Multichannel kalmanfilting for speech enhancement

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***Abstract*: The goal of speech enhancement is to reduce the noise signal while keeping the speech signal undistorted. Recently we developed the multichannel Kalman filtering (MKF) for speech enhancement, in which the temporal evolution of the speech signal and the spatial correlation between multichannel observations are jointly exploited to estimate the clean signal. In this paper, we extend the previous work to derive a parametric MKF (PMKF), which incorporates a controlling factor to achieve the trade-off between the speech distortion and noise reduction. The controlling factor weights between the speech distortion and noise reduction related terms in the cost function of PMKF, and based on the minimum mean squared error (MMSE) criterion, the optimal PMKF gain is derived and analysis the performance of the proposed PMKF and show the differences with the speech distortion weighted multichannel Wiener filter (SDW-MWF). We conduct experiments in different noisy conditions to evaluate the impact of the controlling factor on the noise reduction performance, and the results demonstrate the effectiveness of the proposed method.**

***Keywords*: Speech enhancement, kalman filtering, wiener filtering**

INTRODUCTION

An adaptive kalman filter for speech enhancement is proposed for enhancement of speech degraded by colored additive interference. This algorithm decomposes noisy speech into its components along the axes of a RTF-based vector space of clean speech. It is observed that the noise energy is disparately distributed along each eigenvector. These energies are obtained from noise samples gathered from silence intervals between speech samples. To obtain these silence intervals, we proposed an efficient voice activity detector based on outputs of principle component eigenfilter; the greatest eigenvalue of speech KLT. Enhancement is performed by modifying each RTF component due to its noise and clean speech energies. The objective is to minimize the produced distortion when residual noise power is limited to a specific level. At the end, inverse KLT is performed and an estimation of the clean signal is synthesized. Our listening tests indicated that 71% of our subjects preferred the enhanced speech by the above method over former methods of enhancement of speech degraded by computer generated white Gaussian noise.

Our method was preferred by 80% of our subjects when we processed real samples of noisy speech gathered from various environments. The goal of speech enhancement is to reduce the noise signal while keeping the speech signal undistorted. Recently we developed the multichannel Kalman filtering (MKF) for speech enhancement, in which the temporal evolution of the speech signal and the spatial correlation between multichannel observations are jointly exploited to estimate the clean signal. In this paper, we extend the previous work to derive a parametric MKF (PMKF), which incorporates a controlling factor to achieve the trade-off between the speech distortion and noise reduction.

The controlling factor weights between the speech distortion and noise reduction related terms in the cost function of PMKF, and based on the minimum mean squared error (MMSE) criterion, the optimal PMKF gain is derived and analysis the performance of the proposed PMKF and show the differences with the speech distortion weighted multichannel Wiener filter (SDW-MWF). We conduct experiments in different noisy conditions to evaluate the impact of the controlling factor on the noise reduction performance, and the results demonstrate the effectiveness of the proposed method.

In this paper developed the modulation domain multi-channel kalman filter algorithm for speech enhancement. The proposed MKF work in both modulation domain and STFT domain.so it uses both inter channel temporal correlation and inter channel spatial correlation.

RELATED WORKS

Y. Ephraim (1992), "Statistical-model-based speech enhancement systems," Throughout the RF spectrum to which this standard is applicable, the MPEs apply to exposure of individuals. Areas wherein intense RF fields exist (that exceed the MPEs) would be an exposure issue only when individuals have access to those areas and may become exposed. Hence, compliance with this standard is to be determined by assessing whether persons may be exposed to RF fields exceeding the MPEs and not necessarily by whether RF fields simply exceed the MPEs. This standard recommends that when and where there may be access to RF fields, currents, and/or voltages that exceed the lower tier MPEs (action levels); exposures are to be controlled through the implementation of an RF safety program, as described in IEEE Std C95.7-2005. Application of an RF safety program results in various control measures that can be taken to reduce the probability of a person's exposure exceeding the BRs and MPEs of the upper tier

J. S. Lim and A. V. Oppenheim (1974), "Enhancement and bandwidth compression of noisy speech", Over the past several years there has been considerable attention focused on the problem of enhancement and bandwidth compression of speech degraded by

additive background noise. This interest is motivated by several factors including a broad set of important applications, the apparent lack of robustness in current speech-compression systems and the development of several potentially promising and practical solutions. One objective of this paper is to provide an overview of the variety of techniques that have been proposed for enhancement and bandwidth compression of speech degraded by additive background noise. A second objective is to suggest a unifying framework in terms of which the relationships between these systems is more visible and which hopefully provides a structure which will suggest fruitful directions for further research.

III.PROPOSED METHODOLOGY

Major contributions of this proposed methods are three

1. Multichannel kalman filtering for speech enhancement algorithm which estimate the target signal by using both temporal correlation and spatial correlation of speech. Output target speech incorporate with the noisy observations .State space model of KF include the LP model. In LP model by modeling the evolution by AR model by using temporal correlation of speech
2. Multichannel wiener filtering for speech enhancement in this proposed method don't used LP model.MKF conventional reduce to MWF. Compare to wiener filter kalman gives fast optimum solution .adaptive wiener filter using only temporal evolution of speech
3. Another proposed method some methods have given low SNR values .So in order to improve the SNR values by spectral subtraction method incorporate with wiener filter for speech enhancement. Both spectral subtraction and wiener using AR process analysis the temporal and spatial of target speech to eliminate the noise to give good SNR optimum solution

IV.SIMULATION RESULTS AND PERFORMANCE ANALYSIS

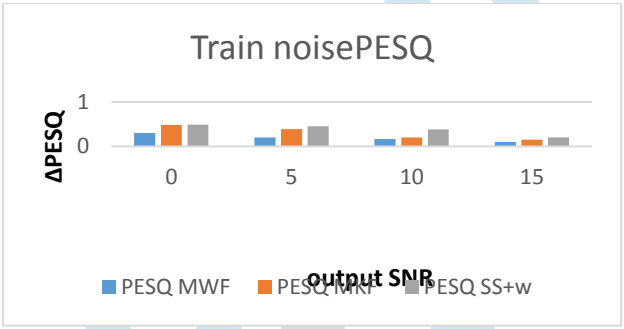

Fig1

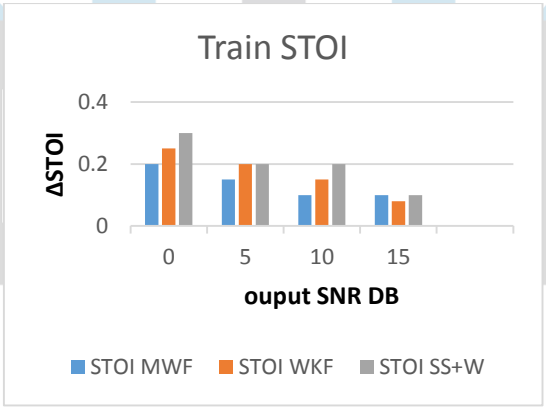

Fig.2

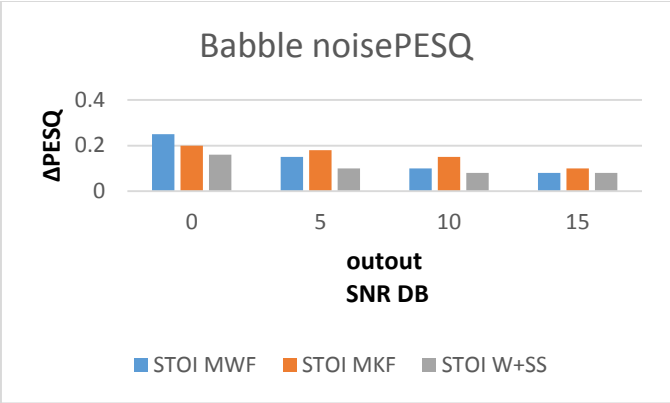

Fig3

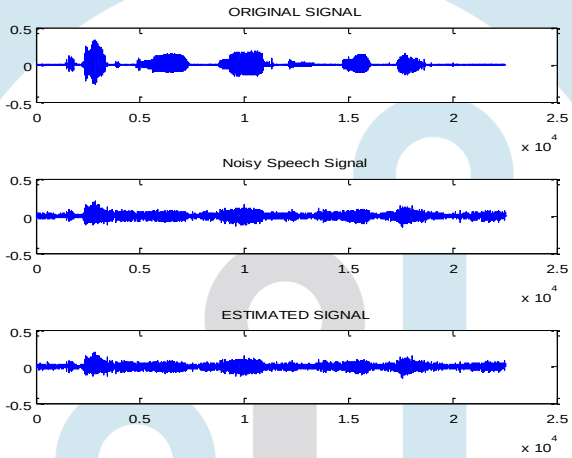

Fig4

CONCLUSION

The proposed MKF During silence intervals, the signal samples (i.e., noise) are stored in a finite length memory and the variances of the noise for each component is computed adaptively using a simple energy detector filter at the output of each eigenfilter. It is assumed that the statistical characteristics of noise do not vary too much until the next noise interval arrives and noise samples are renewed. The proposed speech enhancement system was judged better than the Ephraim's system in our simulations.

The computational complexity of the proposed algorithm is times less than the algorithm proposed by Ephraim and Van Trees. A modulation-domain MKF is proposed in this paper for multichannel speech enhancement. The key feature of the MKF is that it exploits spatial information as well as the temporal information simultaneously to estimate the clean speech signal. To use the spatial and temporal information jointly, the MKF performs LP in the modulation domain and incorporates the spatial information in the STFT domain. An optimal MKF gain is derived to adaptively combine the LP estimation and observation. We show that the MKF is equivalent to the MWF when the LP estimate is not used. Thus an alternative implementation of the MKF, MVDRMDKF, is proposed. The experiments show that the MKF and the alternative implementation MVDR-MDKF always give the same results and outperform conventional MVDR and MWF in various noisy and reverberant conditions.

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