

EFFICIENT EYES DETECTION USING FAST NORMALISED CROSS-CORRELATION

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ABSTRACT

Eye detection is important for finding locations of the face landmarks such as nose, ear and mouth on the face. Template matching and normalized cross correlation techniques are used for eye detection. The template matching is better than appearance and feature based method for eye detection in terms of accuracy. The experiment is performed on chufs database of face image for detection of eyes. The experimental results demonstrate the effectiveness of the template matching methods for eyes detection.

KEYWORDS

Image Processing, Cross-correlation, Template matching.

1. INTRODUCTION

In Computer Vision domain, one of the main development areas is related to the faces, either in static images or video sequence of images. The face detection and recognition have become important in the field of Computer Vision and Pattern Classification [1]. The face recognition have been used in various applications such as security, surveillance systems, human computer interfacing, suspect investigation. The task of eye detection plays very important role in the face detection and recognition. The preprocessing stage of face detection, recognition includes localisation and features extraction of facial components like eyes, nose and mouth etc. The eyes can be considered salient and relatively stable feature in comparison with other facial features.

Once face is detected, it is necessary to align faces for recognition. The face alignment is usually performed by position of other face landmarks with reference to the eye locations [2]. The performance of face recognition rate degrades rapidly when the face components alignment is not proper. This indicates that eye detection is very important in the face recognition system. However, eye detection remains a very challenging task due to several variations. The shape and appearance of eyes vary with identity, viewing direction, illumination condition, eye motion, and occlusion due to eyeglasses [3]. The objective of this work is to present effective and fast eye detection using normalized cross correlation technique.

2. LITERATURE SURVEY

Eye detection plays very important role in the alignment of a face in the proper position for face detection and recognition. Considering the position of the eyes, the distances of the other landmark points are calculated [4]. The methods for eye detection is divided into two main categories : active and passive approach. The active approach consists of focusing on the infrared light beam into the eyes. The cornea region reflects the beam back. This phenomenon produces high bright pupils in gray scale images including eye positions [5].

Cameron Whitelam et al [6] proposed the spectral properties of the pupil near infrared illumination. Eyes are explored in the context of the different bands such as visible, multi spectral and short waves. The eyes on the face images captured under different bands and detected. It is used for the infrared illuminated images only. The passive approach can be further classified into three categories: template matching, appearance and feature based methods.

2.1 Template Based Method

In the template based method, a template consisting one of the feature of a face like eye is prepared. The eye template matching is used to search the image for the eyes on pixel by pixel basis. The accuracy of the matching is better as compared to the appearance and feature based methods for feature detection. The template matching is time consuming due to large search space [7]. In order to improve the efficiency of this method, cross correlation technique has been proposed that reduces the time required for matching template with the region of interest in the face image.

2.2 Feature Based Method

In this method, image feature characteristics such as edge, intensity and colour are used to identify some distinctive features of the eyes. The accuracy of the feature based method is less due to large variations in the feature space. The feature vector is compared with the image vector to find the presence of the feature in the image. Qiong Wang et al [8] used structure of the eye region as important cue for detecting the eye pair. The eye pair detection algorithm works on the whole gray-level image and homographic filter is applied to enhance the contrast of the dark region. The clustering and threshold techniques are used for different gray levels feature separations. The template matching with support vector machine is used for extracting the eyes. Kun Peng et al [9] presented combined approach of feature based method for detecting eye region and template based method for locating center of the iris. The size of eye template is estimated from the width of a face. The horizontal and vertical projections are used for estimation of face width and height.

S.Asteriadis et al [10] presented method for eye localization based on the geometrical information. Initially face is detected and bounding box enclosed on the face. The edge map of face image in the bounding box is extracted. The canny edge detector is used to produce the vector length and edge map for an image. The principal component analysis is applied to find the eigenvectors of training images. The similarity of weights with eye model is used to declare an eye presence.

2.3 Appearance Based Method

In a appearance based detection, features such as color, texture and shape can be analyzed. Generally appearance based method requires large amount of training data for representing eyes of different subjects, orientation and illumination conditions. The classifiers such as neural network and support vector machine are used to detect the eyes in the face image.

Chughoon Kim et al [11] described composite vector with biased discrimination analysis for eye detection. A pattern is represented by the set of variables which are called as primitive variables. The composite vector composed of a number of primitive variables and hybrid cascade detector is constructed for eye detection using haar like features in the early stage and composite biased discrimination analysis(C-BDA) in the latter stage. The C-BDA is derived from covariance of the composite vectors.

Zhou and Geng [12] presented an idea of the integral projection, variance projection and the generalized projection function and implemented hybrid projection function which is better than the variance and integral projection function. It requires each eye should be in separate window.

M. Hassaballah and Shun Ido [13] explored the method based on the entropy of the eye region. The center of eye region is too dark compared to the neighbouring regions. A score based on the entropy of eye and the darkness of an iris is used to detect the eye centre coordinates. A probability distribution of gray values can be estimated by counting the number of times each gray value occurs in the image and dividing by the total number of occurrence. In the eye region, the intensity values are unpredictable and correspondence to the high entropy. An iris is circular in shape and dark in colour. The sum of intensity values in a circle of radius r around the center of each window is calculated. The structure of the paper as follows. Section 3 describes the methodology used to detect the eyes. In section 4, implementation results and discussion are presented. Section 5 presents concluding remarks on the eye detection.

3. METHODOLOGY

In this section we outline the technique to perform eye detection. The proposed method is presented in Fig. 1. In this method we assume that input image consists of single face image. When the face is presented to eye detection system, Face image extracted from the background and face size is calculated. The detailed description of eyes detection system is given in the following steps.

3.1 Preprocessing

The preprocessing is essential for enhancement of the image required for the further processing. The colour image is converted into grey level image. The face image is separated from the background. The face top, bottom as well as left, right boundaries are used to locate face image.

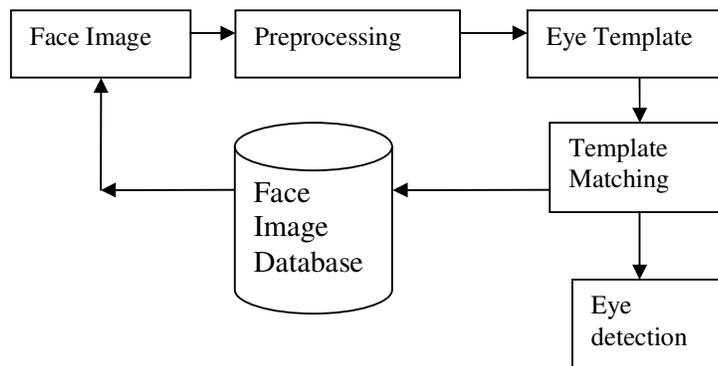


Fig. 1 Eyes Detection System

3.2 Eye Detection

Eye detection is performed by comparing the eye template with face image in order to detect the position of eye on the face. The normalized cross correlation is calculated between template and face image as given in equation (1). The normalized cross correlation gives maximum value of correlation coefficient when the input template matches exactly with the region on the face image. The correlation is statistical technique [14] that can show whether two or more variables are strongly related. The degree of relationship between the variables under consideration is measured through the correlation analysis [15]. The measure of correlation is called the coefficient of correlation or correlation index. The correlation analysis refers to the techniques used in measuring the closeness of the relationship between the variables [16]. The coefficient of correlation is one of the most widely used and observed statistical measure [17-18]

3.3 Template Matching

In the eye template matching method, eye template is prepared for the eye detection on the face image. The templates used for eyes detection are shown in fig 2.



Fig. 2 Eye Template a) Left b) Right

$$\gamma(u, v) = \frac{\sum_{x,y} [f(x, y) - \bar{f}_{u,v}] [t(x-u, y-v) - \bar{t}]^2}{\left\{ \sum_{x,y} [f(x, y) - \bar{f}_{u,v}]^2 \sum_{x,y} [t(x-u, y-v) - \bar{t}]^2 \right\}^{0.5}} \quad (1)$$

Where $f(x,y)$ is image of size $M \times N$

$t(u,v)$ is template $m \times n$

$\bar{f}_{u,v}$ mean of $f(x,y)$ in the region under the template.

\bar{t} mean of the template.

4. RESULT AND DISCUSSION

In this section we represent the experimental results of eye template matching using cross correlation techniques. The proposed method has been tested by images from chufs face database [19]. The experimental results show that, the template matching using the normalized cross correlation method is accurate and fast. The graph in fig. 5 shows the time required to detect right eye is more compare to the left eye. We found that the average time required to detect left eye on the face image is 1.549 seconds and for right eye 1.950 seconds for 20 faces. The time for right eye detection is more due to the position of the eye on the face.



Fig. 3 Left Eye Detection

Table 1. Time for left eye detection

Sr. No.	No of Faces	Time(sec)	Sr. No.	No of Faces	Time(sec)
1	1	0.35	11	11	1.53
2	2	0.60	12	12	1.70
3	3	0.74	13	13	1.79
4	4	0.82	14	14	1.89
5	5	1.09	15	15	2.03
6	6	1.00	16	16	2.21
7	7	1.15	17	17	2.32
8	8	1.23	18	18	2.41
9	9	1.37	19	19	2.58
10	10	1.45	20	20	2.72



Fig. 4 Right Eye Detection

Table 2. Time for right eye detection

Sr. No.	No of Faces	Time(sec)	Sr. No.	No of Faces	Time(sec)
1	1	0.37	11	11	2.01
2	2	0.65	12	12	2.20
3	3	0.79	13	13	2.38
4	4	0.84	14	14	2.48
5	5	1.12	15	15	2.67
6	6	1.16	16	16	2.82
7	7	1.31	17	17	2.99
8	8	1.53	18	18	3.20
9	9	1.66	19	19	3.37
10	10	1.85	20	20	3.52

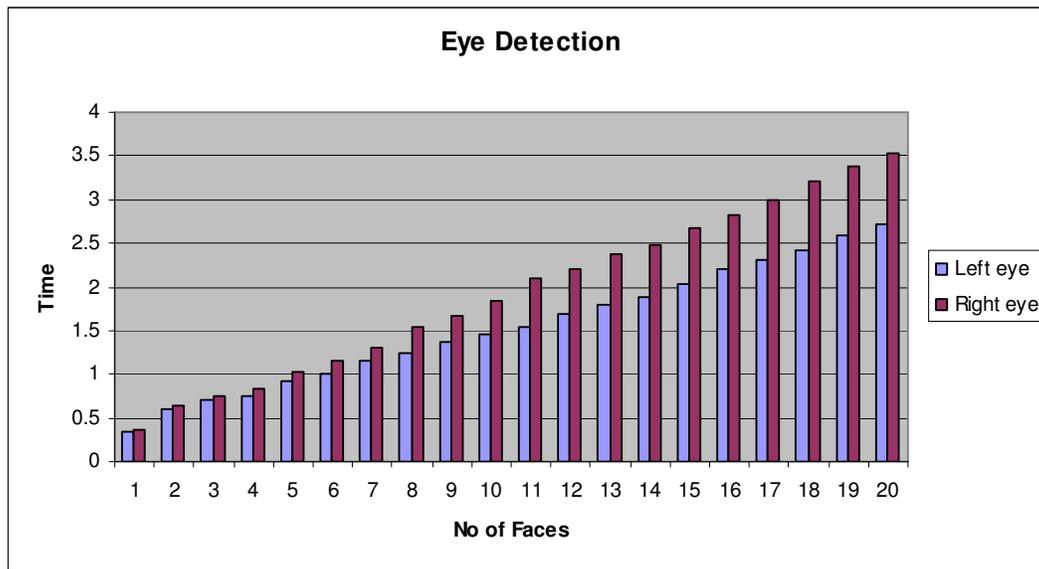


Fig. 5 Time required for Eyes Detection

5. CONCLUSIONS

We have presented a study on the problem of the eyes detection in a face image. The efficiency of template matching method is presented. The eye detection plays important role in the locations of the nose, ear and mouth. The proposed method has been tested by images from chufs face database. We found that the template matching is accurate method for eyes detection.

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