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Research Article

Precise Image Registration with Structural Similarity Error Measurement Applied to Superresolution

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Precise image registration is a fundamental task in many computer vision algorithms including superresolution methods. The well known Lucas-Kanade (LK) algorithm is a very popular and efficient method among the various registration techniques. In this paper a modified version of it, based on the Structural Similarity (SSIM) image quality assessment is proposed. The core of the proposed method is contributing the SSIM in the sum of squared difference, which minimized by LK algorithm. Mathematical derivation of the proposed method is based on the unified framework of Baker et al. (2004). Experimental results over 1000 runs on synthesized data validate the better performance of the proposed modification of LK-algorithm, with respect to the original algorithm in terms of the rate and speed of convergence, where the signal-to-noise ratio is low. In addition the result of using the proposed approach in a superresolution application is given.

1. Introduction

One of the most critical aspects of many applications in image processing and computer vision, including Super-Resolution, is the accurate estimation of motion, also known as image registration. The Super-Resolution (SR) techniques fuse a sequence of low-resolution images to produce a higher resolution image. The low-resolution (LR) images may be noisy and blurred and have some displacements with each other. These methods utilize information from multiple observed images to achieve restoration at resolutions higher than that of the original data. It is widely recognized that the accuracy of motion estimation is arguably the limiting factor in Super-Resolution restoration performance [1, 2], and so any fruitful consideration of this problem promises significant returns.

In SR literatures a variety of registration approaches have been presented. They can be classified into two main approaches: feature-based methods and area-based methods. Usually the motion parameters can be roughly estimated by a feature-based method before being refined by an area-based method [3]. One of the famous registration method is the pioneering work of Lucas and Kanade [4]. This is an area-based method which is based on using of a Taylor series approximation of the images. The motion parameters are the unknowns in the approximation, and they can be computed from the set of equations that can be derived from this approximation. Recently Baker et al. [5] introduced a unified framework for Lucas-Kanade algorithm, and we will use their formulation for explaining our method in the rest of this paper.

Recent advances in Super-Resolution techniques show trends toward methods which consider some prior knowledge or models as the additional input of the SR algorithm [3, 6, 7]. The model-based approaches import plausible high-frequency textures from an image database into the High-Resolution (HR) image. Based on the mentioned hypothesis, in [8], we described a method for increasing the resolution, using an HR training image, in which the entire of HR training image is mapped and fused onto LR image. Its registration stage is a feature-based method using SIFT key-points, which sometimes leads to inaccurate mapping. In [9] we used the LK algorithm for refining the result of the mentioned feature-based registration stage and proposed a method for specifying magnification factor automatically. In this paper we proposed a new version of LK-algorithm