Video Enhancement Using A Robust Iterative SRR Based On A Geman&McClure Stochastic Estimation With A General Observation Model

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Abstract- **This paper proposes the novel robust SRR algorithm that can be effectively applied on the sequence that are corrupted by various noise models and can be applied on the real or standard sequence. First, the proposed SRR algorithm is based on the Geman&McClure norm that used for measuring the difference between the projected estimate of the high quality image and each low high quality image and for removing outliers in the data. Second, in order to cope with real video sequences and complex motion sequences, the proposed SRR is based on a general observation model for SRR algorithm, fast affine block-based transform, devoted to the case of nonisometric inter-frame motion. The experimental results show that the proposed reconstruction can be efficiently applied on real sequences such as Suzie and Foreman sequence and confirm the effectiveness of our method and demonstrate its superiority to other super-resolution methods based on L1 and L2 norm for several noise models (such as AWGN, Poisson, Salt & Pepper noise and Speckle) and several noise power.**

Keywords-component; Image Reconstruction, Video signal processing, Image enhancement

I. INTRODUCTION

In the last two decades, an algorithm for digital image quality improvement attracted large interest uses SRR (Super Resolution Reconstruction). SRR algorithm consists basically of combining multiple corrupted low-resolution (LR) images of the same scene or object to form a higher resolution image [1-4]. Reference [6] reviews several important results on SRR available in the literature from the estimation point of view since the SRR estimation is one of the most importance parts of the SRR research areas and directly affects to the SRR performance. From the literature result, almost SRR algorithms are based on the simple estimation techniques such as L1 Norm or L2 Norm Minimization. For normally distributed data, the L1 norm produces estimates with higher variance than the optimal L2 (quadratic) norm but the L2 norm is very sensitive to outliers because the influence function increases linearly and without bound. Consequence, Reference [6] proposed a robust iterative SRR algorithm based on Geman&McClure norm [7], designed to be more robust than L1 and L2 norm, for classical observation model.

In this paper, we proposed the novel video enhancement framework using a robust iterative SRR based on a Geman&McClure stochastic estimation with a general observation model [5]. Geman&McClure norm is used for measuring the difference between the projected estimate of the high quality image and each low high quality image and for removing outliers in the data. Moreover, Tikhonov regularization is incorporated in the proposed framework in order to remove artifacts from the final answer and to improve the rate of convergence. In order to cope with real video sequences and complex motion sequences such as Susie and Foreman sequence, the proposed SRR is based on a general observation model for SRR algorithm, fast affine block-based transform [5], devoted to the case of nonisometric inter-frame motion. These experimental results demonstrate that our method's performance is superior to what were proposed earlier [1-4, 6].

The organization of this paper is as follows. Section 2 reviews the main concepts of robust estimation technique in SRR framework using L1 and L2 error norm with Tikhonov Regularization. Section 3 introduces our proposed robust super-resolution reconstruction using Geman&McClure error norm minimization with the affine block-based registration. Section 4 outlines the proposed solution and presents the comparative experimental results obtained by using the proposed Geman&McClure norm method and by using the conventional L1 and L2 norm method. Finally, Section 5 provides the conclusion.

II. INTRODUCTION OF SRR

A. Classical Observation Model

In this section, we first propose the problem and the model of super-resolution reconstruction. Define a low-resolution (LR) image sequence, $\{\mathbf{Y}_k\}$, as our measured data (The size of the LR images is $N_1 \times N_2$ pixels). A HR image $\underline{\mathbf{X}}$ ($qN_1 \times qN_2$ pixels) is estimated from the LR sequences, where q is an integer interpolation factor in both the horizontal and vertical directions. To reduce the computational complexity, each frame is separated into overlapping blocks (the shaded blocks in Fig. 1(a) and Fig. 1(b)). For notation convenience, all overlapping blocked in a frame will be presented as a vector, ordered column-wise lexicographically. Namely, the overlapping blocked in LR frame is $\underline{Y}_k \in \mathbb{R}^{M^2}$ ($M^2 \times 1$) and the overlapping blocked in HR frame is $\underline{X} \in \mathbb{R}^{q^2M^2}$ ($L^2 \times 1$ or $q^2M^2 \times 1$). We assume that the two images are related via the following equation

$$\underline{Y}_k = D_k H_k F_{k\_T} \underline{X} + \underline{V}_k \quad ; k = 1,2,\ldots,N \qquad (1)$$

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