An Overview of Challenging Issues in Image Super Resolution Construction

Yogesh Popat[1] Prof. Daxa V. Vekariya[2]
[1,2]Department of Computer Engineering
[1,2]Noble Engineering College, Junagadh Gujarat 362001, India

Abstract— There are many different techniques that are proposed since the Image Super Resolution concept is introduced. Almost approaches that are existing are found to be working well on the toy data or the sample data but faces issues in the real world data. For the development of a practical Image Super Resolution there are many challenging issues ahead that may prevent the proposed techniques and approaches from the desired application. In the following, There are several such challenging issues that we think are important and to be focused on for the further development and wide applications of Image Super Resolution Techniques.

Key words: Image Super Resolution, Image Registration, Super Resolution construction, Image Super Resolution techniques

I. INTRODUCTION

Image registration is mostly considered in the process of multi-image Super Resolution reconstruction where all the spatial samples of the images are fused on one another. Registration of images is the fundamental image processing problem that is famous. The problem becomes even more difficult in the Super Resolution where the input data is mostly the low resolution images with heavy noise and aliasing artefacts. This in turn decreases the efficiency of the basic image registration techniques and approaches and resulting in the more registration errors. The results caused by these registration errors are worse than the noise or blur effects that comes from the varying aperture size of the image capturing hardware. Traditional methods usually takes the registration of images as a different process from the estimation of high resolution image. Hence, the efficiency of the high resolution image quality depends almost on the image registration. There are many image registration techniques proposed from the different principles and theorems in many literatures. Robison et al. proposed that the performance of the registration of images is bounded even for the simplest case of global translation.

The estimation of High Resolution Image from the Low Resolution Image are both dependent on each other. On one side there is an accurate sub pixel motion estimation advantage of High Resolution Image estimation and on the other side qualitative High Resolution image can provide efficient estimation of motion. Tailoring it to the Super Resolution Image construction approach, This Low Resolution registration of image can be referenced together with the High Resolution image construction that is leading to joint ML or MAP framework of simultaneous estimation. These algorithms of joint estimation are used to capture the dependency between the Low Resolution registration of images and the estimation of High Resolution image and likewise the improvements in the performance are judged.

Such registration parameters results into the over fitting of the images. To treat the problem of over fitting, Tipping and Bishop have done a Bayesian approach for the estimation of both the registration of images and blurring parameters by marginalizing the unknowns of the High Resolution Image. The computation cost of such algorithm is however very much high.

The promising results have been demonstrated by the stochastic approaches associated with the High Resolution image estimation with image registration. But such parametric based methods have got limitation. The limitation of stochastic approach is up to the motion models only that they can handle effectively. Generally, the assumptions are made for some simple global motion models.

Other promising approach in Super Resolution construction is the methods based on nonparametric process. Such methods try to remove the explicit estimation of motion.

II. INTENSIVE EFFICIENCY COMPUTATION

Other problem that is limiting the application of Super Resolution Image construction is the computation of large number of unknowns in the image that requires the expensive matrix calculations. The efficiency has always been demanded in the real applications for the utilization of the Super Resolution Image construction. For e.g., Surveillance video needs the construction of Super Resolution Image in the real time. Many algorithms are found targeting the efficiency.

Hardie[13] demonstrated the efficiency of his algorithm and claimed that it is applicable in real time. However, the computation process goes up significantly on the occurrence of the non-translation models, which can be showed by the distributed computing.

Some others also gave a try and modelled the scenarios that can speed up the problem of optimization. Zomet[12] and Farisu have studied the application of Dk, Hk and Fk for the image operations of sampling, shifting and blurring that have bypassed the need of constructing the matrices explicitly and in result that results in the increased computational speed.

However, all such approaches requires the accurate image registration which is intensive from the computation and these algorithms are capable of handling the models of simple motion only up to now that is far from the real world application.

It is also interesting to see how parallel computing, e.g., GPU, and hardware implementations affect the future applications of SR techniques.

III. ROBUSTNESS

There always remains the risk of outliers with the traditional Super Resolution approaches due to the errors, blur, noise, moving objects etc. Such errors are not treated by the Gaussian noise. The robustness of Super Resolution is

interesting because the parameters of image degradation models may not be perfectly estimated and such outliers results in visually disturbing results which cannot be tolerated. However, very less work has been devoted for such aspect. Chiang and Boulte[14] used median estimation to combine the sampled images to deal with the outliers. Zomet[15] have showed the problem in another way. The median based gradient is used for the efficiency optimization that bypasses the effect of outliers. Farisu[16] changed the l2 norm into l1 norm for robust estimation. Pham[17] showed a interpolation of unknown data with the same photometric scheme that was used in the filtering of bilateral. Such uncertainty scheme were found to be used in the models of probabilistic motions[18] that deals with the optical flow motion errors on block matching. Many of these algorithms showed improvements for outliers assumed on the toy data, where more experimental evaluations are needed to see how much the robustness efforts can benefit real SR performance.

IV. LIMITATIONS OF PERFORMANCE

The Super Resolution image construction has become an interesting topic since it was introduced and thousands of papers are published. However, there is very less work done in understanding the fundamentals of limitations over the performance. The camera design helps us to see the factors such as model errors, zooming, frames etc. In short the analysis of the limitations of performance is not tractable. The Super Resolution image construction is the complicated task which consists of dependent components it is still unknown what is the most informative prior given the SR task, especially for the example-based approaches. A good measure is needed instead of mean square error for the evaluation of performance. It is seen that the higher mean square error is not more visually appealing.

Several attempts have been made in last several years for the understanding of the performance in construction of High Resolution image from the Low Resolution images. [1] Has analysed the numeric conditions of the super resolution systems and concludes that how the zoom factor effects the Super Resolution. [19] Has derived the limits based on the perturbation of matrix but it has assumption that image registration is done in prior. Robinson and Milanfar [20] with simple translation model used the Cramer-Rao bounds for the analysis of the registration of image and its limitations of performance. The work was extended by them in [21] that gives the analysis of super resolution performance that includes motion estimation, number of frames, decimation factor and prior information. It was based on the mean square error and the motion model was assumed to be the global translational. Eekeren [22] showed super resolution approaches on real wide data that includes the factors empirically. Even though such efforts are far not enough about super resolution but they do suggests some ways for people to follow.

It is hard to draw the conclusions for the different super resolution techniques. For the performance evaluation some benchmark or real data sets are required for comparison of algorithms.

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