Face Hallucination Using Sparse Representation Algorithm

Sudhir Kumar Vikram Mutneja

***Abstract*— Face Hallucination is a super-resolution technique to obtain high-resolution facial images by taking low-resolution facial images as input. In this paper problem of face hallucination has been approached by using sparse Representation. The image has to be subdivided into different segments so that image pixel information can be retrieved easily from each segment. Each small patch of the image has to be enhanced by using sparse representation. Sparse representation utilizes super resolution model to improve the quality of the image. Super-resolution model couples the small patches dictionaries by using different types of linear shifting experiments. Experimental hallucination results demonstrate that our approach can hallucinate high quality super-resolution faces.**

***Index Terms*— Face hallucination, face recognition, sparse representation, super-resolution.**

I. INTRODUCTION

A. Face Hallucination

Face Hallucination is a super-resolution domain-specific technique to generate high-resolution images from low-resolution input images. It is applied in face recognition systems for identifying a face faster and feasible. Due to the importance of face image in many face recognition systems, face hallucination has become an active area of research [1]. Super-resolution (SR) is a class of techniques that enhance the resolution of an imaging system. In some SR techniques—termed *optical* SR—the diffraction limit of systems is transcended, while in others—*geometrical* SR—the resolution of digital imaging sensors is enhanced.

The goal of Super-Resolution (SR) methods is to recover a high-resolution image from one or more low-resolution input images.

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Methods for SR can be broadly classified into two families of methods: (a) The classical multi-image super-resolution [2-4], and (b) Example-Based super-resolution [5]. In the classical multi- image SR a set of low-resolution images of the same scene are taken. Each low-resolution image imposes a set of linear constraints on the unknown high- resolution intensity values. If enough low-resolution images are available, then the set of equations becomes determined and can be solved to recover the high-resolution image. Practically, however, this approach is numerically limited only to small increases in resolution.

B. Techniques of Face Hallucination

Face hallucination trip taking into account Bayes hypothesis

This system was proposed by Baker and Kanade, the launching of face visualization procedure. The figurine is in context of Bayesian MAP definition and utilization point plunge to streamline as far as possible and it conveys the high rehash purposes of excitement from a gatekeeper structure with the assistance of arranging samples.

Super-resolution from various perspectives utilizing learnt picture models

Capel and Zisserman was the first to propose the nearby by face picture SR method. It partitioned the face picture into four key parts: the eyes, nose, mouth and cheek regions. For every region, it takes in an alternate Principal Component Analysis (PCA) to visualize and copies the locale openly. On the other hand, the reproduced face pictures in this system have obvious obsolete rarities between distinct areas.

Face Hallucination through Sparse Coding

This framework was proposed by J. Yang and H. Tang and it is arranged in fantasizing of a high-resolution face image by taking low-resolution input face. The framework uses the facial highlights by using a Nonnegative Matrix factorization (NMF) approach to manage learn limited part-based subspace.

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Face Hallucination by Eigen-transformation

This technique was proposed by Wang and Tang and it utilizes an Eigen change. This structure sees the strategy as a change between contrasting styles of picture and uses a supervisor part examination (PCA) connected with the low-resolution face picture. By selecting the measure of "Eigen goes up against", we can consider measure facial picture data of low-resolution and unfilled the confusion. In the Eigen change calculation, the fantasized face picture is organized by the direct blend of high-resolution get prepared pictures and the mix coefficients start from the low- resolution face pictures utilizing the principal part examination's system. The figuring enhances the photograph resolution by get-together some high-rehash face purposes of eagerness from the low repeat facial data by **abusing** the relationship between the two ranges. For high- resolution face pictures, PCA can unimportant this related data onto a touch number of key areas. By then, in the Eigen change handle, these vital parts can be aggregated from the central segments of the low-resolution go up against by mapping between the high and low-resolution arranging sets.

II. LITERATURE SURVEY

Chen Caikou et al [6] "A coordinating interest based similitude measure for face acknowledgment". Deficient representation can't just uncover the crucial or basic semantic data around a case, additionally have several reasons of excitement, for occurrence, immediate, flexible etc. Separated and other insufficient representation calculations, arranging energy considering eager iterative processing is also persuading, this article takes it to pick neighbors. All the arranging tests are utilized to manufacture the over complete word reference, Author need to locate the most germane cases serve as a nearby neighbor of the case. Next another thought called the likeness measure is proposed. Creator focus the enormity of the neighbor framework by separating three segments: then requested a outline of word reference parts, the strategy of coefficients and the store produced using orchestrating interests gage; at long last it gets the ideal projection subspace by minimizing as far as possible. Separated and the other highlight extraction system, the proposed technique have a predominant acknowledgment impact and all the more extraordinary. The AR and FERET face picture database demonstrate that it is powerful.

Ptucha, R. et al [7] "LGE-KSVD: Flexible dictionary learning for optimized sparse representation Classification". Lacking representations have effectively been ill-used for the movement of altogether correct classifiers. Appallingly, these classifiers are computationally uplifted and subject to the offensive impacts of coefficient corruption, where for instance, blends in carriage may affect character and surge acknowledgment. We propose a technique, called LGE-KSVD that addresses both issues and fulfills cutting edge results for face and development depiction issues. In particular, LGE-KSVD uses assortments of straight improvement of Graph Embedding to overhaul K-SVD, an iterative system for little yet over complete word reference learning. The dimensionality lessens system, insufficient representation word reference, inadequate coefficients, and sparsity-based direct classifier is regularly balanced through LGE-KSVD. The molecule change approach is renamed to have fluctuating bolster utilizing chart inserting strategies to make a more flexible and astonishing word reference learning tally. Results are gotten for a wide course of action of facial and movement acknowledgment issues to exhibit the power of the proposed framework.

Junjun Jiang et al [8] "Support-driven sparse coding for face hallucination". By intertwining the prior of positions, position patch based face hallucination outing strategies can make phenomenal results and extra handling time. Given a low- resolution face picture, the key issue of these systems is the best approach to encode the data low- resolution patch. Of course, due to security and exactness issues, the coding techniques proposed so far are not acceptable. In this paper, Author demonstrates a novel insufficient coding framework by method for mishandling the reinforce information on the coding coefficients. In particular, the reinforce information is depicted by the area of the photo patch complex, which has been exhibited to be essential in data representation and examination. As showed by the partitions between the information alter and bases in the word reference, Author first doles out various weights to the coding coefficients and a short time later get the coding coefficients by handling a weighted insufficient issue. Our proposed procedure abuses the non-coordinate complex structure of patch tests and the lacking property of the tedious data, provoking relentless and exact representation. Trials of for the most part used databases demonstrate that our framework beats bleeding edge.

Ran He et al [9] "Half-quadratic based iterative minimization for robust sparse representation". Healthy lacking representation has demonstrated giant potential in managing testing issues in PC vision, for case, biometrics and visual perception. Be that as it may, several blazing little models have been proposed and promising results have been getting, they are either for slip change or for disappointment ID, and taking in a general structure that proficiently unites these two edges and looks at their affiliation is still an open issue. In this

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paper, we add to a half-quadratic (HQ) system to handle the strong lacking representation issue. By depicting diverse sorts of half-quadratic confines, the proposed HQ system are material to performing both bungle revision and slip conspicuous verification. All the more particularly, by utilizing the included substance sort of HQ, we propose a ℓ1-regularized blunder adjustment methodology by iteratively recuperating spoiled information from messes up accomplished by clamors and anomalies; by utilizing the multiplicative indication of HQ, we propose a ℓ1-regularized botch an ID structure by grabbing from uncorrupted information iteratively. Creator additionally display that the ℓ1-regularization lit up by delicate thresholding breaking point has a twofold relationship to Huber M-estimator, which hypothetically ensures the execution of liberal lacking representation concerning M-estimation. Examinations on vivacious face acknowledgment under convincing impediment and debasement recognize our structure.

Jujun Jiang et al [10] "Nearest feature line embedding for face hallucination". New intricate technique, called nearest highlight line inserting, for face perception is proposed. While different complex learning based face dream calculations have been proposed beginning late, the majority of them apply the traditional closest neighbor metric to center the subspace and may not viably depict the geometrical data of the cases, particularly when the measure of arranging examples is accumulated. This reported work proposes utilizing the NFL metric to depict the area relations between face tests to enhance the conferring force of the given get prepared illustrations for re-trying. The estimation saves the straight relationship in a smaller neighborhood space than standard complex learning based calendars, which better mirrors the strategy for complex learning hypothesis. Test results show that the structure is persuading at guaranteeing unequivocal visual data.

Xiaofeng Wang et al [11] "A novel method for instance based face super-resolution". Face super- resolution is the particular super- resolution issue considering the property of facial pictures, which changes a high-resolution facial picture from the low- resolution data. Considering the perception that faces are epitomized a few generally free parts, for case, eyes, noses and mouths, Author propose a case based face dream system which merges affiliation pushed non-negative cross area factorization (CCNMF) estimation and High-dimensional Coupled NMF (HCNMF) processing. Separated and existing systems, the proposed CCNMF estimation can make overall face more like the ground truth resist by tackling a section based and bound representation of facial pictures. Similarly, advancement pay by utilizing HCNMF can take as a part of the relationship between high- resolution store resolution improvements to better shield lost high rehash inconspicuous parts. Test results, check the sensibility of our strategy.

Jeong-Seon Park et al [12] "An Example-Based Face Hallucination Method for Single-Frame, Low-Resolution Facial Images". This paper proposes a face hallucination trip system for the remaking of high-resolution facial pictures from single-edge, low-resolution facial pictures. The proposed strategies have been gotten from sample based fantasy routines and transform capable face models. Initially, we propose a recursive slip back-projection technique to adjust for leftover lapses, and an area based remaking strategy to protect the qualities of nearby facial areas. At that point, we characterize a broadened transform capable face model, in which an augmented face is made out of the inserted high- resolution face from a given low-resolution face, and its unique high-resolution proportionate. At that point, the augmented face is isolated into a developed shape and an expanded surface. We performed different visualization trials utilizing the MPI, XM2VTS, and KF databases, looking at the recreation blunders, auxiliary closeness file, and acknowledgment rates, and demonstrated the impacts of face location lapses and shape estimation mistakes. The empowering results exhibit that the proposed strategies can enhance the execution of face acknowledgment frameworks. Particularly the proposed system can upgrade the resolution of single-edge, low- resolution facial pictures.

Xiang Xu et al [13] "Face hallucination: How much it can improve face recognition". Face hallucination trip has been a well known subject in picture handling lately. At present the usually utilized execution criteria for face mind flight are Peak Signal to Noise Ratio (PSNR) and the Root Mean Square Error (RMSE). In spite of the fact that it is legitimately accepted that fantasized high- resolution face pictures ought to have a superior execution in face acknowledgment, we indicate in this paper that the higher resolution, the higher acknowledgment' supposition is not approved methodically by some planned examinations. To begin with, Author represents this supposition just works when the picture arrangement is adequately expansive. Second, on account of extremely compelling low resolutions, the acknowledgment execution of the day dreamed pictures got by some run of the mill existing face visualization methodologies won't move forward. At last, the relationship of the prominent assessment routines in face hallucination trip, PSNR and RMSE, with the acknowledgment execution is researched. The discoveries of this paper can help individuals plan new

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mind flight approaches with a point of enhancing face acknowledgment execution with determined classifiers.

III. PROBLEM FORMULATION

Face hallucination is the process to improve the quality of the facial image by enhancing the degraded pixels available in the image. The main problem in face hallucination is that by improving the quality of the image different components of the image get distorted and proper features cannot be evaluated from this image. To overcome the problem of face hallucination the image has to be enhanced in such a way so that features of the particular image will not be distorted. In this paper face hallucination has been done by using sparse representation to overcome the issue of degradation.

IV. METHODOLOGY

Face hallucination is the process to enhance the resolution of facial image. Low-resolution facial image can be enhanced by using various techniques. Various techniques have been implemented on the image to enhance the resolution [14]. In this proposed work Gaussian filter has been used to remove the noise, super-resolution model using sparse representation model. Sparse representation model used bicubic interpolation. Bicubic interpolation converts the images by interpolating image co-efficient. These co-efficient can be enhanced by using sparse representation. In this process different face image is firstly preprocessed on the basis of different normalization parameters. In the proposed work the input image is taken for process of face hallucination. In this process RGB image or grayscale image has to be taken as input image.

Input image that has been selected for the purpose of face hallucination has to be normalized using Gaussian filter, Gaussian filter is a special type of filter that use different variance level for the filtration of a noisy image. After the filtration process image has to undergo bicubic interpolation so that a low resolution image can be formed on the basis of bicubic interpolation.

After this interpolation the image has to be hallucinating by using sparse based representation super resolution model. This super resolution model uses different operators that have been used for the process of face image enhancement.

Sparse representation super resolution model divides the image into different subsets for the extraction of border and internal area of the image. After that, each patch of the image high-resolution and low-resolution parameters have to be embedded in the image on the basis of different window sizes. These parameters have to be merged in the low resolution image by removing the DC coefficients from the low resolution image. Clustering is used for the prediction of the pixels in which numbers of HR and LR parameters have to be embedded.

After embedding of HR and LR parameters each patch of the image has to be reconstructed for the formation of the image. After the process of the image reconstruction image has to be normalized to acquire actual dimensions of the image. The reconstructed image is the hallucinated image from a low resolution image.

V. RESULTS

Sparse representation based on super resolution is the process to enhance the low resolution image by using different operations. These operators enhance the resolution of facial image efficiently.

Figure 1. Input RGB and Gray Scale Image

In the process of face hallucination input image can be both RGB image and Gray scale image. This image has to be pre processed for the process of face hallucination process.

Figure 2. YCbCr image

This figure represents the conversion of the input image into YCbCr model. This model divides the image into three different components, i.e. Y component, Cb component and Cr component. This Y component has to be utilized for further processing of the image.

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Figure 3. Y Frame of YCbCr component of Image

This figure represents the Y frame extracted from the YCbCr component of the image that is used for further processing under super resolution model for the purpose of face hallucination.

Figure 4. Low Resolution Face Image

This figure represents a low resolution face image that has been reconstructed from input image by using bicubic interpolation of scaling factor 3. This low resolution image has to be enhanced by using different F-special filters for image enhancement.

Figure 5. Face Hallucination Image

This figure represents the hallucinated image that has been reconstructed by using sparse based super resolution model. Super resolution model embeds low and high resolution parameters to image for the process of image enhancement. These parameters enhance the quality of the image by using different clustering and prediction of the location on which different parameters have to be embedded.

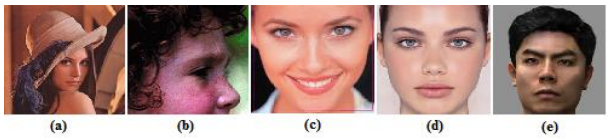

Figure 6. Images used during experiment (a) Lena, (b) Girl, (c) Image1, (d) Image2 and (e) Image3. All images are taken from Google face image [15].

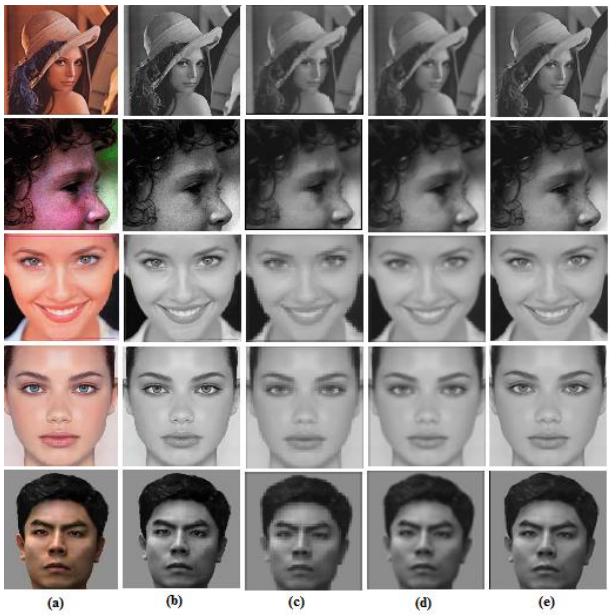

Figure 7. Results compared with bicubic interpolation (a) HR RGB face image, (b) Gray scale face image, (c) LR face image, (d) Bicubic Interpolation face image and (e) Hallucinated sparse representation based face image (Proposed method).

To evaluate the performance of the proposed work different parameters have been computed. These parameters are Peak Signal Noise Ratio (PSNR), Root Mean Square Error (RMSE) and Structure Similarity Index Matrix (SSIM). These parameters are essential for the prediction of performance of purposed system.

Test Images	PSNR	RMSE	SSIM
Lena	30.06	8.007	0.853
Girl	31.652	6.667	0.767
Image1	32.025	6.387	0.93
Image2	30.989	7.196	0.926
Image3	32.298	6.189	0.925

Table 1. Parameters values for bicubic Interpolation

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This table represents the values of different parameters PSNR, RMSE and SSIM for different images. These values for different images have been computed by using bicubic interpolation with scaling factor 3.

Test Images	PSNR	RMSE	SSIM
Lena	34.323	4.902	0.923
Girl	33.403	5.45	0.821
Image1	35.232	4.415	0.961
Image2	34.005	5.085	0.956
Image3	36.698	3.729	0.958

Table 2. Parameters values for Sparse Representation

This table represents the values of different parameters PSNR, RMSE and SSIM for different images. These values for different images have been computed by sparse representation. On the basis of different parameter comparison between different approaches for face hallucination can be made. These parameters have been representing graphically for both approaches used for face hallucination that are bicubic interpolation and sparse representation Super resolution model.

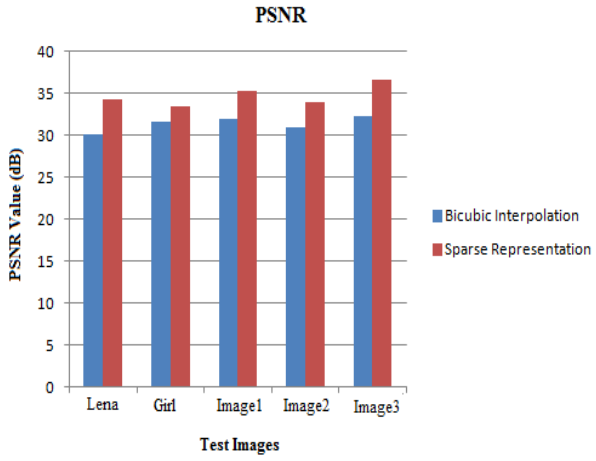

Figure 8. Graphs for PSNR

This graph represents the value of the peak signal noise ratio for both the approaches. On the basis of these approaches the value of PSNR of different images has been measured and represent graphically.

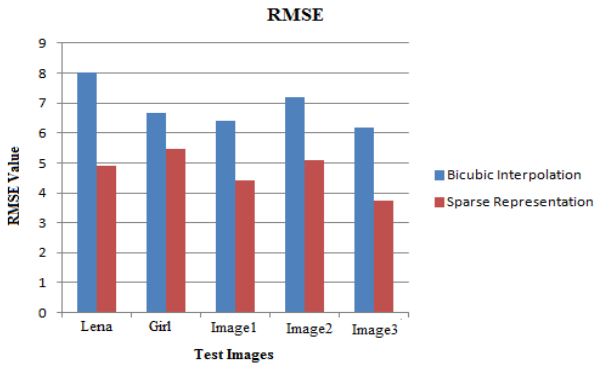

Figure 9. Graphs for RMSE

This graph represents the value mean square error for both the approaches. On the basis of these approaches the value of MSE for different images has been measured and represent graphically.

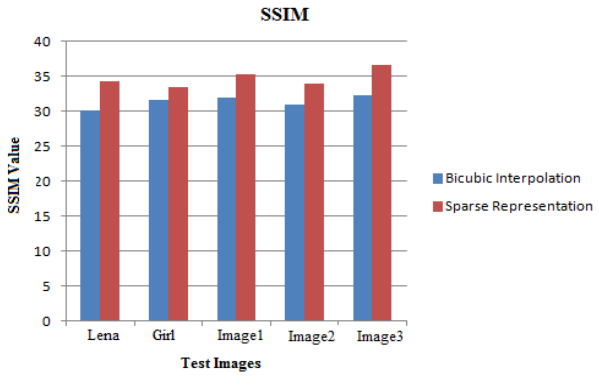

Figure 10. Graphs for SSIM

This graph represents the value structural similarity index for both the approaches. On the basis of these approaches the value of SSIM of different images has been measured and represent graphically.

VI. CONCLUSION

Face hallucination is the process to enhance the low resolution image for utilized in different systems. In the process of face hallucination different operators have been used for the purpose of face hallucination. In this purposed work sparse representation super resolution model has been used for the purpose of face hallucination. This model enhances the resolution of the image by embedding HR and LR parameters at different locations of low intensity pixel in the image. This proposed approach is compared with face hallucination using bicubic interpolation for the performance evaluation. On the basis of different parameters used for face hallucination, one can conclude that sparse representation super resolution model provides better results than that of bicubic interpolation.

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