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Comparative Study and Analysis of Image Segmentation Method to Detect Human Eye

Abstract

Biometric feature detection is one of the complex and most demanding image processing tasks. Human face can be detected by extracting feature of face. Once the face is detected, we can recognize the face. Eye is one of the features that play an important role in detecting Human face. Eye can be detected by geometrical information, elliptical separability filter, color based extraction, red eye pixel based on threshold value, eye center localization, intensity information etc. The goal of this paper is to present a review of latest research in this continued growth of eye detection method. This paper concentrates on the detailed and comparative study of various methods and its effectiveness.

Keywords: Skin Color, Thresholding, Adaboost Learning, Integral Image, Elliptical Separability.

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Introduction

Image segmentation is the process of dividing the image into sub image and extracts the object of interest. It is one of the most complex tasks in image study because the segmentation is the process of image understanding and analysis. Segmentation of simple gray-level images can provide useful information about the surfaces in the scene. The segmentation of image is based on gray level, color, texture, depth or motion. Image segmentation for the extraction of human face is complex task since the human face is a dynamic object that comes in many forms and colors. Segmentation [2] is the important step for efficient detection and extraction of faces in color images. Applications of image segmentation for extracting faces include:

1. Time tracking: Tracking the billed hours of employees by detecting the faces of in and out time of employees.
2. Surveillance camera: Face and motion detection.
3. Video chat: Observing the visitors of chat website.
4. Human computer interaction.
5. Access control etc.

The image segmentation for the extraction of face involves study of facial features and development of method for the detection of facial features. Face detection is an important early step in many computer vision systems, including video supervision for security, driver condition monitoring for automotive safety, responsive user interface, immersive virtual environment, and face recognition. Face detection involves face localization, mouth location, left eye and right eye location.

Facial features vary due to pose and orientation change. It is difficult to locate facial features due to illumination, noise, occlusion and complex background. . The important face parts such as eyebrows, eyes, nose, mouth are used to express facial feature. The face detection in an image has great challenges such as a picture containing zero, one or many faces, sizes of faces vary a lot, faces are not the same due to spectacles, mustache etc.

One of the salient features of the human face [1], human eyes play an important role in face recognition and facial expression analysis. In fact, the eyes can be considered as salient and relatively stable feature on the face in comparison with other facial features. Therefore, when we detect facial features, it is advantageous to detect eyes before the detection of other facial features. Thus, eye position detection is important not only for face recognition and facial expression analysis but also for eye contour detection.

Aim of the Study

1. To present a study over the existing literature on eye detection.
2. To compare the various methods on the basis of algorithm, used databases and its performances.

Background

Robust Face Localization Using Motion, Color & Fusion[3] is a novel hierarchical face detector which combines motion, color and late fusion. Motion segmentation is to eliminate background clutter and to reduce the initial search space. Skin segmentation is used to determine a candidate face. The large amount of variation within the face makes it difficult for any individual technique to perform well under all conditions. The system is capable of localizing faces from still images in real-time with an accuracy of 93.75%. Factor Analysis of Essential Facial Features[3] presents the results of factor analysis to determine the minimum number of facial features required for recognition.

A simple and efficient eye detection method in color images[4] first detects face regions in the image using a skin color model in the normalized RGB color space. Then, eye candidates are extracted within these face regions. Finally, using the anthropological characteristics of human eyes, the pairs of eye regions are selected. It needs no template matching step for face verification.

Eye Detection in Facial Images with Unconstrained Background [5] presents an efficient eye detection approach for still, grey-level images with unconstrained background. The structure of the eye region is used as a robust cue to find eye pair candidates in the entire image. Eye pairs are located by a support vector machine-based eye verifier. The eye variance filter is then used to detect two eyes in the eye region which has been extracted in the eye pair location step. This method cannot deal with large out-plane face rotation because the structure of the eye region changes. In-plane face rotation can be solved by rotating facial images to predefined degrees. The proposed method can deal with glasses wearing and partial face occlusions. The eye detection will fail if the reflection of glasses is too strong or eyes are closed.

A Robust Algorithm for Eye Detection on Gray Intensity Face without Spectacles[6] combines' two existing techniques feature based method and template based method. The algorithm uses feature based methods to detect two rough regions of eye. The precise locations of iris centers are then detected by performing template matching in these two regions. This method works well with the faces without spectacles. The detection accuracy is 95.2% and the average execution time is quite efficient. The method doesn't work so well for the faces with spectacles.

The method Eye detection algorithm on facial color images [7] uses special color space, YCbCr gives information about eyes. Two maps are made according to its components and merge them to obtain a final map. Candidates are generated on this final map. Applying an extra phase on candidates to determine suitable eye pair. The extra phase consists of flexible thresholding and geometrical tests. Flexible thresholding makes generating candidates more carefully and geometrical tests allow proper candidates to be selected as eyes. The results have increased the correct detections and reached the detection rate to 98.5%.

A novel method for detecting lips, eyes and faces in real time[8] presents a real-time face detection algorithm for locating faces in images and videos. This algorithm finds not only the face regions, but also the precise locations of the facial components such as eyes and lips. The algorithm starts from the extraction of skin pixels based on rules derived from a simple quadratic polynomial model. The eye components are extracted after the extraction of skin pixels and lips. The precise face regions are determined accordingly. This algorithm exhibits satisfactory performances in both accuracy and speed. The light condition must be normal and the algorithm does not allow the vast shadows on the faces. The facial components must appear on the images as clearly as possible.

A method[10] is proposed to detect multi view face and eye based on gentle AdaBoost learning. The rotation angle is found to detect multi view face and eye. The method multiple face detection [9] detects pixel based boosted skin, texture and skin using cellular learning automata. The integral image and rectangle features are used for single and multiple face detection using by camshaft, kalman filter.

Template Matching based Eye Detection in Facial Image[11] describes eye detection using template. The template is correlated with different regions of the face image. The region of face which gives maximum correlation with template refers to eye region. The method does not require any complex mathematical calculation and prior knowledge about the eye. The method is simple and easy to implement. The method works in both open eye as well as closed eye.

A method[12] is presented to detect and correct redeye in digital images. Initially cascade of multi stage classifier is used to detect faces. The red-eye pixels are then located with several refining masks computed over the facial region. The masks are created by thresholding per-pixel metrics, designed to detect red-eye artifacts. Once the redeye pixels have been found, the redness is attenuated with a tapered color desaturation. This method gives 95% acuracy.

This paper[13] presents an accurate eye detection algorithm using elliptical separability filter and combined features of eyes. A histogram back-projection method is utilized to extract the rough face region, and then iris candidates are detected by using elliptical separability filter developed based on Fukui et al.'s separability filter. By calculating the similarities of pairs of iris candidates, we determine the pair of iris, which has the largest similarity among others. The similarity of a pair of iris candidates consists of the separability of the pair of iris candidates, the similarity between VQ histograms and normalized correlation coefficient between the region including the pair of iris candidates and eye template. Experimental results show the iris detection rate of the proposed algorithm of 95.2% for 516 images of 86

persons without spectacles in the AR database. The algorithm is demonstrated to be very efficient and robust.

Robust Video-Based Eye Tracking Using Recursive Estimation of Pupil Characteristicnn [14] is a method that utilizes this high-speed property to obtain reliable predictions through recursive estimation about certain pupil characteristics in successive camera frames. These predictions are subsequently used to carry out novel image segmentation and classification routine to improve pupil detection performance. This method seems to have a greater detection rate, accuracy and speed compared to other recently published open-source pupil detection algorithms.

The method [15] analyzes the state of the eye and mouth by extracting contour features. The face area is detected and then, the eyes are located by an EyeMap algorithm through a clustering method to extract the sclera-fitting eye contour and calculate the contour aspect ratio. The value of chromatism s is defined in the RGB space, and the mouth is accurately located through lip segmentation. The color difference of the lip, skin, and internal mouth, the internal mouth contour can be fitted to analyze the opening state of mouth. This method does not need training with high calculation efficiency. This method detects the eye and mouth state by extracting contour features and achieve better results.

The paper[16] presents a novel learning-based method for eye region landmark localization. It uses the detected landmarks as input to iterative model-fitting and lightweight learning-based gaze estimation methods. It uses the existing model-fitting and appearance-based methods in the context of person independent and personalized gaze estimation.

Comparative Study and Analysis of Various Methods

S.No	Paper	Method	Database	Performance
1.	A simple and efficient eye detection method in color images [4]	Skin color model in the normalized RGB color space.	Tested on various facial images	Better performance
2.	Eye Detection in Facial Images with Unconstrained Background [5]	Support vector machine-based eye verifier. eye variance filter	BioID face database	Effective
3.	A Robust Algorithm for Eye Detection on Gray Intensity Face without Spectacles [6]	Feature based method and template based method. iris centers are detected by template matching detection	ORL Database	95.2% efficient
4.	The method Eye detection algorithm on facial color images [7]	5. YCbCr 6. Thresholding and geometrical tests.	Iranian Databases	98.5%.
5.	A novel method for detecting lips, eyes and faces in real time [8] components must appear on the images as clearly as possible.	7. extraction of skin pixels 8. Using simple quadratic polynomial model.	Tested on various facial images	Satisfactory performances in both accuracy and speed.
6.	Multiple face detection [9]	9. Pixel based boosted skin, texture and skin using cellular learning automata. 10. The integral image and rectangle features 11. Camshaft, kalman filter.	Tested on various facial images	95.9%
7.	A method [10]	12. Gentle AdaBoost learning. 13. The rotation angle is found to detect multi view face and eye.	7 different Test Database	88.3%

8.	Template Matching based Eye Detection in Facial Image [11] calculation and prior knowledge about the eye. The method is simple and easy to implement. The method works in both open eye as well as closed eye.	14. Template. 15. correlated with complex mathematical	Tested on images of size 512 X512 implemented in MATLAB	simple method and can easily be implemented by hardware
9.	Method [12]	16. Correct redeye in digital images. 17. cascade of multi stage classifier is used 18. The masks are created	Tested on various images	95% accuracy
10.	Paper [13]	19. using elliptical separability filter 20. Combined features of eyes. . 21. Similarities of pairs of iris candidates.	AR database	95.2% efficient and robust.
11.	Method [15]	22. Eye Map algorithm 23. Chromatisms 24. Color difference of the lip, skin, and internal mouth, the internal mouth contour	CIT, FERET and self built databases	96.56% accuracy

Conclusion

One of the salient features of the human face, human eyes play an important role in face recognition and facial expression analysis. In fact, the eyes can be considered as salient and relatively stable feature on the face in comparison with other facial features. Therefore, when we detect facial features, it is advantageous to detect eyes before the detection of other facial features. Thus, eye position detection is important for face recognition and facial expression analysis. In this paper we have studied existing methods and presented the art of survey on eye detection. We have compared various methods on the basis of techniques used, its performance and test database used.

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