TEST Engineering & Management

September/ October 2020
ISSN: 0193-4120 Page No. 133-138

IMPLEMENTATION OF FAST AND RELIABLE MULTI SPECTIRAL IRIS SEGMENTATION USING DEEP LEARNING

Stuti Saxena[1], Dr. Vikas Somani[2]

[1]Research Scholar (CS), Sangam University, Bhilwara.
[2]Associate Professor and Head (CS), Sangam University, Bhilwara.

Article Info
Volume 83
Page Number:
133-138
Publication Issue:
September/October 2020

Article History
Article Received*: 4 June 2020*
Revised*: 18 July 2020*
Accepted*: 20 August 2020*
Publication*: 15 September 2020*

Abstract

Iris segmentation is a critical step in the entire iris recognition procedure. Most of the state-of-the-art iris segmentation algorithms are based on edge information. However, a large number of noisy edge points detected by a normal edge-based detector in an image with specular reflection or other obstacles will mislead the pupillary boundary and limbus boundary localization. In this paper, we present a combination method of learning-based and edge-based algorithms for iris segmentation. A well-designed Faster R-CNN with only six layers is built to locate and classify the eye. With the bounding box found by Faster R-CNN, the pupillary region is located using a Gaussian mixture model. Then, the circular boundary of the pupillary region is fit according to five key boundary points. A boundary point selection algorithm is used to find the boundary points of the limbus, and the circular boundary of the limbus is constructed using these boundary points. Experimental results showed that the proposed iris segmentation method achieved 95.49% accuracy on the challenging CASIA-Iris-database.

Introduction

In the 21st century, people use electronics (personal computers, laptops, smartphones, smart watches, etc.) to browse through web-based social platforms, store personal images or videos, chat with other people through text or video, and so on. The amount of personal information stored in electronics is increasing by the day. Thus, biometric authentication is required to prevent unauthorized users from stealing such information from personal electronics. Biometric authentication is also used in the access control systems to identify illegal persons and block them from entering private buildings [1].

Among all the biometric modalities, iris recognition is the one with the highest performance, in terms of false acceptance rate (FAR) and false rejection rate (FRR) [2, 3]. Iris as a biometric identification method has a large amount of the complex texture information available for identification. This paper focuses on an iris recognition system that uses the iris texture for biometric identification.

A common iris recognition system consists of six elementary steps: iris image acquisition, image preprocessing, iris boundary segmentation, iris image normalization, feature extraction, and feature matching [4, 5]. The iris boundary segmentation step is a critical step in the entire iris recognition system. In an iris image, most of the iris textures are concentrated in the iris region close to the pupillary boundary. If the boundary of the pupillary region is not accurately located, a large number of iris textures will be missed in the feature extraction step. In most cases, the limbus boundary is obscured by eyelashes, eyelids, and specular reflections, and thus, a number of noisy features will be extracted in the feature extraction step, if the limbus boundary is not accurately located in the iris segmentation step. These features will deteriorate the performance of the entire iris recognition system [5].

In this paper, we present a novel algorithm for iris boundary segmentation. The proposed algorithm breaks down the iris segmentation step into two actions: locating the eye and segmenting the iris region. Judging whether or not the target exists in the image and locating the target are two major challenges in the object detection technology. Firstly, a well-designed Faster R-CNN network model [6] is used to detect and locate eyes in the proposed algorithm. Once the potential bounding boxes of the eye are obtained, a pretrained Gaussian mixture model (GMM) [7, 8] is used to fit the pupillary region. Secondly, an improved limbus boundary localization algorithm [9] is applied to find the limbus boundary points. Thirdly, the iris region is located by identifying the pupillary and limbus boundaries. Fourthly, we evaluate the accuracy of our algorithm with a newly proposed evaluation method. Finally, we conclude our research by discussing result and the possibility of implementing the method to a mobile device.

Human eye along with the visual system plays a major role in the processing of information for perception. Advancements in the field of ophthalmology beset several approaches such as early detection of retinal diseases, accurate diagnosis, and promotion of awareness about eye health, automated detection to prevent vision loss and improvement to the outcomes. Image processing analysis shows prominence in the field of medicine and more particularly in ophthalmology. Detection of any eye disease following the usual procedure may be possible only at its advanced stage and it may be time-consuming too. The manual method of screening the eye also leads to the wrong diagnosis sometimes. Automated and accurate diagnosis of retinal disease is required for preventing loss of vision. Some of the significant retinal disorders include Cataract, Glaucoma, Diabetic retinopathy, Macular Degeneration, Corneal scarring, Floaters and Retinal detachment. An exciting development of recent origin in the medical imaging techniques encompasses progress towards automated diagnosis of the diseases.

Glaucoma is the most common cause of blindness. During 2016, the World health organization estimated the number of loss of vision due to Glaucoma as 4.4 million worldwide. Glaucoma, a significant retinal disorder is characterized by raised Intraocular Pressure (IOP), cupping of the Optic Nerve Head (ONH) and visual field defects. It is a gradual, progressive and irreversible degeneration of optic nerve fibers leading to loss of vision. Statistical data provided by the Glaucoma Society indicates, among the retinal disorders Glaucoma affects 12.3% of the masses in India next to cataract as depicted in Figure 1.1.

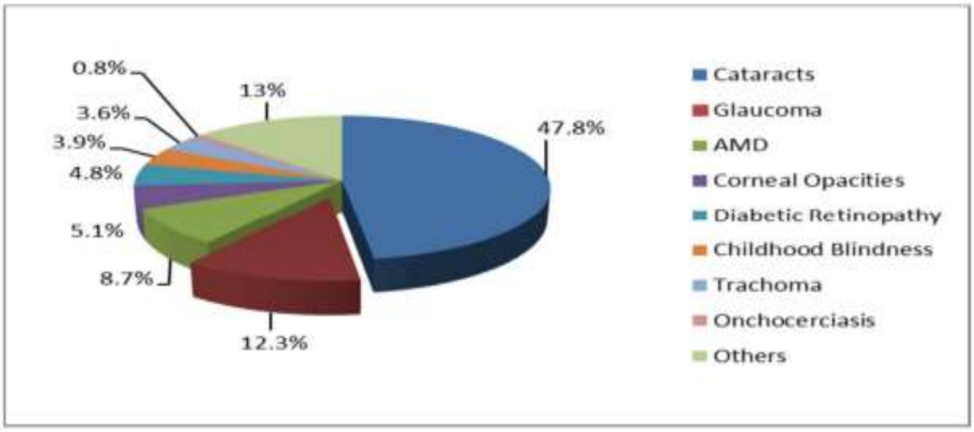

Figure 1 Statistics of Retinal disorders

Glaucoma affects an estimated 12 million individuals in India. By 2020, the number is projected to rise by 33%. (Rohit Saxena et al. 2013). The inability to diagnose Glaucoma has resulted in a significant incidence of blindness among the Indian people. The average number of patients seen by an ophthalmologist is believed to be between 2 and 3 lakh. In such circumstances, a lack of qualified technicians presents a significant problem. Even in a population receiving ocular examination, accurate diagnosis of Glaucoma remains a significant predictor of avoidable blindness. Glaucoma diagnosis and treatment are critical due to the asymptomatic nature of vision loss in the early stages and the irreversible nature of blindness in the later stages.

RETINA AND ITS PATHOLOGY

The visual system plays a major role in processing the information obtained by human beings. A main part of the visual system is the eye that consists of three concentric layers as shown in

Figure 1.2. The outermost opaque, fibrous layer, sclera continues as the transparent cornea in the anterior side of the eye. The middle layer includes the vascularized choroid structure, ciliary body and iris. Light sensitive retina forms the innermost layer of the eye. It converts the light energy focused by the lens into neural signals and then transmits it to the brain through the ONH or the optic disc. The ONH houses the optic nerve as well as the central retinal blood artery. The retina is shaped like a plate and includes light receptors, rods, and cones, which are responsible for dim and strong light vision. The retina can be imaged directly facilitating easy assessment and early

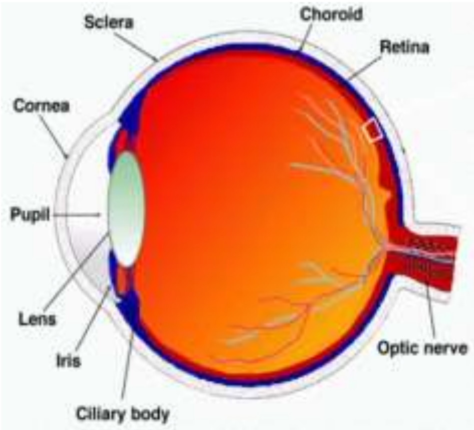

Figure 2 Structure of Eye

Diagnosis of many ocular and systemic diseases. Ocular diseases include Macular degeneration and Glaucoma as the first and the second leading causes for loss of vision (Michael et al. 2010). Retina is also manifest in the organ specific systemic diseases that affect blood circulation and the brain. Systemic diseases include diabetic retinopathy, hypertensive retinopathy, multiple sclerosis, retinal detachment and Retinopathy of Prematurity (ROP).

RETINAL IMAGING METHODS

Imaging the retina helps detection, diagnosis and management of systemic and other ocular diseases. Colour fundus photography, fluorescence angiography, Optical Coherence Tomography (OCT), Ultrasound Bio Microscopy, and Heidelberg retinal tomography are just a few of the imaging modalities available (Stefano Miglior et al. 2003). The OCT and fluorescent angiography are used on a large scale for the diagnosis and analysis of diabetic retinopathy, macular degeneration and inflammatory retinal diseases. Ophthalmoscopy, also known as funduscopy, is a procedure that involves using an ophthalmoscope to look into the eye's fundus and other tissues. It's done as part of an eye exam to look for disease-related abnormalities and track the progression of illnesses like glaucoma.

A specialized fundus camera that consists of an intricate microscope attached to a flash enabled camera is used to photograph the back of the eye. Fundus photography is a fast and simple important imaging tool that has the ability to observe a larger retinal field at a time. It is reliable, non- invasive and easy to use technique for imaging the retina (Abramoff et al. 2010). It is the two-dimensional representation of the light reflected from the semi-transparent retinal layer. Fundus photography is acquired from the digital fundus camera that is mydriatic or non-mydriatic. The mydriatic fundus camera provides high-quality photography that involves dilation of the pupil before imaging. The non-mydriatic camera is smaller and easy to use but is of help only in smaller field of view. The benefits of digital retina pictures include the ability to compare the states of the retinal fundus structures at specified intervals of time, as well as the permanence of the data. Images may be stored and illness development can be tracked over time using fundus photography, allowing for more effective treatment strategies (Khizer et al. 2011). Diabetic retinopathy, glaucoma, and age-related macular degeneration are all diagnosed with color fundus photography, which is widely utilized (Abramoff et al. 2010).

September/ October 2020
ISSN: 0193-4120 Page No. 133-138

SECURE IRIS PATTERN RECOGNITION

The authentication of a human identity is a serious assignment in the present enormously unified civilization. The significance of the consistent human verification method has enlarged in view of high concerns regarding security and quick development. Biometrics is the knowledge of recognizing a individual on the basis of physiological or behavioral character. Applications such as customer control in airports, admittance control in forbidden areas, border control, database access and banking services are some of the instances where the biometric technology has been employed for more reliable identification and verification. Iris based recognition is the most hopeful for serious security environment among various biometric patterns including facial features, finger prints, palm veins, signature, palm prints, retina, gait etc, because of its uniqueness, stability and non-invasive property.

6 IRIS IMAGE DATA PARTITIONING

In this section, the scholar has described how the iris image gained is converted into an R G B matrix into data to be used for Neural Network processing. Each person has their own unique iris pattern, different even between identical twins. Biometric system of iris recognition is used to recognize an individual by verifying the matching patterns found in the iris Ahmad et al**.** (2013). Iris is protected by eyelids, which remains unchanged for lifetime; it may be used as a kind of unique ID or secret code that is not remembered but can be carried anywhere.Iris is a round color muscle, which is delightfully tincture which gives our eye's color. This eye muscle controls the quantity of the light with the goal that based upon lighting conditions, is permitted to enter the eye. Iris is the most characteristic feature of an individual. Even twins do not have similar irises. To tell the truth, even the two irises of an individual are not similar. The probability that two irises are never being precisely the same is assessed at 1 out of 10^{72}. Iris recognition is factually more precise than DNA testing. For these reasons, iris recognition is noticeably fascinating as an alternative way to deal with solid visual recognition of people when imaging is possible at separations of not as much as a meter, and particularly when there is a need to look into huge databases without acquiring any false matches in a countless way.

UPOL Database

Types of Noise in Iris Images

After studying the above described iris databases, we concluded that, the iris database CASIA Ver II, Ver III, and MMU iris database is suitable for the evaluation of robust iris recognition methods, that can overcome Specular and light reflections, and disturbing features like eyelids and eyelashes. We tried to minimize all the pos- sible noise factors. The observations of the available iris image database and in our experimental imaging process, identified and considered the following factors as noise.

BIOMETRICS

Iris is most commonly used in all Biometric authentication systems since authentication using iris is more reliable because the minute architecture of the iris exhibit variations in every humans. The main process in the recognition of the Iris image is basically the extraction of the features and labeling of the Iris images. The Iris images are acquired through camera with subtle infrared illumination to acquire images of the detail-rich, intricate structures of the iris externally visible at the front of the eye. Digital templates encoded from the identified Iris patterns by mathematical and statistical algorithms allow the identification of the individuals. Iris images obtained has similar patterns for persons. The race of the person can also be identified through iris. Asian peoples have iris mostly brown or black in color. Non-Asian people have iris in different shades of red and sometimes blue.

Boundary Detection

In boundary detection there are two steps namely

1. Pupil detection
2. Outer iris localization

September/ October 2020
ISSN: 0193-4120 Page No. 133-138

Pupil detection :

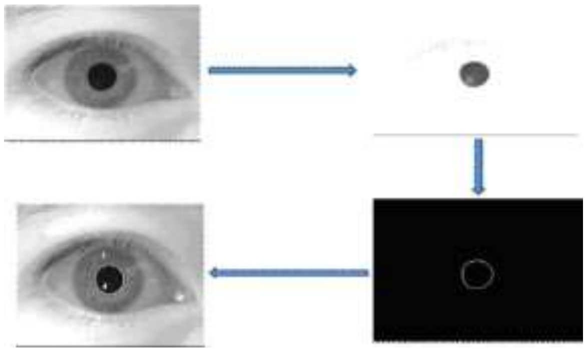

Figure 4– Steps in Inner Boundary Detection of Iris .

Here the contrast of the flash removed image is increased. Then edge detection of contrasted image is performed using canny edge detection. The Canny method finds edges by looking for local maxi ma of the gradient of an image. The gradient is calculated using the derivative of a Gaussian filter. The method uses two thresholds, to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges. Canny edge detection gives the boundary of the pupil, and then by using region props, than the radius of the circle

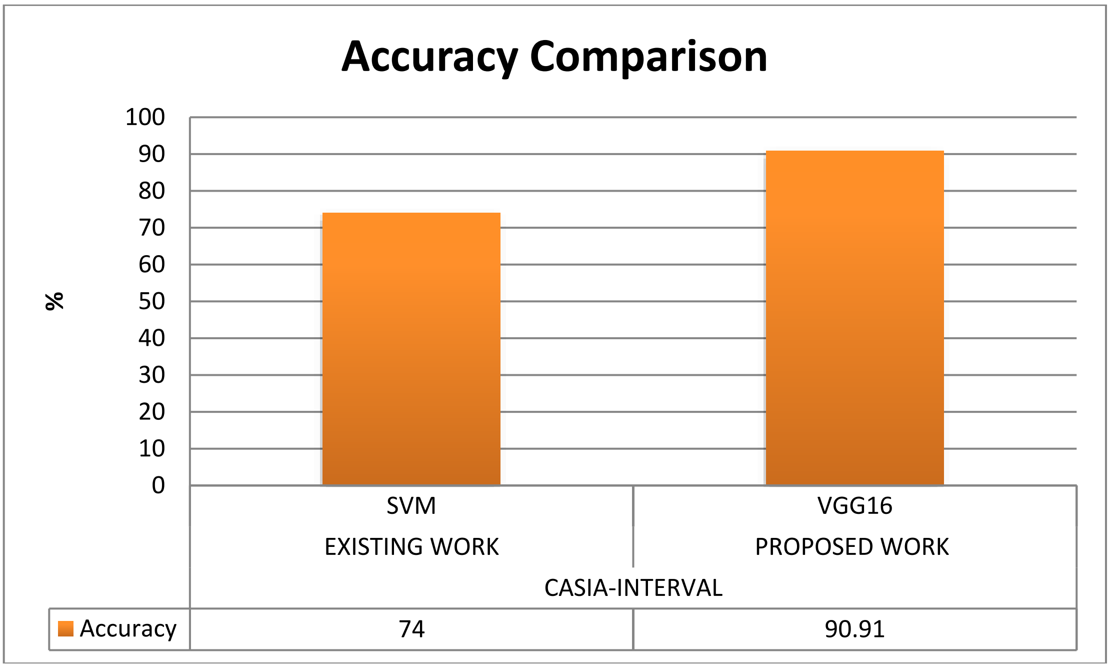

Fig 5 Comparison Result with Existing Work

CONCLUSION:

The proposed system gives accuracy which is higher than the existing algorithms which identifies that the misclassifications are reduced to a greater extend. The Texture method used are thoroughly evaluated and shown to significantly outperform the Texture-based counterparts used for recognizing iris on a number of challenging datasets. The proposed method recognize the iris of the person in the video based on the features extracted exactly even if there were numerous challenges such as illumination variations, Contrast variations and the proposed system detects the liveliness and also it detects the race of the person almost exactly in all the cases. The proposed system is not a completely automated system in order to enhance the system can be automated by avoiding a supervised classifiers.

Iris distribution plays an important role in the overall iris acceptance system. To improve the accuracy of iris distribution, a more accurate iris segmentation algorithm is provided that can detect the final iris distribution. A new method for biometric system based on segmentation of iris is proposed. The proposed system has components for "image preprocessing", "data enhancement" and "classification function extraction". The image pretreatment component retrieves the iris and eye area from the eyeball image in both confined and unrestricted environments.

References

1. Daniel Kerrigan;Mateusz Trokielewicz;Adam Czajka;Kevin W. Bowyer

September/ October 2020
ISSN: 0193-4120 Page No. 133-138

Iris Recognition with Image Segmentation Employing Retrained Off-the-Shelf Deep Neural Networks 2019 International Conference on Biometrics (ICB) Year: 2019

2. Hugo Proença;João C. Neves Segmentation-Less and Non-Holistic Deep-Learning Frameworks for Iris Recognition 2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW) Year: 2019

3. Yuting Yang;Peisong Shen;Chi Chen A Robust Iris Segmentation Using Fully Convolutional Network with Dilated Convolutions 2018 IEEE International Symposium on Multimedia (ISM) Year: 2018

4. Viktor Varkarakis;Shabab Bazrafkan;Peter Corcoran A Deep Learning Approach to Segmentation of Distorted Iris Regions in Head-Mounted Displays 2018 IEEE Games, Entertainment, Media Conference (GEM) Year: 2018

5. Mahmut Karakaya Deep Learning Frameworks for Off-Angle Iris Recognition 2018 IEEE 9th International Conference on Biometrics Theory, Applications and Systems (BTAS) Year: 2018

6. Juš Lozej;Blaž Meden;Vitomir Struc;Peter Peer End-to-End Iris Segmentation Using U-Net 2018 IEEE International Work Conference on Bioinspired Intelligence (IWOBI) Year: 2018

7. Hugo Proença;João C. Neves Deep-PRWIS: Periocular Recognition Without the Iris and Sclera Using Deep Learning Frameworks IEEE Transactions on Information Forensics and Security Year: 2018

8. Yang Meng;Run Wang;Juan Wang;Jie Yang;Guan Gui IRIS: Smart Phone Aided Intelligent Reimbursement System Using Deep Learning IEEE Access Year: 2019

9. Aidan Boyd;Adam Czajka;Kevin Bowyer Learning-Based Feature Extraction in Iris Recognition: Use Existing Models, Fine-tune or Train From Scratch? 2019 IEEE 10th International Conference on Biometrics Theory, Applications and Systems (BTAS) Year: 2019

10. Qianyang Zhuang;Zhang Kehua;Jiayi Wang;Qianqian Chen Driver Fatigue Detection Method Based on Eye States With Pupil and Iris Segmentation IEEE Access Year: 2020

11. Daksha Yadav;Naman Kohli;Akshay Agarwal;Mayank Vatsa;Richa Singh;Afzel Noore Fusion of Handcrafted and Deep Learning Features for Large-Scale Multiple Iris Presentation Attack Detection 2018 IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (CVPRW) Year: 2018

12. Kanishka Singla;Rahul Namboodiri;Priyanka Verma;Rakhshan Anjum Shaikh Novel Approach for Iris Localization using Machine Learning Algorithms 2019 International Conference on Computational Intelligence and Knowledge Economy (ICCIKE) Year: 2019

13. Mohammadreza Azimi;Seyed Ahmad Rasoulinejad;Andrzej Pacut The Effects of Gender Factor and Diabetes Mellitus on the Iris Recognition System's Accuracy and Reliability 2019 Signal Processing: Algorithms, Architectures, Arrangements, and Applications (SPA) Year: 2019

14. S.V. Mahesh Kumar;R. Nishanth;Nidhin Sani;Abin John Joseph;Agath Martin Specular Reflection Removal Using Morphological Filtering for Accurate Iris Recognition 2019 International Conference on Smart Structures and Systems (ICSSS) Year: 2019

15. Muktar Danlami;Sapiee Jamel;Sofia Najwa Ramli;Siti Radhiah Megat Azahari Comparing the Legendre Wavelet filter and the Gabor Wavelet filter For Feature Extraction based on Iris Recognition System 2020 IEEE 6th International Conference on Optimization and Applications (ICOA) Year: 2020