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Recognition of Non Circular Iris Pattern of the Goat by Structural, Statistical and Fourier Descriptors

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Abstract

The present paper has described a comparative study to find the iris pattern of the goat which has nearly rectangular or square type appearance. For detecting the structural descriptors, the deviation of the iris pattern shape and size from a standard circular (annular) shaped have been thoroughly studied. Statistical feature extraction has mainly dealt with the various types of moments e.g. – mean variance skewness and kurtosis[1,2]. Fourier descriptors have been extracted by 2D Fourier Transformation of the entire data set comprising patterns. It has been found that Fourier Descriptors are not directly insensitive to possible geometrical changes of the iris location like translation, rotation and scale change occurring due to eye ball movement and blinking of the eye lids. The result shows that the structural descriptors based pattern recognition rate produce a recognition rate of 97.85% with 4.5% of false acceptance rate and 2.2% false rejection rate. The images during the study were acquired from real life with 16 megapixel camera resolution.

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Keywords: Goat; Noncircular Iris; Pattern Recognition; Spectral Based Descriptors; Statistical.

1. Introduction

Iris pattern recognition is normally applied for keeping the human biometrics required in the various socio and economic background like to prepare various biometric signature and personal identification. Human iris pattern images are stored in CASIA or UBIRIS databases where a huge number of iris images are stored for the use of various purposes. The goat is a domestic animal which is almost found in Asiatic Countries. The goat is kept as a pet for having milk or to consume their flesh as an animal protein. The significance of the goats' eye is their non-circular iris pattern and the shape can be thought of as a near rectangular shape. The proposed study has dealt with 700 goat iris images acquired under uniform daylight illumination with the help of 16 mega-pixel camera. The images of the goat iris are shown in Fig. 1. And so far no study or report is found on the feature extraction and pattern recognition of goat's iris in any published or online literature.

The schematic may resemble with rectangular shape. The rounded corner portion shows the deviation from near rectangular appearance. These areas have been utilized in the present study for feature extraction and matching as they have various structural features and they can be well utilized for feature and subsequent pattern matching. In the next

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Fig. 1. (a) The Iris of a Goat; (b) Rectangular Shape Iris of a Goat.

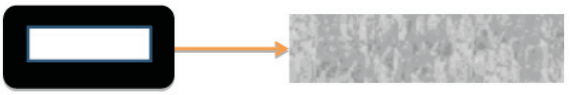

Fig. 2. Normalization of Goat Iris.

phase statistical feature are considered. When any image is considered various attributes can be known either syntactic or geometric axonometric colours, texture and shape of the goats near rectangular iris are considered. The goat's eye contains many interlacing near obliterated attributes like freckles, coronas, stripes, furrow, crypts etc. All these constitute a dataset and these data can be analyzed in terms of statistical features like mean, variance, skewness and kurtosis. In the third phase the image data which includes geometric, statistical, textural, colorize are transformed into frequency domain through MATLAB code (Version R0014) by two dimensional DFT. The drawbacks of Fourier domain feature is that they are sensitive to geometrical variations of the image like translation, rotation, scale changing etc. In addition to it the Fourier domain feature are affected in the boundary area of the eye and thus it renders inappropriate for versatile feature extraction. By comparing the ultimate result it is observed that structural descriptors based recognition produces a recognition rate of 97.85% with 4.5% of false acceptance rate and 2.2% of false rejection rate and 5.14% equal error rate.

1.1 Related work

J. Daugman was the pioneer in the field of Iris Recognition. In his work Integro differential operator is used for Iris Segmentation using Rubber sheet model for Iris Normalization for Iris Recognition.

R. Wildes made the main contending research. His work depended on a Pyramid Laplacian to perform the 2-D band pass decay keeping in mind the end goal to speak to iris pictures. A mapping capacity gave the right correspondence amongst them and the Fischer's Discriminate assessed their similitude. Both of the above works were honoured U.S. Daugman's framework was actualized into equipment and business items from Iris Scan are at present accessible in the business sector.

W. Boles study was based on calculation of zero crossings over the concentric circles that are present on the human irises by wavelet transformation.

Faez Firdaus Jesse Abdullah et al detected found various eye diseases of goats for treatment by different biological measures for Infectious Keratoconjunctivitis a contagious bacterial disease of the eye.

Libor Masek's study was based on both as uniqueness of Human Iris as well as a signature for biometric. The iris Recognition System comprises of a programmed division framework that depends on the Hough Transform, and can confine the roundabout iris and understudy locale, by removing noises like eyelids, eyelashes and reflections. The extracted iris area was then standardized into a rectangular correlate region with steady measurements to represent imaging irregularities. In the last stage the phase related data taken from one dimensional Log-Gabor filter were taken out and quantised into four levels for encoding the unique pattern of the iris under test to a bit dependant template based on biometric. Hamming distance was lastly calculated to classify the iris template matching.

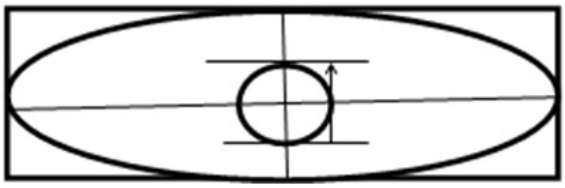

Fig. 3. Horizontal Arrow shows the Distance b whereas Vertical Arrow shows Distance a.

Although a large number of studies on pattern matching and recognition on human iris are carried out no study is so far available in any journals and conference proceedings with goat's irises. The paper organizes as follows:

Section 2 describes the mathematical background of goat's iris pattern. Section 3 tells about the brief process steps and Section 4 has dealt with the results and discussion while conclusion is described in Section 5.

2. Features of Goat Iris and Mathematical Background

2.1 Various geometrical features

a) The area of the near triangular zone = 1/2 Lw. Slight error will be there due to non-linearity of the hypotenuse portion.

b) The curvature of hypotenuse is given by $k = d\theta/ds = \frac{d^2y}{dx^2} \Big/ \left[1 + \left(\frac{dy}{dx}\right)^2\right]^{\frac{3}{2}}$

c) The aspect ratio of the iris is given by b/a outer border.

d) Aspect ratio of Iris/Pupil border

e) The area of the pupil = $\pi\,(b'/2)^2 + \pi\,(a'/2)^2$

2.2 Various statistical features

The entire set has been analyzed from stochastically. Let all parameters are given as a set $S = \{x_1, x_2, x_3, \ldots x_n\}$. Hence the following moment values are considered.

a) Arithmetic mean = $\sum_{i=1}^{n} xi/n = \bar{x}$

b) Geometric mean = $(x_1, x_2, x_3, \ldots x_n)^{1/n}$

c) Variance $\delta_2 = \sum_{i=1}^{n} (x_i - \bar{x})^2/n$

d) Skewness = Skew $(X) = E[(X - \mu/\delta)^3]$

e) Kurtosis = Kurt $(X) = E[(X - \mu/\delta)^4]$

2.3 Various fourier descriptors

The 2D DFT is given by the equation:

$$\frac{1}{MN \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} f(x, y)e} - j2\pi\,(ux/M + vy/N)$$

3. Process Steps for Iris Recognition for Goats

3.1 Image acquisition

This is done by 16 mega-pixel camera and 700 goats eye image are being captured (including both male and female) and have been studied.

Table 1. Simulation Parameters.

Area of Triangular Offset	Curvature of the Hypotenuse ($d\theta/dr$)	Aspect Ratio for Outer Iris Boundary	Aspect Ratio for Inner Iris Boundary	Pupil Area
15.42	0.02	0.765	0.71	4.39

3.2 Removing of occlusion due to eyelash

The eyelash removal is accomplished by using Canny edge detection Algorithm for successive three times as to acquire a perfect sharp image for Iris analysis. It will help in minimizing the trace of eye lashes too that acts as a noise to the image. At the same time Goat eye images are segmented in a satisfactory way[1,2]. The demarcating line between the outer boundary and sclera is done as well as the boundary line between the inner diameter iris and pupils. This will help to locate the near rectangular iris area within the eye. Isolation and removal of other artefacts, if any, is done at the same.

3.3 Normalization

Normalization process will yield iris region that have the same constant dimension so that multiple images of same iris under different conditions will possess characteristic features at the same spatial location. As such when the size of the pupil changes the non linear property of the goat iris deformation due to different constraint gets resolved. The diagram is shown in Fig. 2.

3.4 Feature extraction

The feature extraction process formula is already mentioned in Section 3. Matlab code has been used to find the distance and location between the pixels on the image plane. The results obtained for various feature is given below:

3.5 Stochastic features

The values are entirely variable depending on the clusters of data considered from the total data.

3.6 Fourier domain features

The values fully depend on variation of greyness of the goat iris, Where the rate of change of gray level with respect to space is more, it gives rise to high frequency where the flat region contain lower spatial variation of gray shades gives high frequency.

3.7 Pattern matching and classification

The matching between two goats irises are carried out by using weighted arithmetic mean comparison between two sets of features. The process is very much acceptable in case of goat's eye where a particular gray shade may occur multiple times.

4. Results and Discussions

The results are shown in Table 2, basically the tables are comparative between the proposed three approaches viz. structural, statistical and Fourier domain based. The results are at the same time compared with those obtained by earlier researcher who found recognition rate, equal error rates, false acceptance rate and False Rejection rate with human irises.

From Table 3 it is seen that in the proposed algorithm based on structural (geometrical) features produce the best results during classification of goat Iris. The other methods and their shortcomings are already mentioned in earlier section.

Table 2. Results of Previous Researchers.

Authors	Recognition Rate	Equal Error Rate	False Acceptance Rate	False Rejection Rate
Daugman	99.9	0.95	0.01	0.09
Boles	94.33	8.13	0.02	1.98
Wildes *et al.*	95.10	1.76	2.4	2.9
LaborMasek	96	1.72	1.84	2.0
Avila	97.8	3.3	0.03	2.08
Rai	99	0.92	0.03	0.03

Table 3. Results for the Experiment of Goat in Present Study.

Proposed Experiment	Recognition Rate	Equal Error Rate	False Acceptance Rate	False Rejection Rate
Structural	97.85	2.89	2.2	4.5
Statistical	91.82	6.1	3.1	5.5
Spectral	89.10	5.4	4.6	5.1

5. Conclusions

This present study may be treated as a noble one as it is expected that it would build some basis in the field of pattern matching and recognition in a very efficient manner. Moreover domestic animals census can be done on the basis of Iris pattern matching biometric so as to keep records in government organization. And also male and female species can be identified and can be differentiated with other classification algorithm. Different other algorithms must be carried out continuously so that Iris recognition rate for different domestic animals can be acquired in an effective manner. And mostly infected animals can be distinguished from the groups for better treatment.

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