Author's Accepted Manuscript

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www.elsevier.com/locate/image

PII: S0923-5965(17)30041-3
DOI: http://dx.doi.org/10.1016/j.image.2017.03.004
Reference: IMAGE15188

To appear in: *Signal Processing : Image Communication*

Received date: 8 November 2016
Revised date: 12 March 2017
Accepted date: 13 March 2017

Cite this article as: Khanh Quoc Dinh, Hiuk Jae Shim and Byeungwoo Jeor Small-block sensing and larger-block recovery in block-based compressiv sensing of images, *Signal Processing : Image Communicatior* http://dx.doi.org/10.1016/j.image.2017.03.004

Small-block sensing and larger-block recovery in block-based compressive sensing of images

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Abstract

In the block-based compressive sensing (CS) of images, a small block is more practical due to its low-cost sensing in terms of the required memory and the computational complexity. A large block, however, is more effective in CS recovery because of the high probability of a smaller mutual coherence and a more-compressible representation of the images. This paper proposes a block-based CS scheme that is applicable to images with a small-block sensing and larger-block recovery (SBS-LBR), whereby a block-diagonal sensing matrix is used to arbitrarily set a recovery-block size that is multiple-times larger than the sensing block size; subsequently, a more-compressible transform signal is generated with large-sized sparsifying basis. The proposed SBS-LBR not only facilitates a low sampling cost, but also improves the recovered images from the larger recovery-block size. Our experiment results confirm a theoretical analysis of the scheme, and have shown the improvement from the proposed SBS-LBR with the suggested proper choices regarding the sensing- and recovery-block sizes.

Keywords: compressive sensing, low sampling cost, small-block sensing, larger-block recovery, block-diagonal sensing matrix

1. Introduction

Compressive sensing (CS) [1, 2, 3] is a promising data-acquisition technique that can support a sampling rate lower than the well-established Nyquist/Shannon sampling rate [4, 5]. For a signal x, instead of fully taking n samples that the Nyquist/Shannon rate specifies, only m signal samples, where $m \ll n$, are measured and formed into a measurement vector $y \in R^{m\times 1}$, as follows:

$$y = \phi x, \tag{1}$$

where ϕ is a sensing matrix (SM) of size $m \times n$ satisfying the restricted isometry property (RIP) [1] or the coherence conditions [3]. The ratio $r = m/n$ is called the subrate and represents the CS efficiency in terms of the sampling rate. It is assumed that the compressible form X of the signal x in a selected sparsifying basis ψ is $x = \psi X$; that is, most of the entries of X are zero or very close to zero. X is recovered equivalently to the recovery of x, whereby the ℓ_1-minimization [1] is known as a feasible solver with strong theoretical guarantees, using the following expression:

$$y = \phi x = (\phi\psi)X = \theta X, \tag{2}$$

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