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REAL-TIME PARTIAL FACE OCCLUSION DETECTION USING MATLAB

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Abstract - *Face detection has been one of the most challenging topics in computer vision for the last several years. The goal of face detection is to detect a person even if the face is occluded by some object. Occlusion detection in face verification is an essential problem nowadays. A face is occluded if some area of the face is hidden behind an object like a sunglass, a hand, a mask. Face occlusions can degrade the performance of face recognition systems including humans. Occlusion at faces may be leads to performance degradation of face detection algorithms. The aim of this paper is to discuss a method on face detection under the case of partial occlusion at lower portion in real time condition. This application can be used by the law enforcement agencies, access control systems, surveillance at different public places like ATM machines, air ports etc.*

***Key Words*: Occlusion, Face detection, Frontal face, VJ Algorithm**

1. INTRODUCTION

Face is one of the most important human's biometrics used in every day human communication and due to some of its unique characteristics plays a major role in conveying identity. Face detection is the process of detecting one or more people in images or videos by analyzing it, which is an important part of many biometric, security, and surveillance systems. Although significant progress has been made in face detection technology, it is still suffering when facing uncontrolled environments such as occlusions, drastic illumination changes, facial pose variations etc. The goal of face detection system is to detect a face robustly as possible to the image variations such as illumination, pose, occlusion, expression, etc. While there have been numerous amounts of research works on face recognition under pose/illumination changes, problems caused by occlusions are mostly overlooked, even though facial occlusions are quite common in the real world scenarios.

A face is occluded if some area of the face is hidden by wearing objects like a sunglass, a mask, hats or scarf in the eyes and mouth positions. Facial occlusions can thus degrade the performance of face detection systems. Therefore, robustness to partial occlusions is thus crucial in nowadays. The aim of this work is to propose an effective detection system using MATLAB software for preventing the person with face partially occluded, which has an application in video surveillance areas.

2. LITERATURE SURVEY

Xinting Pan, Xiaobo Chen and Aidong Men in work [1], proposed a particle filter for tracking the object accurately. By using background subtraction the object pixels were first classified as foreground and background in all frames. The object in the scene is considered as the region of interest (ROI). Each object was represented by an elliptical model with parameters like center of the ellipse, length of the major axis of ellipse eccentricity of the ellipse. Occlusion can be detected by the merging and splitting of the ellipse.

Rui Min, Abdenour Hadid and Jean-Luc Dugelay proposed a robust face recognition approach under occlusions which consists of first detecting the presence of scarf/sunglasses and then processing the non-occluded facial regions only in [2]. The occlusion detection is done by using Gabor wavelets, PCA and support vector machines (SVM). For occlusion detection, they divide the probe image into number of facial components and each of the components is individually analyzed by an occlusion detection module. From this potential occluded face components are identified. The LBP features from non- occluded parts are selected and used for recognition. This approach may not be optimal for other types of occlusions because here they are dividing face region into upper and lower part. Thus more accurate segmentation of the occluded regions may then be needed.
In [3], Zhaohua Chen, Tingrong Xu, and Zhiyuan Han have solved the problem of face recognition under occlusion due to sun glasses or scarves. The presence of sunglasses or scarves was detected and the non- occluded region only was processed here. Occlusion can be obtained by selecting non occluded patches from the faces and was detected by using Principal Component Analysis (PCA) and Support Vector Machines (SVM). To detect the occluded region in the face, the image is divided in to finite number of patches and each patch is examined separately. They have divided faces in to 6 symmetrical patches since the configuration and size of the patches are important in the performance of occlusion detection. Then dimension of these patches were reduced by using PCA.

3. PROPOSED SYSTEM

The proposed system is only interested in detecting people who are facing the camera in the video surveillance scenario. Since, the recognition process is required to be finished as soon as possible we need to select certain number of images that contains high probability of being recognizable. In order

to select the quality images from video sequences, frontal face responses are used. Frontal face response can be obtained by using camera which detects the person who is facing to it. The frontal face images captured from video sequence is then given to pre- processing step in which the RGB color image is converted into gray scale images for processing image easily since the images in database are stored as gray scale images. Also the illumination variation can be adjusted to some extent.

Fig 3.1: Block diagram of the proposed system

From this face response, occlusion can be detected by using the Viola-Jones (VJ) algorithm in the MATLAB software. The system is designed to detect the partial face occlusion due to the use of scarf, i.e. the occlusion in the lower portion of the face. When an occluded face is detected, the system will block the person and the occluded image detected will be mailed to authorized persons account. The flowchart of the proposed system is given in Fig 3.2.

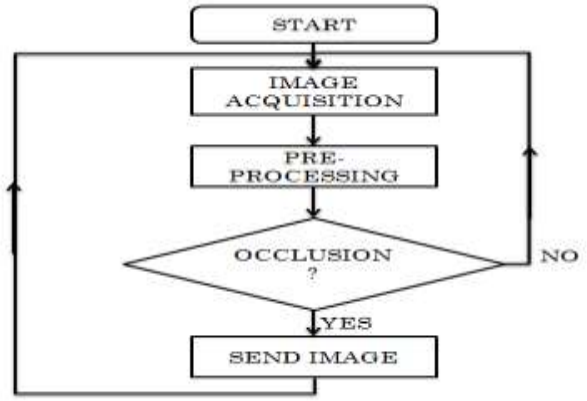

Fig 3.2: Flowchart of proposed system

3.1 IMAGE ACQUISITION

The system is designed for capturing the frontal face image using a webcam. Here the laptop camera of resolution 1280x720 is used. The image captured will be of RGB images so that, we convert it into grayscale images. Here snapshot is taken when a person faces to the camera. From this captured image, we have to check whether the face is occluded or not. For that we are using Viola-Jones algorithm in this system.

3.2 FACE DETECTION METHOD

The basic principle of the Viola-Jones algorithm [4], is to scan a sub-window capable of detecting faces across a given input image. Viola-Jones rescales the detector instead of the input image and run the detector many times through the image – each time with a different size. This detector is constructed using a so-called integral image and some simple rectangular features reminiscent of Haar wavelets.

The first step of the Viola-Jones face detection algorithm is to turn the input image into an integral image. This is done by making each pixel equal to the entire sum of all pixels above and to the left of the concerned pixel. This is demonstrated in Fig 3.2.1.

a) Input image

1	1	1
1	1	1
1	1	1

b) Integral image

1	2	3
2	4	6
3	6	9

Fig 3.2.1: Input image and Integral image

The Viola-Jones face detector analyzes a given sub-window using features consisting of two or more rectangles. The different types of features are shown in Fig 3.2.2.

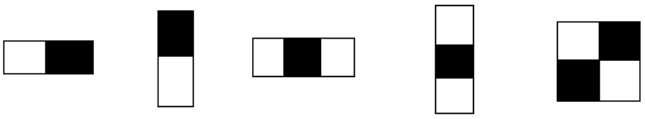

Fig 3.2.2: Different types of features

Each feature results in a single value which is calculated by subtracting the sum of the white rectangles from the sum of the black.

The basic principle of the Viola-Jones face detection algorithm is to scan the detector many times through the same image – each time with a new size. A detector consisting of only one (strong) classifier suddenly seems inefficient since the evaluation time is constant no matter the input. Hence the need for a cascaded classifier arises. The cascade classifier consists of stages, where each stage is an ensemble of weak learners. The weak learners are simple classifiers called decision stumps. Each stage is trained using a technique called boosting. Boosting provides the ability to train a highly accurate classifier by taking a weighted

average of the decisions made by the weak learners. Each stage of the classifier labels the region defined by the current location of the sliding window as either positive or negative. Positive indicates an object was found and negative indicates no object. If the label is negative, the classification of this region is complete, and the detector slides the window to the next location. If the label is positive, the classifier passes the region to the next stage. The detector reports an object found at the current window location when the final stage classifies the region as positive. The stages are designed to reject negative samples as fast as possible.

Here the occlusion detection can be found out by checking the Eyepair No with that of the Face No detected. Eyepair represents a set of two eyes in the face. As said, here we are considering only the case of partial occlusion due to hiding mouth portion using scarf or hand. So always the Eyepair will be visible to the camera if the person is facing to it. If the Eyepair No thus obtained is greater than the Face No detected, then such cases are considered as occluded case and if both the Eyepair No and Face No are same then it is considered as the normal case. At this time, the system will detect the face image.

3.3 SENDING OCCLUDED IMAGE AS MAIL

If the case of partial occlusion has been detected, the proposed system will send the occluded person image to the authorized person. In MATLAB, we can directly send mail with files attached by using the *send mail* function. To use *send mail*, first of all we have to set up an e-mail address and SMTP server information with the *setpref* function.

The *setpref* function defines two mail-related preferences:

- **E-mail address** -- This preference sets our e-mail address that will appear on the message.

- **SMTP server** -- This preference sets our outgoing SMTP server address, which can be almost any e-mail server that supports the Post Office Protocol (POP) or the Internet Message Access Protocol (IMAP).

4. SOFTWARE DESCRIPTION

MATLAB, short for MATrix LABoratory is a programming package specifically designed for quick and easy scientific calculations and I/O. It has literally hundreds of built-in functions for a wide variety of computations and many toolboxes designed for specific research disciplines, including statistics, optimization, solution of partial differential equations, data analysis. MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar no interactive language such as C or FORTRAN. MATLAB is the tool of choice for high productivity research, development an analysis. MATLAB features a family of application-specific solutions called toolboxes. Toolboxes are comprehensive collections of MATLAB functions (M-file) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation and many others.

5. RESULTS AND DISCUSSION

Frontal face responses obtained by using camera is given to a pre-processing step in which the RGB color image is converted into gray scale images. The system is designed for detecting an occluded person who is partially occluded at the lower portion with the help of scarf or hand. If the partial occlusion is detected the system will send the captured image to the authorized person as email.

If the system detects a normal person, it will display to allow person as shown in the Fig 5.1.

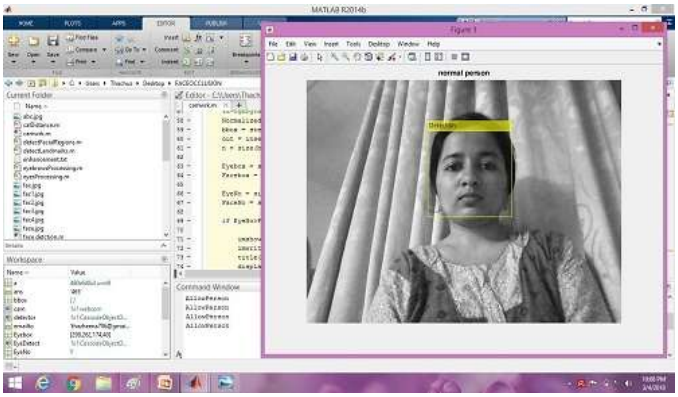

Fig 5.1: When normal person is detected

If the system detects an occluded person (by using scarf and hand), it will display to block person as shown in the Fig 5.2 and Fig 5.3.

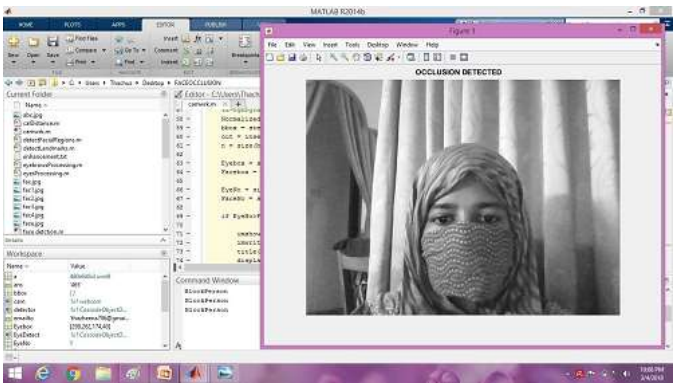

Fig 5.2: When occluded person using a scarf is detected

Fig 5.3: When occluded person using hand is detected

When an occlusion is detected the system will send the captured image as mail to the authorized person as shown in the fig 5.4.

Fig 5.4: Image of a mail

And the mail page will be as shown in fig 5.5.

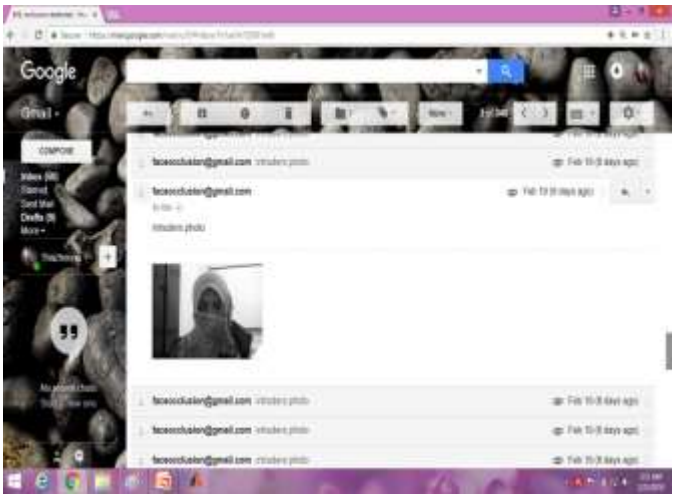

Fig 5.5: Image of an email page

6. CONCLUSION

The main aim of this work is to propose an efficient system for detecting the person with partial occluded face, caused by covering mouth portion (i.e. by wearing scarf or by using hand). Since here the system is going to be implemented in a video surveillance, for obtaining quality images here frontal face cameras are used. Thus large pose variations can be reduced.

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