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A Survey: Face Detection and Recognition from Occluded images

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***Abstract*:** Face recognition system is used to identify a person by comparing a face image in a database record. Face recognition is comparing and matching human beings with their faces. Face occlusion detection is also part of face recognition. Face occlusion is one of the major problems in face recognition. Facial occlusion is different from another kind of challenge in the field of artificial intelligence (AI). Occlusion means some area of the face is hidden behind an object like sunglasses, hand, and mask, etc. This paper gives brief information about face detection and recognition from occluded face images. This paper includes face occlusion detection methods like SVM, LGBPHS, S – LNME, and LBP, etc. that are used to recognize an occluded human face from a database record. This paper contains some publicly available datasets: Occluded LFW dataset, FERFT datasets, WebV-Cele dataset, Bosphorus dataset, UMB (University of Milano Bicocca) datasets and so on.

***Keywords*:** Face Recognition, Face Detection, Face Occlusion Detection, Convolution Neural Networks (CNN), Datasets.

I. INTRODUCTION

In the field of security, biometric techniques, and computer vision, face recognition has become the most challenging field of machine learning and artificial intelligence (AI). For the past few years, face recognition is the most important in the field of law enforcement and security. Face detection, face occlusion detection, expression recognition, face deformation are some of the challenging tasks for face recognition. For the past two decades, face occlusion detection has been the most difficult task for recognizing a human face in database records. Occlusion means human face images are hidden due to some object, hand, scarf, etc. some images are not clear and some part of images are blur can consider as an occluded image. In the occlusion, reshaping some part of a human face like lips, nose, etc.

Occlusion can be divided into three categories: permanent, temporal and partial [1]. In the case of permanent occlusion, the face is occluded by the beard, mustaches, etc. In the temporal occlusion, the face is occluded by hand, scarf, cap etc. some part of the human face is not clear or hidden or missing as known as partial occlusion. There are many methods developed in the last few years, which was used for removing occlusion and used for improving accuracy. There are many CNN architectures used for detecting and recognizing occlusion from human face images. In this paper, we focus on different occluded databases like LFW, Bosphorus and UMB, etc. face occlusion detection has become a very interesting topic for research.

The paper has been structured as follows: In section II, we discussed various face occlusion detection methods. We present different CNN techniques in section III. In section IV, the different datasets of face occlusion detection and recognition are discussed. In section V, conclusion and future work are presented.

II. FACE OCCLUSION DETECTION METHODS

This section provides basic information about the face occlusion detection methods, which are used for face detection and recognition from occluded images. SVM, LGBPHS, LBP, and S-LNME methods are used for occlusion detection.

A. SVM

SVM is the one if the most important method for facial detection. SVM based occlusion detection can be considered as a two-class classification problem [9]. SVM classifier is divided occlusion face image into the occluded part and non-occluded part of an image. It is also known as two-level SVM classifier. This classifier combines the information of both the parts. In this method, first-level SVM classifier is producing decision value, which indicates the probability of occluded or non-occluded images [8]. After that second-level SVM classifier is used these decision values as an input of second-level classifier and generate the final results of occlusion detection. Using the LBP operator, the feature histogram obtained from the face images and detect if the input image contains some kind of occlusions [13].

B. LBP [10]:

The local binary patterns are used for performing non-occluded components from occluded face images. As per this method, an occluded face image is divided into two main components: occluded components and non-occluded components. In representing and recognizing face patterns, LBP provides state-of-the-art results. For face misalignment and pose-variations, The LBP approach is used histogram as features. The calculation of the LBP codes can be done by a single scanned image. Find the value of LBP code using the following equation:

$$LBP_{P,R} = \sum_{P=0}^{P-1} s(g_p - g_c)2^p$$

Where P is equally spaced pixels, R is the circle of radius, gc is a gray value of the center pixel, gp is a gray value of P on radius R and S is a threshold function. This threshold function follows:

$$S(x) = \begin{cases} 1 & if\ x \geq 0 \\ 0, & otherwise \end{cases}$$

For example, figure 1 represent the non-occluded region for face recognition using LBP method.

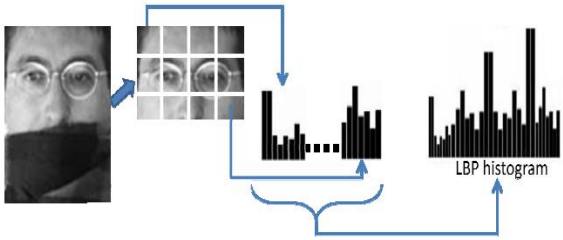

Figure 1: Deriving the LBP histogram from the non-occluded face area.

C. LGBPHS [11]:

Local Gabor Binary Pattern Histogram Sequence (LGBPHS) is robust to noise and local image transformations due to variations of lighting, occlusion and the face image is partially occluded than it is used for face detection and recognition. As per the occlusion problem, these methods divide the face occlusion image into different patches. Gabor is used for extract the feature from the occluded images and after it is used for face recognition. Moreover, this method tests the image on the scarf, sunglasses, cap, and human hand occlusions. The Flow System is shown in figure 2.

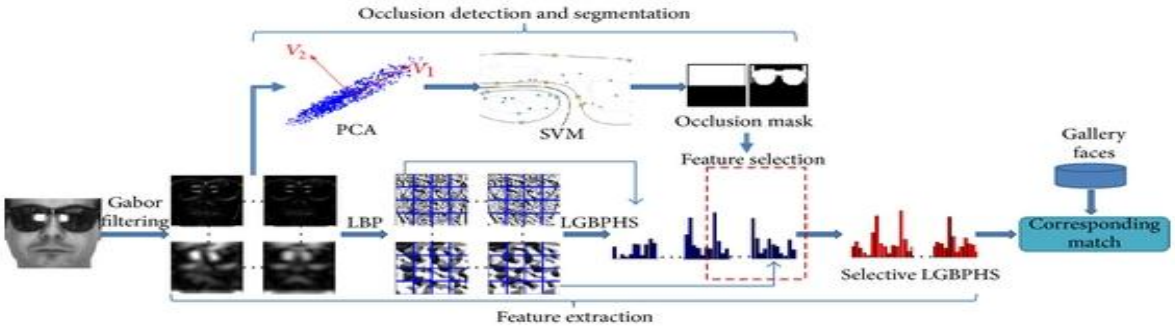

Figure 2: Flow System of LGBPHS Method [9]

There are two approaches to measuring the similarity between two same images: the direct LGBPHS and the weighted LGBPHS. In direct LGBPH method, it is used for histogram matching and similarity between two measurements of the histogram. In weighted LGBPHS, it is very easy to figure out from various areas of the image take different discrimination information that the histogram pieces extracted than after setting the weights to various histogram pieces. It is useful for matching two same images. LGBPHS is one of the face patterns base approach for face detection and recognition from occluded images.

D. S-LNMF [12]:

Using Principal Component Analysis (PCA), face occluded images divided into a number of patches and it uses for face detection from occluded images. S-LNMF is one of the most important faces matching technique for face recognition. LNMF based technique is applied from occluded images. LNMF bases corresponding to only occlusion-free regions are to be integrated when the occluded regions are already identified.

Table 1: Accuracy of Non-Occluded Face and Occluded Face [9].

Method Name:	Non- Occluded Face	Occluded Face
S-LNMF	93.6%	51%
LBP	90%	85,5%
LGBPH	98%	96.25%
SVM	89%	85.6%

IV. FACE OCCLUSION DATABASES

In the past few years, existing labeled face occlusion datasets have been constructed with a clear tendency from

small-scale to large-scale for face learning [2]. We focus on publicly available occluded databases like LFW, Bosphorus and University of Milano Bicocca (UMB) and so on. These databases are briefly available as follows:

A. Labeled Faces in the Wild (LFW) dataset [3]
In these datasets, 13,749 labeled face images are available for 5,749 single identities. This is one of the biggest publicly available datasets. 179MB is the size of the dataset. LFW dataset contains images like Pose variation, Partial Occlusion, Lighting, Blur images, gender and missing some part of the face.

B. FERET datasets [4]:
These datasets included 14,126-labeled faces for 1,199 individuals. FERFT datasets are usable on request. There are a different the type of images included like the variation in colure face, face expression, occlusion and so on.

C. WebV-Cele dataset [5]
There are 6,49,001 face images available for 2,427 single images in WebV-Cele dataset but only 42,118 face images are labeled. These datasets created from YouTube videos. The database is usable on request. The WebV-Cele dataset has images like partial occlusion, age, different pose, facial expression, and quality.

D. Bosphorus dataset:
The Bosphorus dataset is used for research on 3D and 2D human face recognition. There are contained 4,666 face images for 105 individuals. Mainly, there are three unique aspects of this dataset: 1) rich repertoire of expressions, 2) systematic head poses and 3) varieties of face occlusions like the bered & moustache, hair, hand, and eyeglasses. The Bosphorus dataset is used for face processing tasks including expression recognition face modeling, 3D face reconstruction, face detection and face recognition [6].

E. University of Milano Bicocca (UMB) dataset
The University of Milano Bicocca database is facing occlusion database that included 2D and 3D face images. The database is developed by University of Milano Bicocca research center. The UMB dataset contains 143 individuals (98 males and 45 females) and 1,473 total face images (883 non-occluded images and 590 occluded images). The UMB dataset has been a focus on facial occlusion like scarves, hands, hats, eyeglasses, and other miscellaneous objects in the real world scenarios [7].

Table 2: Datasets of Face Images for Face Occlusion Detection and Recognition

Dataset Name:	Unique Identities:	Face Images:
LFW	5,749	13,749
FERET	1,199	14,126
WebV-Cele	2,427	6,49,001
Bosphorus	105	4,666
UMB	143	1,473

V. CONCLUSION

As per this paper, we are present the brief introduction of face detection and recognition from occluded images. Above mention methods and dataset which is mainly useful for detecting and recognizing the occluded face from partial occlusion, blur images, missing part, hidden with a scarf, hand, cap and other kinds of object. We included various methods of face occlusion detection and different occluded datasets, which are used to improve the accuracy and rate of recognition face images. In addition, this paper contains the comparative study of datasets is available currently.

In the future, we will use occluded dataset for face detection and recognition. We will try to face detection and recognition which is more complex on down power image, largely occluded face image which is covered up to 0%, 20%, 40%, 60%, 80% using the different object like the scarf, cap and so on.

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