Journal of Computational and Applied Mathematics 227 (2009) 271–287

Contents lists available at ScienceDirect

Journal of Computational and Applied Mathematics

journal homepage: www.elsevier.com/locate/cam

Wavelet-based dynamic time warping

Sylvio Barbon Jr. [a], Rodrigo Capobianco Guido [a,*], Lucimar Sasso Vieira [a], Everthon Silva Fonseca [b], Fabrício Lopes Sanchez [b], Paulo Rogério Scalassara [b], Carlos Dias Maciel [b], José Carlos Pereira [b], Shi-Huang Chen [c]

[a] *Institute of Physics of São Carlos, University of São Paulo, USP, São Carlos, São Paulo 13566-590, Brazil*

[b] *School of Engineering at São Carlos, University of São Paulo, USP, São Carlos, São Paulo 13566-590, Brazil*

[c] *Department of Computer Science and Information Engineering, Shu-Te University, Kaohsiung County, 824, Taiwan, ROC*

ARTICLE INFO

Article history:
Received 19 June 2006
Received in revised form 30 September 2007

Keywords:
Dynamic time warping
Discrete wavelet transform
Pattern recognition in spoken language

ABSTRACT

Dynamic Time Warping (DTW), a pattern matching technique traditionally used for restricted vocabulary speech recognition, is based on a temporal alignment of the input signal with the template models. The principal drawback of DTW is its high computational cost as the lengths of the signals increase. This paper shows extended results over our previously published conference paper, which introduces an optimized version of the DTW that is based on the Discrete Wavelet Transform (DWT).

© 2008 Elsevier B.V. All rights reserved.

1. Introduction

Two approaches have been intensively used for speech recognition [1]: pattern matching and knowledge-based, implemented by means of Dynamic Time Warping (DTW) and Hidden Markov Models (HMM),respectively. In this paper, we focus on the former approach, that identifies a word or phoneme based on a library of template models [2], for a limited dictionary of voiced speech segments. A modification of the regular DTW algorithm, where the intention is to decrease its computational cost by using the Discrete Wavelet Transform (DWT) [3] to reduce the length of the input signal, and also the length of templates, has been proposed in our previous published conference paper [4]. In this work, we extend our previous results obtained with the proposed DWT-based DTW by presenting three new sets of tests, in addition to the two sets previously presented in [4], showing particular results and confirming the efficacy of the proposed approach.

The remainder of this paper is organized as follows. Section 2 presents a basic review on our previously proposed approach. The additional tests and results are described in Section 3, and, lastly, the conclusions are presented in Section 4.

2. Wavelet-based dynamic time warping

Assuming the discrete-time input speech signal, $x[\cdot]$, with length n, and the templates, $y_k[\cdot]$, with lengths m_k, the proposed algorithm, which is detailed in [4], can be summarized in the following steps.

- **BEGINNING**
- **STEP 1**: Window the input signal and the templates so that they have a length that is a power of 2. It does not matter if the lenghts of the signals are equal or not, however, they must be a power of 2.

* Corresponding author.
E-mail address: guido@ifsc.usp.br (R.C. Guido).

0377-0427/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.cam.2008.03.015

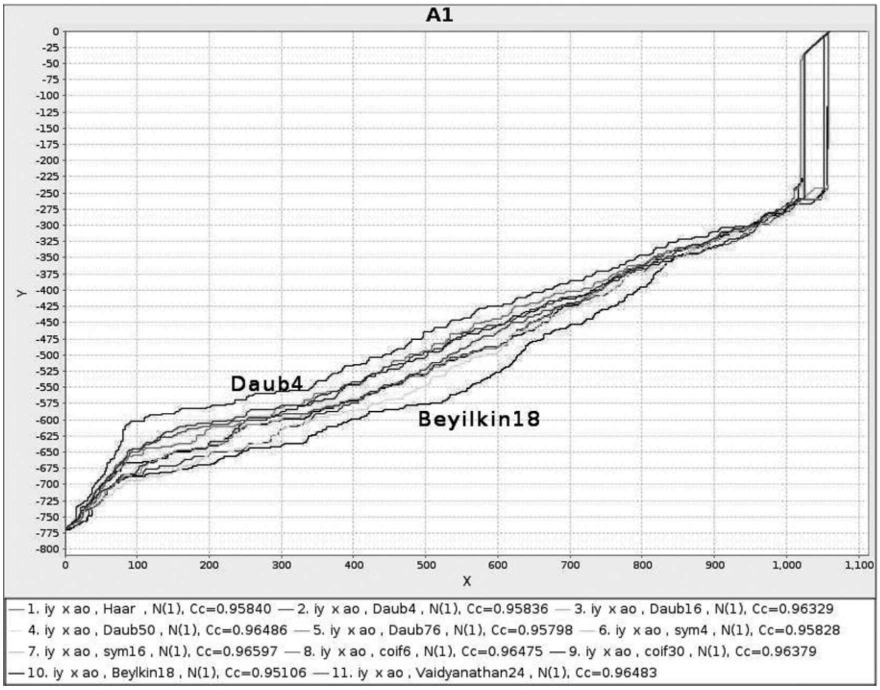

Fig. 1. *Best Path* resulted from the proposed method using $j = 1$ during the third set of tests.

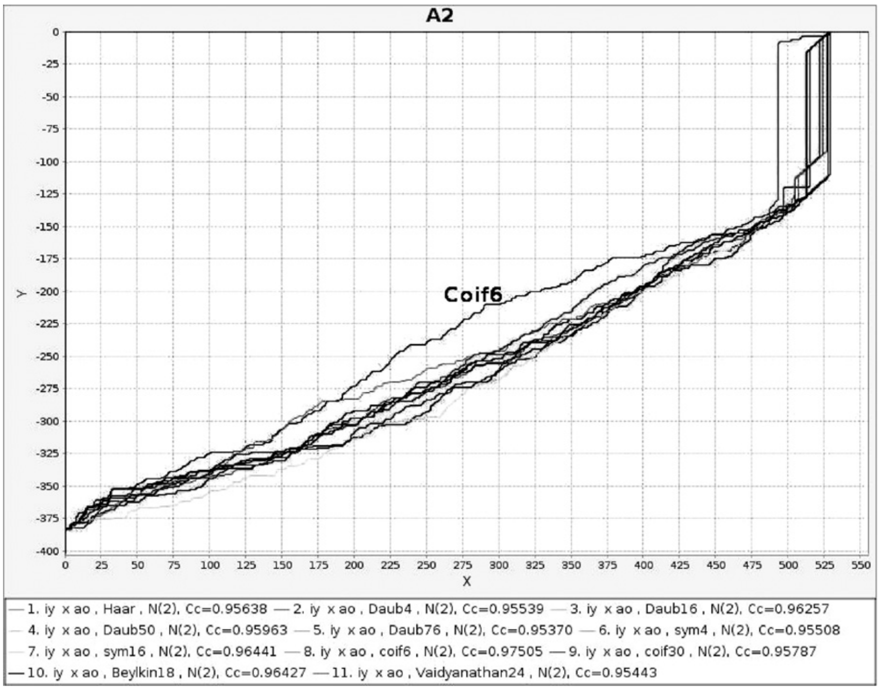

Fig. 2. *Best Path* resulted from the proposed method using $j = 2$ during the third set of tests.

- **STEP 2**: Obtain the jth level DWT of the input and templates, using the family of wavelet filters f, where j and f will be specified ahead;
- **STEP 3**: Consider only the sub-band s of each one of the transformed signals (input and templates), where s will also be specified ahead. The sub-band s of the input signal is called *s-input* and sub-band s of each one of the t templates are, in the same way, called *s-template*-1, *s-template*-2, . . . , *s-template*-t;

Download English Version:

https://daneshyari.com/en/article/4641305

Download Persian Version:

https://daneshyari.com/article/4641305

Daneshyari.com