Chapter 31
Feature-Based Affine Motion Estimation for Superresolution of a Region of Interest

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ABSTRACT

This chapter presents an interpolation method of low-computation for a Region Of Interest (ROI) using multiple low-resolution images of the same scene. Interpolation methods using multiple images require the accurate motion information between the reference image of interpolation and the other images. Sometimes complex local motions applied to the entire images are estimated incorrectly, yielding seriously degraded interpolation results. The authors apply the proposed Superresolution (SR) method, which employs a simple global motion model, only to the ROI that contains important information of the scene. The ROIs extracted from multiple images are assumed to have simple global motions. At first, using a mean absolute difference measure, they extract the regions from the multiple images that are similar to the selected ROI in the reference image of interpolation and use feature points to estimate the affine motion parameters. The authors apply the Projection Onto Convex Sets (POCS)-based method to the ROI using the estimated motion, simplify the iterative computation of the whole system, and use an edge-preserving smoothing filter to reduce the distortion caused by additive noise. In experiments, they acquire test image sets with a hand-held digital camera and use a Gaussian noise model. Experimental results show that the feature-based Motion Estimation (ME) is accurate and reducing the computational load of the ME step is efficient in terms of the computational complexity. It is also shown that the SR results using the proposed method are remarkable even when input images contain complex motions and a large amount of noise. The proposed POCS-based SR algorithm can be applied to digital cameras, portable camcorders, and so on.

INTRODUCTION

In digital multimedia and consumer applications, Resolution Enhancement (RE) of images or video with image details is desired. For example, a high-quality digital image is obtained from a single or multiple Low-Resolution (LR) images or video (Park, et al., 2003; Islam, et al., 2010). Also, digital zooming of the Region Of Interest (ROI) is one of important multimedia or surveillance applications. RE can be achieved by denoising, deblurring, or reconstruction of image details. Digital images are magnified with some image quality degradation. Image interpolation using a single image usually gives image degradation such as blurring of edges and image details. Techniques to achieve higher RE of an image or video in imaging system, using a single or multiple images, are called Superresolution (SR). SR has various applications such as digital television, medical imaging, remote sensing, and so on (Meijering, 2002). Success of SR depends on image interpolation.

Simple linear interpolation methods such as nearest neighbor, bilinear, and bicubic interpolation, based on space-invariant models, are generally used for the computational simplicity, with low-quality image containing some blurred edges and blocking artifacts. For better subjective performance, many interpolation methods have been proposed; including an edge-guided interpolation method via directional filtering and data fusion (Zhang & Wu, 2006), an image magnification method based on similarity analogy (Chen, et al., 2009), a ramp edge model to maintain both the continuity and sharpness of edges (Leu, 2001), a directional interpolation based on the estimated orientation of edges and ridges (Wang & Ward, 2003), a RE method based on Laplacian pyramid representation (Takahashi & Taguchi, 2003; Jeon, et al., 2006), a frequency domain based method (Islam, et al., 2012), a wavelet-based interpolation method (Chang, et al., 2006), training based methods (Freeman, et al., 2002; Sun, et al., 2003), and an interpolative classified vector quantization

method (Hong, et al., 2008). Recently, a sparsity-based patch-based SR method using dictionaries is proposed (Jianchao, et al., 2010). Also a SR reconstruction of multispectral data is presented to improve the clustering and classification efficiency (Li, et al., 2009). A performance evaluation of various interpolation and SR algorithms is presented for various gray level and color images by using both objective measures and subjective evaluation (Ye & Lu, 2011).

SR methods using multiple LR images of the same scene produce the HR image by utilizing sub-pixel information of LR images (Park, et al., 2003; Van Eekeren, et al., 2010). These SR methods generally assume the degradation models and find the solutions, in which motion information between the LR images is needed. Motion Estimation (ME) is very important for obtaining sub-pixel information from multiple LR images. Also, a scene-based video SR using minimum mean square error estimation is presented (Cao, et al., 2011). A joint method for multiframe demosaicing and SR of color images is presented (Farsiu, et al., 2006).

A large number of SR techniques have been investigated with different degradation models for image restoration (Park, et al., 2003). SR methods using multiple images include non-uniform interpolation (Maymon & Oppenheim, 2011), SR reconstruction of compressed video using transform domain statistics (Gunturk et al., 2004), Iterative Back Projection (IBP) (Song, et al., 2010), regularization approach (Tom & Katsaggelos, 2001), and Projection Onto Convex Sets (POCS) (Patti, et al., 1997; Tang, et al., 2011). Because the SR method in the frequency domain is restricted to assume a simple motion model, the spatial domain approaches have been commonly used. In conventional SR methods using multiple images, different ME approaches have been adopted: block matching algorithms (BMAs) for translational models (Tom & Katsaggelos, 2001; Molina, et al., 2003; Cetin & Ari, 2012), gradient descent methods for affine models (Patti, et al., 1997; Tang, et al., 2011;

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