the noise produced.

Corresponding Author: Nuan Song, Air Force Aviation University, Chang Chun 130022, China

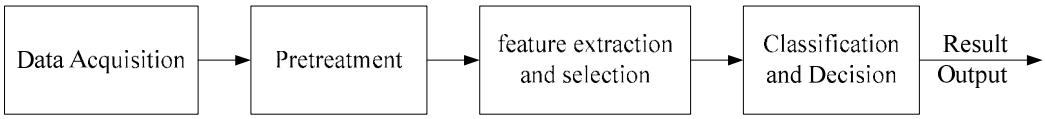


Fig. 1: Diagram aircraft sonic feature target identification system

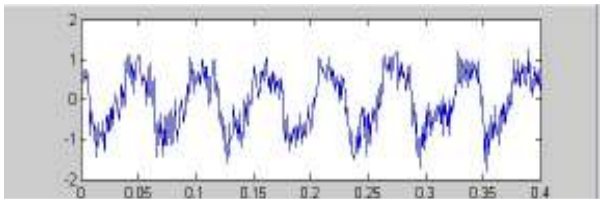


Fig. 2: The helicopter flight state audio signal waveform time domain

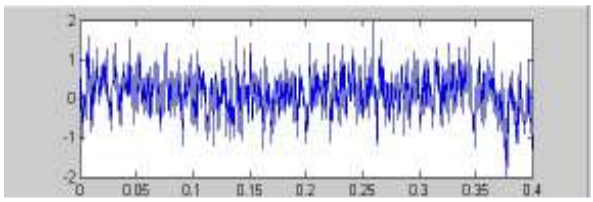


Fig. 3: The fighter flight state audio signal waveform time domain

The rotor broadband noise is the main role in the blades pulse power on random and cause.

Predictably, the typical helicopters noise spectrum is based in broadband noise superimposed on a series of discrete linear spectrum, the Frequency of the linear spectrum were respectively leaf through the frequency BPF (Blade Passing Frequency) and its every harmonic frequency. The main energy of the helicopter noise is generally concentration in the 1000 Hz less than. At low frequency (10-100 Hz), Lord Propeller noise is dominant, noise occurs in the BPF and every harmonic; at the medium frequency band (100-500 Hz) the main contribution of noise is from the tail rotor, noise occurs in the tail rotor BPF and every harmonic; at the higher frequency band, noise present broadband characteristics. The helicopter flying state of the audio signal waveform time domain is shown in Fig. 2.

Fighter planes target audio characteristic analysis: The aircraft noise is all kinds of the acoustic radiation comprehensive when the aircraft flight. The aircraft noise is basically divided into two kinds, namely the propulsion system noise and air dynamic noise. The propulsion system noise is including the propeller noise, jet noise, fan/compressor noise, turbine noise and combustion noise, etc. Air power noise is caused by blowing air flow through the air pressure produced disturbance, also called the noise. For different types of aircraft, the noise source in the plane of the proportion of the total noise is not the same. In the case of fighter, the noise is mainly from the aircraft noise, fan/compressor noise and jet noise etc.

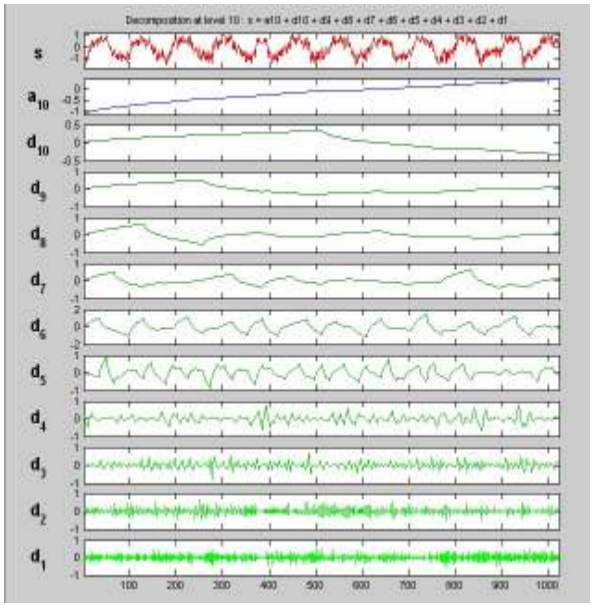
The noise mainly contains: the wing and the rear wing noise, landing device noise, rear edge flap noise and front wing noise seam. In normal flight condition, the main noise is from the wing broadband noise. The grooves and the discrete points in the smooth surface produce the low frequency pure tone. About the Large High-Bypass Ratio Turbofan Aero engine for contemporary, fan/compressor noise has a prominent place. For high speed rotating fan/compressor, discrete noise is dominant. The interference in the leaf between the rotor and the stator interaction produce cyclical change unsteady aerodynamic is fan/compressor discrete noise generation principal principle. The jet noise generation is when the rest of the jet flows into or slower airflow velocity, the jets around the rest of the media and relatively sharp mixed, thus make the jet boundary layer formed in the strongly turbulent pulse. Gas of the need to change the momentum by force to balance and in no solid boundary of pure air flow, the forces of change is caused by the pressure change, flow pressure in the area and cause density ups and downs, it spread to the flow of the regions outside the media, they form a jet mixture noise.

Fighters noise signal is from a low frequency to high frequency broadband signal, the main energy concentrated in the low frequency (500 Hz below), for medium low continuous spectrum, within 800 Hz the low frequency is obviously characteristic peak. The medium frequency noise is by higher harmonic caused by extension. The time domain noise signal waveform of fighter planes flying noise is shown in Fig. 3.

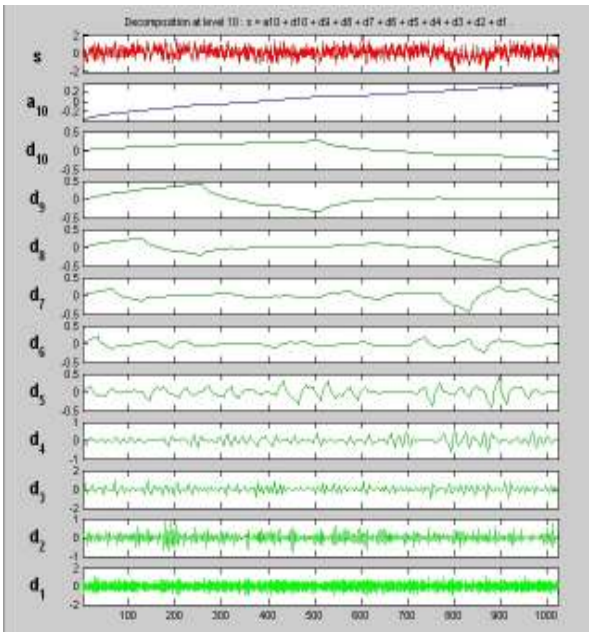
This study focused on two kinds of aircraft, attacking helicopters and a certain type of fighters, using the wavelet analysis method. First, the multi-resolution analysis nature by using wavelet transform, After 10 a layer of decomposition from the passive audio signal of the aircraft, extract the wavelet coefficients from every layer. Finally, calculate the energy of each layer, then take the power for normalization. Get the vector after the three steps as the characteristics vector of aircraft target.

THE AIRCRAFT AUDIO SIGNAL FEATURE EXTRACTION

The wavelet transform can be described as a function $f(t) \in L^2(R)$ through the band pass filter output response. Therefore, the wavelet transform will



(a) The helicopter 10 a layer of wavelet analysis



(b) The fighter 10 a layer of wavelet analysis

Fig. 4: Two kinds of aircraft 10 a layer of wavelet analysis

change a signal into a logarithmic coordinates with the same size of multimodal band set. The resolution cells with scale factor d change and change, when a more hours, the frequency domain distinguish performance is poorer, time domain distinguish performance is better; When a increases, the frequency domain distinguish performance increases study the time domain resolution is reduced. The wavelet transform due to its good time scale positioning properties, make it not only can well reflect the characteristics of the signal frequency domain, but also can be well give its time domain of the description, therefore, by using wavelet transform extracted features has stability.

The wavelet transform is the essence of the original signal filtration process, the wavelet function selection is different and the decomposition results are different. But no matter how to select the wavelet function, each decomposition scale of filter center frequency and bandwidth used a fixed proportion, it will have the so-called "constant Q" characteristics. So the space of the smooth signal and detail signal can provide the original signal frequency when local information, especially it can provide different frequency band on the structure of the information signal. If the different scale of signal decomposition for energy out, then can according to scale these to an order form feature vector for identify with. This is the basic principle which based on wavelet transform to extract the multi-scale space energy characteristics. For microphones, the battlefield target radiation noise contains the distribution of the energy spectrum and the size the of goal, shape and type closely related. Therefore, after the wavelet decomposition of the scale space can be thought of as the energy distribution is the essential characteristics of target, used for recognition.

The wavelet Daubechies, respectively 10 a layer of wavelet decomposition about helicopters and a fighter two kinds of targets audio signal, decomposition in detail signal is shown in Fig. 4.

In this study, the two types of aircraft target level 10 data the scale of wavelet decomposition is calculated study all of the scale space normalization energy. Set e_j to the first level of detail space scale j energy, the scales of energy level 10 characteristic vector can be expressed as:

$$F = (e_1, e_2, e_3, e_4, e_5, e_6, e_7, e_8, e_9, e_{10}) \quad (1)$$

Signal subspace of energy in each can be expressed as:

$$E_j = \sum_{k=0}^{n_j} (d_{j,k})^2 \quad (2)$$

In the expression, n_j is the coefficients for j layer wavelet. Then, using $e_j = E_j/E_{max}$, make the subspace energy normalization, among them $E_{max} = \max(E_j)$.

CONCLUSION

This study mainly studied the aircraft audio feature extraction based on the wavelet analysis. The feature extraction using db2 wavelet, the signal is 10 layer decomposition, extract the every layer of the scale of

coefficient study calculated the different scale of energy decomposition signal and then normalized. Make a group of the normalized data after a histogram, the difference is obvious that using wavelet analysis can be used to extract the characteristics of aircraft audio signal recognition. Finally, make this power forming feature vector according to the scale order for the following classifier design and recognition.

REFERENCES

Al-Taani, A.T., 2003. An Efficient Feature Extraction Algorithm for the Recognition of Handwritten Arabic Digits. Retrieved from: http://130.203. 133. 150/showciting;jsessionid = 72031052068 1DF36 FC1D25B53CDB10FB?cid=5342273

Blumenstein, M., B. Verma and H. Basli, 2003. A novel feature extraction technique for the recognition of segmented handwritten characters. Proceedings of the 7th International Conference on Document Analysis and Recognition (ICDAR).

Jeffrey, S.M. and J.C. Raymond, 2006. Wavelet-based functional mixed models. Royal Statist. Soc., 2: 179-199.

Paul, D.A. and A. Newberg, 2006. Artificial neural network classifier for the diagnosis of Parkinson's disease using TRODAT-1 and SPECT. Phys. Med. Biol., 51: 3057-3066.

Zhu, Q. and A. Abeer, 2003. Non-linear feature extraction for robust speech recognition in stationary and non-stationary noise. Comput. Speech. Lang., 17: 381-402.