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Adaptive Filtering and Voice Compression Using Neural Networks

Kalyan Chatterjee, Mandavi, Prasannjit, Nilotpal Mrinal, Vikash Kumar Saw, Kumari Rupmala, Priyadarshani

Abstract*— *Voice data compression is about a process which reduces the data rate or file size of digital audio signals. This process reduces the dynamic range without changing the amount of digital data of audio signals. Voice compression is one of the leading vicinity of digital signal processing that spotlight on dipping the bit rate of speech signals for transmission and storage devoid of considerable loss of quality. This paper attempts to present an adaptive filtering technique for the removal of useless noise from the audio signals. After the noise removal has been done, the filtered audio signal is taken as the input to the neural network. Finally, the back propagation algorithm is applied for the compression of the audio signals.

Index Terms*— *Adaptive Filtering, Audio signals, Back propagation algorithm, Neural Network, Recursive Least Square Algorithm (RLC).

I. INTRODUCTION

The aim of the voice compression system is to transform the speech signals to a more compact representation which can be transmitted across the channel with comparatively lesser storage memory. Practically it is not possible that one gets full access to entire bandwidth of the network; consequently, networks require compressing the voice signal. Voice analysis is an analytical process in which audio signals are usually processed for the extraction of time varying parameters. Audio signals fall within a frequency range between 20 Hz and 4kHz. According to Nyquist's theorem, an analog signal must be sampled at a rate at least twice that of the highest frequency component of the signal in order to preserve information in the signal. Accordingly to digitize voice signal, the analog voice signal is conventionally sampled at the rate of 8 kHz. The analog samples are typically digitally encoded using pulse code modulation.

The compression of audio signals has many practical applications. One example is in digital cellular technology where many users share the same frequency bandwidth. Compression allows more users to share the system than otherwise possible. Another example is in digital voice storage (e.g. answering machines).

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Mandavi, Information Technology, Bengal College of Engineering and Technology, Durgapur, India.

Kalyan Chatterjee, Computer Science Engineering, Bengal College of Engineering And Technology, Durgapur, India.

Prasannjit, Information Technology, Bengal College of Engineering and Technology, Durgapur, India.

Nilotpal Mrinal, Information Technology, Bengal College of Engineering and Technology, Durgapur, India.

Vikash Kumar Saw, Computer Science Engineering, Bengal College of Engineering And Technology, Durgapur, India.

Kumari Rupmala, Computer Science Engineering, Bengal College of Engineering And Technology, Durgapur, India.

Priyadarshani, Computer Science Engineering, Bengal College of Engineering And Technology, Durgapur, India.

For a given memory size, compression allows longer messages to be stored than otherwise.

II. ADAPTIVE FILTERING

Due to continuous changing of noise over a time period and overlapping of frequencies of noise and signal, adaptive filtering is going to become a necessity. They are proving to be a powerful resource for real time applications when there is no time for statistical estimation. The ability of adaptive filters to operate satisfactorily in unknown and possibly time-varying environments without user intervention and improving their performance during operation by learning statistical characteristics from current signal observations has made them more efficient.

III. RECURSIVE LEAST SQUARE ALGORITHM

There are many algorithms which are used now-a-days. But, due to superior convergence properties and calculation\of result in real time we have used RLC method in this paper. The equations used in this method are:-

$$\mathbf{W}_k = \mathbf{W}_{k-1} + \mathbf{G}_k e_k$$

$$\mathbf{G}_k = \frac{\mathbf{P}_{k-1}\mathbf{x}(k)}{\alpha_k}$$

$$e_k = y_k - \mathbf{x}^T(k)\mathbf{W}_{k-1}$$

$$\alpha_k = \gamma + \mathbf{x}^T(k)\mathbf{P}_{k-1}\mathbf{x}(k)$$

where, ϒ = forgetting factor and μ = learning parameter

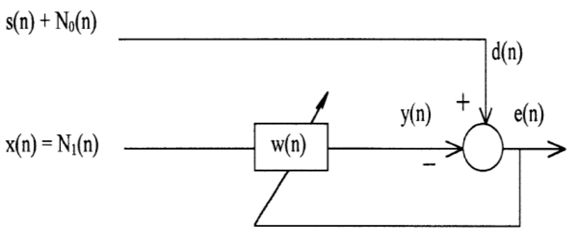

Fig.1 Block diagram of Adaptive Noise Cancellation

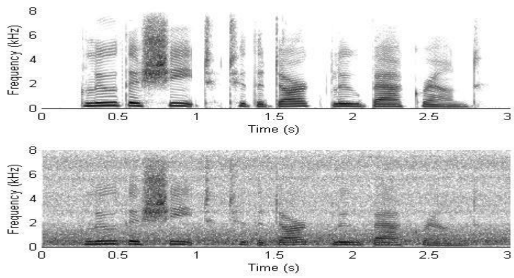

Fig. 2 Original signal and the signal contaminated with noise

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IV. DATA COMPRESSION

Compression is used just about everywhere. All the images we get on the web are compressed, typically in the JPEG or GIF formats, most modems use compression and several file systems automatically compress files when stored, and the rest of us do it by hand. Many compression algorithms exist which have shown some success in electrocardiogram compression; however, algorithms that produce better compression ratios and less loss of data in the reconstructed data are needed. Compression rate measures how much the signal can be compressed from the original one. Compression methods used can be lossless and lossy.

A. Lossless compression

Lossless compression implies the original data is not changed permanently during compression. After decompression the original data can be retrieved. The advantage of lossless compression is that the original data stays intact without degradation of quality and can be reused. The disadvantage is that the compression achieved is not very high.

B. Lossy compression

In lossy compression technique, parts of the original data are discarded permanently to reduce file. After decompression the original data cannot be recovered this leads the degradation of quality.

Fig. 3 Lossless and Lossy data compression

V. DATA COMPRESSION USING BACK PROPAGATION

Back propagation is a systematic method for training multilayer artificial neural networks. It has a mathematical foundation that is strong if not highly practical. It is a multilayer forward network using delta learning rule commonly known as back propagation rule. The training algorithm of back propagation involves four stages:-

i) Initialization of weights.
ii) Feed forward
iii) Back propagation of errors.
iv) Updating of weights and biases

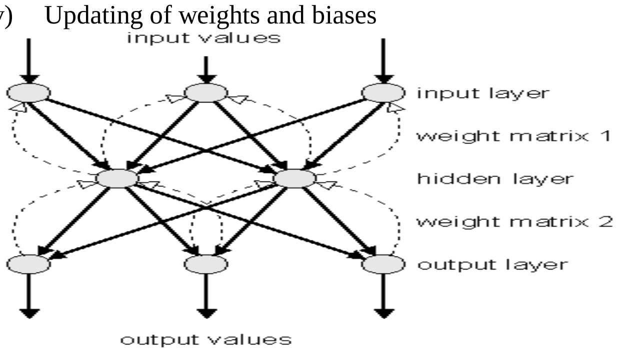

Fig. 4 Back propagation neural network

VI. RESULT

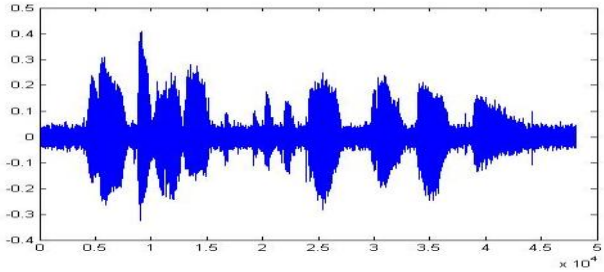

Fig. 5 noisy audio signal

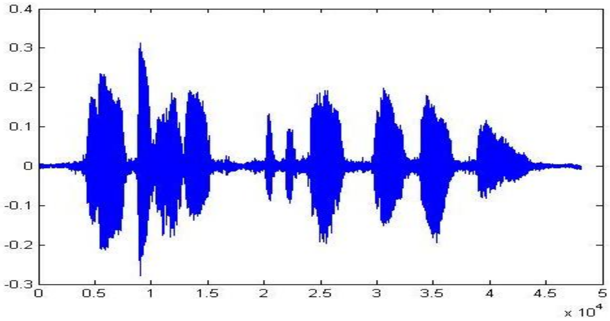

Fig. 6. noise removed after adaptive filtering

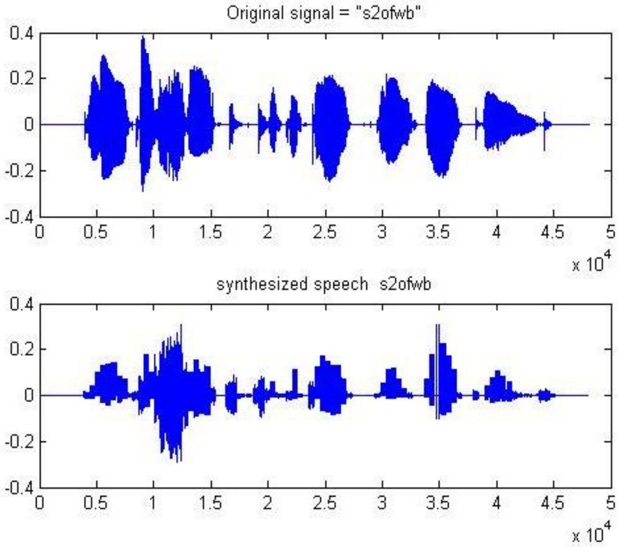

Fig. 7. Original signal and the compressed signal

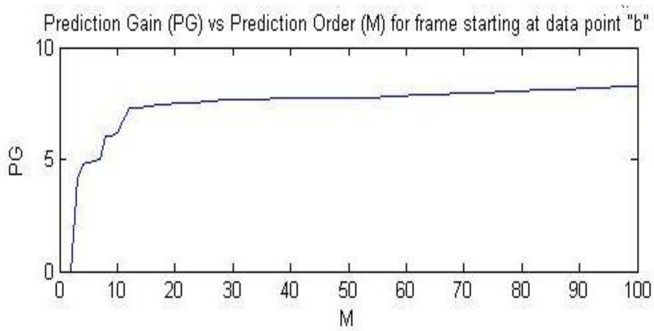

Fig. 8 Prediction gain versus Prediction order graph

VII. CONCLUSION

Simulation of adaptive filtering and back propagation algorithm in this paper has achieved the objective of noise cancellation and data compression of audio signals based on the given data set.

It must be noted that recursive least square method has been used for adaptive filtering of audio signals . After all these processes, back propagation is applied in order to compress the signals and a stable prediction gain versus prediction order graph is obtained. Hence it can be concluded that after adaptive filtering, back propagation method is best suited for data compression algorithm.

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KALYAN CHATTERJEE, Currently working as an Assistant Professor, Department of Computer Science Engineering, Bengal College of Engineering and Technology, Durgapur.

MANDAVI, B.tech 3rd year Student, Department of Information Technology, Bengal College of Engineering and Technology, Durgapur.

PRASANNJIT, B.tech 3rd year Student, Department Of Information Technology, Bengal College of Engineering and Technology, Durgapur.

NILOTPAL MRINAL, B.tech 3rd year Student, Department of Information Technology, Bengal College of Engineering and Technology, Durgapur.

VIKASH KUMAR SAW, B.tech 4th year Student, Computer Science Engineering Deptt., Bengal College of Engineering and Technology, Durgapur.

KUMARI RUPMALA, B.tech 4th year Student, Computer Science Engineering Deptt., Bengal College of Engineering and Technology, Durgapur.

PRIYADARSHANI, B.tech 4th year Student, Computer Science Engineering Deptt., Bengal College of Engineering and Technology, Durgapur.