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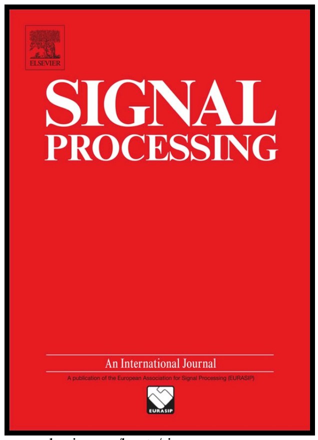

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A fast algorithm for vertex-frequency representations of signals on graphs

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Abstract

The windowed Fourier transform (short time Fourier transform) and the S-transform are widely used signal processing tools for extracting frequency information from non-stationary signals. Previously, the windowed Fourier transform had been adopted for signals on graphs and has been shown to be very useful for extracting vertex-frequency information from graphs. However, high computational complexity makes these algorithms impractical. We sought to develop a fast windowed graph Fourier transform and a fast graph S-transform requiring significantly shorter computation time. The proposed schemes have been tested with synthetic test graph signals and real graph signals derived from electroencephalography recordings made during swallowing. The results showed that the proposed schemes provide significantly lower computation time in comparison with the standard windowed graph Fourier transform and the fast graph S-transform. Also, the results showed that noise has no effect on the results of the algorithm for the fast windowed graph Fourier transform or on the graph S-transform. Finally, we showed that graphs can be reconstructed from the vertex-frequency representations obtained with the proposed algorithms.

Keywords: Graph signal processing, vertex-frequency analysis, windowed graph Fourier transform, graph S-transform.

1. Introduction

Graph theory is a mathematical approach for analyzing the proprieties of data sets that can be represented as graphs [1]. In the graph representation, the vertices (i.e., nodes) refer to objects of interest, and edges describe relationships between the vertices [2]. When applied to data sets, graph theory provides information about the geometric structure of the data and the relationship between data points [3, 4, 5]. For example, relationships between the objects from a given data set can be represented as a weighted undirected graph, where the vertices will describe the position of objects and the weights of the edges will describe similarities between the vertices. Furthermore, a graph representing represents data sets can be modeled such that each

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