Enhancement of DUET Blind Source Separation Using Wavelet

Thasni Maitheen[1], Lekshmi M.S[2]

[1] *PG Scholar, Ilahia College Of Engineering And Technology,Ernakulam,, Kerala, India*
[2] *Asst.Professor,Ilahia College Of Engineering And Technology ,Ernakulam, Kerala, India*

---***---

Abstract - *This paper presents Degenerate unmixing estimation technique (DUET) algorithm used to separate any number of sources using only two mixtures. In previous works ,the estimation of mixing parameters of source signals is based on time frequency representation of two microphone signals. While robustness and source separation efficiency is not good. The proposed system uses complex value filtering that decomposes the real or complex signal into real and imaginary parts in transform domain through Dual tree complex wavelet transform(DTWT). Experimental results shows that Performance excellence of this system is much better than the previous system.*

Key Words: **DUET, DTWT, STFT, BSS , DWT**

1. INTRODUCTION

Blind Source Separation (BSS) [1]techniques attempt to recover Original source signals from the mixtures of these sources, with limited prior knowledge of the original sources or the mixing procedure involved. DUET, (Degenerate Unmixing Estimation Technique), is one of the most popular methods in this field [2]. The method is well suited when sources are W-disjoint orthogonal.

The original DUET algorithm uses STFT (Short Time Fourier Transform) for extracting local mixing parameters. In the proposed algorithm, DTWT is used instead of STFT. The remaining procedures are same as that of original algorithm. By taking the ratios of the mixtures, mixing parameters are estimated. A two-dimensional weighted histogram is used for clustering local symmetric attenuation and delay estimates around the actual symmetric attenuation and delay mixing parameters of the original sources. In histogram the number of peaks represents the number of sources. Mixing parameters represented by peak location.

The technique is valid when the number of sources is larger than the number of mixtures. In an efficient and robust manner DUET solves the degenerate demixing problem. We can summarized in one sentence as a definition: DUET makes it possible to blindly separate an arbitrary number of sources given just two anechoic mixtures provide the time-frequency representations of the sources do not overlap too much, which is ideal for speech.

2. PROPOSED SYSTEM DESCRIPTION

The proposed system is used to separate an arbitrary number of sources from just two mixtures provided that the source signals does not overlap too much. The real implementation setup consists of two closely spaced sensors or microphones, receiving a mixture of signals from various positions. As each signal reaches the sensors or microphones, there will be a difference between the signals received at each microphone.

3. SOURCE MIXING

The measurements obtained from the two microphones we can represents the two mixtures as,

$$x_1(t) = \sum_{j=1}^{N} s_j(t) \qquad (1)$$

$$x_2(t) = \sum_{j=1}^{N} a_j s_j(t-\delta_j) \qquad (2)$$

where N is the number of sources, δ_j is the arrival delay between the sensors resulting from the angle of arrival, and a_j is a relative attenuation factor corresponding to the ratio of the attenuations of the paths between sources and sensors.

4. DUAL TREE COMPLEX WAVELET TRANSFORM

The complex wavelet transform (CWT) [3] is complex valued extension to standard discrete wavelet transform (DWT). Complex value filtering is used by the CWT decomposes the real/complex signal into real and imaginary parts in transform domain. Amplitude and phase information is obtained from the coefficients of the real and imaginary parts . For positive and negative orientations, DTWT have separate subbands. By using two separate DWT decomposition, DTWT calculate complex transform of signal. As compared with Fourier transform, wavelet transform offers better frequency resolution for low frequency components and better temporal resolution for the high frequency components. The transform is 2 times expansive because for an N point signal it gives 2N DWT coefficients. The discrete wavelet packet transform of the input signal can be expressed as follows, X(τ,ω)=DTWT {x(t)} (3)

The proposed algorithm uses 8 level dual tree wavelet packet transform for decomposing the input mixture in to different subbands.

5. AMPLITUDE DELAY ESTIMATION

The Local mixing parameters are obtained by taking the ratios of the two mixtures. It can be expressed as

$$(\tilde{a}(\tau,\omega),\hat{\delta}(\tau,\omega))=\left(\left| \frac{x_2(\tau,\omega)}{x_1(\tau,\omega)} \right|, \frac{1}{\omega}\,\mathrm{Im}\left\{ \ln\left(\frac{x_2(\tau,\omega)}{x_1(\tau,\omega)}\right)\right\} \right) \quad (4)$$

With a simple division we can calculate the attenuation and delay parameters of the mixtures.

6. TWO-DIMENSIONAL SMOOTHED HISTOGRAM

In the mixing model we considered the maximum-likelihood (ML) [4] estimators for a_j and δ_j. Rather than estimating a_j , we estimate,

$\alpha_j = a_j-(1/a_j)$ (5)

which we call the symmetric attenuation because the attenuation is reflected symmetrically about a center point, if the microphone signals are swapped. we need a mechanism for clustering local symmetric attenuation and delay estimates around the actual symmetric attenuation and delay mixing parameters of the original sources. A two-dimensional weighted histogram is used to determine the clusters and estimate mixing parameters (aj, δj).

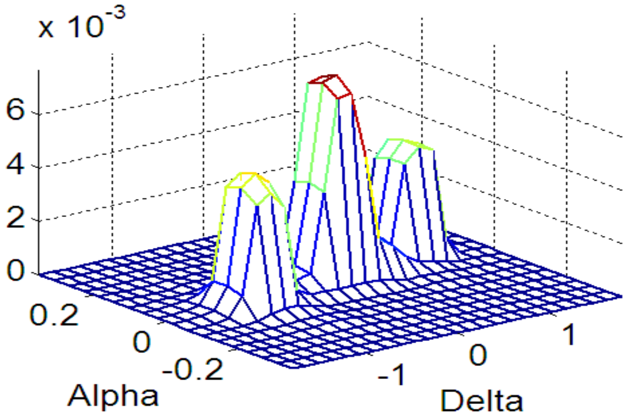

Chart -1: Two-dimensional histogram of symmetric attenuation and delay estimate pairs from two mixtures of three sources

The histogram is the key structure used for localization and separation and chart 1 shows the histogram representation.

The number of peaks represents the number of sources, and the peak locations represents the associated source's anechoic mixing parameters.

7. DEMIXING

In order to demix sources from the mixtures, we construct a binary mask and it can be represented as,

$$M_j(\tau,\omega) = \begin{cases} 1, & (\tilde{a}(\tau,\omega), \tilde{\delta}(\tau,\omega)) = (a_j, \delta_j) \\ 0, & otherwise \end{cases} \quad (6)$$

Demixing of each source is take place by multiplying each mask with one of the mixtures. To reconstruct the original source signals from their wavelet packet transform representations by using inverse dual tree wavelet transform(IDTWT).

8. EXPERIMENTAL RESULTS

The accuracy of the proposed system is evaluated by a series of experiments. Matlab programs with the existing and the proposed models are simulated, similar database are used for existing and proposed models. The separated output quality is measured with signal-to-noise ratio (SNR), Perceptual Evaluation of Speech Quality (PESQ). SNR is a measure of signal strength relative to background noise. Perceptual Evaluation of Speech Quality) provides accurate and repeatable estimates of speech quality.

Table -1: SNR values for separated and original mixture

Mixture	Existing system	Proposed system
-5.75	1.78	3.28

Table -2: PESQ of segregated speech of existing and proposed model

Existing system	Proposed system
1.71	2.64

Experimental results shows that WPT based method provide better performance than STFT based method. SNR and PESQ values are improved as compared with STFT based method. The values are shown in the table 1 and 2. Welch power density of original mixture and separated speech as shown in chart 2.

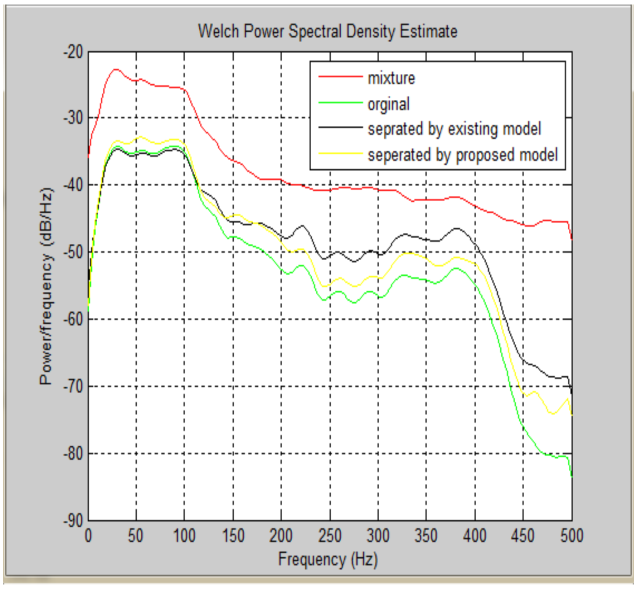

Chart -2: Welch power density of original mixture and separated speech

9. CONCLUSIONS

In this paper, we propose an improved DUET algorithm using DTWT. From the experimental results we can understand that DTWT based DUET provide better performance than STFT. Wavelets act in much the same way as Fourier analysis but can approximate signal which contain both large and small features, as well as sharp spikes and discontinuities. This is due to the fact that wavelets do not use a fixed time-frequency window.

REFERENCES

[1] A. Cichocki and S. Amari, "Adaptive Blind Signal and Image Processing." Wiley, 2002.

[2] Scott Rickard, "The DUET Blind Source Separation Algorithm.", springer,2007

[3] Ivan W. Selesnick, Richard G. Baraniuk, and Nick G. Kingsbury, "Dual-Tree Complex Wavelet Transform", IEEE Signal Processing Magazine November 2005

[4] O. Yilmaz and S. Rickard, "Blind separation of speech mixtures via time– frequency masking," IEEE Transactions on Signal Processing, vol. 52, no. 7, pp. 1830–1847, July 2004