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Robust Non-intrusive Real Time Access Control Squint Eye States Detection Based on Hough Transform on Human Face Images

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***Abstract*— This paper provides an idea about defective binocular vision which causes Vision loss in the turned eye. The eyes need to be straight for the brain to combine the images seen by the two eyes into a single picture. This gives us 3 dimensional visions, which allows us to judge depth. If an eye turns in, it can interrupt the total field of vision. Despite active research and significant progress in the last few years, eye detection and tracking remains challenging due to the individuality of eyes, occlusion, and variability in scale, location, and light conditions. Data on eye location and details of eye movements have numerous applications and are essential in face detection, biometric identification. In this paper, we have proposed an overview on real time access control detection system and their classification with some drawback and basic assumption for squint eye detection.**

This paper reviews current progress and state of the art in video-based eye detection and tracking in order to identify promising techniques as well as issues to be further addressed. We present a detailed review of recent eye models and techniques for eye detection and tracking. We also survey methods for gaze estimation and compare them based on their geometric properties and reported accuracies. This review shows that, despite their apparent simplicity, the development of a general eye detection technique involves addressing many challenges, requires further theoretical developments, and is consequently of interest to many other domains problems in computer vision and beyond[1] [2].

***Index Terms*— Hough transform, image Processing, modeling, projection function, segmentation, eye detection, eye tracking, gaze estimation, gaze tracking, object detection and tracking, human-computer interaction.**
***Discipline* — Electronics & Telecommunication.**

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1. Motivation

We decided to explore the capabilities of an approach which is mostly based on the eye detection and tracking focuses on two areas: eye localization in the image and gaze estimation. Although current methods for eye feature extraction use deformable templates [3] [4].

Therefore it is well-suited for the fusion of partial results with predictions from a model. The algorithm has been applied to test images of faces which were taken under different lighting conditions. The two irises and their features are detected during initialization. Given the features the localization information will be fine-tuned by evaluating a small neighborhood of each iris. The importance of eye movements to the individual's perception of and attention to the visual world is implicitly acknowledged as it is the method through which we gather the information necessary to negotiate our way through and identify the properties of the visual world. Robust non-intrusive eye detection and tracking is, therefore, crucial for the development of human-computer interaction, attentive user interfaces, and understanding human affective states.

2. INTRODUCTION

Squint is a misalignment of the two eyes so that both the eyes are not looking in the same direction. This misalignment may be constant, being present throughout the day or it may appear sometimes and the rest of the time the eyes may be straight. Squint or Strabismus also known as heterotropia. It typically involves a lack of coordination between the extra ocular muscles, which prevents bringing the gaze of each eye to the same point in space and preventing proper binocular vision, which may adversely affect depth perception. Some common ways to detect vision loss relate to symptoms that words on a page look blurred, a dark or empty area appears in the center of vision, or straight lines are distorted. The goal of our research is the on-line processing of eye images, so as to detect the presence of drusen and help the examiner meet the right decision. If the eyes are not looking in the same direction then they are sending different signals to the brain and this can cause double vision. In this condition eyes are not straight. This may have either of the two effects:

- A child would ignore the image coming from the deviated eye, and thus sees only one image. But in the process, he loses the depth perception. This suppression of the image from the deviating eye results in poor development of vision in this eye, which is known as amblyopia.
- An adult cannot ignore the image from either eye, and therefore has double vision. This can be very annoying and may interfere with work.

2.1 What Causes Squint

A squint can occur for a number of different reasons these include:
• Damage to the muscles controlling the eye
• Damage to the nerves controlling the muscles
• Poor development or damage to the eye muscle control centers in the brain
• Poor vision in the eye can stop the brain being able to keep the eyes together. This occurs in adults who have had a squint as a child.

The exact cause of squint is not really known. The movement of each eye is controlled by six muscles. Each of these muscle acts along with its counterpart in the other eye to keep both the eyes aligned properly. A loss of coordination between the muscles of the two eyes leads to misalignment. This misalignment may be the same in all directions of gaze, or in some conditions the misalignment may be more in one direction of gaze, e.g., in squint due to nerve palsy.

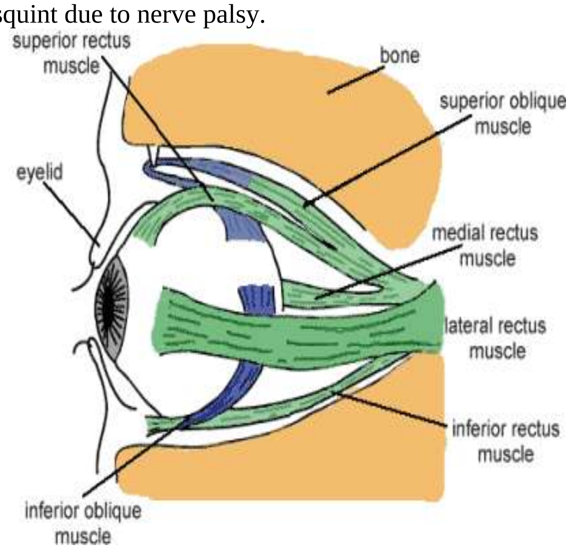

Figure-1

3. METHOD

While the patient is looking on front of camera or object, his eyes are photographed simultaneously by using CCD or standard camera and point flashlights mounted at the center of iris. Based on the position of the reflexes point visible on the iris squint eye, percentage amount of squint and the angle of squint can be determined multiple biometric traits simultaneously. By asking the user to present a random subset of biometric traits, the system ensures that a live user is indeed present at the point of acquisition. However, an integration scheme is required to fuse the information presented by the individual modalities.

3.1 Detection using Hough Transform

The Hough-Transformation is also suited for the detection of the squint eye. The HT is based on the idea of transforming all contour points belonging to the structure into one point of transformation space (accumulator array (AA)). This point is identified as the global maximum of the AA. It becomes more prominent the greater the number of contour points belonging to the transformed object is. The HT can be calculated for any curve described by parameters, which turn into the axes of the AA. Centre, corner and radius of the circular iris in space can thus be read as Coordinates of the global maximum of the AA which in this case is three-dimensional. The binary edge image is produced by calculating the modulus of the gradient of the original image.

3.2 Detection by Nonlinear Enhancement and Segmentation

This algorithm based on histogram-techniques for the problem of squint eye evaluation. The detection of anomalies in human eye's retina is a biomedical problem, appropriate for image processing and automated segmentation, whose solution is intended to help the doctors in their decision making process. Use of the proposed detector may reduce false negatives and give reliable detection accuracy in both position and mass size. Histogram- based enhancement technique (MLE), uses histogram equalization as its core operator and a histogram- based segmentation technique (HALT) to segment areas that differ slightly from their background regions. This method is able to detect actual drusen in all cases. Even in hard-to-diagnose cases, where many small and vague drusen exist.

3.3 Using Projection Function

Due to its indifference against disturbances of the contour of an object Mean and variance projection functions are utilized in each eye pair window to validate the presence of the eye for locating the corner and center point of the eye., So in this technique possible eye areas are localized using a simple thresholding in colour space followed by a connected component analysis to quantify spatially connected regions and further reduce the search space to determine the contending eye pair windows[5].

3.4 Automatic detection by Modelling

This is the simplest yet efficient method for squint eye detection. Modelling the eye by means of its light-refracting layers - cornea, aqueous humour, crystalline lens and vitreous body. is calculated. We modelled the human eye as a circle circumscribed in an ellipse, where circle represents the iris of human eye and the ellipse represents the eye lashes. This is not the only model for an eye; there are infinite models possible and they can be applied as per requirement From the analytical description of the diffraction figures, a rotatory symmetrical model function Due to the low resolution of signals, a simple matched filter is not sufficient for the detection of the squint eye since the digitization only yields a few pixels. Thus, the normed Cross-Covariance- Function is calculated.

4. Methodology For Detection

Before the eye feature detection can begin the search region in the photo is narrowed down by locating the bounds of the face and then locating the bounds of the eye region within that face. It is within the eye region that the necessary eye features can be located. The features to be detected are the pupil centers, the centers of a matched pair of highlights and the corners of the eyes. Additionally, the distance between the eyes is often utilized for face normalization, for the localization of other facial landmarks, as well as in filtering out structural noise.

Research in eye detection and tracking focuses on two areas: eye localization in the image and gaze estimation.

There are three aspects of eye detection. One is to detect the existence of eyes, another is to accurately interpret eye positions in the images, and finally, for video images, the detected eyes are tracked from frame to frame. The eye position is commonly measured using the pupil or iris center. The detected eyes in the images are used to estimate and track where a person is looking in 3D, or alternatively, determining the 3D line of sight. This process is called gaze estimation. In the subsequent discussion, we will use the terms “eye detection” and “gaze tracking” to differentiate them, where eye detection represents eye localization in the image while gaze tracking means estimating gaze paths.

This paper focuses on eye detection and gaze tracking in video-based eye trackers (a.k.a. video-oculography).

We use a variant of the Hough transform for circles that has been proven to be efficient and robust [6] [7]. After estimation of the intensity gradient, presumed edge pixels cast votes for locations of circle centers with radius r. Each edge pixel votes in direction of the gradient for a location which is at a distance of r away from the pixel. A two-step matching process is used for finding the correct radii [8]. We assume that every pixel is a potential edge pixel. This makes the method insensitive to contrast variations due to shading effects.

Assumption:

For squint eye detection the following assumptions should be taken: -

Image should not be too noisy.

- Eyes should be in normal horizontal position (i.e. the head should not be tilted).
- Iris diameter shouldn’t be very small in respect to the size of image.
- The two candidate circles for irises must have similar radiuses. For a normal human subject, the irises are not that different, and have a diameter of around 12 mm (the normal human pupil is around 2-3 mm in daylight and can go to 7mm during nighttime).

The distance between the two centers of the circles divided by the average radius of one circle had to be bounded between some values. In a normal human, the inter eye distance is of about 63 mm with an iris diameter of about 12 mm, this means that the value of the fraction has to be around 5. We could also use the distance between the centers of the ellipses for similar considerations.

4.1 Hough Transform

The Hough transform is a standard computer vision algorithm that can be used to determine the parameters of simple geometric objects, such as lines and circles, present in an image. The circular Hough transform can be employed to deduce the radius and centre coordinates of the pupil and iris regions. An automatic segmentation algorithm based on the circular Hough transform is employed by Wildes et al. Kong and Zhang [9]. Firstly, an edge map is generated by calculating the first derivatives of intensity values in an eye image and then thresholding the result. From the edge map, votes are cast in Hough space for the parameters of circles passing through each edge point. These parameters are the centre coordinates X_c and Y_c, and the radius R, which are able to define any circle according to the equation

$$X_c{}^2 + Y_c{}^2 = R^2$$

A maximum point in the Hough space will correspond to the radius and centre coordinates of the circle best defined by the edge points. Wildes et al. and Kong and Zhang also make use of the parabolic Hough transform to detect the eyelids, approximating the upper and lower eyelids with parabolic arcs, which are represented as:

$$(-(x-h_j)\sin\theta_j + (y-k_j)\cos\theta_j)^2 = a_j((x-h_j)\cos\theta_j + (y-k_j)\sin\theta_j)$$

Where a_j controls the curvature, (h_j ,k_j is the peak of the parabola and θ_j angle of rotation relative to the x-axis. In performing the preceding edge detection step, bias the derivatives in the horizontal direction for detecting the eyelids, and in the vertical direction for detecting the outer circular boundary of the iris. The motivation for this is that the eyelids are usually horizontally aligned, and also the eyelid edge map will corrupt the circular iris boundary edge map if using all gradient data. Taking only the vertical gradients for locating the iris boundary will reduce influence of the eyelids when performing circular Hough transform, and not all of the edge pixels defining the circle are required for successful localization. Not only does this make circle localization more accurate, it also makes it more efficient, since there are less edge points to cast votes in the Hough space are less edge points to cast votes in the Hough space. There are a number of problems with the Hough transform method. First of all, it requires threshold values to be chosen for edge detection, and this may result in critical edge points being removed, resulting in failure to detect circles/arcs. Secondly, the Hough transform is computationally intensive due to its 'brute-force' approach, and thus may not be suitable for real time applications.

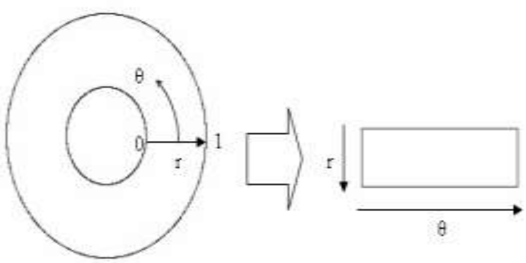

Figure-2

The remapping of the iris region from *(x, y)* Cartesian coordinates to the normalized non-concentric polar representation is modeled as:

$$I(x(r,\theta),y(r,\theta)) \longrightarrow I(r,\theta)$$

with

$$x(r,\theta) = (1 - r)\, x_p(\theta) + r\, x_1(\theta)$$

$$y(r,\theta) = (1 - r)\, y_p(\theta) + r\, y_1(\theta)$$

where $I(x, y)$ is the iris region image, (x, y) are the original Cartesian coordinates, (r, θ) are the corresponding normalized polar coordinates, and are the x_p , y_p x_l , y_l coordinates of the pupil and iris boundaries along the direction. The rubber sheet model takes into account pupil dilation and size inconsistencies in order to produce a normalized representation with constant dimensions. In this way the iris region is modeled as a flexible rubber sheet anchored at the iris boundary with the pupil centre
as the reference point. Even though the homogenous rubber sheet model accounts for pupil dilation, imaging distance and non-concentric pupil displacement, it does not compensate for rotational Inconsistencies. In the Daugman system, rotation is accounted for during matching by shifting the iris templates in the direction until two iris templates are aligned.

5. Results

The algorithm has been tested on images of different persons. Images not evaluable were recognized as such, no false squint being computed in any of these cases and some of the images which could have been analyzed manually were correctly analyzed by this algorithm. Problems are created by reflexes on spectacle frames is taken into account - may falsify the HT to such an extent that the squint is not detected approximately 0.1% .If the image is blurred then no longer matches . The high sensitivity of the system leads to an early recognition of symptoms. This algorithm for the image interpretation for the measurement of the amount of squint was implemented. The total calculations take approx. 30 seconds. The performance of this system has been evaluated by experts. Result obtained from this system correlates well with expert opinion. The system can also identify most of the commonly encountered binocular vision problems. The present system is still in its early stage of development and has limitations. In its present form, it does not provide management strategies or treatment options. It also recognizes only the most common forms of binocular dysfunction.
For the squint eye detection process we have to follow the following steps. For offline and online detection process we use menu toolbar button and direct push button as follows.

1) When we start matlab and open the existing GUI from menu_1 then following figure appears in screen and perform the detection process with images.

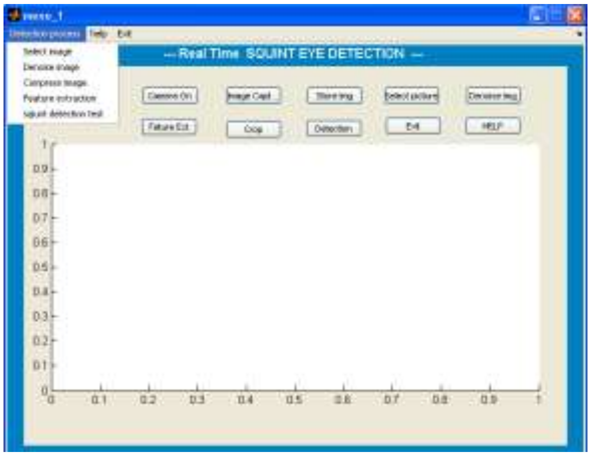

Figure-3

2) First by using detection process toolbar in existing GUI we select the images of face (eye) from work space or we can also use a human face image and it can crop according to size and then use it for further process.

Figure-4

3) If the image is too noisy then after selecting an image we use de-noising process from toolbar menu to reduce the effect of noise. We can also compress and resize the selected image using toolbar specified in detection process.

Figure-5

4) To check whether the eye is squinted or not we use feature extraction toolbar appears from detection process. From where we select 6 points on the both eyes of human face. In left eye we select 3 points: left corner point, center point and right corner point and same for the right eye also: left corner point, center point and right corner point. After selecting six points in human face one message box will appear showing message “all features are collected” as shown in figure.

Figure-6

5) For the detection of squint eye we use squint detection test toolbar appears from detection process. Finally we got the result in screen as shown in the figure.

Figure-7

Interactive Measurement	Evaluable		
	Right	Wrong	Not Evaluable
Series-1 45 Images	43	--	2
Series-2 37 Images	36	--	1
Total 82 Images	79	--	3
Total Percent	96.3%		3.6%

Figure-8

6. Drawbacks

Detection of the iris becomes indifferent to disturbances which can be created by spectacle lenses. Glass reflexes appear as bright spots on dark background and lead to wrong detections even though they may have a radius corresponding to that of the iris. Problems are created by reflexes on spectacle frames which act as the amplitude of the gradient is taken into account may falsify the HT to such an extent that the iris is not detected. If the image is blurred and the model function for the Cross-Covariance-filter no longer matches and is discarded. Through the automatic analysis of images, strabometry becomes suitable for screening. The high sensitivity of the system leads to an early recognition of symptoms, and thus to the desired treatment of the illness at an early stage of its development.

7. Conclusions

In this paper we have focused the different squint aye detection technique. So the detection of abnormalities in human eye's retina is a biomedical problem, appropriate for image processing and automated segmentation, whose solution is intended to help the doctors in their decision making process. Hough Transform can be used for the detection of aforesaid circle and ellipse then final eye is detected with amount of squint by neglecting the wrong detections and ruling out a pair of eyes based on geometrical considerations. This method is applied for online eye detection purpose. It can not be supposed that the contour of the iris is closed and free of distortions.

Due to the indifference to interruptions of the contour of an object the Hough-transformation is especially selected for squint eye detection. A significant factor that affects the overall performance of other approaches is the presence of noise, which makes surfaces look rough and renders the segmentation process difficult. Although, it is not a common case, since the presence of noise is rare in such images and provides adequate results even in the case of noise contamination. Our real time squint eye detection software shows the squinted eye and the related features.

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