Analysis of Speech Signal Compression at various levels and wavelets using DWT

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Abstract

As the multimedia technology progresses, so does the need of speech compression for efficient and cheaper transmission. Discrete Wavelet Transform technique aims at providing effective compression in this field. This paper focuses on the analysis of compression ratios for various wavelets at different levels for a speech sample. In our observation, we determined the best results for the symlet2 wavelet type in terms of the compression ratio and overall audio quality.
This analysis was performed on MATLAB 7.1 R2009 on an Intel i-5 processor based system.

Keywords: DWT, Speech Compression, Compression Ratio, Wavelet

Introduction

Audio Compression is a method to represent the audio signal in lesser number of bits. This can be achieved by either old ways of using DCT and DFT, or by using the advanced, effective and efficient technique of Discrete Wavelet Transform. DWT is based on sub band coding and is observed to yield faster computation. DWT has an advantage over traditional DCT and DFT in terms of adjustable window size and ability to extract coefficients at the frequency of interest.

Speech

Speech is a very basic way for humans to convey information to one another. With a bandwidth of only 4kHz, speech can convey information with the emotion of a human voice.[1,5,6] People want to be able to hear someone’s voice from anywhere in the world-as if the person would be in the same room. Speech can be defined such as the response of the vocal tract to one or more excitation signals.[4]

Discrete Wavelet Transform

DWT is a wavelet transform in which the discretely sampled wavelets decompose the signal into mutually orthogonal set of wavelets. In DWT, the energy is concentrated in time for a small wave providing a tool for analysis of non stationary, transient or time varying phenomenon[2,5].
DWT has a basic concept of signal being divided into low frequency and high frequency components. While the low frequency components store the major information of the signal known as Approximations, the high frequency component imparts the quality to the signal and are known as Details. The original signal is filtered through two complimentary filters and emerges as two signals.[3,6] Concept of down sampling is introduced to avoid doubling of data.

Compression Ratio

Compression Ratio is the ratio of the number of bits in the original signal to the number of bits in the compressed signal[7]

\[ CR = \frac{\text{No. of bits in the original signal}}{\text{No. of bits in the compressed signal}} \]
Results and discussion

Tables:

Table: Compression Ratios at various levels for different wavelets.

<table>
<thead>
<tr>
<th>Wavelet</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haar</td>
<td>7.5169</td>
<td>14.4355</td>
<td>28.0313</td>
</tr>
<tr>
<td>Coif2</td>
<td>7.7007</td>
<td>14.4054</td>
<td>25.6190</td>
</tr>
<tr>
<td>Coif5</td>
<td>7.2484</td>
<td>12.5055</td>
<td>19.4500</td>
</tr>
<tr>
<td>Sym2</td>
<td>7.9154</td>
<td>15.6212</td>
<td>30.3824</td>
</tr>
<tr>
<td>Sym5</td>
<td>7.7630</td>
<td>14.6806</td>
<td>26.6250</td>
</tr>
</tbody>
</table>

Graphs:

Graph 1: Original Signal

Graph 2: Compressed Signal for Level 3

Graph 3: Coif5 wavelet

Graph 4: Sym2 wavelet

Graph 5: Sym5 wavelet

Graph 6: Compressed Signal for Level 4

Graph 7: Coif5 wavelet

Graph 8: Sym2 wavelet

Graph 9: Sym5 wavelet

Graph 10: Compressed Signal for Level 5

Graph 11: Haar wavelet
Conclusion

In our analysis, we compared different wavelet types for level 3, 4 and 5 for a male speech sample. The sample was of the duration of 7 seconds. We observed the best compression ratio for Symlet 2 wavelet type at level 5 for speech sample. The sound quality was considerably good and the distortion was minimum. It was observed that with increase in levels, the compression ratio increased significantly.

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