Eyes Recognition System Using Central Moment Features

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Abstract

Central moment is widely used in pattern recognition because of their discrimination power and robustness. For eye recognition these moments can also be normalized so that the moments are also size invariant. In this work, the proposal Eyes Recognition with Moments System(ERMS) including two methods, first method Shape Feature Extraction(SFE) by using central moment and some image processing techniques worked together for the features extraction, second step is a method to recognition of eyes features by comparing between an input test eyes features (moments) from the input image and an eyes features which store d in the features database.

Keywords: Recognition, Eyes, Central Moment.

نظام تمييز العيون بأستخدام خصائص العزوم المركزية

الخلاصة

تستخدم العزوم المركزية على نطاق واسع في انماط التمييز بسبب قوتها ودقتها. ويمكن استخدام هذه العزوم في تمييز العين حتى يتم اثبات حجم العزوم تلك. في هذا البحث, تم اقتراح نظام تمييز العيون للعزوم (ERMS) والذي يتظمن مرحلتين, المرحله الاولى استخلاص خصائص الشكل (SFE) باستخدام العزوم المركزيه وبعض تقنيات معالجة الصور والتي تعمل معا لأستخلاص الخصائص, المرحله الثانيه هي تمييز خصائص العين والذي يتم بمقارنة خصائص العين تم ادخالها مع خصائص العيون في قاعدة البيانات للنظام.

1. Introduction

One major task of pattern recognition, image processing: is to segment image into homogenous regions, in the several methods for segmentation are distinguished. Common methods are threshold, detection of discontinuities, region growing and merging and clustering techniques [1, 2, and 3].

In image processing, computer vision and related fields, an image moment is a certain particular weighted average (Moment) of the image pixels' intensities, or a function of such moments, usually chosen to have some attractive property or interpretation [1]. Image moments are useful to describe objects after segmentation. Simple properties of the image which are found via image moments include area (or total intensity). The higher order moments give even more detailed shape characteristics of the polygons such as symmetry, etc. The image moments have been used before in other contexts. M.K. Hu (1962) derived a transformation of the normalized central moments to make the resulting moments invariant, central moments. These moments continue to be published in books on image processing. Hu has used the moments for character recognition [4], *Y.D., B.B., D.E., R.S.,* They investigate the performance of the use of a partial

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iris for recognition based on a one-dimensional [5].

An Eyes recognition system is a computer application for automatically identifying or verifying a person from a digital image or a video frame from a video source. One of the ways to do this is by comparing selected Eyes features from the image and an Eyes database. It is typically used in security systems and can be compared to other biometrics such as fingerprint or Face recognition systems [6].

In this proposed, used the boundary description to represented the data obtained from the segment process for the color image and will use the one simple techniques and the task at same time, a technique detect edges using the Sobel Filter and threshold definitely going to get an image with boundary values (0,1) in addition to some of the techniques(section 2) with image processing used to obtain the best results respectively.

2. Image Processing Requirement

In the Eyes Feature Extraction, the traditional approach is followed using B/W blocks and shape information. Image segmentation with traditional edge detection method, threshold, and preprocessing techniques like median filter, thinning and limitation for (Black/Whit) object, is required for this application in order to remove noise effect and to simplify the test image processing [7]. Preprocessing steps include several traditional image processing methods which are applied together to obtain a better-input data for Eye Recognition step.

2.1 Edge Detection and Threshold Image

The Sobel edge detection operator has been applied successfully to all three planes in the RGB space and the gradients were summed to obtain the resultant edges. Sobel operator can computed on each of the three RGB planes and then sum the results. For their map processing application where colors and objects are well defined, this seems to be an adequate technique for edge detection. Threshold is one of the most important approaches to image segmentation. Suppose that the intensity histogram corresponds to an image, f (x, y) composed of light objects on a dark background, such that object and background pixels have intensity grouped into two dominant modes [1,4].

2.2 Pre-Processing Operations:

In the Eyes Recognition part for our system, the traditional approach is followed using B/W blocks and shape information. Preprocessing like thinning and Limitation is required for this application in order to simplify the test image [8]. Preprocessing steps include several traditional image processing methods which are applied together to obtain a better-input data for Eyes Recognition [1, 2].

2.3 Description and Representation

Basically a region has two options to represent, one represented based on the properties of Foreign Affairs (borders), and the second normalize can be represented in terms of the properties of the Interior (its constituent elements). But the choice of a particular method of the description is part of the task of making the data resulting from the process of segment a useful in computer. The external representation is when the focus is the President on the properties of shape, while the description of procedure is chosen when attention is focused on properties such as color, reflection and Installation [9].

2.4 Moments in image processing

Moments are the statistical expectation of certain power functions of a random variable. There are two ways of viewing moments, one based on statistics and one based on arbitrary functions such as f(x) in one dimension or f(x, y) two dimension. As a result moments can be defined in more than one ways.

I. Central Moments

Central moments are defined as: [1, 4]

$$\mu_{pq} = \int_{-\infty}^{\infty}\int (x - \bar{x})^p (y - \bar{y})^q f(x,y)\,dx\,dy \quad \ldots (1)$$

$\bar{x} = M_{10} / M_{00}$, $\bar{y} = M_{01} / M_{00}$

Where p and q are the components of the centered.

If $f(x, y)$ is a digital image, then the previous equation (1) becomes:

$$\mu_{pq} = \sum_x\sum_y (x - \bar{x})^p (y - \bar{y})^q f(x,y) \quad \ldots (2)$$

The central moments of order up to 3 are: [1]

$\mu_{00} = M_{00}$, $\mu_{01} = 0$, $\mu_{10} = 0$

$\mu_{11} = M_{11} - \bar{x} M_{01} = M_{11} - \bar{y} M_{10}$

$\mu_{20} = M_{20} - \bar{x} M_{10}$

$\mu_{02} = M_{02} - \bar{y} M_{01}$

$\mu_{21} = M_{21} - 2\bar{x} M_{11} - \bar{y} M_{20} + 2(\bar{x})^2 M_{01}$

$\mu_{12} = M_{12} - 2\bar{y} M_{11} - \bar{x} M_{02} + 2(\bar{y})^2 M_{10}$

$\mu_{30} = M_{30} - 3\bar{x} M_{20} + 2(\bar{x})^2 M_{10}$

$\mu_{03} = M_{03} - 3\bar{y} M_{02} + 2(\bar{y})^2 M_{01}$

It can be shown that:

$$\mu_{pq} = \sum_m^p \sum_n^q (-\bar{x})^{(p-m)} (-\bar{y})^{(q-n)} M_{mn} \quad \ldots (3)$$

II. Shape Features

In many applications such as shape recognition, it is useful to generate shape features which are independent of parameters which cannot be controlled in an image. Such features are called invariant features. There are several types of invariance. For example, if an object may occur in an arbitrary location in an image, then one needs the moments to be invariant to location. For binary connected components, this can be achieved simply by using the central moments, μ_{pq} [10].

If an object is not at a fixed distance from a fixed focal length camera, then the sizes of objects will not be fixed. In this case size invariance is needed. This can be achieved by normalizing the moments: [1,3,6]

$$\eta_{pq} = \mu_{pq} / {}^{y}\mu_{00} \quad \ldots (4)$$

where

$y = ½ (p+q) + 1$ for $p + q = 2,3,\ldots$

A set of seven invariant moments can be derived from above moments (eq. 1,2,3 and 4), which are our Features uses to recognition an eye image input.

$\partial_1 = \eta_{20} + \eta_{02}$

$\partial_2 = (\eta_{20} + \eta_{02})^2 + 4\eta^2_{11}$

$\partial_3 = (\eta_{30} + 3\eta_{12})^2 + (3\eta_{21} + \eta_{03})^2$

$\partial_4 = (\eta_{30} + \eta_{12})^2 + (\eta_{12} + \eta_{03})^2$

$\partial_5 = (\eta_{30} + 3\eta_{12})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{21} - \eta_{03})(\eta_{21} + \eta_{03})$

$\partial_6 = (\eta_{20} + \eta_{02})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + 4\eta_{11}(\eta_{30} + \eta_{12})(\eta_{21} + \eta_{03})$

$\partial_7 = (3\eta_{21} - 3\eta_{03})(\eta_{30} + \eta_{12})[(\eta_{30} + \eta_{12})^2 - 3(\eta_{21} + \eta_{03})^2] + (3\eta_{12} - \eta_{03})(\eta_{21} + \eta_{03})[3(\eta_{30} + \eta_{12})^2 - (\eta_{21} + \eta_{03})^2]$

3. Eyes Recognition System

Recognition algorithms can be divided into two main approaches, Shape Features Extraction and Eyes Recognition steps.

After applied shape features extraction (SFE) steps on the input eyes image, we define Maximum Two Objects, Right Eye and Left Eye in the Eyes Image Input, for each object (Eye) we define 7 Features resulted from SFE applied for each Object (Eye), each Object have its boundary rectangular (Limit of region). In the Eyes Recognition using Moments (ERM) system, each test image including for the system to recognition it, will be applied first in the SFE system to get their 14 features (7 for each eye) to compare its features with features for different images of eyes stored in our database system.

The two methods can be calculated by using Algorithm (1) and Algorithm(2):

4. Experimental and Results

The results of image segmentation is the first step in this work and the task to identify and distinguish between objects were entered and stored in database, then compared between the entrance is a newly characterized to any image data back, this process is the discrimination and that will be apply to the eyes image only to find out of the image of eyes back to the input image data that was already stored in the database. In the recognition step, the data will be compare with the specification of the eyes image and what had been extracted based on the methods that was represented and described of the part of the moments, considering the features that was stored in images database.

The experiment is calculated under the following conditions:

1. Only the frontal view of the eyes image is analyzer throughout this system.
2. Just two eyes from the face are capture from the input test image.
3. All of the test images have same size.

For Merry eyes image in Figure (1), Table (1) including all the information of features for this test image. Each eyes image test has 14 features, and it will be saved in the database system to recognition level, where Id_Address is the name of eyes image saved in database system.

Our image databases have 30 testing images and saving their features to recognition system by compare the features with central moments.

The system has two levels:

Shape Features Extraction SFE, the result for this level from step1 to step 5 in Algorithm(1), such as gray scale transform, edge detection, enhancement, thinning, and limitation, shown in figure (1). So, in step 6 and step 7 from SFE method(Algorithm(1)) is to find 14 features (7 for each eye), and then saved it in the database image of our system.

Figure (2), show another test eyes image for recognition it with database images. After we find the features moment form Baby eyes image, we saved this features in id-address as Baby Image1, we made a comparison between 14 features with 30 eyes image features saved in our database. In (Tables (2) and (3)), we can see 14 features for both image Baby Image1 and Baby Image2, we have 14 features for each image (Baby Image1 and Baby Image2) and we can see the differences between each feature its very small and that clear in the rate value result of their images in figure(3).

In compare step from Algorithm(2), we find another eyes image have same rate value (F) which is suggested in our recognition method, named Baby Image2 this image have same value of ratio 91.2312 %, (see figure (3) for database result).

This eyes image founded (Baby Image2) in image database is same as eyes image for (Baby Image1), but we add some color around tow eyes and change its brightness (for Baby Image1) to change it for testing our recognition system (figure (4)show both eyes baby images).

5. The Conclusion

The higher order of moments give even more detailed shape characteristics of the object, the major disadvantage of moments in general is that they are global features rather than local.

For eye recognition these moments can also be normalized as above so that the moments are also size invariant. In the our proposition for an Eye Recognition with Moment (ERM) method by using central moment in eye recognition. Firstly general image processing technique was used together to work for best result of regions.

One of the ways to do that recognition by comparing input test person eyes features from the input image with eyes features saved in database. From recognition result (rate value) more than one of the features will be seen in database and recognized for test eyes input image, therefore the image has Maximum rate value it is the true recognized eyes back for test eyes of input image.

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Algorithm(1): Shape Features Extraction
Step 1: Input true color eyes image.
Step 2: Convert true Color Image in to Gray Scale Image.
Step 3: Smoothing Gray image.
Step 4: Edge Detection Image , and thresholding.
Step 5: Preprocessing of objects that result from Step4. By Thinning its boundary and limitation (Region Growing) for all objects which result from the thinning.
Step 6: Compute The seven Moments values(shape features) , in our case, we have an image include two eyes(that is the Maximum object in the image), so we can get seven moment values for each eye, that mean we have 14 moment values for each input image (7 for each eye). That is the features for eyes image input.
Step7: Saved all moment values (features) for all eyes image testing in Data base system to use it in Recognition Point for this system.

Algorithm(2): Eyes Recognition
Step 1: Input a new color eyes image.
Step 2: applied Step2 to step6 in Algorithm (1), to get 14 Features for new eyes image input.
Step 3: Compare the 14 Features from step2 within each 14 Features from our database by:

$$F = \sum_{i=1}^{14} (F_i\ p / F_i\ db) * 7.14$$

Where: F is the summation of ((F_i p / F_i db) * 7.14) , it will between (7.14 *14 %) and (100%), 7.14 is the average of (100/14) for 14 features.
(F_i p) is the feature gets it from new person eyes image, (F_i db) is any feature gets it from our database.
Step 4: we get the rate of $F \geq 85\%$, to say what one features from database is same of features get it newly from new eyes input to recognition it.
Step 5: for step 3 , if the result is more than one eyes image features have same rate value ($F \geq 85\%$), the Maximum value is the nearest features back in to test person eyes image.

Table (1): Information of features for Merry Eyes image.

Id_Address In Database	Merry	
Features	Left Eye	Right Eye
∂ - 1	0.453351	1.772195
∂ - 2	1.088270	3.548980
∂ - 3	2.232460	5.925235
∂ - 4	2.018557	5.920805
∂ - 5	4.141964	11.843825
∂ - 6	2.561538	7.695295
∂ - 7	3.13586	7.597364

Table (2): Information of features for Baby Image1 Eyes image.

Id_Address In Database	Baby Image1	
Features	Left Eye	Right Eye
∂ - 1	1.025676	1.973333
∂ - 2	2.119378	3.952125
∂ - 3	3.780077	6.530295
∂ - 4	3.713611	6.524815
∂ - 5	7.460454	13.052370
∂ - 6	4.773300	8.500877
∂ - 7	4.226646	8.825244

Table (3): Information of features for Baby Image2 Eyes image.

Id_Address In Database	Baby Image2	
Features	Left Eye	Right Eye
∂ - 1	0.922730	1.800535
∂ - 2	1.898212	3.606396
∂ - 3	3.447983	6.011655
∂ - 4	3.396429	6.006290
∂ - 5	6.818634	12.015264
∂ - 6	4.345534	7.809489
∂ - 7	4.072237	7.850368

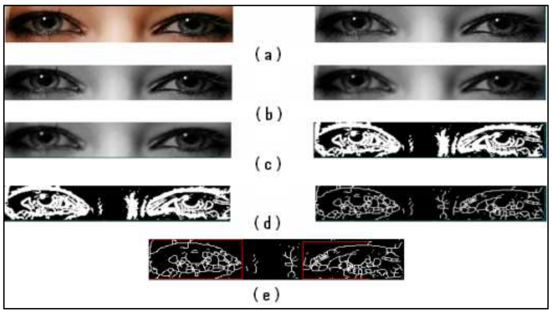


Figure (1) :Merry Eyes (a) Original eyes color image to Gray Scale image, (b) Gray Scale image Enhance, (c) Sobel Filter with threshold, (d) thinning image, and (e) Limit eyes region

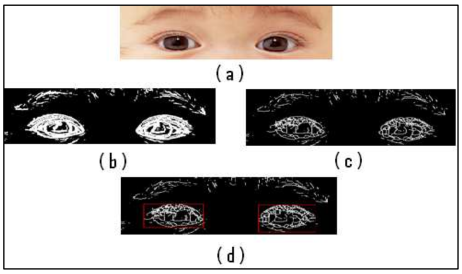
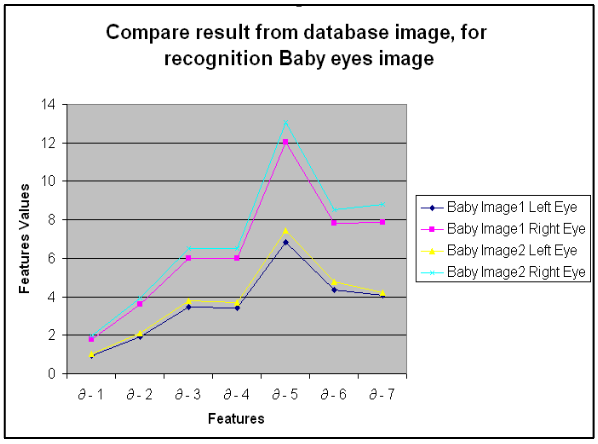


Figure (2) :Baby Eyes (a) Original eyes color image , (b) Sobel Filter with threshold, (c) thinning image, (d) Limit eyes region.



Figure(3): Compare result from database image, for recognition Baby eyes image.

Figure (4): Both Deferent Baby Eyes (a) Original Baby Image1 eyes, (b) Baby Image2 eyes changer