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A HIGH SENSITIVE APPROACH FOR GENDER PREDICTION BY USING PUPIL DILATON

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Abstract - Pupil dilation is rarely analyzed in usability studies although it can be measured by most video-based eye-tracking systems and yields highly relevant workload information. Algorithms developed by the researchers for recognizing gender by their Pupil dilation patterns have now been tested in many field and laboratory, producing no false matches in several million comparison tests enabling real-time decisions about personal identity with extremely high confidence. The variety of factors that can influence pupil dilation and the distortion of pupil-size data by eye movements yields the size of the pupil as seen by the eye-tracker camera depends on the person's gaze angle. The high confidence levels are important because they allow very large databases to be searched exhaustively without making false matches despite so many chances. In the present study, we developed and implemented a neural-network based calibration interface for eye-tracking systems, which is capable of almost completely eliminating the geometry-based distortion of pupil-size data for any human subject. It also helps, for providing more security to the information.

Keywords- Pupil dilation, recognizing gender, eye-tracking systems, pupil-size, false matches.

INTRODUCTION

Biometrics refers to the identification and verification of human identity based on certain physiological traits of a person. The commonly used biometric features include speech, fingerprint, face, handwriting, gait and hand geometry etc. The face and speech techniques have been used for over 25 years, while iris method is a newly emergent technique.

In the evaluation of human-computer interfaces, an increasing number of researchers conducted on analyses of users' eye movements during task completion [1]. Gaze trajectories indicate difficulties that users encounter with certain parts of the interface and point out inappropriate spatial arrangement of interface components. However, when performing such studies, scientists often neglect the analysis of another variable that they receive as a "product" of video-based eye tracking, namely the size of the user's pupil.

It is well known from a variety of studies on participants that pupils dilate with increasing cognitive workload when imposed. This effect has been demonstrated the tasks such as mental arithmetic, sentence comprehension [2], and letter matching. Besides cognitive workload, the intensity of ambient illumination is the other major factor determining the size of a person's pupil. Changes in illumination can therefore interfere with the use of pupil size as a measure of cognitive workload [3]. To reliably measure workload, they have to compensate for such changes in illumination [4]. Furthermore, scientists face a technical problem: Since participants move their eyes during experiments, their pupils find different angles and distances towards the monitoring camera of the eye tracker. This, in turn means that the size of the pupil measured by the system is the number of pixels that belong to the pupil in the camera image – varies with the participant's gaze angle.

The iris is the colored part of the eye behind the eyelids, and in front of the lens. It is the only internal organ of the body which is normally externally visible. These visible patterns are unique to all individuals and it has been found that the probability of finding two individuals with identical iris patterns is almost zero. Though, there lies a problem in capturing the image, the pattern variability and the stability over time, makes this a reliable security recognition system.

Biometrics is the automated use of physiological or behavioral characteristics to determine or verify identity. Biometric authentication requires only a few seconds and biometric systems are able to compare thousands of records per second. Finger-scan, facial-scan, iris-scan, hand-scan and retina-scan are considered physiological biometrics and voice-scan. signature-scan are considered as behavioral biometrics. A distinction may be drawn between an individual and an identity, the individual is singular, but he may have more than one identity, for example ten registered fingerprints are viewed as ten different identities.

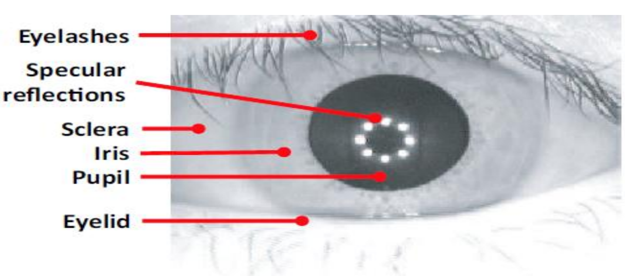


Figure. 1. Iris image with typical elements labeled.

The combinatorial complexity of phase information across different iris textures from persons spans around 249 degrees of freedom and generates discrimination entropy of about 3.2 bits/mm^2 over the iris, enabling decisions about personal identity with extremely high confidence. The extracted feature is the phase characteristic of the picture element in study, related to adjacent ones, in an infrared (not color) iris photograph. This means, for example, that false match probabilities might be as low as one in 1074. False reject rates may be as high as 5–10% depending on ambient conditions, so scientific tests should be done under ideal conditions to minimize chance for errors [4].

The matching process is as follows: a user initially enrolls in biometric systems by providing biometric data, which are converted into a template. Templates are small archives called "pupil codes" consisting of optimized and filtered biometric acquired images. These templates are stored in biometric systems for the purpose of sub sequential comparison. Then the user presents his biometric data again and another template is created. The verification template is compared with the enrollment template and the mathematical differences between the iris codes are computed. This mathematical difference is called the Hamming distance (HD). In other words, the Hamming distance is the numerical difference between two iris codes. The Hamming distance between identification and enrollment codes is used as a score and is compared to a threshold for a specific equipment or use, giving a match or non-match result. Systems may be highly secure or not secure, depending on their confidence threshold settings.

RELATED WORK

Stephen Lagree and Kevin W. Bowyer [5][7] concerned with analyzing iris texture in order to determine “soft biometric”, or demographic, attributes of a person, rather than identity.. They first consider both problems using similar experimental approaches. Contributions of this work include greater accuracy than previous work on predicting ethnicity from iris texture, empirical evidence suggests that gender prediction is harder than ethnicity prediction, and empirical evidence on ethnicity prediction is more difficult for female’s eye than for male eye. The function of the iris is to control the amount of light that enters the eye. It has tiny muscles that allow it to dilate and constrict the size of the pupil for light regulation.

It is flat and separates the front and back of the eye [6]. It is protected in the front of the eye by the cornea. The basic structure of the iris is genetically determined. However, the exact composition of the iris is based on the conditions in the embryo during development and is thus very unique. In rare cases, the iris develops abnormally. Some parts of the iris are defined at birth but other parts do not solidify until about two years of age. In addition, the iris size and coloring continue to develop until adolescence.

The iris changes very little after adolescence with the exception of de-pigmentation and a decrease in size of the pupil in advanced age [7]. It is necessary to delve into the structure of the iris in order to realize its uniqueness. It is made up of four different layers. The back layer is heavily pigmented and makes the iris opaque so that light only reaches the eye through the pupil. The next layer contains the sphincter and dilator muscles that allow for constriction and dilation. The third layer is the stromal layer which, “consists of collage nous connective tissue in arch-like processes.” In this layer are corkscrew-like blood vessels that span out radially. The exterior layer is called the “anterior border layer” and is denser than the previous layer with more pigmentation.

The color of the iris is created by different levels of light absorption in the anterior border layer. Little pigmentation in this layer results in a blue appearance because light reflects from the back layer of the iris. The more pigmentation a person has in the anterior border layer, the darker their iris is. The overall visual appearance of the iris is due to its multi-layered structure.

The Previous research considered either the problem of predicting ethnicity from iris features or the problem of predicting gender from iris features, but has not considered both problems using the same dataset and similar experimental approach. Our work is the first to report on predicting both ethnicity and gender and on the mixed effects of the two problems and find improved accuracy relative to previous work on predicting ethnicity from iris texture. Accuracy of predicting {Asian, Caucasian} ethnicity using person-disjoint 10-fold cross-validation on a 120-person, 1,200-image dataset exceeds 90%. Accuracy on predicting gender using person disjoint 10-fold cross-validation on a 60-person, 600-image dataset is close to 62%. This is below the accuracy previously reported by Thomas et. al. [8] for gender prediction. Based on our experimental results, it appears that predicting gender from iris is a more difficult problem than predicting {Asian, Caucasian} ethnicity. It also appears that predicting ethnicity is more difficult for females than for males. On the other hand, they do not see any evidence that the difficulty of predicting gender varies across ethnicity.

PROPOSED TECHNIQUE

The pupil dilation approaches assume that the boundary of pupil is a circle. However, according to our observation, circle cannot model this boundary accurately. To improve the quality of segmentation, a novel active contour is proposed to detect the irregular boundary of pupil.

Robust representations for pattern recognition must be invariant to changes in the size, position, and orientation of the patterns. In the case of iris recognition, we must create a representation that is invariant to the optical size of the iris in the image (which depends upon the distance to the eye, and the camera optical magnification factor); the size of the pupil within the iris (which introduces a non affine pattern deformation); the location of the iris within the image, and the iris orientation, which depends upon head tilt, tensional eye rotation within its socket (cyclovergence), and camera angles compounded with imaging through pan/tilt eye-finding mirrors that introduce additional image rotation factors as a function of eye position, camera position, and mirror angles.

Fortunately, invariance to all of these factors can readily be achieved.

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. [9], Kong and Zhang [10], Tisse et al. [11], and Ma et al. [12]. 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 define any circle according to the equation:

$$x^2_c+y^2_c-r^2_c+=0$$

A maximum point in the Hough space will correspond to the radius and centre coordinates of the circle best defined by the edge points. By making use of the parabolic Hough transform we detect the eyelids, approximating the upper and lower eyelids with parabolic arcs, which are represented as;

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

which controls the curvature, (h_j, k_j) is the peak of the parabola and $\boldsymbol{\theta_j}$ is the angle of rotation relative to the x-axis.

Pupil Detection: Proposed Near-circular Active Contour

In order to effectively extract a pupil boundary, it is essential to define the contour characteristics that the system aims to capture. In general, a pupil boundary is a closed, continuous and smooth curve, which is near-circular. In order to achieve a better performance in the next stages of an iris recognition system, it is essential to capture this contour with respect to a proper center point and a proper angular resolution. The center point of the contour is defined as the mean of the vertices, which can be written as:

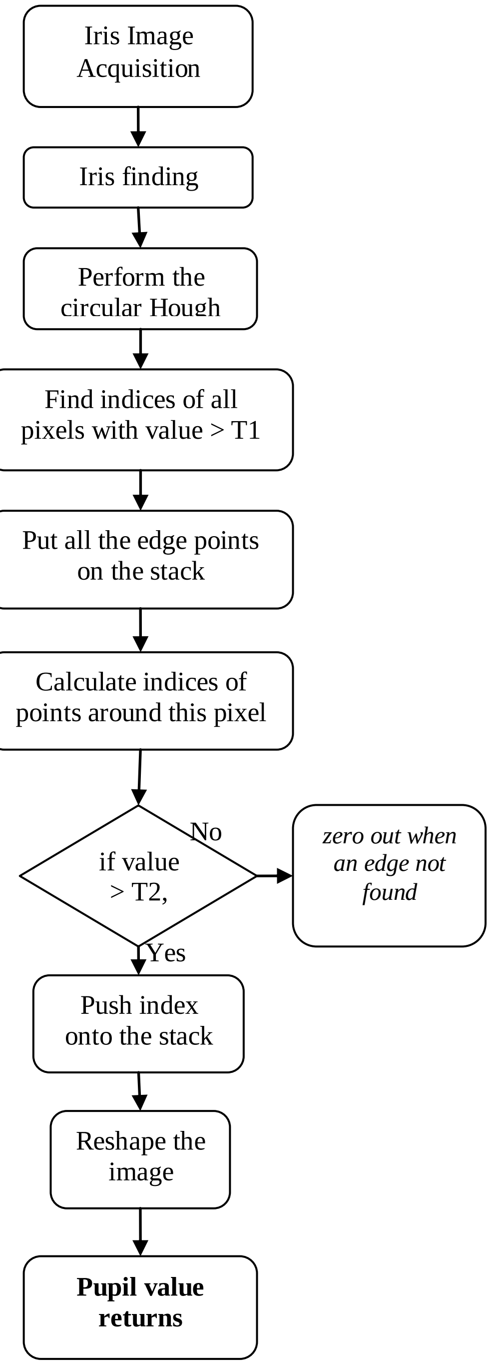
$$C = (x_c, y_c) = \frac{1}{N}\sum_{i=1}^{N} V_i$$

Where N is the total number of vertices and V_i is the $_{ith}$ vertex.

The angular resolution of the contour is another important aspect that should be considered. The continuity criterion is defined based on the angular resolution rather than the distance between the vertices which is common in general active contour models [13]. This resolution is chosen based on the average radius of pupils in the database of eye images. Considering the average radius of 45 pixels, the perimeter of a circle has around 285 pixels.

In this case, a resolution of 400 angles is chosen in order to obtain contours that are pixel-wise continuous. The number of vertices is constant and each vertex represents a specific angle throughout the process. This condition can be considered as angular forces that bring the vertices in the right angular position with respect to the updated contour center.

PROPOSED ALGORITHM



EXPERIMENT ANALYSIS AND RESULT

This research paper has presented a Pupil dilation system, which was tested using two databases of grey-scale eye images in order to verify the claimed performance of gender detection technology. An automatic segmentation algorithm was presented, which localizes the pupil region from an eye image and isolate eyelid, eyelash and reflection areas. Pupil dilation results are shown in table 1. It is clear from table 1 that pupil radius of female eyes is smaller than male eyes.

Table 1: Show Results of Male and Female Pupils

S.No.	Male/Female	rowp	colp	r
1	Fl1	105	225	42
2	Fr1	120	112	55
3	Fl2	108	243	48
4	Fr2	93	115	52
5	Fl3	98	140	72
6	Fr3	122	67	50
7	Fl4	100	222	43
8	Fr4	113	148	47
9	Fl5	115	122	52
10	Fr5	120	115	55
11	Fl6	128	132	58
12	Fr6	83	187	55
13	Fl7	133	190	47
14	Fr7	123	107	50
15	Fl8	113	122	52
16	Fr8	112	208	48
17	Ml1	112	120	52
18	Mr1	112	112	62
19	Ml2	112	120	55
20	Mr2	117	110	58
21	Ml3	112	120	52
22	Mr3	112	112	62
23	Ml4	112	120	55
24	Mr4	117	110	58
25	Ml5	110	120	55
26	Mr5	108	115	60
27	Ml6	122	110	67
28	Mr6	113	110	60
29	Ml7	110	120	55
30	Mr7	122	110	67
31	Ml8	108	115	60
32	Mr8	113	110	60

Analysis of our algorithm for Pupil dilation system has revealed a number of interesting conclusions. from this table 1 segmentation is the critical stage of Pupil dilation, since areas their wrongly identified as pupil regions will corrupt biometric templates resulting in very poor recognition.

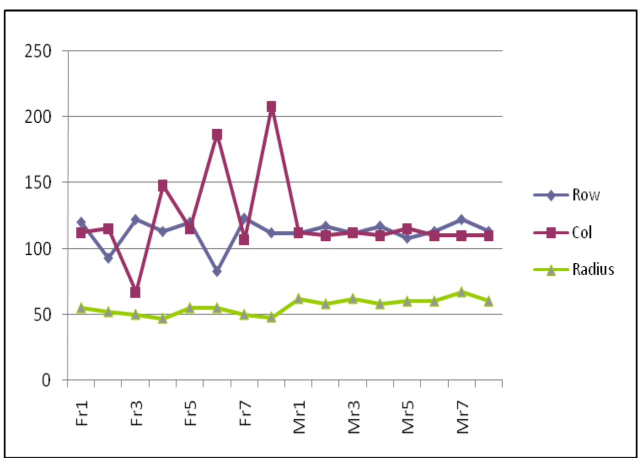


Figure. 2. Show Results of Male Pupil Dilation

The results shown that the segmentation of the Pupil dilation is use full for gender detection and its result become good because of its success dependent on the imaging quality of eye images. Here we find Value of male pupils are constant and value of female pupil always varies or different.

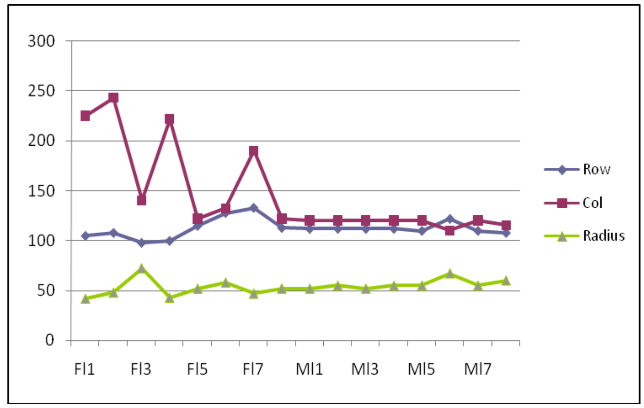


Figure. 3. Show Results of Female Pupil Dilation

The optimum centre wavelength for the optimum recognition when encoded using a filter is of 18.0 pixels. For both data sets, a filter bandwidth with σ/f of 0.5 and template resolution of 20 pixels by 240 pixels was found to provide optimum encoding. For the data set, perfect recognition was possible. from the fig 2 and 3 results confirm that Pupil dilation is a reliable and accurate biometric technology for gender identifying.

CONCLUSION

This research paper has presented a Pupil dilation system, which was tested using two databases of grey-scale eye images in order to verify the claimed performance of gender detection technology. Firstly, an automatic segmentation algorithm was presented, which would localize the pupil region from an eye image and isolate eyelid, eyelash and reflection areas. Automatic segmentation was achieved through the use of the circular Hough transform for localizing the pupil regions and the linear Hough transform for localizing eyelids. Threshold was also employed for isolating eyelashes and reflections. Secondly, the segmented pupil region was normalized to eliminate dimensional inconsistencies between pupil regions. Finally, features of the pupil were encoded by convolving the normalized iris region with 1D Log-Gabor filters and phase quantizing, to produce a bit-wise biometric template. From pupil dilation we identify genders.

The system presented in this publication was able to perform accurately, however there are still a number of issues which need to be addressed. First of all, the automatic segmentation was not perfect, since it could not successfully segment the pupil regions for all of the eye images in the two databases. In order to improve the automatic segmentation algorithm, a more elaborate eyelid and eyelash detection system could be implemented.

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