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Manish Sharma, Shreyansh Agarwal, U. Rajendra Acharya

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Application of an optimal class of antisymmetric wavelet filter banks for obstructive sleep apnea diagnosis using ECG signals

Manish Sharma[a,*], Shreyansh Agarwal[a], U. Rajendra Acharya[b,c,d]

[a] *Department of Electrical Engineering, Institute of Infrastructure Technology Research and Management, Ahmedabad, India*
[b] *Department of Electronics and Computer Engineering, Ngee Ann Polytechnic, Singapore 599489, Singapore*
[c] *Department of Biomedical Engineering, School of Science and Technology, Singapore University of Social Sciences, Singapore.*
[d] *Department of Biomedical Engineering, Faculty of Engineering, University of Malaya, Malaysia*

Abstract

Obstructive sleep apnea (OSA) is a sleep disorder caused due to interruption of breathing resulting in insufficient oxygen to the human body and brain. If the OSA is detected and treated at an early stage the possibility of severe health impairment can be mitigated. Therefore, an accurate automated OSA detection system is indispensable. Generally, OSA based computer aided diagnosis (CAD) system employs multi-channel, multi-signal physiological signals. However, there is a great need for single-channel bio-signal based low-power, portable OSA-CAD system which can be used at home. In this study, we propose single-channel electrocardiogram (ECG) based OSA-CAD system using a new class of optimal biorthogonal antisymmetric wavelet filter bank (BAWFB). In this class of filter bank, all filters are of even length. The filter bank design problem is transformed into a constrained optimization problem wherein the objective is to minimize either frequency-spread for the given time-spread or time-spread for the given frequency-spread. The optimization problem is formulated as a semi-definite programming (SDP) problem. In the SDP problem, the objective function (time-spread or frequency-spread), constraints of perfect reconstruction (PR) and zero moment (ZM) are incorporated in their time domain matrix formulations. The global solution for SDP is obtained using interior point algorithm. The newly designed BAWFB is used for the classification of OSA using ECG signals taken from the *physionet's Apnea-ECG* database. The ECG segments of 1 minute duration are decomposed into six wavelet subbands (WSBs) by employing the proposed BAWFB. Then, the fuzzy entropy (FE)

*Corresponding author
Email addresses: manishsharma.iitb@gmail.com (Manish Sharma), shreyanshag@gmail.com (Shreyansh Agarwal), aru@np.edu.sg (U. Rajendra Acharya)