Optimum signal and image recovery by the method of alternating projections in fractional Fourier domains

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Abstract

This paper presents a signal and image recovery scheme by the method of alternating projections onto convex sets in optimum fractional Fourier domains. It is shown that the fractional Fourier domain order with minimum bandwidth is the optimum fractional Fourier domain for the method employing alternating projections in signal recovery problems. Following the estimation of optimum fractional Fourier transform orders, incomplete signal is projected onto different convex sets consecutively to restore the missing part. Using a priori information in optimum fractional Fourier domains, superior results are obtained compared to the conventional Fourier domain restoration. The algorithm is tested on 1-D linear frequency modulated signals, real biological data and 2-D signals presenting chirp-type characteristics. Better results are obtained in the matched fractional Fourier domain, compared to not only the conventional Fourier domain restoration, but also other fractional Fourier domains.

1. Introduction

In many signal processing and optical applications, the need for signal recovery arises when some part of a signal is missing or incomplete. An example of these applications is the obscuration of EEG signals with functional magnetic resonance imaging (fMRI) in the presence of burst noise [1]. In case of 2-D signals, estimating the background of an image behind an obstacle is a problem of signal recovery in image processing [2,3]. Recovery of lost blocks in block-based image and video coded signals [4,5] is another recent problem, since the encoded bit stream might be damaged during transmission on unreliable networks, especially in real-time video transmission. Packet loss in some packet switching networks including asynchronous transfer mode (ATM) is common in most networks [6] that cause some part of the image or video to be lost because of different reasons such as congestion and buffer overflow. Alternating projections onto convex sets have been studied in the fields of interpolation, extrapolation, and restoration in the conventional Fourier domain [7,8]. Moreover, image recovery [2–5], signal synthesis [9], and other areas [10,11] including medical imaging and tomography [12] have also been investigated.

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