IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 17, Issue 1, Ver. VI (Jan – Feb. 2015), PP 64-69
www.iosrjournals.org

Face Image Restoration based on sample patterns using MLP Neural Network

Mahdi Nadiri Andabili [1], Kaveh Kangarloo [1], Fardad Farokhi [1]
[1]*(Department of Electrical Engineering / Central Tehran Branch, Islamic Azad University, Tehran, Iran)*

Abstract: *In this paper, a sample based face image restoration method using MLP neural networks is presented. First, an HR (High Restoration) image is changed to a number of LR (Low Resolution) images by the observation model. Then, using a set of patches extracted from HR & LR images the MLP network is trained. After the training, a model is created which can be used for restoration. The proposed algorithm has been applied on ORL database. The sensitivity of algorithm to geometry changes and noise level was studied. The results reveal that the proposed method had better results of statistical criteria and visual evidences respect to some other methods.*
Keywords: *Face, MLP Neural Network, Observation- Model, Image Restoration*

I. Introduction

For some applications such as medical imaging, analysis of satellite images, astronomy and surveillance, a high quality image is required [1]. One of the main weaknesses of surveillance systems is their low resolution. In order to overcome to this problem (avoid changing the applied hardwares as cameras), image restoration techniques can be used. Software based methods are cost-effective respect to hardware upgrading. The main idea is based on combining useful data available at several frames of low resolutions (LR) to create an image of higher resolution (HR) [2-3]. Many researches have been conducted in this respect [4-5]. An SR (Super Resolution) algorithm usually consists of three main stages namely registration, interpolation and restoration [6]. In order to create an SR image, different methods have been presented in the recent years.

One of the highly-applied methods for SR is to use interpolation method for increasing dimension of images to increase the number of pixels POCS (Projection Onto Convex Sets) algorithm is another approach where is based on repetitive attitude. In this algorithm, first, registration parameters are estimated and then interpolation and restoration are carried out in one stage so that HR Images could be obtained [7].

From among other SR methods, one may point out an estimation method based on MAP. First, adaptability of LR images is performed and then, the estimation is made. Actually, these two stages are interdependent [8]. Papoulis - Gerchberg (P-G) method is one of other well-known algorithms used for image restoration. It uses the spatial & frequency information to achieve an HR image in a process based on repetition [9].

SR algorithms based on learning the patterns has been used a lot in the recent decay in many SR approaches. Learning is based on selected patterns where the relation between image patches in high resolution and its corresponding of low resolution image is modeled through learning algorithms to create an HR image. In these algorithms, a training set has been used consisting of a few corresponding Patches of HR and LR [10]. Variety and complexity of image pieces reveal that SR is fundamentally a nonlinear operation. In complicated images, several estimation functions are used instead of single approximation. In this paper, the proposed method for face image restoration is based on modeling.

The goal of this research is to restore low quality face images to recognize and confirm identity. From among the four methods propounded above, the recommended method brings about the best results in terms of visual and statistical criteria. The order of the paper goes in such a way as at section 2, the observation model has been described. The proposed method has been put forth for face restoration at section 3. The results of simulation have been given at section 4. Consequently, conclusion has been indicated at section 5.

II. Observation model

Digital imaging systems are not complete due to hardware limitation because the images achieved in different ways are destroyed. In order to study the image degradation in most researches, a model is used .

$$Y_K = D_K H_K F_K X + V_K \qquad K = 1,2,...,K$$

Where X is the desired HR image and Y_k is the K-th LR. F_k encodes the motion information for K-th frame. H_k models the blurring effects. D_k is down-sampling operator and V_k is noise term [4].

III. Proposed algorithm

In Fig.1 , the block diagram of proposed algorithm is displayed. In this algorithm, first LR images are achieved by applying the observation model on the HR image. Then, using the respective method based on pattern, the HR and LR images are extracted with non-overlapping in blocks in the size of (7×7 pixels). Each block obtained through HR and LR images are changed in form of a vector according the method presented in [11]. Finally, the created matrixes are used for training the MLP neural network. After the training process a model is created. In other words, nonlinear regression based on models network can be used for restoration.

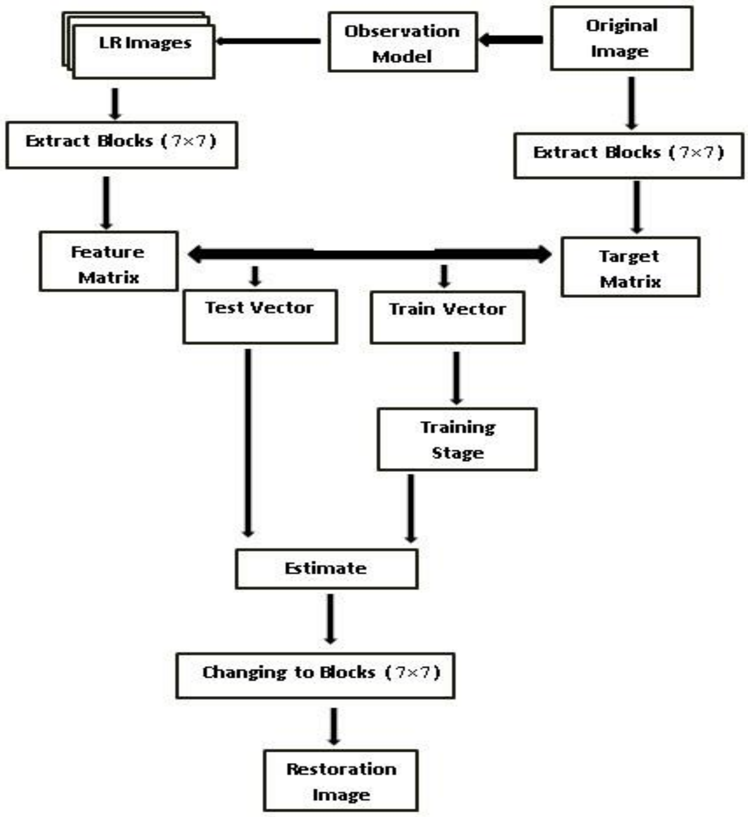


Figure 1. block structure of the proposed algorithm

IV. Experimental Results

The results of the proposed algorithm were evaluated in term of visual and statistical criteria. Furthermore, we shall compare the results to other common methods used in some related researches. Moreover, MATLAB software has been used for implementation and comparison result.

1. ORL Database

In order to study the efficiency of the proposed algorithm the ORL database has been used [12]. The ORL database has 400 images of 40 different persons. The face image of each person has been taken in 10 different gestures. The size of all images is given as 112 x 92 pixels (Fig.2).

Figure 2. Some images of ORL Database

2. Accuracy

Assessment criteria for comparing the results of different methods of SR have been given. In the mainly, three criteria mean square error (MSE), peak signal to noise ratio (PSNR), and structural similarity measure (SSIM) are used to evaluate the accuracy of the restoration results [6-13-14].

$$MSE = \frac{1}{M \times N} \sum_{i=1}^{M} \sum_{j=1}^{N} \left(X_{ij} - Y_{ij} \right)$$

Where Xij is pixel of row i and column j of the original image. Y_{ij} is the pixel of row i and column j of the restored image. M, N is the number of pixels of the two images. MSE criterion is used to calculate the error of the restored image.

$$PSNR = 10Log_{10}\left(\frac{255 \times 255}{MSE} \right)$$

PSNR criterion is used to measure the similarity between the two images in the presence of noise. It should be noted that PSNR is sensitive to the slightest change in values of pixels and is disable to describe the quality of image. Another important criteria in examination and assessment of SR is the criterion for SSIM that measures the quality of the relationship between patch of restored image (y) and its corresponding in the degraded image(x).

$$SSIM(x, y) = \frac{(2\mu_x \mu_y + C_1)(2\sigma_{xy} + C_2)}{(\mu_x^2 + \mu_y^2 + C_1)(\sigma_x^2 + \sigma_y^2 + C_2)}$$

Where μ_x, μ_y are average of x and y patches. σ_{xy} is the covariance of x and y.

$$C_1 = (k_1 L)^2 \text{ ، } C_2 = (k_2 L)^2$$

Where L is the maximum values of pixels. Default values of K_1 and K_2 are mainly equal to 0.01 and 0.03 [14]. in most paper MSSIM that is obtained through averaging of SSIM as an assessment criterion.

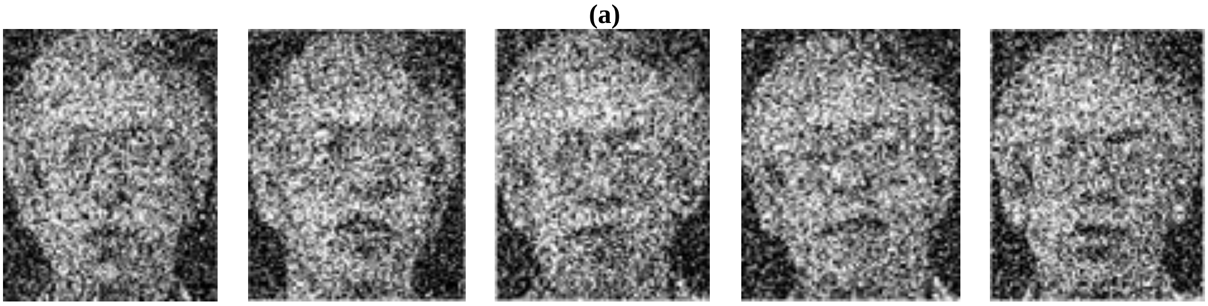
3. Simulation

Applied MLP neural network has been encoded in form two hidden layers with 50 and 60 neurons. Based on the proposed algorithm is examined in two stages. In the first stage, just geometry changes are included. In the second stage, the change in noise level has been considered.

3.1. Geometry changes

At first, five images of a person (taken in different gestures) are selected. Then, based on the observation model, corresponding LR images are created (Fig. 3).

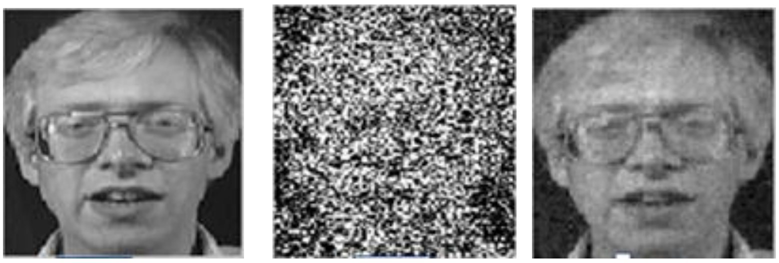
(a)



(b)

Figure 3. a) five images selected from a user which are taken in different gestures **b)** LR images created using the observation model

Blocking the selected images, the vectors are extracted and MLP network is trained. In order to evaluate the proposed method. Another image from the selected user is taken. Using the observation model a degraded version is constructed and used for simulation. The restoration result is show in Fig .4

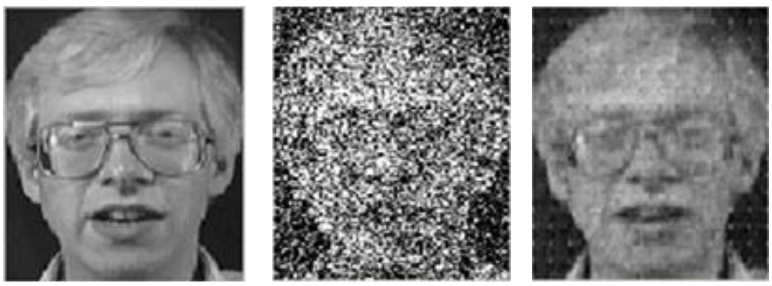


(a) **(b)** **(c)**

Figure 4. The result of proposed method **a)** original image **b)** Corrupted image **c)** resorted image

3.2. Noise Consideration

In the second stage, the sensitivity of the proposed method to noise level is examined. An image is selected and then, changing the additive Gaussian noise of observation model, five LR images are generated. The mentioned procedure is taken and the MLP network is trained. At test stage, another image gesture of the user is selected, degraded and applied for restoration. Fig.5 shows a sample result.



(a) (b) (c)

Figure 5. The result of proposed method a)original image
b) Corrupted image (SNR=3.3 dB) c) restored image

Three assessment criteria namely MSE, PSNR and MSSIM are calculated for the obtained images in two states. The results are given in table (1).

Table 1: Assessment criteria for two sates proposed algorithm

	Geometry test	Noise level test
MSE	443.6433	775.0461
PSNR(dB)	21.6605	19.2374
MSSIM	0.5509	0.4237

Comparing the results in the aforesaid two stages, it is observed that the image obtained in the first stage is more desirable the second stage. Then, the results obtained from the proposed method have been compared with POCS and Papoulis-Gerchberg (P-G) methods. In Fig.6 the results of applying the aforesaid four methods have been given for one sample image. As it is found in the said image, the proposed method in the first stage (geometry changes) shows the best results from among other methods.

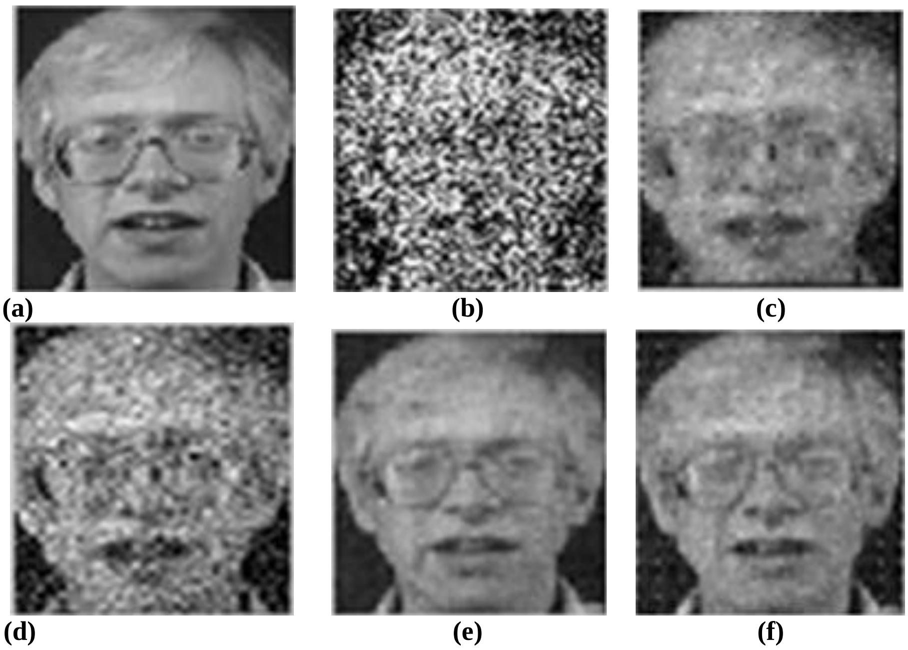


Figure 6. Image restoration obtained with four methods **a)**Original image **b)** Corrupted image **c)** POCS **d)** P-G **e)** Geometry changes **f)** Noise consideration

In table (2), based on the aforesaid three assessment criteria, the results of the two methods of POCS and P-G were compared to the proposed method in the first stage that revealed more desirable results compared to the second stage. The results of the aforesaid table (2) show that the proposed method under state of change in image geometry brings about the best result because it has the best PSNR, the least MSE and the most MSSIM respectively.

Table 2. Assessment criteria for three methods

	P-G test	POCS Test	Geometry test
MSE	1748.5	1205	443.6433
PSNR(dB)	15.7041	17.3209	21.6605
MSSIM	0.1054	0.1887	0.5509

V. Conclusion

In the recent two decays, the need for HR images especially in medical cases for diagnosis of diseases or spatial images has led to development of a new branch in image resolution known as SR. The goal of the SR is to create HR images from the LR images. In this paper, a method has been proposed by using MLP network for approximation of image based on train patterns. Comparing the results obtained to those of common methods like POCS and P-G based on assessment criteria show that the proposed method in first stage had best result. For the proposed method in the first stage, the effect of change in image geometry has been studied by considering change in gesture of face image. For this purpose, an image was selected from ORL database and then by the use of observation model, five noisy and blurring images have been generated. Then, it was entered the MLP network. The results were obtained through test image. In the second stage, five images with five Corrupted images of the same were entered the neural network. Then, after test of network by an image that has not been entered the network before, an exit image was obtained. Under this stage, the results are more desirable than those under the first stage. After comparing the results of the previous methods and the proposed method based on assessment criteria of SR namely PSNR, MSE, and MSSIM, the proposed method has shown more desirable results.

References

[1]. Sh.Zhang and Y.LU , Image Resolution Enhancement Using a Hopfield Neural Network, International Conference on Information Technology , 2007 , 224-228.

[2]. A.J. Shah , Image Super Resolution-A Survey ,1st International Conference on Emerging Technology Trends in Electronics, Communication and Networking, 2012 ,1-6.

[3]. V.H.Patil, D.S.Bormane, and V.S.Pawar, Super Resolution using Neural Network, Second Asia International Conference on Modelling & Simulation, 2008 , 492-496 .

[4]. P. Milanfar, Super-Resolution, 1(CRC Press is an imprint of Taylor & Francis Group, 2011), 1-24.

[5]. S. CHaudhuri , SUPER-RESOLUTION IMAGING, (Kluwer Academic Publishers, 2002) .

[6]. K.Nasrollahi and T.B.Moeslund, Super-resolution: a comprehensive survey, Machine Vision and Applications , , 2014, 1423–1468.

[7]. H.Huang , X.Fan , Ch.Qi and Sh.H.Zhu , A learning based POCS algorithm for face image super resolution reconstruction, Proceedings of the Fourth International Conference on Machine Learning and Cybernetics, 2005, 5071-5076.

[8]. S.Ch.Park, M.K.Park, and M.G.Kang , Super Resolution Image Reconstruction :A Technical Overview, IEEE Signal Processing Magazine , 2003, 21-36.

[9]. E. Salari and G. Bao, Super-resolution using an enhanced Papoulis–Gerchberg algorithm, IET Image Process, 2012, 959–965.

[10]. K. Taniguchi, M.Ohashi, H.Xian-Hua, Y.Iwamoto, S.Sasatani and Ch.Yen-Wei, Example-Based Super-Resolution using Locally Linear Embedding, 6th International Conference on Computer Sciences and Convergence Information Technology, 2011, 861-865.

[11]. P.Hannequin and J.Mas, Statistical and heuristic image noise extraction (SHINE): a new method for processing Poisson noise in scintigraphic images, Institute Of Physics Publishing, 2002,4329–4344.

[12]. M.A.Khan, Dr.Javad, and M.A.A, Face Recognition using Sub-Holistic PCA, British Journal of Science , 2011, 111-120.

[13]. Liyakathunisa and V.K.Ananthashayana , Supr Resolution Blind Reconstruction of Low Resolution Images using Wavelets based Fusion, World Academy of Science, Engineering and Technology, 2008, 172-176.

[14]. S.A.Ramakanth and R.V.Babu , Super Resolution Using a Single Image Dictionary, IEEE Conference , 2014,1-6.