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Noisy speech enhancement using discrete cosine transform [1]

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Abstract

This paper illustrates the advantages of using the Discrete Cosine Transform (DCT) as compared to the standard Discrete Fourier Transform (DFT) for the purpose of removing noise embedded in a speech signal. The derivation of the Minimum Mean Square Error (MMSE) filter based on the statistical modelling of the DCT coefficients is shown. Also shown is the derivation of an over-attenuation factor based on the fact that speech energy is not always present in the noisy signal at all times or in all coefficients. This over-attenuation factor is useful in suppressing any musical residual noise which may be present. The proposed methods are evaluated against the noise reduction filter proposed by Y. Ephraim and D. Malah (1984), using both Gaussian distributed white noise as well as recorded fan noise, with favourable results. © 1998 Elsevier Science B.V. All rights reserved.

Résumé

Cet article illustre les avantages apportés par l'utilisation de la Transformation Cosinus Discrète (DCT) par rapport à celle de la Transformée de Fourier Discrète (DFT) standard, pour le débruitage de la parole bruitée. On montre comment dériver un filtre MMSE à partir de la modélisation statistique des coefficients DCT. On montre également comment dériver un facteur de sur-atténuation basé sur le fait que, dans les signaux bruités, l'énergie de la parole n'est pas toujours présente à chaque instant ni dans chaque coefficient. Ce facteur de sur-atténuation est utile pour supprimer tout bruit résiduel musical. Les méthods proposées ont été évaluées favorablement par rapport du filtre de réduction de bruit proposé par Ephraim et Malah (1994), en utilisant tant du bruit blanc guassien que du bruit de ventilateur enregistré © 1998 Elsevier Science B.V. All rights reserved.

Keywords: Speech enhancement; MMSE amplitude estimation; Noise removal; Discrete cosine transform (DCT)

1. Introduction

It is often necessary to perform speech enhancement through noise removal in speech processing systems operating in noisy environments. As the presence of noise degrades the performance of speech coders and voice recognition systems [1,2], it is therefore common to incorporate speech enhancement as a preprocessing step in these systems. The other important application of speech enhancement is to improve the perceptual quality of speech in order to reduce listener's fatigue. The additive noise may be due to the noisy envi-

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[1] Speech files available. See http://www.elsevier.nl/locate/specom.

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