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Detection of Moving Vehicles Using Multiple-Level Decomposition Wavelet Analysis

By

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Abstract:

This paper introduces an enhanced set of feature extraction for Automatic ground vehicle recognition (AGR), AGR features recognition is a required task in security and surveillance systems. Vehicle direction may be used in tracking object for traffic control or other applications. Multi-acoustic sensor and single seismic sensor were used for feature extraction and direction tracking. Wavelet analysis was used as a powerful tool for acoustic feature extraction. Sixth level wavelet analysis has enabled the extraction of enough features leading to high precision tracking and recognition.

Keywords:

Voice recognition, Detection of moving vehicles.

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1. Introduction:

The goal of AGR is to detect the arrival of vehicles and identify its type. Generated Acoustic waves from a vehicle were used for extraction of its acoustic features, which were considered as acoustic signatures. Vehicle presence recognition was carried out by implementing three main steps: First, The training step, which was mainly dedicated to form a reference feature for establishing database for the features of each vehicle type. Second, the Identification feature extraction step, which aims for extraction of features of the current acquired signals. The third step is responsible for the deciding which of the extracted features (in second step) belong to target signal acquired in the 1st step [1]. The extracted features should enable the differentiation between different sound sources. Numerous approaches for sound recognition have been proposed. Those approaches primarily differ from each other based on the way they the features were extracted and how the decision making step was accomplished done. Acoustics signals emitted by vehicles have quasi-periodic structure. It stems from the fact that each part of the vehicle emits a distinct acoustic signal which is included in the frequency domain and appears in a few dominating bands .As the vehicle moves, the conditions are changed and the configuration of these bands may vary, but the general disposition remains [2]. Therefore, the acoustic signature for the class of signals emitted by a certain vehicle is assumed to be obtained as a combination of the inherent energies in blocks of wavelet packet coefficients of the signals, which is related to a certain frequency band. These assumptions have been taken into account in the detection and identification of a certain type of vehicle. This paper represents an enhanced algorithm for acoustic signature extraction with the help of wavelet analysis. Wavelet analysis is a powerful tool for feature extraction, it depends on speaks on approximations and details. The approximations are the high-scale, low-frequency components of the signal. The details are the low-scale, high-frequency components.

Section 2 of this paper illustrates the related work. Section 3 describes the proposed algorithm, Section 4 discuses the performance evaluation algorithm including experimental results. Section 5 presents some concluding remarks.

2.Related work:

In this Many researchers' papers have proposed method for handling the detection of moving objects. The key difference was the way the acoustic signals were analyised. Basically, there were two ways for acoustic signal analysis. First, using time, Kie B. Eom.[3] introduced a time-varying autoregressive modeling approach for the analysis of the signals following the application of a discrete cosine transform. Second, using the frequency domain, this way can be divided into Fourier and wavelet analysis, M.E.Muich [4] used a short Time Fourier transform (STFT) to perform classification of moving object. Amir Averbuch[2] has proposed a technique for feature extraction depends on wavelet analysis of acoustic signal combined with a procedure of random search for a near optimal footprint (RSNOFP) for decreasing the number of false alarms. Choe et al. [5] utilized the discrete wavelet transform in order to extract the acoustic features. The classification to vehicle types was achieved by a comparison of the feature vectors to a reference database via statistical pattern matching. Ruhi Sarikaya[6] used a technique based on wavelet analysis for extract acoustic features set called subband based cepstral (SBC) parameter similar to the one presented in this paper. In his proposed technique 24 subband wavelet packets transform. Which represent the Mel-scale frequency division, as shown in Figure (1) were the wavelet packet tree was constructed by cascading the basic two channel filter bank into various levels. But, in the method proposed by this paper, work we used two models 48 and 64 subband wavelet packet transform for extract SBC features were used .

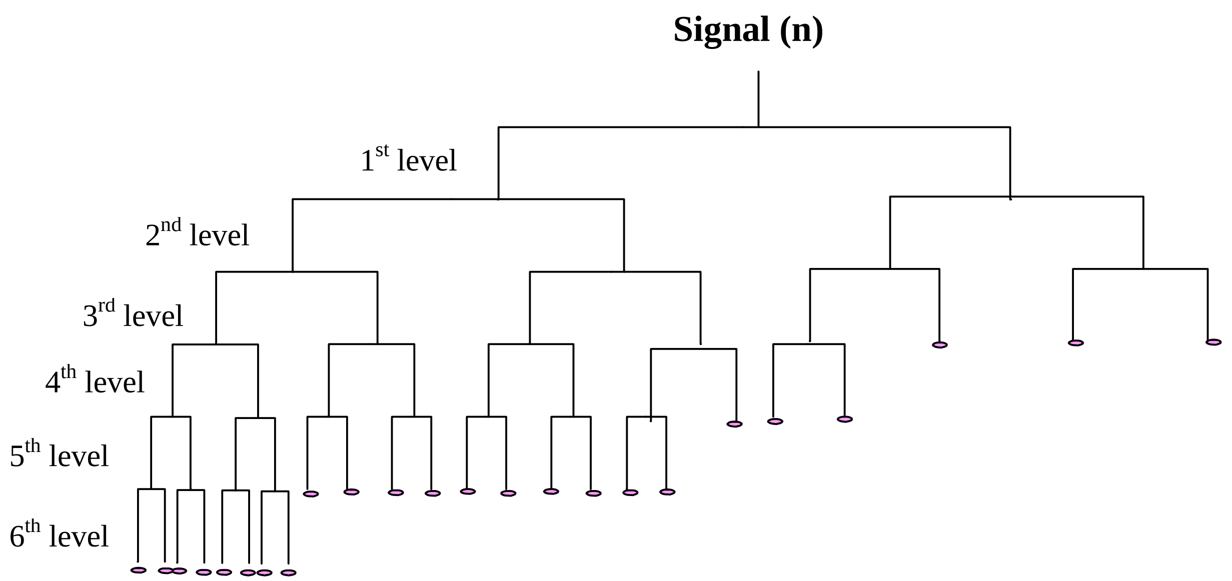
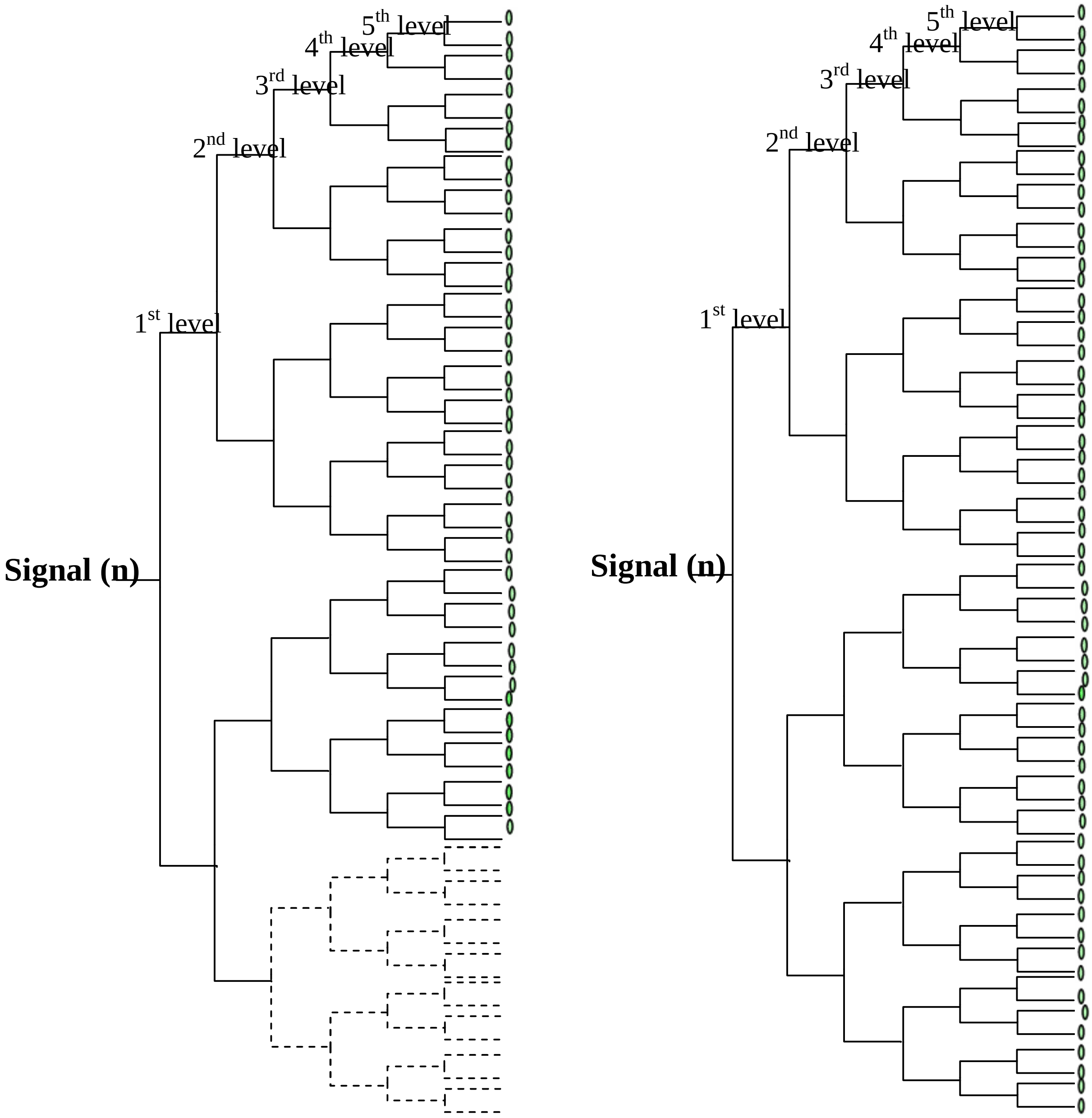


Figure (1): *Distribution of 24 subband wavelet tree*

3. Algorithm:

In this paper we address a technique to enhance the extracted feature for the training step. The extracted features were based on wavelet analysis, these features are the SBC two models were implemented form which the (SBC) parameters were extracted, these models represent the distribution of subband obtained by wavelet analysis. Figure(2) depicts the subband distribution for the two models.



(a) (b)

Figure (2): *system sensitivity by (a) 48 distributed subband (b) 64 distributed subband*

Figure.3 illustrates the functional block diagram of the proposed technique for the detection of Moving Vehicles technique. The functional block diagram consists of four steps: Window step, Wavelet Transform step, Energy distribution step and SBC Extraction step.

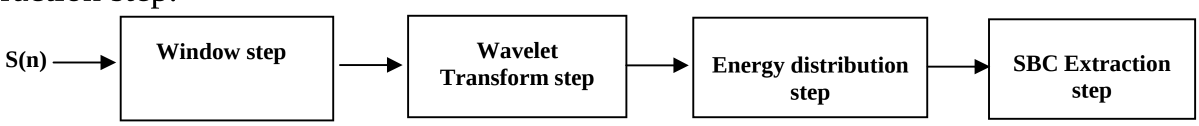


Figure (3): *Functional block diagram of proposed technique*

The technique starts with Window step, in which a window is applied to the captured signal to construct a frame with the specified sound samples numbers. Then the Wavelet Transform step starts. This step is responsible for transformation of frame (packet) obtained from first step, as mentioned before two subband distribution models were constructed, these two model would be implemented in the Wavelet Transform step, figure 3 illustrates the two subband distribution models .The Energy distribution stage enables the calculation of energy at each subband in the model. The energy of sub-signals for each subband is computed and then scaled by the number of transform coefficient in that subband. The subband signal energies are computed for each frame using the following formula:

$$S_i = \frac{\sum_{m \in i} [(Wx)(i), m]^2}{N_i} \tag{1}$$

Where WΨx is wavelet packet transform of signal x ,i is subband frequency index and Ni is the number of coefficients in the ith subband.
Finally, SBC Extraction step is to deduce the SBC parameters,the SBC parameters are derived from subband energies which are obtained from the previous step by applying the discrete Cosine Transformation defined by the following :

$$SBC = \sum_{i=1}^{L} \log S_i \cos\left(\frac{n(i-0.5)}{L}\pi\right), n = 1,.....n' \tag{2}$$

Where n' is the number of SBC parameter and L is the total number of frequency bands.
A configuration similar to the one reported in [6] was used, sound wave was sampled at 8kHz, a frame size of 24 msec and 10 msec skip rate were chosen

4. Results and Discussion:

This section demonstrates the results obtained by applying the proposed vehicle detection technique using 64 and 48 subband distribution models to acoustic signals of different vehicles types. The results were compared with the results obtained by applying the technique using 24 subband distribution model. In order to acquire the generated acoustic wave from different moving objects (vehicles), a high fidelity recording system was used .After acoustic signal recording, a play back system was used to play the signal for deep signal analysis using signal processing platform, the following Figure(4) demonstrates fragments of acoustic signals that were recorded for three different types of vehicles.

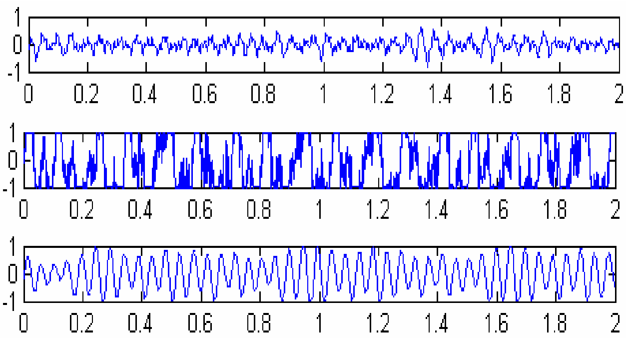


Figure (4): *Fragment of three different vehicles acoustic waves*

For each model, three different packets of the same acoustic signal were selected and the proposed technique was applied to these packets to obtain SBC features. Figure (5) shows the extracted SBC feature for 24, 48 and 64 subband distribution models. Figure (6) illustrates the difference between the three packet's features for the same acoustic signal.

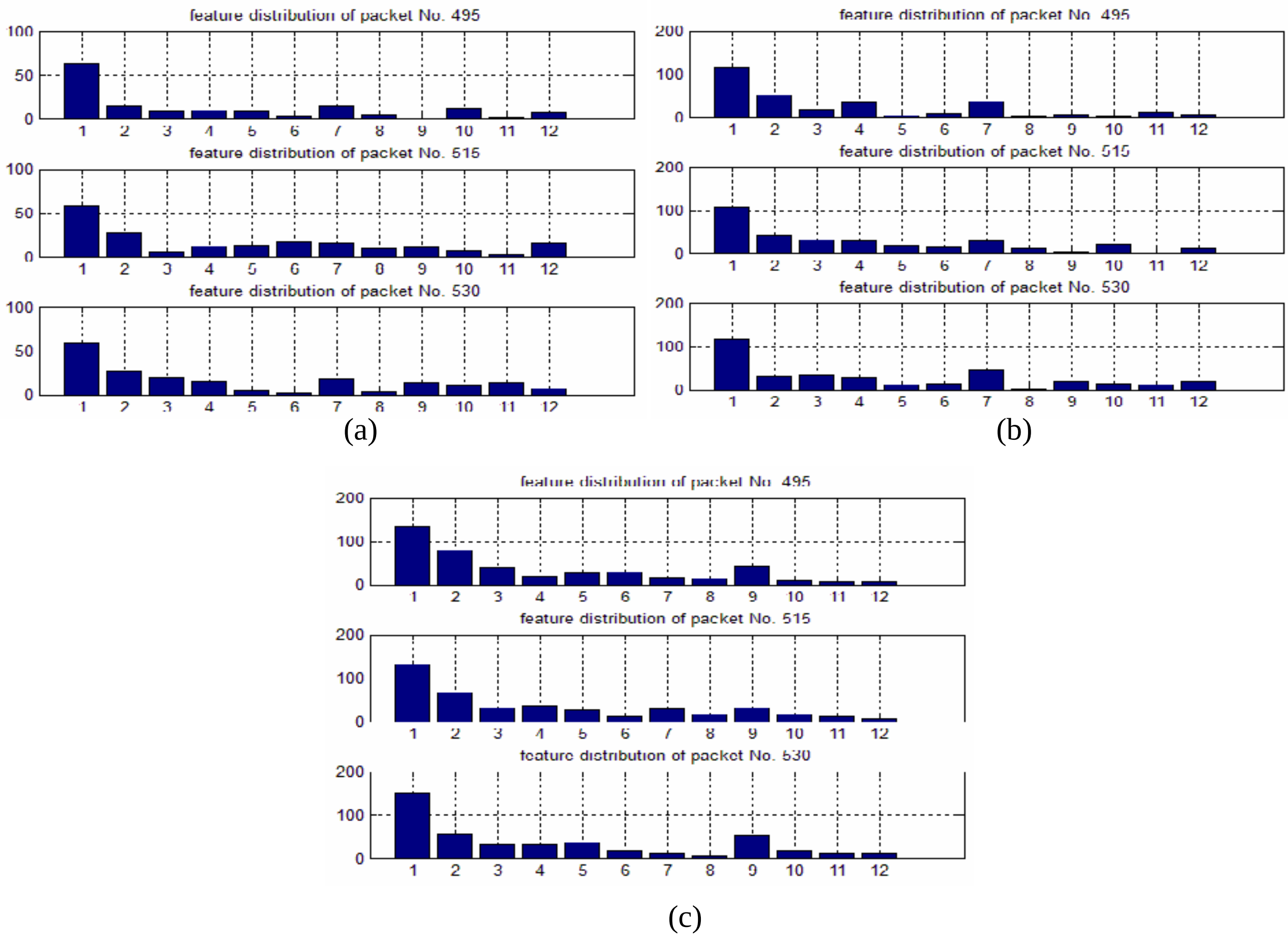


Figure (5): *Extracted SBC features, (a) 24 (b) 48 and (c) 64 subband models*

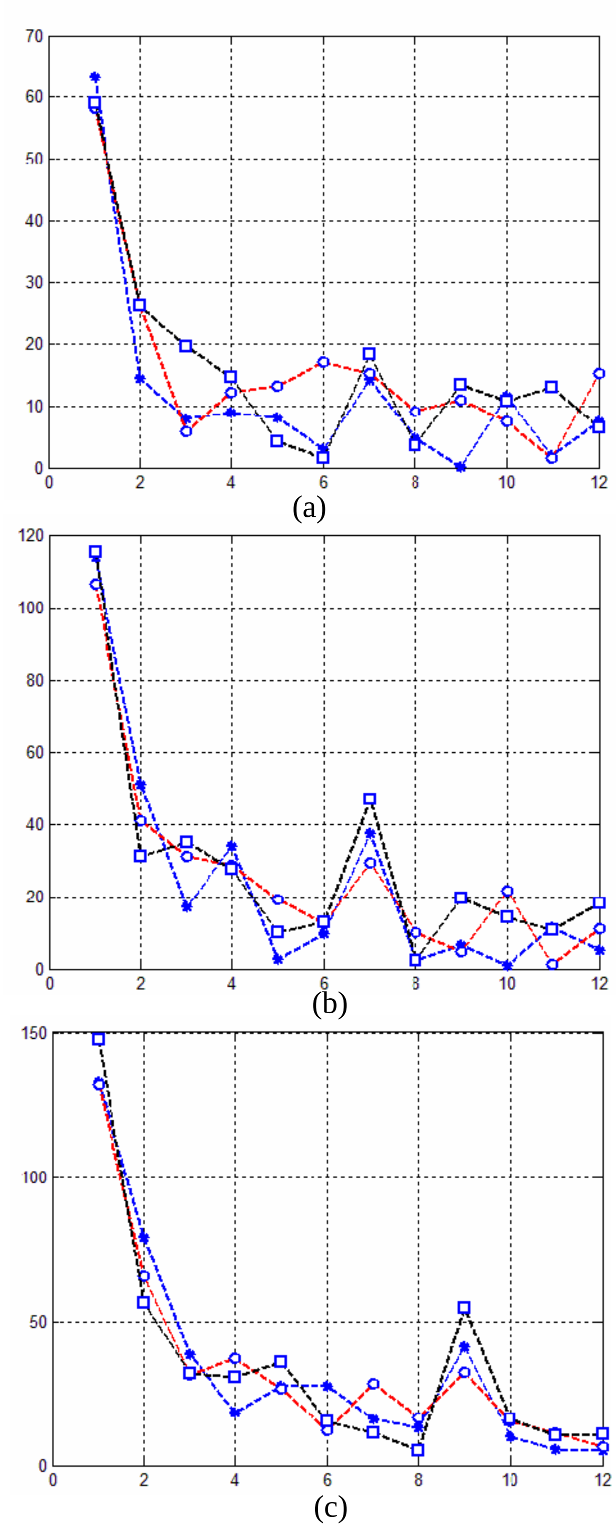


Figure (6): *Comparison between three packet's features for the same acoustic signal, (a) 24 (b) 48 and (c) 64 subband models*

The proposed technique was constructed using matlab ver.7.3 platform and then it was executed by 1.7GH core 2 duo platform with 4G byte of memory and the execution time of proposed technique were evaluated as depicted by Table (1) .By comparing the results in that table it would be clear that the execution time for the It shows that the execution time for 24 model is less than 48 and 64 models, on the other hand, By analyzing the data illustrated by Table (2) ,the packet's features in the 24 subband model are less than that related to the 48 and 64 subband models for the same signal.

The feature Strength Coefficient (FSC) is the examination of the presence of a certain feature in a randomly chosen signal packets (window) .i.e. the SBC value of the feature is expected to be the same every time a packet is examined for the same signal and is define by the following formula:

$$S = \frac{\sum_{i=1}^{i=12}(|a_i - b_i|)}{\sum_{i=1}^{i=12} a_i} \tag{3}$$

Where a_i is the SBC value for the 1st packet and b_i is the SBC value for the 2nd packet

Table (1): *Execution time for each model*

Model	**Execution Time (in seconds)**
24	1.667
48	1.720
64	1.977

Table (2): *Comparison between three packet's features for the same acoustic signal*

FSC	**Packet No.**	**24 Node**	**48 Node**	**64 Node**
S1	495,415	0.3964	0.3812	0.2243
S2	495,430	0.4813	0.3640	0.2872
S3	415,430	0.4804	0.3087	0.2435

4. Conclusions:

In this work, an enhanced algorithm for moving vehicle detection and recognition is presented. The experimental results have proven that increasing the number of subband from 24 to 48 subband then to 64 subband has a great effect on the algorithm ability to Recognize a certain feature for the same acoustic signal. The trade of between total processing time and number of related subband is crucial for certain application.

5. REFERENCES:

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