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An Approach for Restoring Occluded Images for Face-Recognition

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Abstract: The Systems that rely on Face Recognition (FR) biometric have acquired great importance ever since terrorist threats injected weakness among the implemented security systems. Rest biometrics as iris or Fingerprints recognition is not trustworthy in such situations whereas FR is considered as a better compromise. In Image processing, Occlusion refers to facade of the face image which can be due to hair, moustache, sunglasses, or wrapping of facial image by scarf or other accessories. Efforts on FR appears in controlled environment have been in the picture for past several years; however identification under uncontrolled condition like partial occlusion is typically quite a matter of concern. Based on review of literature and its analysis so far, a classification made in this paper to solve the challenges in recognition of face in the presence of partial occlusion. The methods used are INPAINTING based methods that make use of Exemplar-based Inpainting, Feature-Extraction, and Fast Weighted-Principal component analysis (FW-PCA),etc.
The presented approach in this paper describes the removal of Occlusion from images or restore the occluded part of image using Exemplar-based Image Inpainting technique, feature extraction and FW-PCA(Restoration) combinations.

Keywords: Occlusion; Image Inpainting; Exemplar based inpainting technique, Face-detection, Feature extraction, Image Restoration, FW-PCA.

I. INTRODUCTION

OCCLUSION is defined as an Obstacle or any unnecessary-object in image disturbing the matching sometimes called recognizing process. Occlusion in an image refers to hindrance in the view of an object. Occlusion observed can normally be natural as well as synthetic. Natural occlusion indicates to obstruction of views between the two image objects without any intension while synthetic occlusion refers to artificial blockade of intentionally covering the image's view with a white/black solid rectangular block. Partial occlusion has been observed in many areas of image processing. It is found in iris recognition where the eyelashes occlude the iris; identification via ear can also be occluded by the presence of earrings. Even in real time application face image intentionally becomes occluded via accessories such as

- Sunglasses, scarf, beards, hat.
- Hand on face
- Face dirt
- Face behind Fence
- Texture on Face images, etc.

Digital Image Processing (DIP) is the analysis and manipulation of digitized image, especially in order to improve its quality and parameters. Almost all of the technical fields are impacted by DIP. It is widely used in Medical Field, Video processing, robot vision, Remote Sensing, etc. Recently the research areas in Images processing recently acquired a lot of attention in analysis of biometrics such as Iris, Fingerprint, Hand, Ears, Face-Recognition.

Though tracking and recognizing face objects is a routine task for humans and building such a computerised system are still an active research. Despite several proposed face recognition schemes, image based approaches are possibly the most promising ones. However, the images patterns of face objects can dramatically change due to occlusion type, lighting and viewing variations. The major portion due to which conflict occurs while Face recognition, is facial occlusion. The research for removal of such facial occlusion using restoration or reconstruction of specific area is currently an active field. Here, system is proposed where it is possible to remove occlusion from faces and person may be predicted.

The paper is organized as follows: Section 2 comprises review of related work done; section 3 comprises Proposed work and flow of project; section 4 describes Implementation work; section 5 states Conclusion and Future work.

II. RELATED WORK

An In jan-2014, Christine Guillemot and Olivier Le Meur presented two major approaches in "IMAGE INPAINTING -Overview and recent advances". They proved that system comprise of Diffusion-based inpainting or Examplar-based inpainting techniques have major application as image disocclusion and such systems may be discovered in order to improve results and accuracy[1].

Tomoki Hosoi, Sei Nagashima and Koichi Ito[2] contributed a lot in reconstruction of occluded images and

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finding most approximated matched images. They followed popular techniques of PCA and FW-PCA for Face Recognition and Identified FW-PCA providing appropriate weights to sample images. Facial Occlusion is a critical problem for Face recognition. Addressing this problem, they proposed a method for restoring occluded regions in face images. The proposed method employs Fast Weighted Principal Component Analysis (FW-PCA), which computes PCA only with effective pixels. The adoption of FW-PCA makes it possible to detect and restore occluded regions in face images.

Through a set of experiments using public face databases, they demonstrated the effectiveness of the proposed method compared with the conventional methods.

Mahroosh Banday and Richa Sharma , in July-13, presented "Image Inpainting- An Inclusive Review of the Underlying Algorithm and Comparative Study of the Associated Technique " in which A comparative study to provide a comprehensive visualization of different types of image inpainting techniques were discussed[3].

Shermina .J and V. Vasudevan in Jan-12 proposed a system of an Efficient Face Recognition system based on Partial Occlusion and expression, the face they recognized by using the PCA. From the implementation result, it was proved that, proposed method recognizes the face images effectively [4].

Marcelo Bertalmio and Guillermo Sapiro, proposed a robust method of "Image Inpainting" in which they introduced a novel algorithm for digital inpainting of still images that attempts to replicate the basic techniques used by professional reconstructors.

After the user selects the regions to be restored, the algorithm automatically fills in these regions with information surrounding them.

Their experimental results stated that 'The inpainting algorithm presented has clearly motivated by and has borrowed from the intensive work on the use of KNN algorithm in image processing[5].

Aleix M. MartõÂnez, Member of IEEE in june-2002 described a system To make the recognition system less sensitive to the differences between the facial expression displayed on the training and the testing images, they weight the results obtained on each local area on the basis of how much of this local area is affected by the expression displayed on the current test image[6].

In dec-2012, Rui Min and Jean-Luc Dugelay presented the system where solution to newly identified facial occlusion problem viz. sparse occlusion in the context of Face Biometrics in Video surveillance. Experiments demonstrate that the proposed approach significantly improve various face recognition algorithms in presence of complex sparse occlusions[7].

III. PROPOSED SYSTEM MODEL

The working model for proposed system is as follows:-

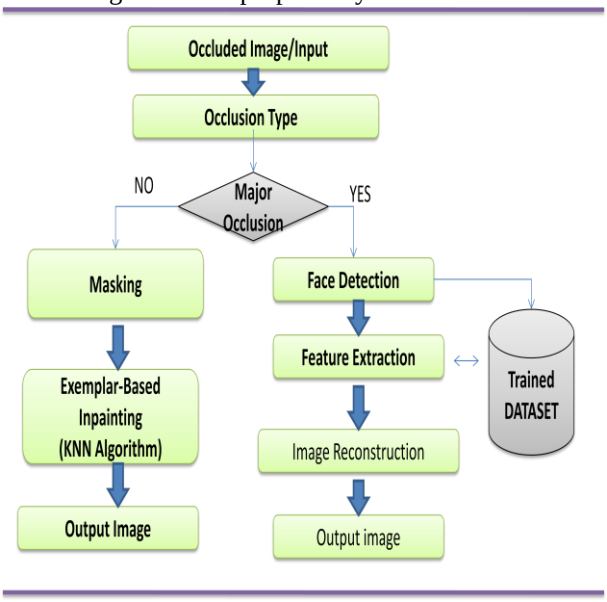

Fig 1:- Project Flow

The Process is initiated by Selecting the input image which is found occluded from the system simply browsing the required path.

As the selected image get labelled, Our approach is to visualize the image and classify on the basis to occlusion and classify in the category of Minor occlusion or major occlusion.

Minor Occlusion - It is an occlusion type where regular and effective pixels is get occluded by contradict pixels on texture part of image which could be impainted using their background pixels. Eg. Tattoo, beard, moustache, etc.

Major Occlusion - This category consist of occlusions which occupies some hindrance part of typical recognizable feature of face like eye, nose, mouth, etc behind, and which is not possible to impaint for recovery, such occlusions are called Major occlusions. Eg. Goggle, Scarf, masks, etc.

As the input image is categorized, it would be then travelled though proper channel for manipulation.

i) If occlusion is Minor, then with the help of Image-Impainting technique it remove occluded pixels to get occlusion-free image. Here, proposal is to use Exemplar based Image-Impainting technique where KNN (K-Nearest Neighbour) algorithm works on pixels to replaced occluded pixels with reference to background pixels. Just in single iteration it retrieve image which seems original and cleaned image as it had never be occluded.

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ii) In case II, consider the occlusion as major which is not possible to recover with above process, then it have to be processed by another process of feature extraction shown in project flow. Major occlusion images has to be followed by three process:- a) Face-Detection b) Feature Extraction and c) Image Reconstruction.

A. Face-Detection

The input image is to be normalized first before get proceeded to further steps. Normalization leads to image detected face compare with dataset which again get trained with the help of this process on the other hand. Here, only facial part is detected and extracted from overall image excluding background area. The output image obtained is normalized and relevant to undergo further process.

B. Feature Extraction

This module takes input image obtained by Face detection which is normalized . In this, image feature get extracted in the form of vectors and represented by 66 lines of code in the .txt file. It includes feature like Color segmentation, Edges and Texture. As the feature get extracted it is then compared by features of trained dataset. The matching is contradictorily done on the basis of Differences in vectors of input image and images from dataset. The least 5 difference obtained means 5 are matching image. Here, minimum difference means maximum matching image. By obtaining matching vectors, those images are get redirected on the label.

C. Image-Reconstruction

From all 5 images it is possible to easily select anyone related image referring to which it can substitute the occluded part. As the Occluded pixels of input image get substituted by pixels of matching image. After the process it return the output image seems to be dis-occluded.

The input image which was occluded undergoes the process, completion of which get resultant image as occlusion free way to comply with the conference paper formatting requirements is to use this document as a template and simply type your text into it.

IV. IMPLEMENTATION WORK

A. Image Impainting

Impainting is done by sampling, and by copying or joining together patches (called *exemplar*) taken from the known part of the image, So, the corresponding methods used are known as exemplar-based techniques. Exemplar-based inpainting symphonizing entire patches by learning from patches in the familiar part of the image and these methods are known to be faster than PDE pixel based approaches.

Input Image:- Input image given is a photograph, natural image and synthetic image for dealing with, that contain coloured images of different size etc. that is given to image inpainting.

Masking of Image:- It covers the region of unwanted object either single or multiple if required from the original image through paint called mask image or target which is to be inpainted.

Incomplete Salient Structure Completion:- Combining incomplete salient structures is the key to obtain feasible inpainting results. However, simple association or extension of the incomplete salient structures results texture features are used to determine the similarity of incomplete salient structures.

Texture Propagation of Completed Salient Structures:- After structure completion, its propagated texture information into the target region through patch based processing order divergent of Exemplar-based inpainting technique.

Inpainted output Image:- The output will be required image which is completely inpainted image where it emerges as occlusion is removed from the occluded input image[1].

Fig 2:- Impainting process

B. Face-Detection

The Viola–Jones object detection framework is the first object detection framework to provide competitive object detection rates in real-time images proposed in 2001 by Paul Viola and Michael Jones. Despite it can be trained to detect various variety of object classes, it was motivated primarily by the problem of face detection. This algorithm is implemented in OpenCV as `cvHaarDetectObjects()`.

The basic principle of the Viola-Jones algorithm is to scan a sub-window qualified of detecting faces across a given input image. The standard image processing advent would be to rescale the input image to different sizes and then run the fixed size detector through these images.

This approach turns out to be rather time engrossing due to the calculation of the different size images. Adverse to the standard approach Viola-Jones rescale the detector instead of the input image and run the detector many times through the image – each time with a different size.

At first one might suspect both strategies to be equally time consuming, but Viola-Jones have presented an algorithm which is a scale invariant detector that requires the same number of calculations whatever the size. This detector is constructed using a so-called integral image and

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some simple rectangular features redolent of Haar wavelets.

It uses the package of XML file containing Thousands of positive tested samples and negative tested samples which provides the algorithm better accuracy and perfection in detection.

Using this algorithm, dataset is normalized which is called trained dataset so that input image is feasibly compared with dataset images[8].

Fig 3:- Trained dataset

C. Feature Extraction

Feature Extraction is the key method in CBIR (Content based image retrieval). A certain number of features for each image are extracted, defining its high level content information. Then, according to the similarity of these vectors, comparisons of two specific images are estimated in numbers.

This class uses different techniques to extract features related to a single or the group of images. Two methods in this class which extracts the features:

ExtractSingleImage : which extracts the features for a single selected image and it is used to extract the features of the input image.

ExtractAll : which is used to extract the features for all images available in dataset. It takes approximate about half an hour for this method to complete and stores the result table in a text file named: "Features.txt".

FEATURE EXTRACTION PROCEDURE:-

a) The first step is the Colour Extraction which computes the feature vector consisting of 18 real numbers for each available image. Notable is that for each of these features, a normalization step is provided to fit the numbers between 0-10.

b) Then the edge map of the given image is calculated. It is implemented in Canny Edge Detector class. It provides a binary image which consists of just zeros and ones. So, further computations will be much easier.

c) The last step is Texture Extraction. It uses co-occurrence matrix to extract texture features, and provides 48 real numbers as feature vector.

d) At last, these two vectors are concatenated to each other and a 66 length feature vector for each image is computed.

D. Image Reconstruction

The normalized input image **x** which is reconstructed using the method of FW-PCA which consist of-

a) Training process :- The eigenspace **E** is computed using all the training images, The standard deviation of the reconstruction error for each pixel $\sigma = [\sigma 1\ \sigma 2\ \cdots\ \sigma N]$T is also computed.

b) Reconstruction process :- First, the initial weight for FW-PCA is determined using the sub-samplings of the input image. *M* pixels are extracted from the input image according to *S* random sampling patterns. Considering the extracted pixels as the effective pixels, the reconstructed image $\hat{\mathbf{x}}_s$ ($s = 1, \cdots, S$) for each sampling pattern is computed by using FW-PCA i.e., Then, the reconstruction error $\mathbf{r}_s$ between **x** and $\hat{\mathbf{x}}_s$ is obtained by

$$\mathbf{r}_s = |\mathbf{x} - \hat{\mathbf{x}}_s|.$$

Note that the pixel values of **x** is normalized so that they have the same mean and variance of $\bar{\mathbf{x}}$ during each iteration. The pixel values of effective pixels in the final reconstructed image $\hat{\mathbf{x}}$ is normalized so that they have the same mean and variance of the normalized input image **x**.

c) Occluded-region restoration :- As mentioned above, image reconstruction for the whole input image is done using the eigenspace **E**. The reconstructed image $\hat{\mathbf{x}}$ may result in the smoothed image of the input image **x**. Therefore, only the missing pixels of the input image **x** are replaced by the pixels of the reconstructed image $\hat{\mathbf{x}}$. The restored image $\tilde{\mathbf{x}}$ is obtained by

$$w_i = \begin{cases} 1 & \text{if } (|\hat{x}_i - x_i| < \theta_i) \\ 0 & \text{otherwise} \end{cases} \qquad (i = 1, \cdots, N),$$

Finally, restoration is done only on the occluded regions of the input image [2].

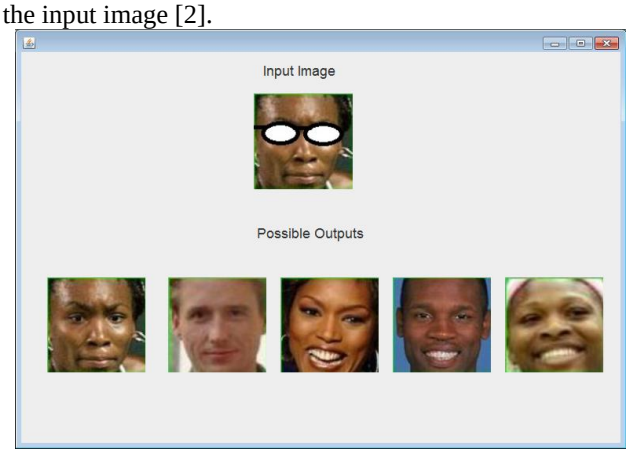

Fig 4:- Matched images

V. CONCLUSION

It is observed that Combination of KNN algorithm, Voila-jones algorithm, Feature extraction and FW-PCA in a single system makes it possible to remove Facial occlusion as well as restoration of occluded images provides good results with better accuracy within seconds. Further

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processing in presented system will lead to save more processing time with the use of clustering.

Face recognition challenges would be reduced to certain extent using removal of Occlusion mechanism with quick relevant output images.

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