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Automatic Detection of Diabetic Retinopathy using Deep Learning

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ABSTRACT: Biometric system is a pattern-recognition system that recognizes a person based on the personal physiological or behavioural characteristics that the person possesses. Human retina, one source of biometric provides the most reliable and with the emerging potentials of automated image processing a highly secure means of authentication is possible. The proposed system describes the development of segmentation methodology in the processing of retinal blood vessel image obtained using fundus colour photography. It is a personal identification system based on the vascular pattern of human retina consisting of three stages; i.e. preprocessing, feature extraction and finally the classification process. The colour fundus retinal image is acquired from the medical fundus camera from which the blood vessel pattern is segmented using morphological operations with the disc shaped structuring element. The features extracted from the vessel pattern are provided to the Neuro-fuzzy classifier, an advanced rule-based classifier providing access to the person.

General Terms

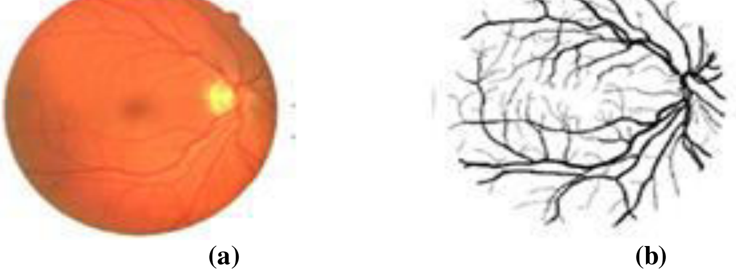
Biometric systems, retinal vascular pattern, fundus.

KEYWORDS: biometric, morpological operations, authentication, neuro-fuzzy classifier.

I. INTRODUCTION

Biometric system use distinctive anatomical and behavioral characteristics of humans to confirm a person's identity by extracting and comparing patterns in their characteristics against computer registered patterns. The extracted patterns are matched against previously indexed patterns, and, within convinced tolerances, a confirmed match can be used to authenticate person's identity. Biometric resources include fingerprint, face, hand or finger geometry, iris, retina, signature, speech, hand vein, etc. each has its own merits and demerits. However no biometric traits are perfect for identification [7][11].

Diabetic identification based on retinal vasculatures in the retina provides the most accurate and high level of security to access control systems. Recently, there has been much interest in retina identification. Although there are several systems based on the traditional biometrics but all of these can easily be forged. Human retina contains vascular pattern which is unique in every human and can be used in biometric system. Unlike traditionally used biometric systems, vascular pattern of human retina is the most reliable and stable source for biometrics [26]. It is not easy to forge as it lies at back end of human eye and is not directly accessible. The groundwork of the retinal recognition is the retinal fundus image acquired from the fundus camera consisting of low power microscope and is used by eye specialists for treatment of retinal diseases The fundus of eye refers to the interior surface of the eye opposite to the lens. The retinal fundus image and the blood vasculature extracted are shown in the following Figure 1



(a) (b)

Figure 1 (a) Retinal Fundus Image (b) Vascular Pattern

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II. BLOOD VESSEL EXTRACTION

2.1 Image Acquisition

Retinal photography is acquired through the use of a complex optical system, called a fundus camera[24]. It is a specialized low power microscope with an attached camera, proficient of simultaneously illuminating and imaging the retina. It is designed to image the interior surface of the eye, which includes the retina, macula, optic disc and posterior pole [1] [3].

2.2 Pre-Processing

Fundus image is an RGB image consisting of three channels (red, green and blue).The extraction of blood vessels can be accomplished by separation of the retinal image into individual channels and using only one of them (green). The blue channel is characterized by low contrast and does not contain much information. The vessels are visible in the red channel but this channel usually contains too much noise.[6] While the green component of the colour retina image gives the best result in the contrast of blood vessels (darker blood vessels on a bright background) [9] and also provides decreased computational time [8]. Therefore, the green channel of the image is used in the automated analysis suppressing the other to colour components [28].

2.3Enhancement

A Contrast-Limited Adaptive Histogram Equalization (CLAHE) was applied for contrast enhancement [4][10]. CLAHE operates on small regions in the image. The contrast of each small region is enhanced with adaptive histogram equalization. The green channel image provides maximum contrast between the image and the background, with most values in the middle of the intensity range. This adaptive histogram equalization produces an output image as in Figure 3(b) having values evenly distributed throughout the range.

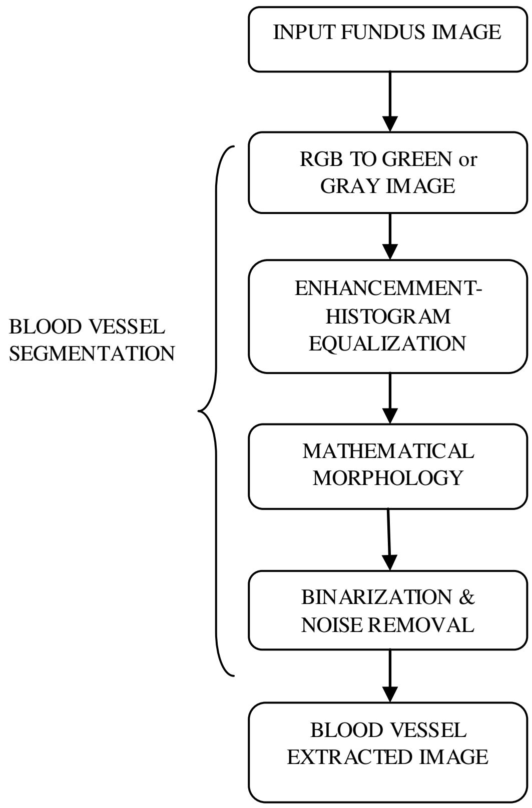

Figure 2 Process involved in blood vessel extraction

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2.4Mathematical Morphology

This section details the segmentation of digital fundus images for extraction of the blood vessel pattern. The proposed approach utilizes mathematical morphology operations for the segmentation [19] [20]. Initially, the color digital fundus images are converted to gray scale images to segment the abnormal areas. Erosion and dilation are the two basic operations in mathematical morphology. Two different combinations of these operations represent the rest of the operations. The symbols$\oplus$, Θ, $\circ$ and $\cdot$, respectively denote the four morphological operations: dilation, erosion, opening and closing [28]. A function $f(x, y)$ denotes the image, where $(x, y) \in f$ and the function $h(x, y)$ or h will act as the structuring element. The morphological operations are defined as follows:

Dilation:

$$(f \oplus h)(x, y) = \sup\{f(x-r, y-s) + h(r, s)\}$$

Erosion:

$$(f \,\Theta\, h)(x, y) = \inf\{f(x+r, y+s) + h(r, s)\}$$

Opening:

$$f \circ h = (f \,\Theta\, h) \oplus h$$

Closing:

$$f \bullet h = (f \oplus h) \,\Theta\, h$$

where sup{ } and inf{ } denote the supremum and infirmum operations respectively.

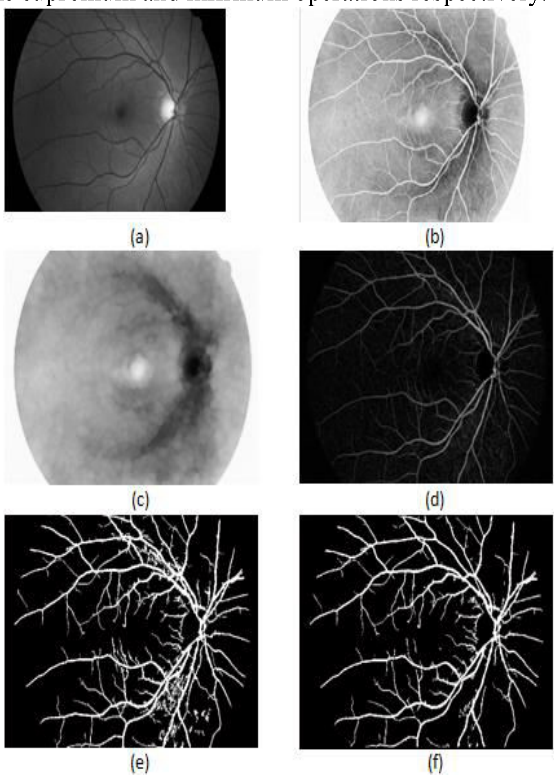

Figure 3 Process involved in blood vessel extraction (a) Green component image (b) Enhanced image (c) Image after opening (d) Removed optic disc (e) Binarized noisy image (f) Noise removed blood vessel pattern.

In this approach binary open morphological operation is used for the segmentation of fundus photographs [5]. Erosion followed by dilation forms a powerful operator called opening. Generally, objects that are adjoined are detached, objects that are adjacent are spaced, and the holes within the objects are enlarged by opening [16][17]. The gray scale digital fundus images are segmented using binary morphological operation followed by subtraction of opened image from enhanced image [18].

2.5Binarization and Noise Removal

Image binarization converts an image of 256 gray levels to a black and white image using a threshold value. The median filter is a nonlinear filter, which effectively reduces impulsive distortions in an image and without too much distortion to the edges of such an image [22]. It is an effective method of suppressing isolated noise without blurring sharp edges.

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2.6Feature Extraction

Feature extraction is the process of acquiring higher level image information. The features are extracted from the noise removed vascular pattern resulting from the segmentation process. Feature selection involves selection of features that provide better class separability and are exploited in the process of matching and classification [21].

III. NEURO-FUZZY CLASSIFICATION

Neuro-Fuzzy classifier is a hybrid intelligent system incorporates the reasoning style of fuzzy systems through the use of fuzzy sets. It is a linguistic model consisting of a set of IF-THEN fuzzy rules defined over the features selected. The classifier is trained with publicly available databases and the process involved is illustrated in Figure 4. The training data or hand labeled ground truths do not contribute directly to the design of the algorithm in these approaches.

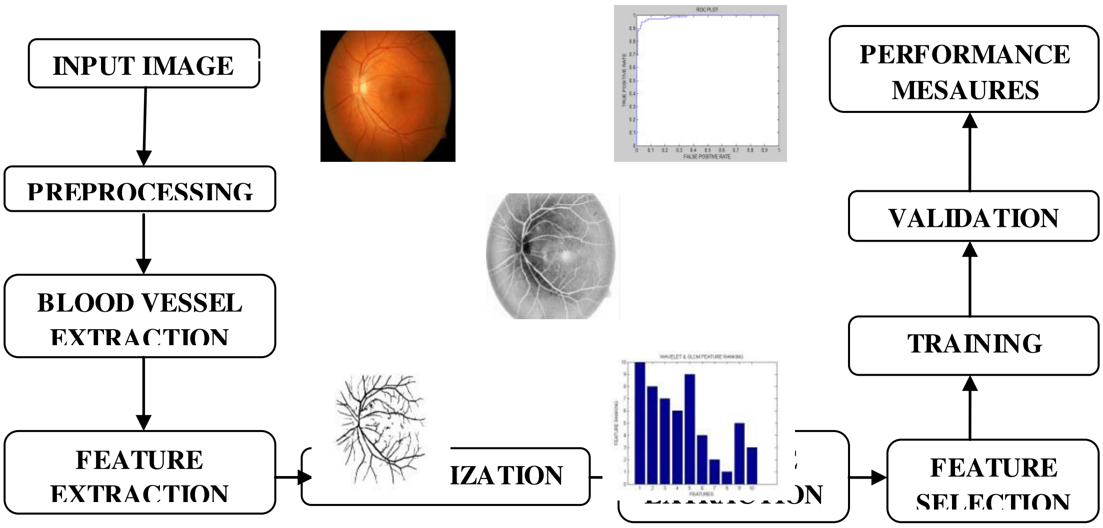


Figure 4 Training phase of the classifier

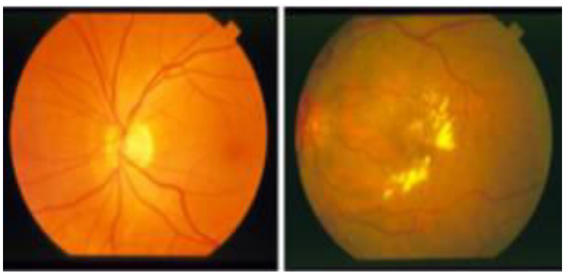
It uses linguistic descriptions like genuine and imposter in providing access control. The fuzzy process is based on finding the membership functions of the linguistic values. The system is tested with the publicly available databases other than used for training to evaluate its performance.

IV. PUBLICLY AVAILABLE RETINAL IMAGE DATABASES

A summary of all the publicly available retinal image databases is given in this section. Most of the retinal vasculature segmentation methodologies are evaluated on the following databases.

4.1 STARE database

The STARE database contains 20 images for blood vessel segmentation; ten of these contain pathology. Figure 5 shows retinal images from the STARE database. The digitized images are captured by a TopCon TRV-50 fundus camera at 35◦ field of view. The images are digitized to 605×700 pixels, 8 bits per color channel. The approximate diameter of the FOV is 650 × 500 pixels[14].



(a) **(b)**

Figure 5 Retinal Images from STARE: (a) healthy retina (b) pathological retina.

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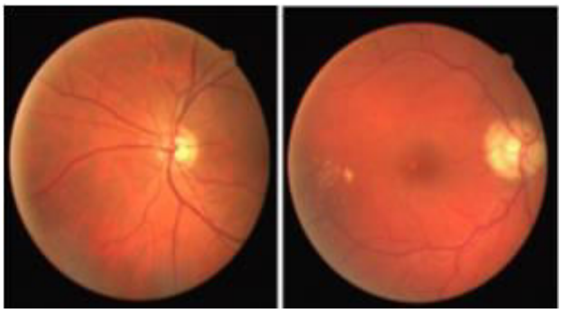
4.2 DRIVE database

The DRIVE (Digital Retinal Images for Vessel Extraction) [14] is a publicly available database, consisting of a total of 40 colour fundus images. The images are obtained from a diabetic retinopathy screening program in Netherland. The screening population consisted of 453 subjects between 31 and 86 years of age. Each image has been JPEG compressed, of the 40 images in the database, 7 contain pathology, namely haemorrhages, exudates and pigment epithelium changes. Figure 5 shown is an example of both normal and diseased images. The images are obtained using a Canon CR5 non-mydriatic 3-CCD camera with a 45◦ field of view (FOV). Each image is captured using 8 bits per color plane at 768×584 pixels[14][15].



(a) (b)

Figure 6 Retinal images from DRIVE: (a) healthy retina, (b) retina showing pathologies.

4.2MESSIDOR database

The Messidor-project database is the largest database of 1200 retinal images. The images acquired at three different ophthalmology departments using a non-mydriatic 3CCD camera at 45◦ FOV with a resolution of 1440×960, 2240×1488or 2304×1536 pixels are stored in TIF format. Out of 1200 Images 800 are captured with pupil enlarged. The reference standard encloses the grading for diabetic retinopathy and the risk of macular edema in each image[13].

4.3REVIEW database

The Retinal Vessel Image set for Estimation of Widths (REVIEW) has been made available online in 2008 by the Department of Computing and Informatics at the University of Lincoln, UK. The database includes 16 mydriatic images with 193 annotated vessel segments consisting of 5066 profile points manually marked by three independent experts. The 16 mydriatic images are subdivided into four sets such as, the high resolution image set (HRIS, 8 images), the vascular disease image set (VDIS, 4 images), the central light reflex image set (CLRIS, 2 images) and the kickpoint image set (KPIS, 2 images) [2].

4.4VARIA database

The VARIA database is a set of retinal images used for authentication purposes. The database has 233 images from 139 different individuals, out of which 59 had two or more samples. The images with optic-disc centered have been acquired with a TopCon non-mydriatic camera NW-100 model with a resolution of 768x584[23].

V. CONCLUSION

Biometric systems confirm a person’s identity by extracting and comparing patterns in their physical characteristics against computer records of those patterns. The extracted patterns are matched against previously indexed patterns, and, within convinced tolerances, a definite match can be used to confirm an individual’s identity. The commonly used biometrics includes fingerprint, iris, face and speech recognition. Although there are highly accurate systems based on this biometrics but all of these can easily be forged. The proposed system utilizes the uniqueness of the retinal vascular pattern of a person as the source of biometric. The primary process involves the extraction of blood vessel pattern which is obtained with the use of morphological operations. The results indicate that this simple and fast automated blood vessel segmentation process facilitates the design of more secure and fast biometric system.

VI. FUTURE SCOPE

Traditional blood vessel segmentation processes have been utilized in hospitals to easily detect diseases occurring in the eyes by the physicians. It is hoped that the proposed retinal image analysis method of segmenting the vascular

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pattern provide a more reliable and stable authentication system. The future line of work is the expansion of the system by defining optimization algorithm for patterns to enhance the search through database of most similar pattern.

VII. APPLICATIONS

In order to lessen the time and stress undergone by the ophthalmologists in detection, diagnosis and treatment of Diabetic Retinopathy (DR), the retinal image processing have been applied. This determines the presence of DR and its severity in a patient by applying techniques of digital image processing on fundus images taken by the use of medical image camera by medical personnel in the hospital [12]. Thus, automated diagnosis replaces manual diagnosis and problem of detection of DR in the later stage for optimal treatment may be resolved.

This project work is one of the methods of applying digital image processing to the field of biometrics in order to provide a more secure access control. Until now the retinal image analysis has been exploited in the area of medical science. Automated blood vessel segmentation from retinal fundus images using digital image analysis offers huge potential benefits.

REFERENCES

[1] Adam Hoover and Michael Goldbaum (2003) “Locating the optic nerve in a retinal image using the fuzzy convergence of the blood vessels” IEEE Transactions on Medical Imaging, Vol. 22, no. 8.
[2] Al-Diri,B.,Hunter,A., Steel,D., Habib,M., Hudaib,T., Berry,S., REVIEW – a reference data set for retinal vessel profiles, in:Engineering in Medicine and Biology Society, 2008 EMBS2008. 30th Annual International Conference of the IEEE,2008, pp. 2262–2265.
[3] Cassin,B., Solomon, S.A.B.,”Dictionary of Eye Terminology”,2nd Edition., Triad Publishing Company, 1990.
[4] Chaudhuri, S., Chatterjee, S., Katz, N., Nelson, M. and Goldbaum, M. (1989) “Detection of blood vessels in retinal images using two dimensional matched filters,” IEEE transactions on Medical Imaging, 8, 263-269.
[5] Cree, M., Leandro, J., Soares, J. & Jelinek, H. (2005) “Comparison of various methods to delineate blood vessels in retinal images,”Proc. of the 16th National Congress of the Australian Institute of Physics, Canberra, Australia, pp. 17-25.
[6] Gonzalez.R.C., and Woods, R.E.,“Digital image processing”, Prentice hall, second edition, 2002.
[7] Jain,A.K., Ross,A., Prabakar,S.,(2004) “An Introduction to biometric recognition,” IEEE Transactions on Circuits and Systems for Video Technology.
[8] Jaspreet Kaur, Dr.H.P.Sinha (2012)”Automatic localisation of optic disc and macula from the fundus image ,”International journal of Advanced research in computer science and software engineering, vol 2,Issue 4.
[9] Joshi,V.S., Garvin,M.K., Reinhardt,J.M. and Abramoff,M.D.,(2011) “Automated method for the identification and analysis of vascular tree structures in retinal vessel network,” in Proc. SPIE Conference on Medical Imaging, Vol. 7963, no. 1, pp. 1–11.
[10] Kevin Noronha, Jagadish Nayak , Bhat, (2006) ” Enhancement of retinal fundus image to highlight the features for detection of abnormal eyes,” IEEE.
[11] Kresimir, D.I. and Mislav, G.,(2004) “A survey of biometric recognition methods,”46th International symposium on Electronics in Marine, ELMAR-2004, Zadar, Croatia, 16-18.
[12] Martinez-Perez,M., Highes,A., Stanton, A., Thorn,S., Chapman,N., Bharath, A. and Parker,K., (2002) “Retinal vascular tree morphology: A semiautomatic quantification,” IEEE Transaction on Biomedical Engineering, Vol. 49, no. 8,pp. 912–17.
[13] MESSIDOR: Methods for Evaluating Segmentation and Indexing techniques Dedicated to Retinal Ophthalmology,http://messidor.crihan.fr/index-en.php, 2004.
[14] Niemeijer, M., Staal, J., Ginneken, B., Loog, M. & Abramoff, M. (2004) “Comparative study of retinal vessel segmentation methods on a new publicly available database,” SPIE Medical Imaging, Vol. 5370, pp. 648-565.
[15] Niemeijer, M., Staal, J., Ginneken, B., Loog, M. & Abramoff, M. DRIVE: digital retinal images for vessel extraction,http://www.isi.uu.nl/Research/Databases/DRIVE,2004.
[16] Pinz, A., Bernogger, S., Datlinger, P. & Kruger, A. (1998) “Mapping the human retina,” IEEE Transaction on Medical Imaging, Vol.17, No.4, pp. 606-619.
[17] Serra.S.,(1988) “Image analysis and mathematical morphology” Vol. 1, Academic Press, London.
[18] Serra,S.,(1986) "Introduction to mathematical morphology, ” Computer Vision, Graphics, and Image Processing, vol. 35,no. 3, pp. 283–305.
[19] Soille,P.,(1999)“Morphological Image Analysis,”Springer Verlag Berlin Heidelberg.
[20] Sternberg,S.R.,(1986) “Grayscale morphology,” Computer Vision, Graphics, and Image Processing, vol. 35, no. 3, pp.333–355.

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[21] Siddalingaswamy, P.C., Prabhu, G.K. and Mithun, D. (2006) "Feature extraction of retinal image," Proc. of the National Conference for PG and Research scholars, 24-27.
[22] Tariq,A and Akram,M.U.,(2010) "An Automated System for Colored Retinal Image Background and Noise Segmentation", IEEE Symposium on Industrial Electronics and Applications (ISIEA 2010), pp. 405-409.
[23] VARIA: Varpa Retinal Images for Authentication, http:/ /www.varpa.es/varia.html.
[24] Ward,N.P., Tomlinson,S. and Taylor,C.J., (1989) "Image analysis of fundus photographs," Ophthalmology, vol. 96, no. 1, pp. 80-86.
[25] Wu, D., Zhang, M., Liu, J.C. and Wendall, B. (2006) "Adaptive detection of blood vessels in retinal images," IEEE Transactions on Biomedical Engineering, 53, pp.341-343.
[26] Yan Sui, Xukai Zou, Du.E.Y,(2011) "Biometric-based Authentication:A new approach,"International Conference on Computer Communications and Networks(ICCN).
[27] Yitao Liang, Lianlian He, Chao Fan, Feng Wang, Wei Li, (2008), "PreProcessing Study of Retinal Image Based On Component Extraction," IEEE Proceedings of International Symposium on IT in Medicine and Education, pages: 670-672.
[28] Zana,F. and Klein, J.C.(2001) "Segmentation of vessel-like patterns using mathematical morphology and curvature evaluation," IEEE Transaction on Medical Imaging,Vol. 10, no.7,pp.1010-1019.