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# Acoustic Echo Canceller Using Independent Component Analysis

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**Abstract:** ***Acoustic echo canceller (AEC) aims to remove the undesired echoes which come due to loudspeaker and microphone coupling in hand free communication system. In hand free communication system when echoes is picked up by the microphone is mixed with original source signal, system shows poor performance. There are so many techniques which are used to remove echoes from original source signal or speech signal. One method is adaptive filter but adaptive filter method is not so much effective in the presence of more than one speaker, double talk and other external sound to diminish the noise or echoes .so we proposed independent component analysis (ICA) which is a method of blind source separation (BSS). Independent component analysis can cancel the echoes effectively without need of double talk detector by separating near end signal and far end signal.***

**Keywords:** AEC, ERLE, PSTN, ICA, BSS

## 1. Introduction

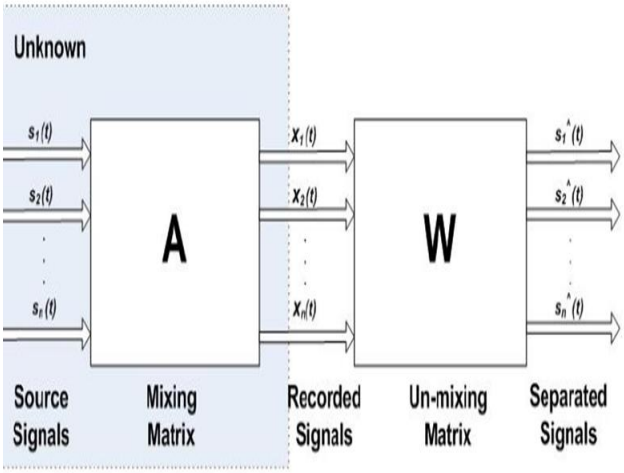
Today people are more interested in hand free system, in such a situation they use loudspeaker and high gain microphone. Some time echoes are generated during coupling of loudspeaker and microphone like in teleconference when more than two people participate in conversation at same time. These generated echoes make conversation poor. echoes is the repetition of the waveform due to the reflection from various points, if a reflected wave arrives after a very short time of direct sound it is considered a spectral distortion or reverberation. When the reflected waveform arrives a few tens of millisecond after the direct it is heard as a distinct sound. Echoes become annoying when delay exceeds thirty millisecond such echoes sound must be loud enough and it become disruptive [1]. There are various reasons to generate the echoes but primary reason is impedance mismatch. Impedance mismatch is occurring when two wire network meet four wire network [2]. In the communication system basically there are two types of echoes one is acoustic echoes and other is hybrid echoes [3].

Acoustic echo: acoustic echo results from a feedback path set up between the speaker and microphone in mobile phone, teleconference or hearing aid system . Acoustic echo is usually reflected from a multitude of a different surface such as walls, ceilings, floors, and travels through different path.

Hybrid echo: hybrid echo generate impedance mismatch. Hybrid echo generated from the public switched telephone network (PSTN) echoes on a telephone line. The device which is used to connect two wire networks to four wire network is known as hybrid. Hybrid echo is not generated in mobile phone. So hybrid network is not used in hand free phone. There are many techniques to remove the echoes but blind source separation (BSS) is the foremost technique to remove the echoes. Independent component analysis (ICA) is a method of blind source separation.

## 2. Blind Source Separation (BSS)

In a hand free mobile system when large acoustic noise picked up by microphone is mixed with echo, echo cancellation system shows poor performance then we use blind source separation (BSS) technique to control the acoustic noise which has to be suppressed. Basically BSS is a technique in for estimating the individual source component from their mixture at multiple sensors. It is called blind because we don't use any other information besides the mixtures or very little information about the source signal [4]. Familiar situations in which this occurs are a crowded room with many people speaking at the same time. There are many methods in the blind source separation but we will use ICA method to solve the problem. ICA is a computational method for separating a multivariate signal into additive subcomponents supposing signals are independent to each other [5]. ICA is the general idea to separate original source signal; it is described as an extension of the principal component analysis. ICA not only uncorrelates the signal but also reduce higher order statistical dependencies.




Block diagram of Blind source separation

## 3. Objective

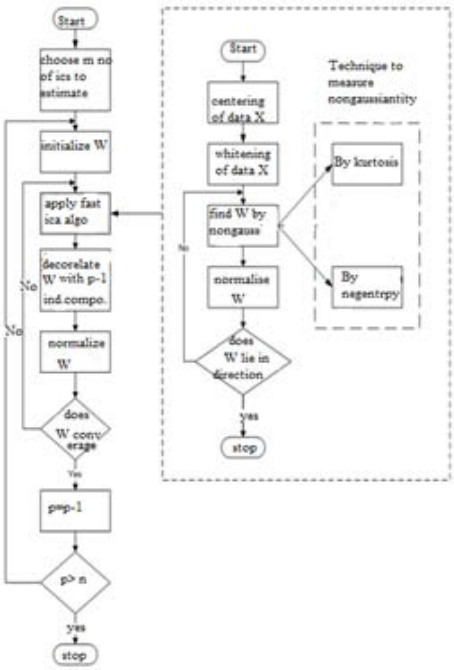
Blind source separation is one of foremost technique which is used in this era . it is used in many sectors such as in telecommunication, to find hidden factor in financial data, medical signal analysis etc. objective of this technique is to separate the source signal from the mixed the signal and increase the speed and accuracy . For this purpose we use Fast ICA algorithm. Fast ICA algorithm distributive and parallel. In Fast ICA algorithm PCA (principal component analysis) is used as a preprocessing steps. Main objective is to increase the speed and accuracy of the algorithm.

## 4. Proposed Method

We use Fast ICA algorithm with kurtosis method to remove the undesired echoes which reduce the signal quality . we defined all the of Fast ICA algorithm through this flowchart. Independent component analysis (ICA) is a statistical and computational technique for finding hidden factors .ICA method works on two principles one is Maximize the non gaussianity and second is minimize mutual information. The classical measure of nongaussianity is kurtosis or the fourth-order cumulant. The kurtosis of y is classically defined by

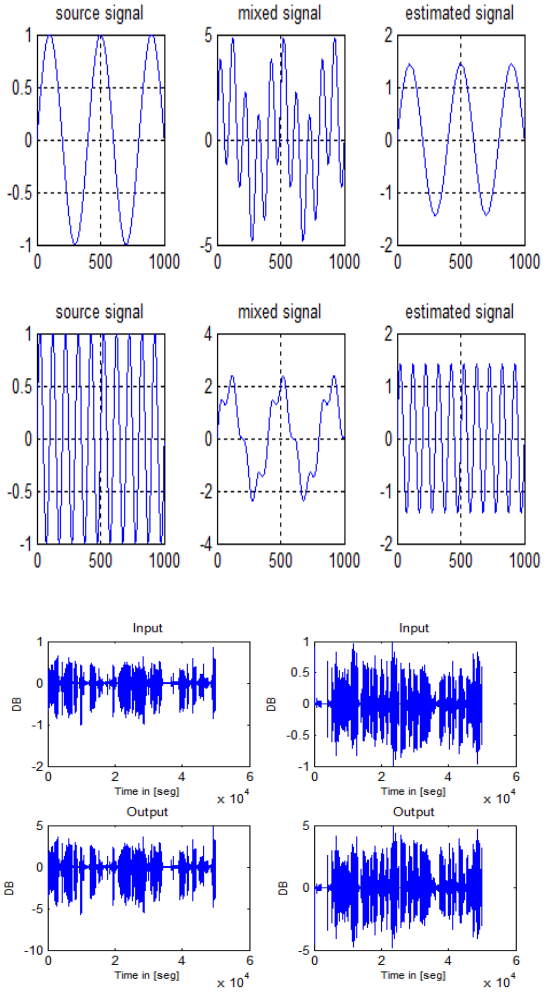
$$\text{kurt}(y)=E\{y^4\}-3(E\{y^2\})^2$$

Actually, since I assumed that y is of unit variance, the right-hand side simplifies to $E\{y^4\}-3$. This shows that kurtosis is simply a normalized version of the fourth moment $E\{y^4\}$. For a gaussian y, the fourth moment equals $3(E\{y^2\})^2$. Thus, kurtosis is zero for a gaussian random variable. For most nongaussian random variables, kurtosis is nonzero. Kurtosis can be both positive and negative. Random variables that have a negative kurtosis are called sub gaussian, and those with positive kurtosis are called super gaussian. Minimize mutual information means make the signal independent. They have no information about other signal.




## 5. Results

Fast ICA algorithm provide better result to remove the undesired echoes from the signal, it provide high speed and accuracy (90 to 95 %) with less complexity. Fast ICA algorithm is neural, parallel and distributive. This method take less number of iteration as compare to other so convergence speed of Fast ICA algorithm is superior from others.




Fast ICA algorithm using Kurtosis method

| No. of Iteration | ERLE(echo return loss enhancement) | Distortion | Accuracy |
|---|---|---|---|
| 5 | 30 | 0.31 | 90 to 95 % |

## 6. Conclusion and Future Work

In this paper we purposed kurtosis method for blind source separation which provides better result. Due to its good properties it is used in many real applications such as telecommunication, finding hidden factor in financial data, face recognition, medical signal processing etc. main advantage of this algorithm is its ability to adopt variation in environment and its robustness. An example of a real-world communications application where blind separation techniques are useful is the separation of the user's own signal from the interfering other users' signals in CDMA (Code-Division Multiple Access) mobile communications. Future

scope is to reduce complexity in neurons spike sorting, automatically used in image processing and increase its robustness in optically imaging of neurons.

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