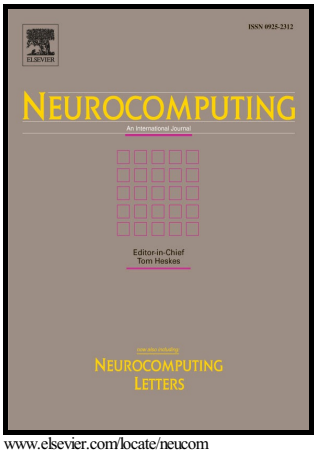

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Single Image Super-Resolution via Blind Blurring Estimation and Dictionary Learning

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Abstract

Learning-based methods have been becoming the mainstream of single image super resolution (SR) technologies. This kind of methods makes it effective to generate a high resolution (HR) image from a single low resolution (LR) image. There exists, however, two main problems with these methods: the quality of training data and the computational demand. We propose a novel framework for single image SR tasks in this paper, which consists of blur kernel estimation (BKE) and dictionary learning. BKE is utilized for improving the quality of training samples and realized by minimizing the dissimilarity between cross-scale patches iteratively. Couple dictionaries are trained by improved training samples before sparse recovery. More important is that a selective patch processing (SPP) strategy is adopted in BKE and sparse recovery, which brings more accurate BKE results and immensely reduces time consumption of the entire process. The experiments show that the proposed method produces more precise BKE estimation and better SR recovery than several typical SR algorithms at a higher efficiency.

Keywords: Super Resolution (SR); Non-Local Self-Similarity (NLSS); Blind Blurring Estimation (BBE); Dictionary learning.

1. Introduction

Image super-resolution (SR) is a cluster of technologies recovering a super-resolved image from a single image or a sequence of images of the same scene, which is a basic operation of many subsequent image manipulation (such as feature extraction [1] and image fusion [2]). In many practical applications, however, it is not easy to obtain an adequate number of LR observations. Therefore, single image super-resolution has attracted great attentions in recent years.

Machine learning based methods are promising technologies for SR problem, and it has become the most popular topic in single image SR field. Freeman et al. [3] proposed example-based learning method firstly. The algorithm predicted HR patches from LR patches by solving Markov Random Field (MRF) model via belief-propagation algorithm. Then, Sun et al. [4] enhanced discontinuous features such as edges and corners etc. by primal sketch priors, which extended example-based method further. To improve execution efficiency, Chang et al. [5] proposed nearest neighbor embedding (NNE) method motivated by the philosophy of locally linear embedding (LLE) [6]. They assumed LR patches and HR patches have similar space structure. The coefficients of LR patch can be solved through least square problem, which are then applied to HR