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Liveness Detection Based on Human eye Blinking for Photo Attacks

Dhadigi Naga Nishanth, G. Mallikarjuna Rao

Abstract: Auto face recognition mainly implemented to avoid the replication of identity to demonstrate through security check. This rage of face verification has brought intensive interest about facial biometric towards attacks of spoofing, in which a person's mask or photo can be produced to be authorized. So, we propose a liveness detection based on eye blinking, where eyes are extracted from human face. The method of face recognition was applied by utilizing OpenCV classifier and dlib library, and a concept of edge detection and calculation of structure to extract the portion of the eye and to observe and make note of variation in the attributes of the eyes over a time period was employed. The landmarks are plotted accurately enough to derive the state of eye if it is closed or opened. A scalar quantity EAR (eye aspect ratio) is derived from landmark positions defined by the algorithm to identify a blink corresponding to every frame. The set of EAR values of successive frames are detected as a eye blink by a OpenCV classifier displayed on a small window when person is in front of camera. Finally, it gives the accuracy result whether it is human being or spoof attack.

Keywords: Eye blinking, , face recognition, Liveness detection, spoofing attack.

I. INTRODUCTION

Evolution of HCI (Human-Computer Interaction technology), improved the computer vision systems for individual observations, that successively play vital role in our lives [3]. A pattern-recognition system is employed for identification or authentication of users, to support their distinctive physical properties. Compared to native security systems such as passcodes, Biometric techniques are employed for personal verification applications and ease of individual verification by using human intrinsic features [2, 4]. Recognizing individuals through their faces is a very important development as the task of recognizing peers through their faces becomes easy [5]. Face recognition which is the foremost biometric options, where features of the face are extracted simply with no natural contact [7]. That is been implemented successfully in several personal recognition applications like surveillance, enforcement of law, data security and open-end credit card authentication [8]. Since ancient face recognition systems don't contemplate the presence of the person, facial recognition systems are mostly attacked by acts which tries to get access to information or a service as a licensed adversary. Two dimensional spoofing attacks are best examples which employ a user's facial duplicate as a mask or photo [5, 10]. These attacks can be segregated as image attacks, video attacks and mimic mask attacks. Image of a authorized person on electronic screen or paper sheet is produced in image attack whereas video is used in video attack and camouflages of a legitimate user is used in mimic attack [5, 10].

In order to prevent the two dimensional spoofing attacks, detecting the liveness of the person in the video stream is implemented. Liveness detection module is the source to face recognition system which starts if projected subject is determined by liveness detection as true or false [5, 10]. The process is terminated when a suspicious content found or else it is forwarded to face recognition. .

The person's activity surveillance systems in which eye blink detection is essential are Vehicle driver sleepiness [7], dry eye disease prevention [9], etc. If blinking is not detected in a particular time then system warns for spoofing attack, dry eye disease. Now, present implemented systems are effective and laid back [4, 6]. Effective methods utilize high-end hardware which makes it reliable and costly that includes close up cameras, infrared cameras. Systems which are laid back works by using inbuilt camera and method that find out the eye blinks in a streaming video and motion detection for eye portion is proposed [5].

From a optical flow, considering the distance between vertices of eye to a certain threshold based on which the system makes the decision whether eye lids covering the eye portion for a certain period [2]. A model to find out eye state of closing and opening from a source image by eye lid vertices position changes, matching to the templates of open and closed eye[7]. The past approaches have a drawback of imposing the robust hardware requirements, image quality, face orientation towards camera, etc.

II. BACKGROUNDS AND RELATED WORKS

Blinking is action of frequent opening and closing of the eyelid. Blinking can be occurred by three causes, which are Reflex blink , Voluntary blink and spontaneous blink[1]. Blink occurring without internal attempt and external stimulation comes under spontaneous blink which happens effortlessly, same as digestion and breathing. It is to moisture the eye with tears and clears away the tissue layer and mucosa [1, 7, 9]. Generally, 2-10 seconds interval between eye blinks is maintained by a healthy adult.

An individual blinking average is 0.28 blinks/second or 17 blinks/min while a person speak it raises to 26 blinks per minute and reduces to 4.5 blink/sec [8]. Assuming 17 blinks/min average, 0.2-0.4 seconds/blink is considered. Every dataset contains images with opened eye, photo or a mask of a person does not contain blinking movement. As the average time of exposure is assumed as 0.03 seconds, so capturing of a person with blinking is done by 7.5% [9, 10].

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***** Correspondence Author
D.Naga Nishanth, CSE department, GRIET, Hyderabad, India. Email : naganishanth@gmail.com
G.Mallikarjuna Rao, CSE department, GRIET, Hyderabad, India. Email: gmr_888@yahoo.com

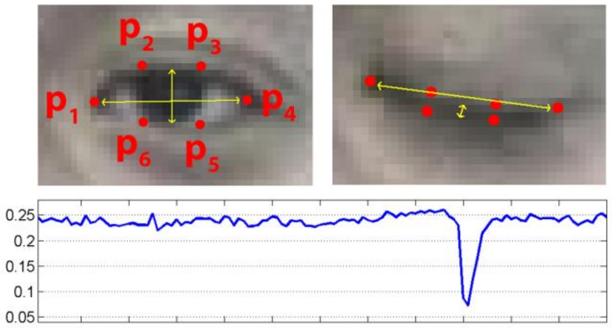


Figure 1: state of opening and closing with six eye landmarks, graph is blink indication with respect to time.

The pattern of blinking depends on duration of blink, lid close and open movement of eye speed and angle of eye lid which it differs for every individual[l]. eye lid indexes are restrained by utilizing the progressive facial landmark predictor and from these landmark plots of eye region, the Eye Aspect Ratio(EAR) is derived which indicated the state of eye i.e., closed or opened [1]. A EAR value of a single frame might not determine the perfect blink. So, a small temporary screen is trained on continuous frames by OpenCV classifier [1].

Features description:

Eye landmark are plotted and Euclidean mean of vertical and horizontal landmarks of eye region is calculated for every frame [1].

$$EAR = \frac{||p_2 - p_6|| + ||p_3 - p_5||}{2||p_1 - p_4||} \quad .... (1)$$

In which p1 to p6 are the two dimensional eye plots, interpreted in Figure 1.

When an eye is opened totally, EAR value remains unchanged and reduces to zero corresponding to eye closing movement. Flat rotation of head and constant size of the frame might not affect the aspect ratio of eye but it differs for every individual. Assuming that both eyes are closed and opened simultaneously, mean of EAR values is taken from both eyes [1].

III. PROPOSED SYSTEM

1. System Architecture

In this section, aliveness detection of a human being in the class of eye blink technique is proposed to avoid the unauthorized access to services, premises and online transaction, etc. Liveness factor is taken into consideration for user to avail the permitted services or information. System architecture can be divided into three blocks, which are respectively Face detection, Eye blink detection, Liveness detection/declaration. The function of each function is described as follows:

A. Face detection: The front-facing camera of the electric device acquires a face image. The detected face is plotted with human face 68 face landmarks points.

B. Eye blink detection: Eye region of the face image is located and extracts the landmarks of eye. It recognizes eye-blinking features and counts the number of eye blinks.

C. Liveness detection/declaration: considering blinks count in duration, it declares that is it a real human or a photo and saves the total video stream to the disk.

2. Face detection

Face detection includes detecting human faces and localizing the features of face in an image or video. Extrapolation of points on a face image to segment the region is known to be Localization of Face Landmark (or Face Alignment) [8]. Dlib library consisting of the face landmark detection module which implements the Ensemble of Regression Trees (ERT). This method applies clean and agile factor (pixel magnitude variations) to plot directly the landmark positions [2, 4, 8]. The cascade of regressors performs refinement by iterative process to estimate the positions subsequently. For every iteration, to decrease the alignment error of extrapolated points, a new estimate is produced by the regressors from the previous estimate. 68 facial points mapping to the facial features on the face image is located by this already trained face landmark predictor offered by python dlib. This predictor is trained on 300-W dataset which 68 facial landmarks are based on.

Figure 2: 68 face landmarks detected by dlib facial landmark predictor.

Based on elucidations and some datasets, shape predictors are trained and created. Landmark plots on Face region are present in dataset and annotations. Many algorithms like CNN detectors; OpenCV, Dlib, etc. easily detect the face in the image.

3. Eye detection

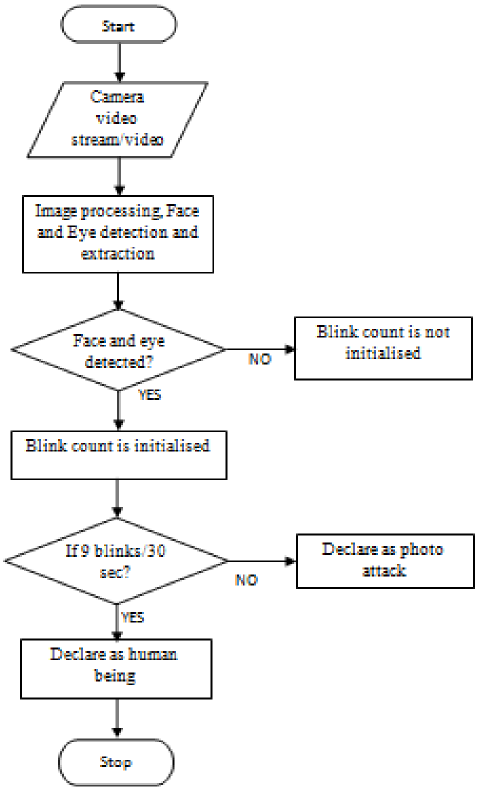
Based on those 68 facial landmark points, regions of face can be acquired via simple indexing of Python (since the above face plotted image is one-indexed, zero-indexing in Python is considered). So, Eye landmarks are extracted as 6 landmark points. Once the eye features are found then EAR values will be calculated on frame-by-frame in a optical flow. Euclidean distance of two adjacent points on eye is obtained and ratio of vertical and horizontal plots is derived by considering 2 means of vertical points and double of horizontal points as eye have single set of horizontal plots.

4. Tuning arguments

For the sake of determining if a video stream consists of a blink, Algorithm requires two tuning arguments:

For the specified successive frames EYE_AR_CONSEC_FRAMES, if the value of EAR does not exceed the specified threshold value-EYE_AR_THRESH and again exceed the threshold then eye blink is registered. Performing a trial and error process for some testing videos, it was noticed that the best approach was to allocate the value of EYE_AR_THRESH as 0.30 and EYE_AR_CONSEC_FRAMES as 3. These arguments are convincingly a person and head facing sensitive, but from our analysis. These two values could do best derived the average eye blink behavior.

Flow chart of our proposed method:



5. Liveness detection/declaration

BIinks are counted with respect to consecutive frames which have EAR values below threshold value. Standard Video streaming speed is assumed as 30 fps for experimental purpose and every frame is included for calculating EAR value to ensure it is above 0.30 as EYE_AR_THRESH (threshold value) for EYE_AR_CONSEC_FRAMES (3 consecutive frames). Eye blink is significantly detected when eye is closed mostly in 3 consecutive frames. So, for three successive frames, EAR value is added to get a 13-dimentional features. Thus assuming a healthy adult blinks 17 times in a minute. If blinks registered are more than 9 blinks within 30 seconds then it is considered as living human and proceeded to recognition system or it is declared as photo.

IV. RESULTS AND SCREENSHOTS

An effective algorithm for the liveness detection of human being by localizing the eyes on the face image and finding the ratio of distance between eyelids to determine the close and open eye. Algorithm performs liveness detection for a specified time interval and declares message as it is human being or photo based on blink count. The output derived from execution of the project is provided. There are two uses cases, a person facing the camera and a photo of legitimate person handled by someone.

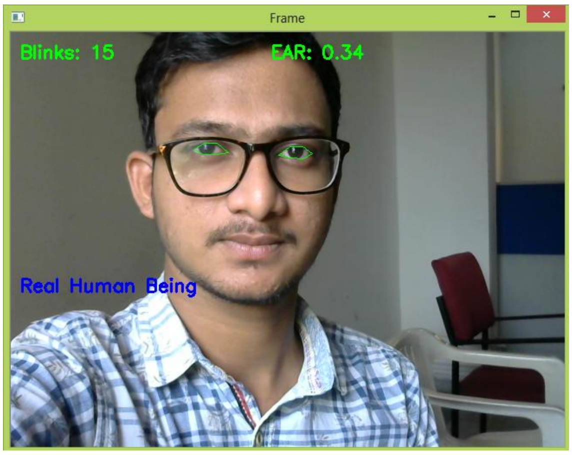


Figure 3: Person facing camera for liveness detection.

The above figure which consist of a person in front of the camera for liveness detection is shown and as the project relied on concept of natural blinking i.e., 17 Blinks/min, the algorithm checks whether person blinking and considering blink counts(9) in a specific time period(30 sec) in a 30 fps video stream. Blink count on the left of the camera and EAR value changing per frame is observed on the streaming above. The blink count is above threshold count within time/frames. So, It is declared as real human being.

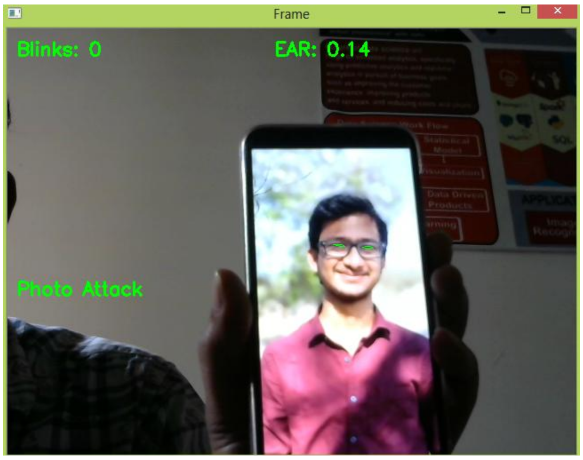


Figure 4: Photo of a person placed in front of camera.

The above image is for second use case: photo of a person placed in front of camera and obviously, The algorithm is so robust that it does not detect any blink as there is a negligible difference in the eye points in photograph. So, After analysis for specific time it declares as photo attack.

V. CONCLUSION

The method of face recognition and a concept of edge detection and calculation of structure to extract the portion of the eye and to observe and make note of variation in the attributes of the eyes over a time period were employed.

We propose an algorithm which can state the liveness of a human based on blinking rate in high and moderate light conditions. The detection is done irrespective of age, gender and transparent glasses. The scope of this work is to implement with infrared camera so that a best accuracy can be obtained even in low light conditions.

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AUTHORS PROFILE

Dhadigi Naga Nishanth is pursuing his post graduation degree in the department of computer science and engineering at Gokaraju Rangaraju Institute of Engineering and Technology (GRIET), Hyderabad, Telangana, India. He has completed his Bachelor of Technology degree in the stream of Computer Science and Engineering from Malla Reddy College of Engineering and Technology (MRCET), Hyderabad. His research interests are Data science, image processing and Big data Analytics. He is a member of Computer Society of India (CSI).

Mallikarjuna Rao Gundavarapu obtained B.Tech degree from Nagarjuna University in the specialization Electronics and Communication in 1988. He is a double PhD from JNTUH. His research interests are Pattern Recognition, Parallel Computing and Artificial Neural Networks. Mr. Rao is presently working as a Professor in Gokaraju Rangaraju Institute of Engineering and Technology. Professor Rao has 12 publications in various international journals and conferences. He is instrumental in established Parallel Computing and Operating Systems Lab at GRIET under MODROB scheme. He proposed salable and portable feature extraction technique Local Active Pixel Pattern, LAPP.