International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 12 | Dec -2016 www.irjet.net p-ISSN: 2395-0072

A survey of Super resolution Techniques

Krupali Ramavat[1], Prof. Mahasweta Joshi[2], Prof. Prashant B. Swadas[3]

[1.] *P. G. Student, Dept. of Computer Engineering, Birla Vishwakarma Mahavidyalaya, Gujarat,India*
[2.] *Professor, Dept. of Computer Engineering, Birla Vishwakarma Mahavidyalaya, Gujarat, India*
[3.] *Professor, Dept. of Computer Engineering, Birla Vishwakarma Mahavidyalaya, Gujarat, India*

Abstract - *The image processing field is quite advance now a days. Many important developments have taken place over the last three or four decades. Super Resolution is really very important subject for Image Processing. Super resolution describes increasing the resolution of an image using various algorithms and construct a high resolution image from one or more low resolution images. This paper reviews various super-resolution technique with their advantages and disadvantages. Finally presented challenge issues and future research directions for super resolution.*

Key Words: **Image resolution, Super resolution, Interpolation, Wavelet transform, Learning, Reconstruction.**

1. INTRODUCTION

Out of all five senses vision is most advanced, so it is not surprising that images play the single most important role in human perception. Most of all important applications for military and civilian, High Resolution images are required and always desirable [2]. Recent advances in image and video sensing have intensified user expectations on the visual quality of captured data [4]. Due to limitations like camera cost, power, memory size and limited bandwidth, it is not always possible to get high resolution image [3]. Image super-resolution produces a high-resolution image using one or more low-resolution images [1]. The subject has become really popular research area due to fact that High Resolution images contained more data which does not directly exist in the LR images. Resolution is determined by the pixel density [2].High Resolution image can be gained using various methods that can be classified into three types [1]:

1.1 Interpolation based:

Image interpolation [1], [2], [3], such as Bilinear and Bicubic is the most popular algorithm for simply resizing images, but it cannot avoid undesired artifacts such as jagging and blurring[10].

1.2 Reconstruction based:

Reconstruction based techniques [7],[8] uses the pair relationship between Low Resolution image and High Resolution image, through this linear equations are developed and using these equations the pixel values can be connected of HR and LR images [1].

1.3 Learning based techniques:

In these methods [4], [5], [6], [9], [10], the correspondences between LR and HR image patches are first learned from a database of LR and HR image pairs, and then applied to a new LR image to recover its HR version [7].

2. RELATED WORK

Below are the important methods in super resolution and author's main observations are listed below:

2.1 Wavelet Transform based interpolation techniques:

For enhancement of resolution working on wavelet domain facilitates to utilize the sub bands, and authors had used various transform like SWT, DWT, CT according to their need. There are various types of interpolation methods like nearest neighbor, Bilinear, Bicubic, etc. But among these many interpolation, Bicubic interpolation produces a high resolution image [refer table 1] but it causes to blurring artifacts, so to reduce the quantity of blurring artifacts the wavelet domain is useful [1]. In [1] for the up-sampling of the input low resolution Bicubic interpolation is used. Stationary wavelet transform (SWT) is used for enhancement of the edges of image. The sub-bands which are produced as result of SWT would be modified using boost value. Then the sub-band are combined using ISWT which produced High resolution image. In [2], Classical DWT suffers a problem that it is not translation invariant transform, So SWT sub bands is used for image registration. After registration the

rotation by 45 degree and up-sampling is proposed. Up sampling is done by a factor of 2. Up sampling creates space for the missing coefficients in the Curvelet domain and these coefficients are interpolated. A Curvelet transform based interpolation to form a single high resolution image. In [3], SWT and DWT both are applied to LR image. As SWT generates each sub band of the size of image while in DWT each sub band is half the size of image, so before DWT, Bicubic is used but it will not affect the size of image. The output sub-bands of both transform will pass through Gaussian filter which will remove the blurring effect. After IDWT up-sampling will provide the HR image.

Figure 1 Test Image

Table 1 PSNR for various Interpolation

Interpolation	PSNR
Bicubic	32.61
Directional Cubic Convolution	27.74
Directional Filtering and Data Fusion	28.60
Iterative Curvature Based Interpolation	31.93

2.1 Restoration:

In [7], authors have established a new method for an edge-directed single-image super-resolution algorithm through using a new adaptive gradient magnitude self-interpolation. The proposed constraint HR with preserve image details or sharp edges, while suppressing the ringing, blocking, and blurring artifacts, especially along salient edges. In [8], Hybrid algorithm which are provided that adds the advantages of the simple Maximum Likelihood estimator and the capability of the Projection on to convex sets to incorporate this problem. It is noticed that there is a capability of restoration of an image whose resolution is improved, based on several motionless blurred, decimated, and noisy images. This model enabled the direct generalization of classic tools from restoration.

2.2 Learning based:

Recently, example based SR reconstruction methods were introduced, which use direct image examples as a prior for proper regularization. Here, the dictionary is learnt from natural images and used to reconstruct HR image [4]. The approach requires a larger sized dictionary.

In [5] the authors overcome this by introducing a sparse representation method for compact dictionary learning. Consuming time is less and quality is better. This method however does not succeed in suppressing unwanted artifacts.

In [6] authors have trained HR dictionary via kernel PCA instead of linearly related dictionary. In recovering the detail of image these directories are important. A compact solution is proposed for the preparation of KPCA dictionary, and leads to real time SR application.

In [9], the authors extend sparse representation based learning approach to learn various bases or sub dictionaries with de-blurring which is shown to suppress the unwanted artifacts. It present an efficient single image SR method for images based on learning a cluster of mapping relationships between the LR and HR. The learned mapping functions is effectively and efficiently transform the input image into the expected HR image. In [10], the method has explained of generating the dictionary based on local self-similarity and the directional similarity. It removed the interpolation artifacts using the patch pairs based on the image degraded model. Also is suitable for hardware implementation in consumer imaging devices. The proposed SR algorithm produces better quality in the sense of both preserving edges and removing undesired artifacts such as ringing and noise.

Table 2 Analysis of various methods

No	Name	Publisher	Method	Advantage	Disadvantage	Future work
1	Super-Resolution Using Edge Modification through SWT	18th International Conference on Information Visualisation-2014	SWT	In Comparison the output image will be better.	The curves of an image would not as clear as the edges.	Enhance the curve of image with good PSNR ratio.
2	Hybrid Super Resolution using SWT and CT	International Journal of computer application-2012	SWT & CT	High PSNR & No need to filter to avoid interpolation error	High computation time	minimize the time elapsed with good PSNR
3	Single Image Super Resolution In Spatial and Wavelet Domain	The International Journal of Multimedia & Its Applications-2013	Spatial-domain	The taken time will be less than others.	The quality of image and Peak Signal to noise ratio would be average.	Visual quality should be increase
4	Image Super Resolution with Direct Mapping and De-noising	Fourth International Conference of Emerging Applications of Information Technology-2014	Direct Mapping	In comparison the time taken will be less. Algorithm complexity less. Reduce noise effect.	Output quality is less	Improve quality of image.
5	Image Super-Resolution based on Patches Structure	4th International Congress on Image and Signal Processing-2014	Patch structure	Peak signal to noise ratio is high, quality is better	Efficiency is less	Focus on finding more and better properties of image patches
6	Single-Image Super-Resolution Based on Compact KPCA Coding and Kernel Regression	IEEE SIGNAL PROCESSING LETTERS-2015	Kernel principle component Analysis	The data which is dirty[noise] can be recover	The design modelling is hard.	To make an easy system

7	Edge-Directed Single-Image Super-Resolution via Adaptive Gradient Magnitude Self-Interpolation	IEEE Transactions On Circuits And Systems For Video Technology-2013	Gradient Sharpening [Adaptive]	The image is gained with shared edge	Computation time would be high	Time complexity should be decrease.
8	Restoration of a Single Super resolution Image from Several Blurred, Noisy, and Under sampled Measured Images	IEEE TRANSACTIONS ON IMAGE PROCESSING-1997	Reconstruction based	Effectiveness of method is high as well as it is simple in comparison with others.	Computation time is high so as result the time taken by completing the process would be higher.	Reduce processing time.
9	Learning Multiple Linear Mappings for Efficient Single Image Super-Resolution	IEEE TRANSACTIONS ON IMAGE PROCESSING-2015	Learning based	Noise effect is removed	Efficiency of the process is not so good.	To improve system performance.
10	Multi-Frame Example-Based Super-Resolution Using Locally Directional Self Similarity	IEEE International Journal on Consumer Electronics-2015	Example based	The artifacts caused by interpolation would be removed.	Peak Signal to noise ratio is low.	To enhance image more time.

3. CONCLUSIONS

In this paper the various techniques for Super resolution is discussed. We have specified various methods for enhancement of resolution of an image. Advantage, Disadvantage and application of various technique is also included. In future by extension or integration of the above method a new method can be derived which can generate more detailed SR image as the result

REFERENCES

[1] Arif, Fahim, and Tabinda Sarwar. "Super-Resolution Using Edge Modification through Stationary Wavelet Transform." *2014 18th International Conference on Information Visualisation*. IEEE, 2014.Deepa K Davis & Rajesh Cherian Roy. "Hybrid Super Resolution using

SWT and CT". International Journal of Computer Applications (0975 – 8887) Volume 59– No.7-2012.

[2] Davis, Deepa K., and Rajesh Cherian Roy. "Hybrid Super Resolution using SWT and CT." *International Journal of Computer Applications* 59.7 (2012).

[3] Naik, Sapan, and Nikunj Patel. "Single image super resolution in spatial and wavelet domain." *arXiv preprint arXiv:1309.2057* (2013).

[4] Bhosale, Gaurav G., Ajinkya S. Deshmukh, and Swarup S. Medasani. "Image Super Resolution with Direct Mapping and De-Noising." *Emerging Applications of Information Technology (EAIT), 2014 Fourth International Conference of*. IEEE, 2014.

[5] Chen, Huahua, Baolin Jiang, and Weiqiang Chen. "Image super-resolution based on patches structure." *Image and Signal Processing (CISP), 2011 4th International Congress on*. Vol. 2. IEEE, 2011..

[6] Zhou, Fei, et al. "Single-image super-resolution based on compact KPCA coding and kernel regression." *IEEE Signal Processing Letters* 22.3 (2015): 336-340.

[7] Wang, Lingfeng, et al. "Edge-directed single-image super-resolution via adaptive gradient magnitude self-interpolation." *IEEE Transactions on Circuits and Systems for Video Technology* 23.8 (2013): 1289-1299.

[8] Elad, Michael, and Arie Feuer. "Restoration of a single superresolution image from several blurred, noisy, and undersampled measured images." *IEEE transactions on image processing* 6.12 (1997): 1646-1658.

[9] Zhang, Kaibing, et al. "Learning multiple linear mappings for efficient single image super-resolution." *IEEE Transactions on Image Processing* 24.3 (2015): 846-861.

[10] Jeong, Seokhwa, Inhye Yoon, and Joonki Paik. "Multi-frame example-based super-resolution using locally directional self-similarity." *IEEE Transactions on Consumer Electronics* 61.3 (2015): 353-358.

[11] SubhasisChaudhuri (Indian Institute of Technology), "Super Resolution Imaging" Kluwer Academic Publishers, pp.1-44, 2002.