# Image Super-Resolution based on Efficient Novel Two-Stage Super-Resolution Technique

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## ABSTRACT
Super resolution increases the resolution of the image. This paper proposes the two stage novel SR method. . In the firststage, of the proposed method first jointly train two dictionaries for the high and low resolution image patches. Then apply a sparse representation for each low-resolution image patch, and correspondingly generate a high-resolution intermediate image by exploiting the high-resolution dictionary and low-resolution dictionary. In the second stage,of the proposed method a higher resolution image is obtained by fusing the intermediate high-resolution image sequence based on projection onto convex sets (POCS) method, increase image magnification while keeping goodeffectiveness. Experiment results show theeffectiveness of the proposed method and improved performance over other SR algorithms.

**Keywords**: Super-resolution, Sparse representation, POCS

## 1. INTRODUCTION
Super-resolution (SR) image reconstruction is an areaof research, because it cansolve the inherent resolution limitation of low cost imaging sensors such as cell phone, medicalimaging equipment, surveillance cameras and so on. In medical imaging for example, a high-resolution medical image is very helpful to make a correct diagnosis[1]. The task of super-resolution image reconstruction is to produce a high-resolution image from one or a set of low-resolution images of the desired scene. In the last decades, lots of approaches to solve the SR problem have been proposed [1], such as Projection onto Convex Sets (POCS) [2], structure-adaptive normalized convolution (NC) [3], Bayesian Maximum a Posteriori (MAP) [4], Iterative Back-projection (IBP) [5] and so on.There are two kinds of approaches: single-based super-resolution and sequence-based super-resolution. The sequence-based SR produces a high-resolution image by fusing a set of low-resolution images based on some prior knowledge such as generation model or some assumptions. It is a severely ill-posed problem because the number of low-resolution images is insufficient and image registration in the first step is ill-conditioned. This paper, proposednoveltwo-stage SR approach this can combine two kinds of advantages together.In the first stage, first jointly train two dictionaries for the high- and low- resolution image patches. Then apply a sparse representation for each low-resolution image patch, and correspondingly generate a high-resolution intermediate image by exploiting the high-resolution dictionary and low-resolution dictionary. Then, in the second stage, a higher resolution image is obtained by fusing the intermediate high-resolution image sequence based on POCS method, increase image magnification while keeping good Effectiveness.

## 2. BACKGROUND
Image super-resolution (SR) are techniques aiming to estimation for the high-resolution (HR) image from one or more low-resolution (LR) images, which offer the promise of overcoming some of the inherent resolution limitations of low-cost imaging sensor and allow better utilization of the growing capability of HR displays. The super-resolution approaches normally require multiple LR inputs of the same scene with sub-pixel motions. The SR task is thus cast as an inverse problem of recovering the original HR image byfusing the LR inputs, based on reasonable assumptions or prior knowledge about the observation model. However, SR image reconstruction is typically severely ill-conditioned because of the insufficient numberof observations and the unknown registration parameters. Various regularization techniques are therefore proposed to stabilize the inversion of this ill-posed problem.

## 3. PREVIOUS WORK DONE
Xiaoqing Su et al. [1] proposed the pattern of two-step SR methods. Two sparse representation dictionaries are trained from low and high resolution training image patches. After that for each low-resolution image, a relative high-resolution intermediate image is generated using sparse representation of these low-resolution image patches that is based on learning dictionary method. At the final step a set of high-resolution intermediate images are obtained, Author use an improved multi-frame POCS method to fuse these images and generate the final higher resolution image. In this paper, Author present a novel two-stage super-resolution (SR) algorithm combined sparse signal representation with the projection onto convex sets (POCS). Author comparesproposed method with other state-of-the-art image super-resolution methods such as Bicubic interpolation, structure-adaptive normalized convolution (NC)and the standard POCS method. Author computes Peak Signal to Noise Ratio (PSNR) and Structural Similarity (SSIM) to qualitatively measure the validity of these algorithms. Experiment results givethe effectiveness of method and the improved performance over other SR algorithm parameter considered PSNR, Bicubic NC and POCS. Advantages of proposed method Single-based SR based on learning dictionary can make full use of self-information such as the image local correlation and the non-local similarity while sequence-based SR can exploit. Cons of the2$^{nd}$ stage of the proposed method increases the consuming time.Tomer Peleg et al. [2] proposed data clustering and cascading several levels of the basic algorithm. Author suggest a training scheme for the resulting network this

method demonstrate the capabilities of the algorithm, showing its advantages over existing methods based on a low and high resolution dictionary pair, in terms of computational complexity, numerical criteria and visual appearance. To solve the previous work problem this paper address single image super-resolution using a statistical prediction model based on sparse representations of low and high resolution image patches. This model allows us to avoid any invariance assumption, which is a practice in sparsity-based approaches treating this task. Prediction of high resolution patches is obtained via MMSE and the resulting method has the useful interpretation of a feed forward neural network .Author considered the parameter SSD, DL , ESF , LPA-ICI , AFD,LDI-NAT ,VDI-N and VDI. The advantage of VDD is for a smooth region, the edge direction is accurate, and for a complex region, if the domain edge exists, the detection is also accurate and the proposed interpolation method has advantages in preserving the smooth edges and details of the image[4]. If no domain edge is measured by VDD, the edge direction will not be estimated. Artifacts can be reduced to some degree because no wrong edge direction is estimated. The previous work on the number of interpolation technique.

## 4. EXISTING METHODOLOGY

A novel two-stage SR method can combine two kinds of advantages together.In the first stage each image of the input low-resolution image sequence is magnified by using sparse representation super-resolution which based on learning dictionary. After that a high-resolution intermediate image sequence from the input image sequence. In the second step, a higher resolution image is obtained by fusing the intermediate high-resolution image sequence basedon POCS method. So, increase image magnification while keeping goodeffectiveness.The suggestion for model is desire to predict for each LR patch the missing HR detail via a pair of LR and HR dictionaries with different number of atoms. In First, step each dictionary is at characterizing signals of different qualities, so it seems natural to use fewer atoms for the lower quality content.InSecond, step working with a small and orthogonal (possible only in the complete and under-complete cases) dictionary for the LR patches allows for avoiding typical high-complexity sparse-coding computations, utilized in previous work.A novel image interpolation method is proposed that called the contrast-guided image interpolation that method is one of the most important attributes to the human visual system (i.e., contrast) into the design of image interpolation process. This method can be viewed as an extension of the existing edge-guided image interpolation methods, since the information regarding how strong of each detected contrast boundary or edge is completely not considered in the existing methods.

## 5. ANALYSIS AND DISCUSSION

The novel method follows the pattern of two-step SR methods[1]. In the First step, two sparserepresentation dictionaries are trained from low and high resolution training image patches. Then, for each low-resolution image, a relative high-resolution intermediate image is generated using sparserepresentation of these low-resolution image patches based on learning dictionary method. In the final step, a set of high-resolution intermediate images are obtained, Author use an improved multi-frame POCSmethod to fuse these images and generate the final higher resolution image[2]. The diagram of the processis presented in Figure 1.

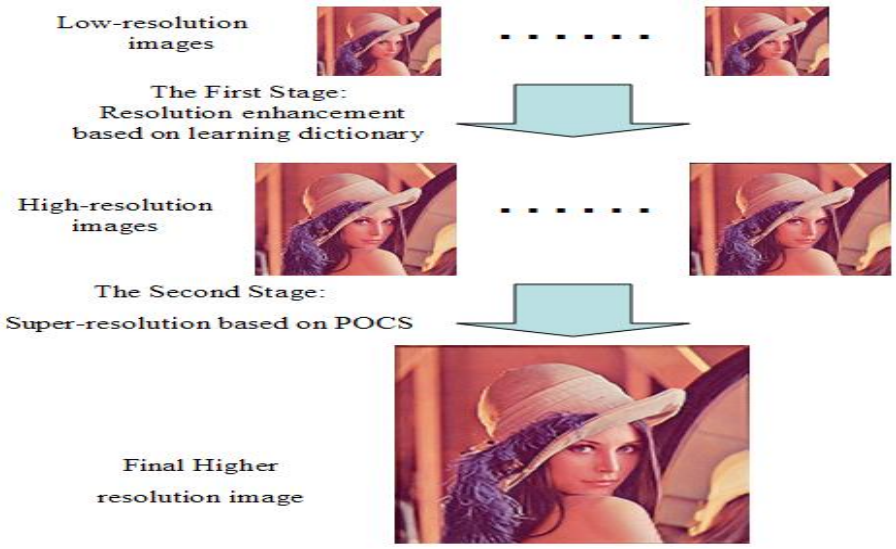


**Figure 1.The diagram of two-stage super-resolution method [1]**

**Table I performance comparison of different SR method using PSNR**

| Image | Bicubic | NC | POCS | Our method |
|---|---|---|---|---|
| Lena | 19.73 | 19.57 | 19.44 | **21.15** |
| Girl | 18.78 | 18.80 | 18.63 | **20.25** |
| Butterfly | 17.85 | 17.15 | 17.28 | **19.24** |

**Table II performance comparison of different SR method using SSIM**

| Image | Bicubic | NC | POCS | Our method |
|---|---|---|---|---|
| Lena | 0.6589 | 0.6481 | 0.6735 | **0.7195** |
| Girl | 0.6829 | 0.6673 | 0.6985 | **0.7527** |
| Butterfly | 0.7460 | **0.8724** | 0.7744 | 0.8557 |

Simulation results demonstrated that the effectiveness of the proposed method and the improved performance over other SR algorithms. The future work is to find a more efficient algorithm to fuse the images in the second stage and reduce the consuming time. Table I,II shows the result of SR method in terms of PSNR, SSIM.

To enhance the performance of the suggested scheme, that incorporating three additional principles which have been found to be useful in previous work. In the Firststep, to allow for better representation capability, the single prediction model is replaced by a union of models and each LR patch is assigned to the model that fits it best,similar to previous work. In the Second step, to stabilize the reconstruction process and reduce hallucination artifacts, suggest a gradual increase in resolution. This is obtained through a multi-level scale-up scheme, where each level takes as input the output of the previous one and further improves its resolution. In the Generation of Directional Variation Fields: variations of pixel-intensity values along the tangent direction of contrast boundary is always much smaller than that of the direction normal to the boundary. Directional variation (DV) values along two orthogonal directions for each pixel simultaneously in order to determine whether it is situated on a contrast boundary or not.In the Diffusion of Directional Variation Fields: The purpose of diffusing the DV fields is to realize the objective on proportionally reflecting the amount of local contrast for each detected contrast boundary presented in the DV fields that are generated by the steps. Extensive simulation results have shown that the proposed contrast-guided image interpolation is superior to other state-of-the-art edge-guided image interpolation methods. The computational complexity is relatively low when compared with existing methods. The proposed method can be viewed as an extension of the existing edge-guided image interpolation methods, since the information regarding how strong of each detected contrast boundary or edge is completely not considered in the existing methods.

Objectively and subjectively using various demosaicking methods. To conduct the experiments, the first implemented procedure using a Bayer color filter array on the target testing images, and then Authors applied different demosaicking methods to reconstruct the three color channels from the mosaicked image. Finally, compared VDI with conventional methods, such as SSD, DL, LPA-ICI, ESF, AFD and LDI-NAT[4]. Utilizing a voting-based direction detection method, the interpolation direction can be determined more accurately than in conventional methods. Using the color channel correlation, the missing green component is pre estimated, and then a local adaptive gradient inverse weighted interpolation method is adopted to refine and enhance the interpolation performance along the detecteinterpolation direction. The Future work is on the quality improvement of the proposed method.

## 6. PROPOSED METHODOLOGY

A newly proposed novel two-stage SR approach which can combine two kinds of advantages together.In the first stage, Instead of directly using raw pixel values, extract simple features from HR/LR patches respectively as the signals in their coupled spaces. The DC component is first removed from each HR/LR patch then each image of the input low-resolution image sequence is magnified by using sparse representation super-resolution which based on Orthogonal Gaussian Mixture Models (OGMM) [4] is used to classify the low resolution image patch automatically according to their features Therefore a high-resolution intermediate image sequence from the input image sequence , the mean value of a patch is always preserved well through the mapping from HR space to LR space. Then, in the second stage, a higher resolution image is obtained by fusing the intermediate high-resolution image sequence based on POCS method, extract gradient features from LR image patch.


Resolution based on
OGMM method

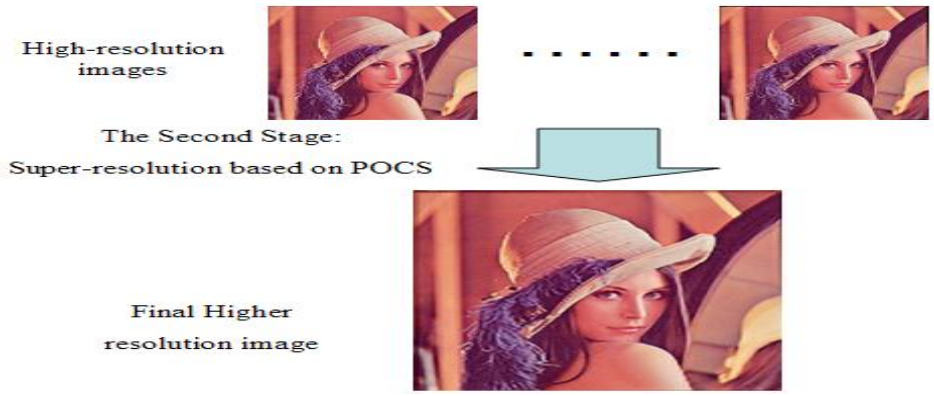


**Fig2. Overview of Proposed method**

## 7. POSSIBLE OUTCOMES AND RESULT

The proposed two step novel SR method increase image magnification while keeping good effectiveness.Firstly, this method allow for better representation capability, the single prediction model is replaced by a union of models and each LR patch is assigned to the model that fits it best, similar to previous work. Secondly it stabilizes the reconstruction process and reduces hallucination artifacts and increases in resolution. Simulation results demonstrate the effectiveness of this method and the improved performance over other SR algorithms.

## 8. CONCLUSION

In this paper, newly proposed a novel two-stage super-resolution algorithm based OGMM model and POCS. In the first stage, first jointly train two dictionaries for the high- and low- resolutionimage patches. Then apply a sparse representation for each low-resolution image patch, andcorrespondingly generate a high-resolution intermediate image by exploiting the high-resolutiondictionary and low-resolution dictionary. Then, in the second stage, a higher resolution image is obtained by fusing the intermediate high-resolution image sequence based on POCS method.So, in this way proposed method increases the super resolution of image and increase image magnification while keeping good Effectiveness. The future work is to find a more efficient algorithm to fuse the images in the second stage and reduce the consuming time of the proposed method.

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