Iris Detection Using Morphology
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Abstract
For accurate iris recognition, it is essential to detect iris. Iris recognition systems are mainly dependent on the performance of iris localization processing. So, the goal of this work is iris detection, where it is suggested using morphological operations (erosion and dilation) in iris detection. Erosion is used to erode away the boundaries of undesirable regions of foreground pixels in annular of iris that resulted from threshold process. Whereas, dilation is gradually used to enlarge the boundaries of regions of foreground pixels such as pupil who shrunk by erosion operation. Then, smoothing the edges by using mean filter. The significant drawbacks of this method are that some operations were manipulated manually such as; removing the eyelids and eyelashes from the original image.

Keywords: Iris detection, Morphology, Iris localization.

الخلاصة
من الضروري أن تعمل كشف الأذار لتمييزها بشكل دقيق. أنظمة تعرف الأذار تعتمد بشكل رئيسي على أداء معالجة تحديد موقع الأذار. لذا الهدف من هذا البحث هو الكشف عن الأذار باستخدام عملية التوفولوجيا (التوسع والتاكل). يستخدم التأكل للتنخفض من حدود المناطق غير مرغبة بها للكائنات الأمامية في حلقة الأذار الناتجة من عملية العينة بينما التوسع هو كبير الحدود للكائنات الأمامية تدريجيا مثال البويض الذي تغلف من جراء عملية التأكل. ثم استخدام المرشح المتوسط لتثبيت الحواف. هذه الظاهرة هو أن بعض العمليات تم معالجتها بيدا مثل إزالة الرموش والجنون من الصور الأمامية.

الكلمات المفتاحية: الكشف عن أذار، توفولوجيا، أذار

1. Introduction
With current stress on security and surveillance, automatic personal identification in less cooperative situations has been an important research topic. Iris recognition has been studied for personal identification because of iris’ extraordinary structure and non-invasive characteristics (Huang J. et al., 2003). The iris provides one of the most stable biometric signals for identification, with a distinctive texture that is formed before age one and remains constant throughout life unless there is an injury to the eye. Compared with other biometric features such as face and fingerprint, iris patterns are more stable and reliable (Huang J. et al., 2003) (Du Y. et al., 2004). Biometric is an automated of identifying person or verifying the identity of a person based on the physiological or behavioral state. The human iris, as shown in Fig. (1), has an extraordinary structure and provides abundant texture information. The spatial patterns that are apparent in the iris are unique to each individual. Individual differences that exist in the development of anatomical structures in the body result in the uniqueness (Ma L et al., 2002). Iris detection is one of the most accurate and secure means of biometric identification while also being one of the least invasive. Fingerprints of a person can be faked dead people that come to life by using a severed thumb. Thieves can do a nifty mask to fool a simple face recognition program. The iris has many properties which make it the ideal biometric recognition component. The iris has the unique characteristic of very little variation over a life’s period yet a multitude of variation among individuals. Irises are not only different among identical twins, but also between the left and right eye. Because of the hundreds of degrees of freedom, the iris gives and the ability to accurately measure the textured iris, the false accept probability can be estimated at 1 in 10^31. Another characteristic which makes the iris difficult to be faked is its responsive nature. Comparisons of measurements
taking a few seconds apart will detect a change in iris area if the light is adjusted whereas a contact lens or picture will exhibit zero change and flag a false input (Robichaux P, 2004). Most modern iris detection algorithms use random circles to determine the iris parameters. Having a starting point at the pupil, these algorithms guess potential iris centers and radii. Then they integrate over the circumference in order to determine whether it is on the border of the iris. Although this is highly accurate but the process can consume a lot of time (B. Lipinski, 2004). In (Ma L et al., 2002) the iris is localized in two steps: (1) approximate region of iris in an image can be found by projecting iris image in horizontal and vertical direction. (2) The exact parameters of these two circles are obtained by using edge detection and Hough transform in a certain region determined in the first step. The combination of edge detection and Hough transform is adopted to localize the iris, and is used by (L. Ma et al., 2004), where circular symmetric and Gobar filters are used to detect the iris pattern in (A. Chitra and R. Bremananth, 2003). This module explains an alternate approach which is much easier, and does not consume a lot of time.

Fig. 1: Typical human eye

2. Morphological Operations
Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. By choosing the size and shape of the neighborhood, you can construct a morphological operation that is sensitive to specific shapes in the input image. The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. The number of pixels added or removed from the objects in an image
depends on the size and shape of the structuring element used to process the image. In the morphological dilation and erosion operations, the state of any given pixel in the output image is determined by applying a rule to the corresponding pixel and its neighbors in the input image (Che Mat et al., 2006).

2.1 Erosion and Dilation

Let $A$ and $B$ be sets in $\mathbb{R}^d$, $d > 0$. Let $(B)_x$ denote the translation of $B$ by $x$ and let $B^*$ denote the reflection of $B$ with respect to its origin. The erosion of $A$ by $B$, $A \ominus B$, is defined as:

$$A \ominus B = \{ x | (B)_x \subseteq A \} \quad (1)$$

which, in words, says that the erosion of $A$ by $B$ is the set of all points $x$ such that $B$, translated by $x$, is contained in $A$. The dilation of $A$ by $B$, $A \oplus B$, is defined:

$$A \oplus B = \{ x | (B^*)_x \cap A \neq \emptyset \} \quad (2)$$

Thus, the dilation of $A$ by $B$ is the set of all $x$ displacements of the origin of $B^*$ such that $B^*$ and $A$ overlap by at least one nonzero element. Set $B$ is commonly referred to the structuring element in erosion, dilation and in other morphological operations. These operations can also be expressed in terms of the Minkowski operators. From the above definitions, erosion and dilation can be described simply in terms of adding or removing $n$-voxels from the binary image, according to certain rules which depend on the pattern of the neighboring $n$-voxels and the size and shape of the structuring element. Therefore, erosion can be explained as a process where the interior of the object is shrunk as much as the size of the structuring element, whereas dilation is a process that elongates the interior of the object (J. Rodriguez and D. Ayala, 2001).

2.3 Structure Element

An essential part of the dilation and erosion operations is the structuring element used to probe the input image. A structuring element is a matrix consisting of only 0's and 1's that can have any arbitrary shape and size. The pixels with values of 1 define the neighborhood. Two-dimensional, or flat, structuring elements are typically much smaller than the image being processed. The center pixel of the structuring element, called the origin, identifies the pixel of interest the pixel being processed. The pixels in the structuring element containing 1's define the neighborhood of the structuring element. These pixels are also considered in dilation or erosion processing. Three-dimensional, or nonflat, structuring elements use 0's and 1's to define the extent of the structuring element in the $x$- and $y$-planes and add height values to define the third dimension (Che Mat et al., 2006).

3. Iris localization

Iris localization is the process of completely and efficiently eliminating pupil, eyelashes and other portions that are not necessary from the captured image (A. Chitra and R. Bremananath, 2003). The iris is an annular portion between the pupil (inner boundary) and the sclera (outer boundary). Both the inner boundary and the outer boundary of a typical iris can approximately be taken as circles. However, the two circles are usually not concentric (L. Ma et al., 2004). So, the iris image, as shown in Fig.1, contains not only the region of interest (iris) but also some ‘useless’ parts (e.g. eyelid, pupil etc.). In addition, a change in the camera-to-eye distance may result in the possible variation in the size of the same iris. Furthermore, the brightness is not uniformly distributed because of non-uniform illumination (Ma L et al., 2002).
4. The Proposed Method Technique of Iris Detection

The proposed method is including several stages:

Choosing the images: human eye images contain sclera, iris, pupil, eyelids, eyelashes and some skin outside the eye (A. Basit, M.Y. Javed, 2007). Eyelids and eyelashes may occlude the effective regions of the iris for feature extraction, and the failure of iris localization (i.e., large localization errors) may cause false nonmatching (L. Ma et al., 2004). Eyelids and eyelashes are removed manually in this experiment, so no attention has been considered on detection of eyelids and eyelashes. All images in our paper have been chosen with care. Fig. 3(a) shows some samples of these images.

Detection the iris: first, the iris is detected by thresholding. Principally, two thresholds are determined by taking the histogram for that image. As shown in Fig. 2(c) the threshold is not enough to detect a pure iris. There are some undesired clusters in the detected iris. So, it has to use additional technique for removing these clusters.

Morphological Erosion: before erosion process, the background of iris image should be dilated in each direction. This process is for rid of distortion of image which is resulting from dilation process of the pupil, which will be explained later. Fig. 2(d) show this process. The image should erode many times for removing all the clusters in iris region. As shown in Fig. 2(e) the resulted image is not similar to the original, where we notice the pupil became a bit smaller than before, so the iris region became more dilated.

Morphological Dilation: the pupil has to be dilated many times to get back to its original size as many times it was eroded in it. As a result, the iris region will get back to its normal form as indicated in Fig. 2(g). The iris that is shown in Fig. 2(f) was eroded and dilated without dilating the background of the image that was discussed earlier. So, there are distortions in edges of iris.

Smoothing of Edges: While edge detection is an important first step for many vision systems, the linked lists of edge points produced by most existing edge detectors lack the higher level of curve description needed for many visual tasks (D. G. Low, 1988). Therefore, we need a technique for smoothing the edges. The most promising candidate would seem to be smoothing with mean filter, as has been proposed in many other areas of image analysis. Fig. 2(h) shows smoothing of image edges.

Figure 2: (a) Original iris (b) histogram of iris (c) The detected iris by using two thresholds (d) Dilating the background of iris image from each direction (e) Application of erosion process (f) Application of dilation process without dilating of the background (g) Application of dilation process with dilating of the background (h) smoothing of edges using mean filter
5. Experimental Results

We measured the algorithm performance of the proposed iris detection with the CASIA database Ver 1.0 (http://www.nlpr.ia.ac.cn/english/irds/irisdatabase.htm). All samples have been chosen carefully. Fig. 3 shows examples of our proposed iris detection results.

![Figure 3: (a) CASIA database Ver 1.0 (b) Iris detection using morphology operations (c) Smoothing edges using mean filter](image)

6. Conclusions

In this paper, morphology technique (erosion and dilation) was used to detect the iris. Morphology operations were used as following step for threshold. The proposed technique is very easy in comparison with the other techniques. It does not need any information about pupil to discover location of the iris. Consequently, it does not need guess potential iris centers and Radii. So, the process not consume a lot of time, and complexity of computations. At the same time, it gave comparable performance like the other techniques.

7. References


