A Survey on Fast Super Resoluted Image using Convolution Network

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Abstract— Aim of Super resolution is to generate high-resolution image from single or multiple low resolution of the same picture or image. With one single low resolution image it's very challenging to produce high-resolution image because a single low-resolution image contain the less information. Due to the ability of preserving edges, kind of method called Total variation based method was proposed as regularization function for some inverse problems. Novel super resolution method proposed which based on Total Variation regularization and total variation up sampling with Gaussian noise which provide better resolution image with preserving only texture components. But still it takes the more processing time due to the calculation of total variation in the input Image. To overcome problem of existing work, Novel approach of neural network which is consists of three layers namely convolution layer, max-pooling layer and reconstruction layer. This approach will try to reduce the processing time as well as increasing the PSNR ratio.

Key words: Image Processing, High-Resolution, Super Resolution, Gaussian Noise

I. INTRODUCTION

Super resolution is very important in image processing. Super resolution aim to generating the high resolution images from the one or multiple images of the same scene of low resolution images. During the process of the image capture sometimes, the collected images are often with low-resolution due to the poor equipment performance and environment. For getting the more information about an image, high-resolution (HR) images are always required for further image processing and analysis. High resolution images not only give the viewer a pleasing appearance but also helping Better analysis and feature extraction form HR images in several applications such as in medical imaging for MRI (Magnetic resonance imaging),PET(Positron emission tomography),Satellite imaging, Target recognition [12]. In satellite imaging applications such as remote sensing and LANDSAT, several images of the same area are usually provided, and the SR technique to improve the resolution of target can be considered. Another application is conversion from an NTSC video signal to an HDTV signal since there is a clear and present need to display a SDTV signal on the HDTV without visual artifacts [12].The sensor size and the density of detectors that form the sensor primarily determine the spatial resolution of the captured images. The larger size of the sensor and/or the higher density of the detector, better the spatial resolution of the acquired images. The most direct hardware-based approach of increasing the spatial resolution is to reduce the detector size or, equivalently, to increase the detector density.

Alternatively, the sensor size can also be increased. However, smaller detectors have [18] lower dynamic range; less fill factor, worse low light sensitivity, higher dark signal, higher diffraction sensitivity, and higher similarity. Also, the hardware cost increases with both the increase of detector density and sensor size. Thus, the aforementioned hardware-based approach often restricts the maximum achievable resolution of the captured images. Besides the sensor-imposed restriction, there are several other factors that limit the capture of HR images, including lens and atmospheric blurs, finite shutter speed, finite aperture, movement of objects in the scene, sensor noise, and media turbulence.

The most direct solution to increase spatial resolution is to reduce the size of pixel (i.e., increase the number of pixels per unit area) by sensor manufacturing techniques [12]. As the size of pixel decreases, however, the amount of light available also decreases. It generates shot noise, which degrades the image quality severely. The high cost for high precision optics [4] and image sensors are also an important part in many applications regarding HR imaging. Therefore, a new approach against increasing spatial resolution is necessary to overwhelm these limitations of the sensors and optics manufacturing technology.

Scope of this research has many applications such as the surveillance or forensic purposes such as face of a criminal or the licence plate of a car. Another scope is frame freeze in video to obtain the high resolution frame from the video, tomography in medical imaging. Face hallucination also the scope of this project for identifying faces faster and more effectively.

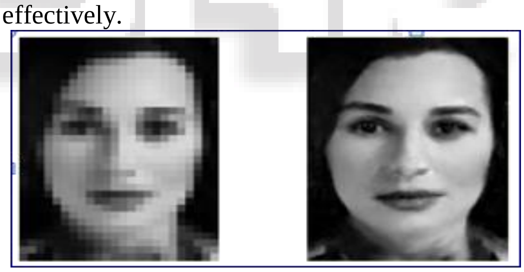

Fig. 1.1: Face Hallucinations using super resolution technique[24]

II. SUPER RESOLUTION TECHNIQUES

Super resolution methods can be divided into three main groups: Interpolation based methods, Reconstruction based methods, and Example based methods.

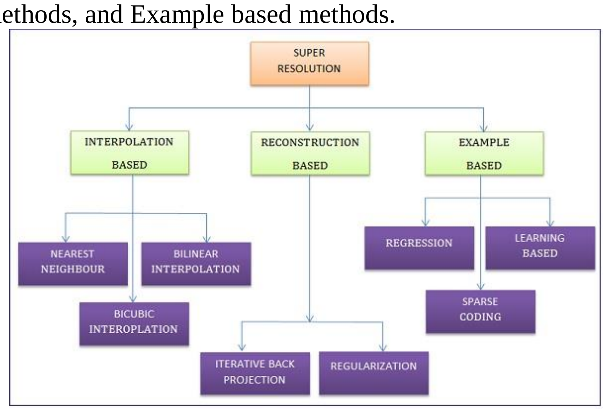

Fig. 2: Classification of Super resolution techniques

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A. Interpolation based methods

1) Nearest neighbor interpolation:

"The basic, very simple method is the nearest neighbor interpolation. It use the value of nearest pixel value does not consider the values of neighboring points at all. This method simply determines the "nearest" neighboring pixel, and assumes the intensity value of it. This method is simple and easy to implement. Figure 2.1.1 shows the nearest neighbor interpolation technique.

But the main drawback of this interpolation method is that it generate poor quality image. It produces the jaggy effect in the image.

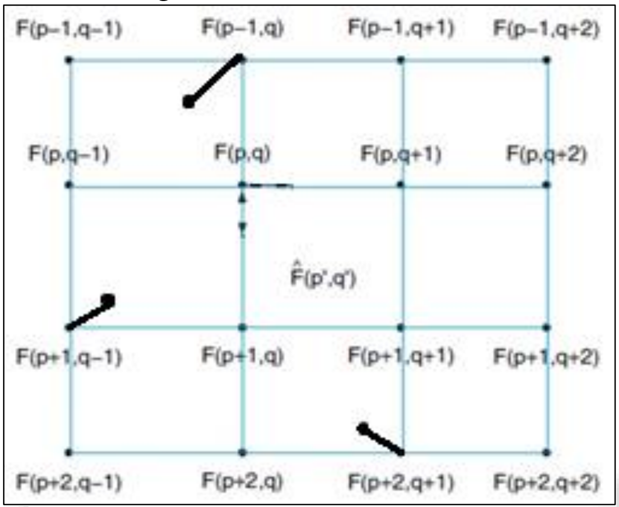

Fig. 2.1.1: Nearest neighbour interpolation

2) Bilinear interpolation:

Another method for interpolation is bilinear interpolation method, in which nearest four pixels value is used to determine the interpolated value for estimated pixel. The figure 2.1.2 shows the bilinear interpolation method representation.

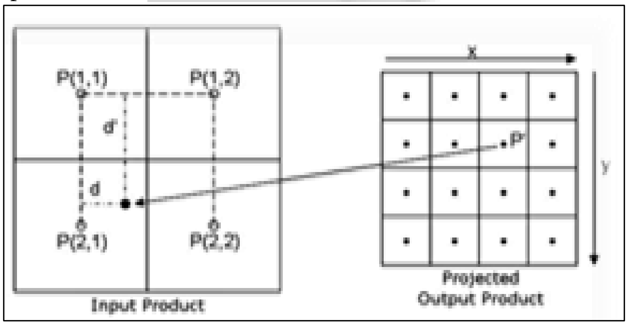

Fig. 2.1.2: Bilinear interpolation method [26]

Advantages of bilinear interpolation methods is that its more accurate than the nearest neighbour interpolation. Still the image quality is poor.

3) Bicubic interpolation:

Bicubic interpolation is one of the most useful techniques among the other interpolation based methods.

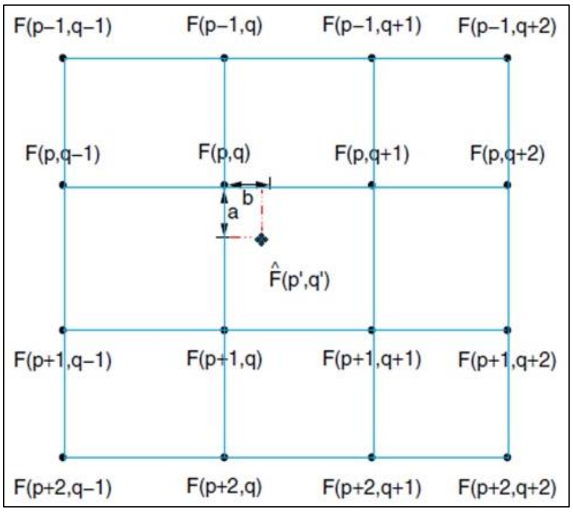

Fig. 2.1.3: Bicubic Interpolation method [27]

Figure 2.1.3 shows the Bicubic interpolation method. Bicubic interpolation is best interpolation method compare to the other interpolation method. It sharpens the edges and enhances the resolution of the image but the drawback is that it generating the ringing artifacts.

B. Example based methods[10]

Freeman et al. (2002) proposed the thought of example-based super-resolution algorithm. Firstly, the high-resolution images are applied to form the training set, which contains the high-frequency of the images and a group of subsample low-resolution images. Later on, in the training set, the knowledge about the high-frequency and the corresponding low-frequency is learnt. Every patch of low resolution images searches the best matching pair from the training set to reconstruct the high-resolution image by adding the high–frequency information to the low resolution image [10].

1) Learning based METHOD [11]:

Learning based approach is quite similar to the example based approach. In learning based method there are also two phase of training phase and super resolution phase.

"In training phase pairs of low resolution and corresponding high-resolution images are collected. Then in the super resolution phase each patch of low given low resolution image compared with low-resolution patches, and the high-resolution patch corresponding to the nearest low-resolution patch is selected as output. Compared to the example based method learning method have disadvantage of one-to-multiple low-resolution patch to high-resolution patch. "

2) Regression based method:

Regression method attempts to learn the relationship between the LR patches and the HR patches by regression function. This group of methods are not based on learning assumption. Similar to the Neighbor-Embedding method, LR training is chosen according to the similarity between LR patches and LR test patch. , HR training set identified corresponding to the LR training set.

3) Sparse coding method:

"Sparse representation for SR reconstruction uses sparse coding based on l_1 regularization to learn two coupled dictionaries: D_h for HR patches and D_l for LR ones. The process of learning two coupled dictionaries adopts joint

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dictionary training method, which forces that the sparse representation of the HR patch is the same as that of the corresponding LR one. Given the sampled training image patch pairs$P = \{X^h, Y^l\}$, where$X^h = \{x_1, x_2, \dots, x_n\}$ are the set of sampled HR image features and $Y^l = \{y_1, y_2, \dots, y_n\}$are the set of sampled HR image features [20]."

C. Reconstruction based methods

"SR image reconstruction is one of the most spotlighted research areas, because it can overcome the inherent resolution limitation of the imaging system and improve the performance of most digital image processing applications. There are several SR reconstruction approaches such as Regularized SR reconstruction approach, Iterative Back Projection (IBP), Projection onto convex set (POCS) approach etc., [12]"

1) Iterative Back Projection[13]:

"Irani and Plege formulated the iterative back-projection (IBP) algorithm for super resolution by utilizing the same approach that used in tomography. In Computer-Aided Tomography (CAT), the image of 2-D is reconstructed from 1-D projections along many direction. The HR image is estimated by consecutively back projecting the error between simulated LR image via imaging model and observed LR images. It starting with initial estimate for the HR image, the back-projection process is repeated iteratively for each incoming LR image. For the i^th inbound LR image, the basic update equation can be written as [13]:"

$$\hat{F}^{i} = \hat{F}^{i-1} + H_{BP}(G_i - \hat{G}_i)$$
$$= \hat{F}^{i-1} + H_{BP}(G_i - A\hat{F}^{i-1})$$

III. LITERATURE REVIEW

In this section, numbers of research papers with their publication, description of the each paper mentioned as well as at the end prepared the table of survey methods of each paper with its advantages and disadvantages.

Super resolution techniques divided into three categories: interpolation based, example based and reconstruction based. Interpolation is the basic technique for image super resolution it apply the interpolation kernel or base function as smooth prior to estimate the in high resolution grid. But these methods poorly in high-frequency areas such edges and corner and creates the blurry effect. Example based methods based on the over-completed techniques improve the result. The high resolution image is estimated with help of training image dataset. Major issue in this method is determination of type and number of trained images needed from the dataset. In regularization method, it first estimates the sparse domain of the HR image patches and then utilizes a non-local self-similarity constraint to achieve the HR image.

Hiroki Tsurusaki , Masashi Kameda, Prima Oky Dicky Ardiansyah "Single Image Super-Resolution Based on Total Variation Regularization with Gaussian Noise [32]" they propose a single image super-resolution based on total variation regularization (TV) with Gaussian noise to improve sharpness of texture. TV is expected to improve texture, since we can decompose a given input image into structural component and texture component by TV image-decomposition. The conventional method of super-resolution using TV (SRTV) has been proposed by Saito et al.. However, it has been not able to solve the problem that is difficult to improve texture. In order to solve the above problem, our proposed method use patch similarity based super-resolution. to generate additional components for improvement of sharpness

F Shi, J Cheng, L Wang, PT Yap, D Shen "LRTV: MR Image Super resolution with Low-Rank and Total Variation Regularization [3]" they recover high-resolution images from the low-resolution counterparts for improving the analysis and visualization. Total variation method retains edge sharpness during image recovery but this method only utilize information from local neighbour hoods and neglecting the useful information from the remote area. So the propose method integrate the both local and remote information for better image recovery. Matrix completion algorithm used for effective estimation of the missing values in a matrix form a small sample of known entries. Matrix completion method assume that the recovered matrix has low rank and then uses this property as constraint or regularization to minimize the difference between the given incomplete matrix and estimated matrix

Lin Li, Yuan Xie, Wenrui Hu, Wensheng Zhang "Single Image Super-Resolution Using Combined Total Variation Regularization by Split Bergman Iteration [1]" the problem of generating a high-resolution image from a single degraded low-resolution input image without any external training set. Propose a novel super-resolution (SR) method based on combined total variation regularization. In the first place, propose a new regularization term called steering kernel regression total variation (SKRTV) which exploits the local structural regularity properties in images. In the second place, another regularization term called non-local total variation (NLTV) is proposed as a complementary term in our method, which makes the most of the redundancy of similar patches in natural images. The NLTV method breaks the locality constraint in the conventional TV-based methods, and estimates the pixel value from all the similar patches collected from a large region. It takes advantage of the redundancy of similar patches existed in the target image which is very helpful in the reconstruction task of image and suppressing noise.

Qiang Wang, Zhenghua Wu, Mingjian Sun, Ting Liu, Bo Li, Naizhang Feng, Yi Shen "Single image super resolution using directional total variation regularization and alternating direction method of multiplier solver [4]" the conventional approaches is to regularization to overcome the limitation caused by the modelling. In this paper approach propose to explore the underlying information for the images with structured edges by using directional total variation. An alternating direction method of a multiplier-based algorithm is presented to effectively solve the resulting optimization problem. Most of the regularization based methods applicable to generic images but ignore the potential and high level information with high-level information with structure edges or textures. Directional Total variation method not only sharpens the edges but also suppressing noise from the image.

Yichao Zhou, Zhenmin Tang, Xiyuan Hu "Fast Single Image Super Resolution Reconstruction via Image

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Separation[2]" fast single image super resolution reconstruction approach proposed via image separation. Assumption is that the edges, corners, and textures in the image have different mathematical models. In this paper, approach is divided into three steps: 1) separate the input image into cartoon and texture subcomponents by using non-linear filter based image decomposition technique, 2) use improve local-self similarity model based algorithm to interpolate cartoon subcomponent and wavelet domain Hidden Markovian Tree (HMT) model based algorithm to zoom the texture subcomponent, 3) fusing the interpolated cartoon and texture subcomponent together to derive the high resolution in this approach simple convolution and linear algebra used for decomposition and super resolution .by using the fast non-linear cartoon + texture filter bank decompose the cartoon and texture components from single low resolution image.

IV. Problem Statement

Till now the Super resolution method proved as efficient while working with Total variation regularization method. But there are limitations of total variation regularization

1) It is too expensive and major problem is more time of solving the total variation calculation in the image.
2) In some of the images it cannot preserves the texture components or Sharpness of edges.

V. Conclusion

Super resolution is the fundamental research area in image processing and overcome the resolution problems of imaging systems. An interesting point finding from this survey is that, since different SR methods have been developed for different applications using different model parameters and assumptions, it is difficult to perform a fair comparison among them. At the end conclude that, by using well trained Convolution Neural Network (CNN) we can enhance the resolution of image from low resolution to High resolution. And also we reduced the processing time for generating the final high resolution image.

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