JCSE International Journal of Computer Sciences and Engineering Open Access
Survey Paper | Volume-2, Issue-12 | E-ISSN: 2347-2693

# Diverse Frameworks on Retina Verification

Anitha L.[1*] and Arunvinodh C.[2]

[1*,2] *Department of Computer Science and Engineering, Calicut University, Kerala, India*

**www.ijcaonline.org**

Received: Nov /26/2014 Revised: Dec/08/2014 Accepted: Dec/22/2014 Published: Dec/31/ 2014

***Abstract***— This paper mainly presents different methods for the person authentication. The survey mainly includes the following methods; a high performance system with features obtained from human retinal images, retina verification using feature point based biometric pattern, then using the digital retinal images, retinal fundus biometric analysis, score level fusion of left and right irises, using 2-D matched filters, then using 2-D morlet wavelet method and finally using the biometric graph matching algorithm.

***Keywords***—Retinal Feature Extraction, Retina Vessel Detection, Multigraph Attributes, Biometric Graph Matching, Person Verification

## I. INTRODUCTION

The pattern in the retina is highly unique across the human population. The retina is robust to changes in human physiology, remaining almost the same throughout the lifespan of an individual. The retinal image is not as accessible as common commercial biometrics like finger print and face, as it is internal to the body, though it is claimed to be possible to capture a retina image from up to 1 metre. As accessibility is desirable in most commercial biometric systems, it also makes the biometrics easier to spoof. When the user is co-operative, the retinal vasculature is a biometric that is best suited to high security applications. If authentication is in real time, liveness is automatically ensured. Such advantages, along with improvement in scanning technology, have improved the retinal biometric in the last few years. The most recent method that is the verification based on the biometric graph matching algorithm explains an automatic retina verification frame work using BGM algorithm where the vascular pattern of a retinal image is processed to created a spatial graph template. An algorithm is presented, which compares two graphs derived from two retinal images and returns a set of distance measures between them. The unavailability of large retinal databases inhibits large scale and consistent testing of any retinal verification system. To survive this issue, the data- base used is split into 2 parts - training set and testing set. Kernel density estimation method is used to model the distribution of distances resulting from comparisons in the training set. The model is then used to select an appropriate operating threshold for the system. This system is tested at the chosen threshold using the testing set. Each pair of templates from the testing set is given to the BGM to determine the distance . If that distance is less or equal to the specific threshold ,then they are noted as genuine, otherwise, they are labeled as imposter.

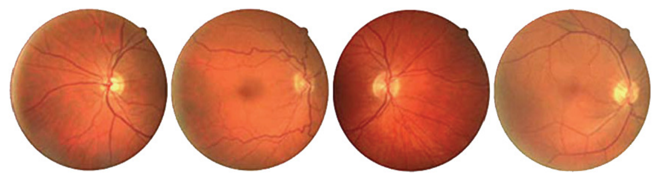

Figure 1: Retina images from four different subjects

## II. LITERATURE SURVEY

### A. *High performance system with features obtained from human retinal images*

A novel biometric identification system with high performance based on the feature obtained from retinal images. It is composed of three principal module including blood vessel segmentation, generation of the features, and also feature matching[1]. Blood vessel segmentation module has the role of extracting blood vessels pattern from retinal images. Feature generation module consists of the following stages. Initially, the optical disk is found and a circular region of interest (ROI) around it is selected in the segmented image. Using a polar transformation, rotation invariant template has been created from each ROI. In the coming stage, these templates are analyzed in three different scales using wavelet transform to separate vessels according to their diameter measures. In the previous stage, vessels position and orientation in each scale are used to define a feature vector for each subject in the database. For feature matching, we are introducing a modified correlation measure to obtain a similarity index for each scale of the feature vector. Experimental results, including 300 retinal images obtained from 60subjects, demonstrated an average equal error rate equal to 1 percent for our identification system. This illustrates different parts of our new biometric identification system based on retinal images. As illustrated in the block diagram, this system is composed of three principal modules including blood vessel segmentation, generation of the features, and feature matching. Blood vessel segmentation provides a binary image containing blood vessels pattern which will be used by the next module. Feature generation module contains several sub modules: (i) vessel masking in the vicinity of OD, (ii) polar transformation to obtain a rotation invariant binary image containing major retinal vessels, (iii) multi scale analysis of the resulted binary image using wavelet transform in order to separate vessels according to their diameter sizes, and (iv) feature vector construction from three images, each containing vessels with specified range of diameter size. Feature matching module contains the following sub modules: (i) computation of similarity indices called SIs for three different scales, (ii) scale-weighted summation of SIs for generating the total SI, and (iii) threshold the computed SI for subject identification. Blood vessel segmentation is essential for our biometric identification system. For extracting retinal vessels, we use an algorithm. This algorithm has the following steps: (i) using a template matching technique OD in retinal image is localized; (ii) the original image is divided by the correlation image obtained in the previous step to achieve a new image in which undesired brightness effect of OD is suppressed, (iii) the vessel/background contrast is enhanced using a new local processing operation based on statistical properties of the resulted image, and (iv) finally, a binary image containing blood vessels is resulted by histogram threshold of the contrast enhanced image.

### *B. Retinal Verification by Feature Points Biometric Pattern*

An efficient method for person identification. The biometric pattern of the system is a set of feature points representing landmarks in the retinal vessel tree[2]. The pattern extraction and matching is explained. A deep analysis of similarity metrics performance is presented for the biometric system. A database from users on different times is used. Here, the system allows to establish a wide confidence band for the metric threshold where no errors are obtained for training and test sets.In this work an efficient method for person's authentication is done. The system's pattern is a set of feature points representing landmarks in the retinal vessel tree. The pattern extraction and matching has been described. A deep analysis of similarity metrics performance is presented for the biometric system. Reliable authentication of persons is a growing demanding service in many fields, not only in police or military environments but also in access control or financial transactions. Traditional authentication systems are based on knowledge (a password, a pin) or possession (a card, a key). But these systems are not reliable enough for many environments, due to their common inability to differentiate between a true-authorized user and a user who fraudulently acquired the privilege of the authorized user. A solution to these problems has been found in the biometric-based authentication technologies. A biometric system is a pattern recognition system that establishes the authenticity of a specific physiological or behavioral characteristic. Authentication is usually used in the form of verification (checking the validity of a claimed Identity) or identification (determination of an identity from a database of known people, this is, determining who a person is without knowledge of his/her name).This method proposes a biometric system for authentication that uses the retina blood vessel pattern. This is a unique pattern in each individual and it is almost impossible to forge that pattern in a false individual. Of course, the pattern does not change through the individual's life. Most common diseases like diabetes do not change the pattern in a way that its topology is affected. Thus, retinal vessel tree pattern has been proved a valid biometric trait for personal authentication as it is unique, time invariant and very hard to forge. The results showed a high confidence band in the authentication process but the database included only 6 individuals with 2 images for each. A weak point of the proposed system was the necessity of storing and handling a whole image as the biometric pattern. Thus it facilitates the storing of the pattern in databases and even in different devices with memory restrictions like cards or mobile devices.

### *C. Personal authentication using digital retinal images*

A very good method for the identifying persons based on matching digital retinal images introduced. The matching process works by first extracting a set of feature points and then register them on to measure the degree of similarity between the input images[3].The feature points are only the ridge endings and ridge bifurcations from vessels and obtained from a crease model of the retinal vessels. The method is well developed and tested to get a good set of feature points. Then, pairs of sets will be matched in the exact order to get a well accurate and reliable similarity measure for the authentication procedure.

### *D. Retinal Fundus Biometric Analysis*

An authentication system for person identification. In the image pre-processing phase, a strong contrast exaltation between blood vessels and also the background in retinal image is carried out; after that blood vessels are extracted and next the vasculature bifurcation And crossover points are recognized within squared shaped regions used for windowing the image[4]. Finally the features sets are compared with a pattern recognition algorithm and as a result a novel formulation is introduced to evaluate a similarity score and to obtain the personal identification.

*E. A robust person authentication based on score level fusion of left and right irises and retinal features*

This method combines the features of both retina and irises. This is also called a multimodal approach. This does reduce the entire computational time and the storage requirements of the iris code. Iris and retina biometric recognition system offers a very much highly reliable solution for the person authentication[5].

*F. Detection of blood vessels in retinal images using 2-D Matched filters*

First, the detection of blood vessels done here. Then the planning of matched filters. Here, associate used for feature extraction . Thought of matched filter determination used to detect piecewise linear segments of blood vessels[6]. Automatic detection of blood vessels in retinal structures helps physicians in finding out ocular diseases. Performs well in finding the fluoresce in angiogram images. Because of very big size of convolution kernel, it takes long time to run in an ordinary computer. So, run in machine vision systems having special hardware support for real time convolution operations.

*G. Shape signature for retinal biometrics*

Deals primarily with encoding the vessel structure surrounding the optic disc. The process is less suitable for finding out from large databases[7].It's a really new method based on the shape signature to quantify the contours of the retinal structure to increase the inter-personal distance and also to decrease the effects of improvement of new blood vessels around the optic disc. Correlations are found as a measure of similarity of 1560 unique retina pairings of different eye images. The results are obtained from a modified shape signature method of quantifying the contour of the retinal structure for the branch shaped vessels. The distribution of the correlation, which varies from -0.54 to 0.76, shows a normal distribution with a mean of 0.09. The effects to translation, scaling, rotation, and noise are also found out[7].

*H. R-V Segmentation using the 2-D Morlet Wavelet and Supervised Classification*

A process for machine-controlled segmentation of the vasculature in retinal[8]. This process do segmentations by classifying every image picture element as vessel or non-vessel,supported pixel's feature vector.The performance is evaluated on publically obtainable DRIVE and STARE databases of manually labelled non-mydriatic pictures.

*I. Retina Verification System Based on Biometric Graph Matching:*

Automatic retina verification Framework employing a biometric graph matching (BGM) algorithm[9]. The retinal vasculature is extracted using a family of matched filters within the frequency domain and morphological operators. Then, retinal templates are outlined as formal spatial graphs extracted from the vasculature. The BGM algorithm, a noisy graph matching algorithm, robust to translation, nonlinear distortion, and small rotations, all these used to compare retinal templates. The BGM algorithm makes use of graph topology to describe three distance measures between a pair of graphs, two of which are new. A support vector machine (SVM) classifier is used to compare between genuine and imposter comparisons. Using both single and multiple graph measures, the classifier gets entire separation on a training set of images from the VARIA database (60% of the data), equaling the state-of-the-art for retina verification. As the available data set is too small, kernel density estimation (KDE) of the genuine and imposter score distributions of the training set are used for measuring quality of the BGM algorithm. In the 1-D case, the KDE model is tested with the testing set. A 0 EER on testing shows that the KDE model is well suited for the empirical distribution. For the multiple graph measures, a good combination of the SVM boundary and the KDE model is employed to obtain a fair comparison with the KDE model for the single measure. The vascular pattern in the retina is thought to be very much unique. Apart from its claimed distinctiveness, the retina is robust to changes in human physiology, remaining almost the same throughout the lifespan of an individual. Since it is internal to the body, the retinal image is not as accessible as common commercial biometrics like fingerprint and face. While accessibility is desirable in most commercial biometric systems, it also makes the biometric easier to spoof. The retinal vasculature is a biometric that is best suited to high security applications where the user is co-operative . Liveness is automatically ensured if authenticating in real time. These advantages, along with improvement in scanning technology, have contributed to the resurgence of interest in the retinal biometric in the last few years . This method proposes an automatic retina verification framework where the vascular pattern of a retinal image is processed to created a spatial graph template. An algorithm is presented, which compares two graphs derived from two retinal images and returns a set of distance measures between them. The lack of much publicly available retinal databases inhibits large scale and consistent testing of any retinal verification system. To survive this issue, the database used is split into 2 parts - a training set and a testing set. KDE is applied to model the distribution of distances resulting from comparisons in the training set . The model is then used to select an appropriate operating threshold for the system. The verification system is tested at the chosen threshold using the testing set. Each pair of templates from the testing set is given as input to the BGM to find and analyze the distance between them. If this distance is less than or equal to the threshold which is already set, they are labeled as genuine, otherwise, they are labeled as imposter. For biometric purposes, retinal templates have been created using general image processing techniques on the raw image and entire images have been matched based on correlation of the overall blood vessel pattern from the image. Next describing about the retinal image enhancement. The image pre-processing procedure is the most important step in the retina feature extraction task. Its aims to obtain images which have normalized intensity, uniform size and shape, and show only enhanced retinal vessels. The retinal image normalized using histogram equalization . The blood vessels usually have poor local contrast . So in order to enhance the vessels, matched filter detection is used to detect piece-wise linear segments of vessels in retinal images. Next is the discussion on retinal feature extraction. Feature extraction is the process of generating features that is to be used in the classification process . The extraction task transforms rich content of images into various content features. In this research work, the skeleton of the vessels is extracted based on morphological image analysis and the feature points (vessel bifurcations and crossovers) are used for classification .Next and the final phase in it includes about retinal graph. The retinal template is defined as a spatial graph extracted from the retinal vasculature. The retina graph is defined by g = (V,E,μ, ν), where the vertex set V is set of feature points extracted from the skeleton of the image and the edge set E is the set of pairs of feature points connected by a vessel. Next is about BGM algorithm. Image samples from the same retinal vascular pattern could vary due to noise, translation, rotation and minor scale changes involved during image capture. Furthermore, the skeleton of the vasculature could be extracted partially when retinal images have slight variation in illumination. These issues cause changes in the structure of the spatial graphs, i.e., change in the location of the vertices, number of edges and number of vertices. Therefore, retina graphs are examples of noisy spatial graphs. The BGM algorithm is a noisy spatial graph matching process that involves two divisions: graph registration and error-tolerant graph matching . The graph registration step makes the graphs by comparing edge and vertex labels. The error-tolerant graph matching stage outputs a spatial graph called the maximum common sub graph (mcs), which will be the intersection of the two compared graphs. Then, the BGM algorithm uses topological features of the mcs to compare between genuine and imposter comparisons.

## III CONCLUSION

In the above literature survey, most of the methods are having a good accuracy for results. In last method described in the literature survey,ie., in the retina verification system based on the biometric graph matching algorithm the steps are entirely different. An automatic retinal verification system described based on the Biometric Graph Matching algorithm. The future work in this area will include improving the algorithm for the removal of spurious vertices during graph creation, optimizing the registration algorithm to get better speed, using some additional graph based edge and vertex attributes derived from the retinal image for matching and using new distance measures to support the classification task. This research also seeks to test the verification system on larger retina databases with high quality color images when such become available.

## ACKNOWLEDGMENT

The authors would like to thank Royal college of engineering and technology for providing good infrastructural facilities during the work. The authors wish to express their gratitude to Varpa research organization for providing the necessary data set that were required.

## REFERENCES

[1] H. Farzin, H. Abrishami-Moghaddam, and M. S. Moin, "A novel retinal identification system", EURASIP Journal of Advances Signal Processing, Volume-**2008**, Page No (**1–10**), April **2008**.

[2] M. Ortega, M. G. Penedo, J. Rouco, N. Barreira, and M. J. Carreira, "Retinal verification using a feature points-based biometric pattern", EURASIP Journal of Advanced Signal Processing, Volume-**2009**, Page No (**1–13**), March **2009**.

[3] C. Mariño, M. G. Penedo, M. Penas, M. J. Carreira, and F. González, "Personal authentication using digital retinal images", Journal of Pattern Analysis and Applications, Volume-**9**, No-**1**, Page No (**21–33**), **2006**.

[4] V. Bevilacqua, L. Cariello, D. Columbo, M. D. Fabiano, M. Giannini, G. Mastronardi, and M. Castellano, "Retinal fundus biometric analysis for personal identifications", Proceedings of International Conference of Intelligent Computing, Page No (**1229–1237**), September **2008.**

[5] L. Latha and S. Thangasamy, "A robust person authentication system based on score level fusion of left and right irises and retinal features", Proceedings of Computer Science, Volume-**2**, Page No (**111–120**), January **2010**.

[6] S. Chaudhuri, S. Chatterjee, N. Katz, M. Nelson, and M. Goldbaum, "Detection of blood vessels in retinal images using two-dimensional matched filters", IEEE Transaction in Medical Imaging, Volume-**8**, No-**3**, Page No(**263–269**), September **1989**.

[7] M. Z. C. Azemin, D. K. Kumar, and H. R. Wu, "Shape signature for retinal biometrics",Proceedings of International Conference of Digital Image Computer Technology and Applications,Page No (**381–386**), December **2009**.

[8] J. Soares, J. Leandro, R. Cesar, H. Jelinek, and M. Cree, "Retinal vessel segmentation using the 2-d Gabor wavelet and supervised classification," IEEE Transaction in

  

Medical Imaging, Volume- **25**, No-**9**,Page No (**1214–1222)**, September **2006**.
[9] Seyed Mehdi Lajevardi, Member, IEEE, Arathi Arakala, Stephen A. Davis, and Kathy J. Horadam "Retina Verification System Based on Biometric Graph Matching" IEEE Transaction in Image Pocessing, Volume-**22**, No-**9**, September **2013**.
[10] R. C. Gonzalez, R. E. Woods, and S. L. Eddins, "Digital Image Processing Using MATLAB", Upper Saddle River, NJ, USA: Prentice-Hall, **2003**.
[11] B. Ulery, W. Fellner, P. Hallinan, A. Hicklin, and C. Watson, "Studies of biometric fusion," Department of Commerce, National Institute of Standards Technology, Gaithersburg, MD, USA, Tech. Rep.IR **7346**, Sep. **2006**.
[12] VARPA. "Varpa Retinal Images for Authentication Database", http://www.varpa.es/varia.html, **2006**
[13] R. Hill, "Biometrics: Personal Identification in Networked Society". New York, NY, USA: Springer-Verlag, Chapter-6, Page No (**123–141**), **1999.**

  