RECONSTRUCTION OF PARTIALLY DAMAGED FACIAL IMAGE

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Abstract

This paper addresses the problem for Reconstruction of Partially damaged Human Facial image. This is an ill posed problem. The process of reconstruction goes through a series of basic operations in image processing. Images are combination of shape and texture, so the approach is to reconstruct the shape and texture using a facial image database [9]. The proposed method takes input as a damaged image (10% to 30%), and applies Statistical approach to reconstruct the facial image. Experimental results show that the reconstructed images are realistic and very close to the undamaged (Original) image.

Keywords- *Face Reconstruction, Damaged Face, Reconstructed Face, Reference Face, warped image*

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1. INTRODUCTION

In the previous studies related to the facial image reconstruction the process of reconstruction itself is too much complex. In previous studies [1][2], they followed very complex data completion algorithms, and digital image processing operations for the process of reconstruction. In various recent studies they have taken entirely different approach for reconstruction [3][7]. In their work Deng,Dong,Xudong,Kin and Qionghai proposes a spectral graph based algorithm for face Image repairing [3]they first cluster the images which have a similar sparse representation to the query image. Then find the best-matched patch for guidingthe synthesis of the missing parts. The patch obtained is used to guide the in-painting work of the damagedpart of the occluded face. But here the key is to find the ideal patch, which is not always easy. In their work Tang, Zhuang, Wang, Shih and Tsai [7] aims to remove only part of a face region (e.g., part of mouth or nose), whereas in most papers, the complete components can be removed. Their approach uses the source information in the same face, instead of using deduced sample faceregions from the face database.

In our paper a facial database has been used [9], the input to the system is a damaged frontal facial image.The databasecontains facial images with constant illumination and frontal view of the face,from the database the average of all the faces is derived, and is called as REFERENCE FACE. Then separate the shape and texture of the input image[4]. The shape is the displacement of the pixel in the input image to the corresponding pixel in the reference image, and the texture is the gray value of the pixel when the input image is mappedon to the reference face (warped image). Data completion algorithm has been applied for reconstructing incomplete facial data (Shape and Texture) [5][6] with the help of reference image.After that we will combine the reconstructed shape with the reconstructed texture to obtain the reconstructed facial image [1][2][4].

The proposed method shall reconstruct images distorted due to noise or if any object (like eyeglasses or scarf etc)covered any part of the face.

2. PROPOSED METHOD FOR RECONSTRUCTION

The proposed method of reconstruction include five major steps, in the initial and foremost step the Reference face has been calculated. The calculation of reference face involves the transformations according to the prior conditions for the input images. If the input image restricted to be a frontal image with constant illumination and orientation then directly the average facewill be calculated, otherwise as much as freedom is given to the type of input image which are to be scaled (scaling, rotations, etc.).The facial image database used for the proposed method contains frontal images [9].

The process of reconstruction goes through two prior conditions, initially before the reconstruction process the damaged region must be known and displacement of the corresponding pixels in the input image to the reference image must also be known.

In the next step Warping is performed. Warping is nothing but mapping of an image on other image that is the texture of one image is mapped on the shape of other image[4].This way with the help of warped image the texture difference between the input and reference image is calculated. Now to calculate the shape difference between the input and the reference face mark the co-ordinates of major facial components like- corner of eyes, corner and tip of nose, contour of mouth and whole

facial outline, etc on input and the reference face and then just take the difference between them and then take average of it. Add these average differences to the Reference image to get the reconstructed face.

Finally the damaged region (of the input image) is replaced by the corresponding reconstructed ones (from the reconstructed face).

Step 1) Get the average face of all the facial images, name it as Reference Face.

Step 2) Input the damaged image and warp theInput Image on to theReference Image

Step 3) Get the texture at corresponding points on warped image and the reference image for the undamaged part ofwarped image, and calculate the average ofdifference between them.

Step 4) From the reference and damaged input image get the co-ordinates of few major parts of them (Such as Corners of eyes, Tip of nose, Corners of Mouth etc.), and then calculate the average of difference between them (i.e. the average shape difference only).

Step 5) Collect the co-ordinates of damaged region input image as well as corresponding points on reference face, and replace the pixels adding the shape and texture difference to them as-

"g(i,j)=l+f((i+x_avg),(j+y_avg))"

Where;

g(x,y)→Input damaged face.

f(x,y)→Reference (average) face.

x_avg, y_avg→Are average difference in x and y co-ordinates (i.e. shape difference).

l→ Average texture difference.

The images reconstructed using the proposed methodlooks very real and close to the original one.

3. EXPERIMENTAL RESULTS

Initially four images are considered from our facial database [9]to verify the proposed method.

Fig-1: Images Taken

Now the process of reconstruction performed on them, as per the algorithm.

The average of these four images are calculated and named it as reference image as shown below.

Fig-2: Reference Image

Now input the damaged image to be reconstructed. One image has been taken from the database and removed some part of it (10% to 20% of the face). In present case the left eye of an image has been removed as shown below.

Fig-3: Damaged Image

Now warped the input image on to the reference image, i.e.taken the texture of the input damaged face and placed it in to the reference face i.e.on to the shape of the reference face, as shown below.

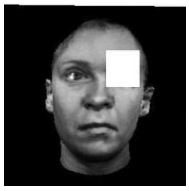


Fig-4: Warped Image

In the continuation the texture at corresponding points on warped image and the reference image are collected.A GUI (Graphical User Interface) may be used for collecting the co-ordinates of major parts of the face like Tip of Nose, Lip's area, Ear's corners, Forehead, etc.With the help of these points we take the Gray value at those points on both the Warped as well as the input image.As the shape of both the images are same, so it's not required to collect co-ordinates from both the images, so onlythe co-ordinates on reference image are collected and used it for getting texture on both the images.

After thatthe difference between them is calculated, and then the average of all differences (i.e. the average texture difference).

Then the reference and damaged input image has been taken and on the similar waysgot the co-ordinates of few major parts of them, for the undamaged part.The only difference to the previous calculation is this time opened both the images on the GUI for taking the corresponding points on both the images. As the shape of the images are not same.Then calculate the average difference between them (the average shape difference).

Finally the co-ordinates of damaged region on input as well as corresponding points on reference face has been stored, and replaced the pixels adding shape and texture difference to them, and got the reconstructed image of the input damaged image, as shown below.

Fig-5: Reconstructed Facial Image

4. SOME MORE SAMPLE RUNS-

The algorithm can be implemented on different number of facial image databases. For showing this some more combination of image databases has been used. Then reconstruction of the occluded face has been shown below. It can be generalized to any extent. The images taken are all from a Facial database [9].

Run-1-
Herefour imageshave been taken again.

Fig-6: Images Taken

In this sample run another important facial component, "Nose" has been removed to make the input occluded face. The process will be exactly same.Again the reference face has been calculated and with the help of reference face reconstruction of the damaged image has been performed. The damaged, reference and warped imaged are shown below.

Fig-7: Damaged Image

Fig-8: Reference Image

Fig-9: Warped Image

Fig-10: Reconstructed image

According to the algorithm explained earlier, the input damaged image has been reconstructed, as shown above.
Here the texture of the reconstructed part of the image is not exactly same as the input image, so this is the point we are working.It can be reduced by Dilation Morph able operation.

Run-2-
Here takenfive pictures as shown below, and similarly taken their Average as Reference image, then Warp the input damaged image on it, and proceed further for reconstruction, as shown below.

Fig-11: Images Taken

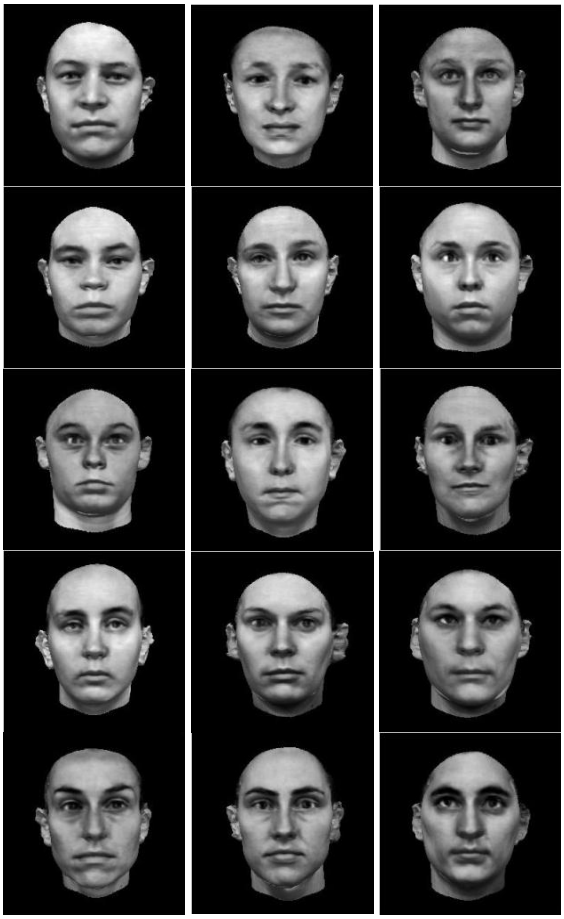
The damaged image and the Reference and warped images can be shown below-

Fig-12: Damaged Image **Fig-13:** Reference Face

Fig-14: Warped Image **Fig-15:** Reconstructed Image

Finally after the processing the reconstructed image can be shown above.Here the resultant reconstructed image is more real than the previous case.

Run-3-
Here takennineteen faces from the database as shown below-



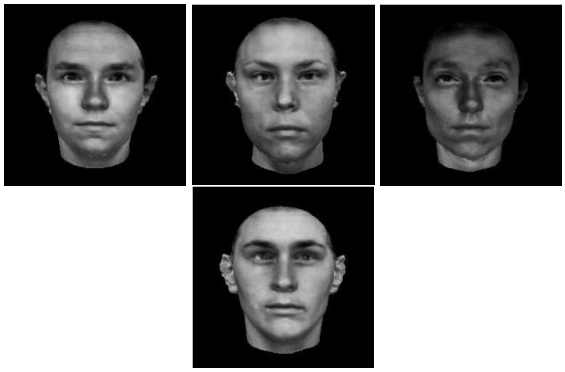


Fig-16: Images Taken

Now the damaged, reference, warped and reference images can be shown below-

Fig-17: Damaged Image **Fig-18:** Reference Image

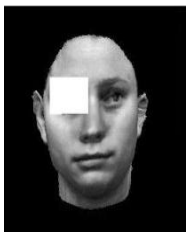


Fig-19: Warped Image **Fig-20:** Reconstructed Image

Here the texture again is not exactly matching with the input image, but still the image looks good.

CONCLUSIONAND FUTURE SCOPE

In the process of reconstruction by the proposed method the faces damaged or occluded up to 15% to 20 % can be reconstructed as the real image.

This can also be seen by comparing the reconstructed image to the Original one. The histogram plot shown below has considered only the reconstructed part of the image to the original image of our very first example.

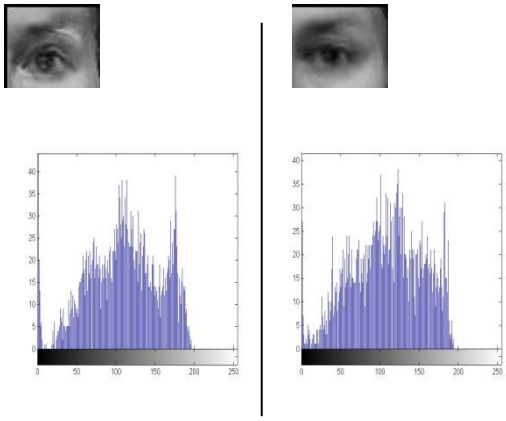


Fig-21: Original Image **Fig-22:** Reconstructed Image

The difference between the original and the reconstructed image is negligible as can be seen below-

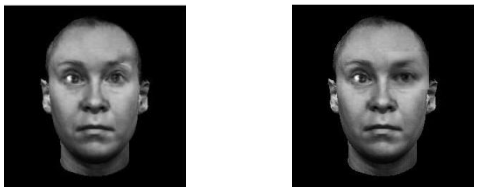


Fig-23: Original Image **Fig-24:** Reconstructed Image

The sample run of the proposed algorithmperformed with 4, 5 and 19 facial images, can be extended to work with a facial database of thousands of faces, and by which it can reconstruct many different types of faces. Some more image processing operations like Dilation Morphological operation or some other technique have to be adopted, to make the reconstructed image more real and close to the original one. But up to certain limit proposed algorithm still make good reconstructed images. The work can be further utilized in image detection, Virtual Reality simulation, Plastic surgery simulations, Face recognition, Human Computer Interaction and animations, Crime investigations.

The presented method can be improved by introducing various methods for calculation of better reference image and the reconstruction can also be tried with some complex mathematical operators for data completion. These improvements can produce more realistic and clear reconstructed images.

The database contains images of 7 views of 200 laser-scanned (Cyberware TM) heads without hair [9][10]. The 200 head models were newly synthesized by morphing real scans to avoid close resemblances to individuals [11].

The proposed method has been implemented using the system configuration as follows:

Processor: Intel® Pentium® 4 CPU 2.80GHz
Installed Memory (RAM): 2GB
System Type: 32-bit Operating System
Operating System:Windows 7 Enterprise Service Pack 1
Programming Language Used: MATLAB 8

Further the work can be utilized to reconstruct images of historical monuments. It can be extended for skull to image construction, for use in forensic studies and for 3D Face reconstruction.

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BIOGRAPHIES

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