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APPLICATION OF KERNEL REGRESSION IN SINGLE IMAGE SUPER RESOLUTION

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Abstract - Super resolution is an enhancement technique used for converting one or more low quality image in high quality image. Single image is effectively resolved with two methods interpolation based and learning based method. Traditional interpolation methods are unable to produce sharp edges and clear details. So learning based method is applied in this paper. Second order kernel regression is used at the output of testing and training phase to reduce the mapping error. Training features are extracted using K-singular value decomposition dictionary. Kernel allow data to map into high dimensional for increasing computational efficiency. This method is capable to reduce use of dictionary. Comparison between old method and presented method were done based on peak signal to noise ratio and mean square error values. Result of experimentation shows that implemented SR method is more efficient and robust to different data types. Result shows that implemented SR method has much future scope with high resolution factor.

Keywords - Kernel regression, K-singular value decomposition, steering matrix

I. INTRODUCTION

Now day's images are playing important role in our day to day life. A high quality image is visually comfortable to watch. Capturing image with costly cameras is one of the options for getting high resolved image. But maintenance and repairing of such gadgets require time and money. Hence Super Resolution (SR) technique of single and more images are comes with numbers of application. Super resolution images have more application in the area like medical imaging, image processing, surveillance, remote sensing etc.

Simply super resolution of image means enhancement of Low Resolution (LR) component in High Resolution (HR). There are some methods for such enhancement based on techniques used for resolution 1) Interpolation based method 2) Reconstruction based method 3) Learning based method. On the basis of number of input images super resolution technique is classified in two division single input SR method and multi input SR method.

As super resolution of single image is ill-posed problem. This problem firstly resolves with orthodox interpolation method like bi-cubic interpolation, nearest neighbour interpolation cubic interpolation etc. Interpolation means up-sampling method to get high resolution image. This method has high execution speed with less calculation. On other hand initial smoothness can be more effective at some images where more edges and corner are present. But in the case of natural images where improper differentiation and curves are present it causes blurring effect [7].

Reconstruction based method [8] is multi-input super resolution method. More than one low resolution images are captured with different angle and different distances with reference to single image. That low resolution images are fused to get high resolution image. R-SR method, probabilistic methods are some of reconstruction based method. This method is restricted as magnification factor increases and number of input image decreases.

Machine learning based algorithm is classified in two divisions that are pixel based and patch based procedure. Machine learning based SR method using patches is also referred as example based SR. Example based SR method require single image to process. LR and HR patches are trained in training phase to create dictionary which further help to estimate high quality image. Less computational time and more magnification factor makes this method attractive than others. At vey first freeman introduced a technique of mapping from LR image patches to HR image patches using Marcov random field [10] which is optimized by belief propagation. Based on same approach J.Sunetal.[12] proposed primal sketch prior for estimating HR image with high quality.

Wang etal.introducesreconstruction constraint and patch processing based image synthesis constraint in a general probabilistic framework to bridge a gap between LR and HR image [9]. H. Chang, D. Yeung et al. presented a new method of resolution using neighbour embedding which is inspired by local linear embedding method [11]. After that, super resolution of single image using sparse signal representation is proposed which was the great contribution in learning based SR field [6]. Sparse representation seeks for every patch of the low-resolution input to get coefficients of sparse

representation to generate the high-resolution image. In this method require LR and HR dictionaries require more memory for storage. In order to reduce use of dictionary paper is present. Efficient local learnable kernel regression method for getting high quality image is proposed by author. Local matric learning methods are taken as employee for reconstructing high resolution image. This process is efficient at run-time because of several subspace are created by local metrics and training process is held off-line increases computational efficiency [1].

A new approach is presented by author for single image super resolution via multi-kernel regression. Aim of this method is to learn the related map between space of high resolution patches and space of blurred high resolution image patches [2]. Author presented a median based parallel steering kernel regressionknown as an improved version of steering kernel regression. Kernel regression has two draw backs (computationally intensive and spurious edges) which were overcome in this paper. Implementing this method on GPU's and multi-cores removes computationally intensive property. By applying median filter spurious edges were removed. This method has better result than simple kernel regression [3]. A simple, fast and effective cascaded linear regression for super resolution of image establishes relation between LR patches and HR patches which gives the estimated HR image using cascaded linear regression. To decrease the gap k-means algorithm is used for cluster making from LR patches and linear regression is learned at iterations. Linear least square function leads to closed form solution to make system computationally efficient [4]. A reconstruction based super resolution method based on fusion of KSVD and semi-coupled dictionary learning is use to create dictionary pair. By application of this method training time consuming is reduced. The experimental result shows visual differences for reconstructed results [5]. Author presented image SR method using sparse representation. Sparse representation is applied on the patches of LR image to generate coefficient which will use for estimating HR image. Learned dictionary pair is more compact representation than old one. This method has fast processing speed with HR image superior to old SR methods [6].

II. DETAILS EXPERIMENTAL

Inspired by the success of kernel regression used for image reconstruction in [3] and single image higher resolution in [2] implemented method is proposed. In this section framework and details about algorithms are explained.

2.1. Kernel regression

This is two-step method where first is an initial estimation of the image gradients is made using some gradient estimator. Here second order kernel regression method is taken as gradient estimator [13]. Then estimate is used to measure the dominant orientation of the local gradients of image.The second stage is called filtering stage, this orientation information is used to adaptively "steer" local kernel. With these adapted kernels, the de-noising results in preservation of final output details. The mathematical equation for steering kernel is:

$K(x_i - x, y_i - y) \equiv K_{H_i^s}(x_i - x)(1)$ Where, H_i^s are the data-dependent full matrices also known as steering matrices. The steering matrices are defined as

$H_i^s = h\mu_i C_i^{\frac{-1}{2}}$

Where,

y_i = Measured data

$k(.)$=Adaptive filter

$k_{H_i}(.)$ =Spatial matric kernel function

Ci's are (symmetric) covariance matrices based on the local grey-values, h known as smoothening factor.

2.2. Steering matrix

The filtering procedure takes the technique one step further. For the next measurement estimation of parameters and function is required. This estimation is used to weight the respective measurement. Firstly gradient image is estimated then dominant orientation of local gradient in image is measured using this estimation. Then data-adapted kernel takes the matrices from.

2.3. Up-sampling

Up-sampling is tool used for increasing sampling rate of signal. It can refer to one step of process, the other step being interpolation. In training phase low resolution patches are trained by KSVD to extract feature and train patch for high resolution. Kernel regression creates coefficient trough steering matrix. Patch processed part fuse with steering matrix to create high definition image. After that to remove remaining noise and error image is up-sampled.

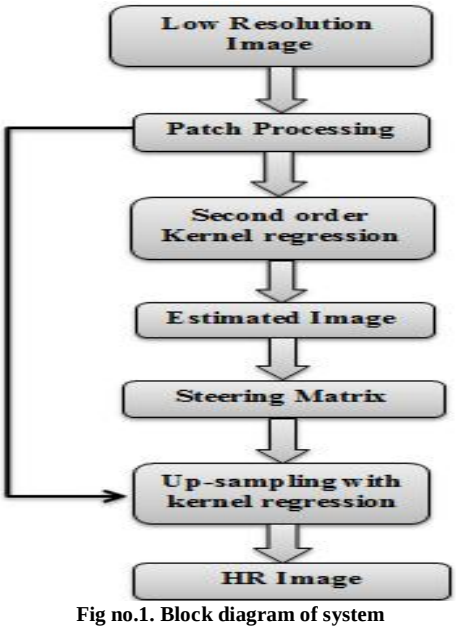


Fig no.1. Block diagram of system

Super resolution is process of estimating highly resolved image form low resolution image as shown in Fig.2. In this implemented paper second order kernel regression is used. Generally second order kernel regression is widely used to map the function. Low resolved image is firstly patch processed for feature extraction. Kernel regression interpolates and de-noises input data to produce gradient image. After kernel regression Steering matrix is obtained which is used further used to up-sampling. Patch processed data and steering matrix factors are up-sampled with kernel regression to get high quality image at output. Flow of system is explained in Fig.1

System is tasted on magnification multiple factor 2,3,4,5. At magnification factor 2,3,4 result imageshave good visualization with good feature details. System is tasted for more than 4 magnification factor and result comes with smooth features which make image blur.

III. RESULT AND DISCUSSION

Results of experimentation are discussed below,

3.1. Setting

In implemented method input image size is of 128×128 which later patched in 64×64 size patch. Image is magnified by magnification factor 3.This system is tested on real time 50 images. The implemented algorithm is performed on PC in MATLAB 2012a environment.

3.2. Discussion

Implemented method is compared with SERF method using parameters mean square error and peak signal to noise ration. Here in implemented method mean square error is decreases with increase in peak signal to noise ration. This gives image more clarity than SERF method. Compared results are given in table no 1.

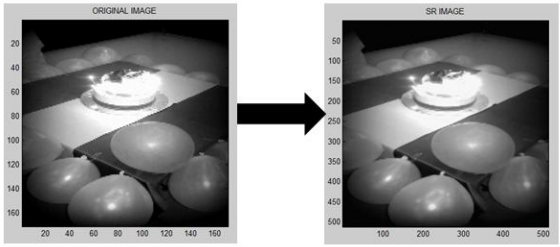
Sr.no.	used method		SERF Method	
	MSE	PSNR	MSE	PSNR
1	1419.24	28.6854	1425.23	27.6798
2	3966.5	24.2219	4001.21	23.4412
3	4254.22	23.9178	4255.32	21.9287
4	3748.86	24.467	3756.32	22.6218
5	4468.29	23.7046	3756.91	22.7811
6	3448.3	24.8299	4480.92	22.9987
7	3332.22	24.9787	3468.92	23.7048
8	4596.84	23.5814	3468.43	21.4412
9	3973.56	24.2142	3350.14	23.6671
10	3979.07	24.2082	4601.15	23.010
11	4036.8	24.1456	4097.54	23.4081

TABLE.1: Comparison Between Kernel Regression Method And SERF Method

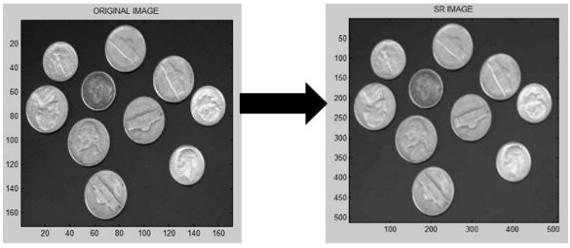
This system is robust for different data type of images as shown in fig.1. Algorithm is tested on PNG,JPG, BMP,GIF image and respective super resolved images have big difference. As the jpg and PNG is one of the best format file for image because of its storing capacity and some other quality requires for photography than BMP and GIF formats. High resolution image of BMP and GIF is not highly defined as compare to PNG and JPG.

CONCLUSION

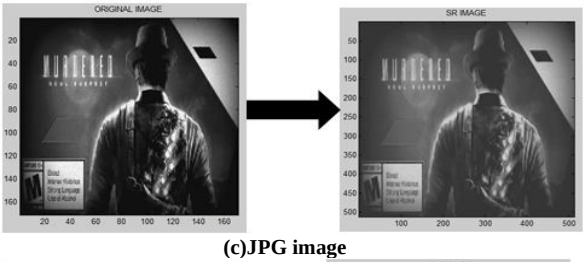
In this paper super resolution using kernel regression method is simulated. This framework consists of 2nd order kernel regression, up-sampling, steering matrix. De-noising and interpolation property of kernel regression is advantageous to system. This system is used to decrease dependency on dictionaries. This makes system robust. Experimental results are compared with old SERF method on basis of peak signal to noise ration and mean square error. In future, RGB image can be tested with this method by converting it for three channels and increase in magnification is also a future scope.



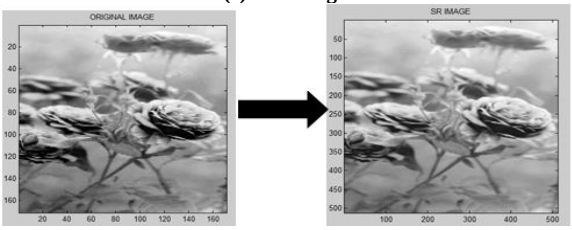
(a) GIF image



(b)PNG image



(c)JPG image



(d)BMP image

Fig.2. Super resolution of different image type

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