PROCESSING OF ARABIC SPEECH USING MULTI-LEVEL WAVELET TRANSFORM

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ABSTRACT

In this paper the effect of using the coefficients of the low frequency filters at different levels of the wavelet transform of an Arabic speech samples is presented. Specifically, the discrete wavelet transform is computed to approximate a speech signal at different wavelet levels in preparation for speech processing, or transmission. The low frequency wavelet coefficients at each level of the decomposition are used as a representation for the Arabic speech signal in the wavelet domain. Then, the auto-correlation of the resulted low-frequency coefficients is computed to find out the effect of the wavelet level on the peak of the correlation of the processed Arabic speech signal. Using this method, cross-correlating the entire unknown speech sequence with a known speech sample, in order to recognize the spoken speech, is avoided. Also, the time taken for recognizing or transmitting a speech sample can be decreased due to the reduction in the sequence length that represents the speech sample. The results showed that Arabic speech samples are identified satisfactorily to 1/6.25 resolution. The quality of the Arabic speech samples is affected by the level of the wavelet transformation. The experiments showed that the wavelet transform can be carried out to the third level of the wavelet decomposition with an acceptable audition quality.

Keywords: Arabic Speech Processing, Wavelets, Discrete Wavelet Transform, Correlation**.**

1. INTRODUCTION

Speech signals are one of the most important means of communication among the human beings. The speech signal is a slowly time varying signal in the sense that, when examined over a sufficiently short period of time, its characteristics are fairly stationary; however, over long periods of time the signal characteristics change to reflect the different speech sounds being spoken [[1]].

Arabic is one of the world famous languages. It is currently the sixth most widely spoken language in the world with an estimated number of 250 million speakers [[2]]. Arabic language differs from other languages, e.g. English, in terms of the number of the alphabet letters, and the pronunciation of some of the letters. There has been little research on Arabic speech compared to other languages.

Wavelet-based processing techniques can be used to reduce the amount of data representing speech signals in order to decrease processing time, transmission time, and required storage capacities.

Processing and analyzing of speech signals using wavelet transform were conducted by many researchers; e. g. [3] , [4] , and [5] . In most of the cases English speech samples were used in the analysis.

The work in this paper illustrates the effect of the wavelet analysis on the Arabic speech samples. Specifically, different wavelet filters are used to test its ability to concentrate the speech signal energy in a limited number of coefficients. The effect of the wavelet level of decomposition on samples of the Arabic speech is also investigated. The samples are reconstructed from the low-pass wavelet coefficients at different levels and they are correlated with the original sequence to study the wavelet level effect on the correlation height which is considered as the peek of the correlation sequence.

2. WAVELET TRANSFORM

The wavelet transform (*WT*) is one of several mathematical tools that is useful in the analysis and design of systems and signals. Its representation basically involves the decomposition of the signals in terms of small wave components called wavelets. Wavelet theory is employed in many fields and applications such as signal and image processing, communication systems, and many other signal processing areas [[6] , [7] , [8]]. The wavelet transform has proven to be very efficient and effective in analyzing a very wide class of signals and phenomena [[6]]. It has the ability to compact the signal energy into few large coefficients. The original signal can be reconstructed perfectly from these few coefficients while suppressing the other coefficients without losing most of the features of the signal.

There are many sets of wavelet bases that can be used to represent a signal. Each basis in a certain wavelet set is constructed form one function called: the mother wavelet [[6] , [9]]. The analysis of the functions using wavelets involves two basic operations on the mother wavelet. These operations are the scale operation, and translation operation [[6] , [9]].

The discrete wavelet time series is necessary for implementation of the wavelet transform on digital computers. It is defined with respect to a mother wavelet ψ_{jk}. The discrete wavelet time series can be written as

$$Wf(j,k) = a^{-j/2} \sum_{n=-\infty}^{\infty} f(n)\, \psi(a^{-j}x - kb) \qquad (1)$$

where a, b are the scale, and translation parameters respectively; j, k correspond to the discrete scale, and translation steps respectively.

The discrete inverse wavelet transform is used for restoring a function from the wavelet domain back to the time domain [[6] , [9]]. It can be written as