Fingerprint Image Identification Algorithm Based on Angle Direction of Objects

Diyar M. Witefee and Tawfiq A. Al-Asadi
Information Technology College, University of Babylon
E. mail: Dyarz2017@gmail.com

Abstract: Fingerprint identification is one of the most important biometric techniques utilized for determining the similarity between the matching images. This paper will be presenting a new identification technique depending on the angle direction of the objects contained in images. The performance of identification techniques relies on the quality of the image. The quality of fingerprint image may not always be well due to many reasons such as contain noise which hinders the clarity of image structures.

Keywords: Image of Fingerprint, Thinning, Minutiae based matching, Feature Extraction.

1. Introduction

Biometrics science is the analyzing of physical and/or behavioral characteristics that specific to each individual for identification the identity in a reliable and fast way by using of unique biological characteristics. It addresses a longstanding concern to prove individual's identity and individual’s verification, by making use of what makes once different. Historically, applications that using biometrics are military access control, criminal or civil identification and technical framework. Today is including banking, retail, and mobile commerce.

Fingerprint is one of the most widely used biometric. It can be defined as the graphical flows of ridges in human fingers which are formed during infancy. According to researches, not even two people have the same fingerprints. Even the ten fingers of the same person differ with respect to their corresponding fingerprints. Fingerprint image can be used for many purpose such identification and verification.

In this study, the pre-processing is applied to enhance, morphology and thinning the fingerprint image then the local features (Minutiae) extracted; finally the fingerprint images are matching based on the angle direction of the minutiae points. Based on a specific threshold of the correct number of matching score the identification of the fingerprint image is determined.

2. Related work

Over the years, research on image identification has offered a lot of matching methods. Typical examples include the local and global methods like Minutia matching; correlation depended on matching, neural network-based matching and pattern matching.

- Manickam, A., Devarasan, E., Manogaran, G. (2019) [6] introduces a model to perform matching for latent fingerprints using Scale Invariant Feature Transformation (SIFT). Their model consist of two phases (i) contrast enhancement using a fuzzy set (ii) extraction of SIFT feature points
from fingerprints. Then matching algorithm is performed with \( n \)- number of images and scores are calculated by Euclidean distance.

- Alejandro Valdés Camejo and Javier Lamar León [7] used the application of the algebraic topology to present an algorithm for fingerprints verification. They defined local structures based on neighboring minutiae. The extraction of features is based on the homology variation of neighboring minutiae. In addition, a matching method is presented based on the topological information.

- Kimfung Liu and Wenzhong Shi [8] proposed a new developed computational fuzzy topology to define the topological relations among spatial objects. They used the value of a level cutting which represent the intersection between both boundaries with interior and the exterior. They submitted an approximation of these overlapping areas.

3. Research Methodology

Before performing the image matching, a pre-processing step is performing to increase the image quality (corrective measures). Many reasons caused low quality in the fingerprint images such as partial images, the problem of the sensors and the skin problems. Pre-processing step include the enhancement of the image, morphology and thinning process. Then the step of feature extraction is performing which involve extraction the local features (Minutiae) and global features (core and delta). Often the images are different in rotation angle and scale space, and then the next step is the alignment step for the images to be matched. After the alignment step, the images will be in the same rotation angle and similar scale space. The final stage is the matching step, which is performing between the input image and images store in the dataset and then determines the similarity among them.

The proposed system, which is used for fingerprint images identification, illustrate in figure-1 consist of three steps:
The initial stage is the pre-processing stage of the proposed system, are clarified the following points:

1. The input and reference fingerprint images are converted to a binary image: each pixel value in the binary image can be one of two values, either 0 or 255 value.
2. The binary images are enhanced by applying Gabor filters on it: Gabor filters are classified as filters that are sensitive to frequency and orientation, utilized for the analysis of texture and edge. The filter could be modulated by a Gaussian envelope and found the same frequency and direction as a sinusoidal plane.
3. Apply the morphology operations on the input and reference images to improve the enhanced images by focusing on the important objects.
4. Perform Thinning operation on the fingerprint images, It is a morphological process that is adapted to erase the foreground pixels from the binary pictures.

The second step is Features extraction step of the system which is a minutia extraction is performed by using the eight-neighbor technique. This technique is better than the other methods because of the efficiency of its computation and its simplicity. This method involves thinning image utilizing where the ridge flow has connected at eight points. The minutiae pixels are extracted by using a 3X3 window by scanning the local region of every Pixel in the image.

The third step is Fingerprint Identification, which clarifies in the following steps:

- The matching images are blocked into 8-blocks.
- Each minutiae in the input image are matched with all the minutiae that lying in the same block of the image of the reference image.
- To determine the similarity between minutiae, the matching step is performed by using the direction of line between the minutiae pixel and its neighbor pixel by using the equation (1). The direction should be equal in the matched minutiae object.

\[ \Phi = \tan^{-1}\left( \frac{y_{m}-y}{x_{m}-x} \right) \quad \ldots (1) \]

Where,

- \((x_m, y_m)\) the coordinate of minutiae pixel
- \((x, y)\) the coordinate of its neighbor.

4. The Outcomes with the Discussion

The proposed system applied on a fingerprint dataset that download from Neurotechnology company website. It was founded in Vilnius, Lithuania in 1990 with the key idea of using neural networks for applications such as biometric person identification, computer vision, robotics and artificial intelligence. The following results is for input and reference images which are illustrated in figure-2.

The results of the first step of the proposed system can be showing in the figure-3.
The results of second stage for input image and the reference image are illustrated in table-1.

Table-1 Minutiae Feature vectors

| Reference Image | Input Image   |
|-----------------|--------------|
| (193,385)       | (46,259)     |
| (225,353)       | (101,299)    |
| (237,154)       | (200,106)    |
| (252,292)       | (215,383)    |
| (267,377)       | (226,318)    |
| (269,256)       | (238,338)    |
| (302,373)       | (272,272)    |
| (331,413)       | (272,296)    |
| (339,376)       | (282,305)    |
| (368,388)       | (54,313)     |
| (93,303)        | (71,164)     |
| (122,428)       | (80,177)     |
| (148,344)       | (91,272)     |
| (175,355)       | (138,38)     |
| (211,263)       | (167,372)    |
| (252,296)       | (255,58)     |
| (291,115)       | (251,191)    |
| (342,241)       | (255,295)    |

The results of final stage of the system are calculate the direction of angles for the minutiae points of the input and reference images according equation-1 and return the identification if performed between the two images.

5. Conclusion

After applying the proposed system, we got the result that either the two images belong to the same person or not. The system gave a higher rate of matching when the two images belong to the same person. It also gives a lower rate when the two images belong to different persons.

References

[1] Anil K. Jain, Jianjiang Feng, Karthik Nandakumar, “Fingerprint matching”, 2010.
[2] Jain, A.K., Prabhakar, S., Hong, L., Pankanti, S," Filterbank-based fingerprint matching", IEEE Transaction on Image Processing ,2000.
[3] Saeed Mehmendant and Asadollah Shahbahrami, "A Comparison between Different Fingerprint Matching Techniques ", Springer-Verlag Berlin Heidelberg, 2011.
[4] Daniel Peralta , Mikel Galar , Isaac Triguero, Daniel Paternain , Salvador Garciae, Edurne Barrenechea , Jos'e M. Ben'itez, Humberto Bustince , Francisco Herrera "A Survey on Fingerprint Minutiae-based Local Matching for Verification and Identification: Taxonomy and Experimental Evaluation", January 7, 2015.
[5] Meryam Elmouhtadi, Sanaa El fkihi and Driss Aboutajdine, "Fingerprint Identification Using Hierarchical Matching and Topological Structures", Chapter, First Online: 15 October, 2017.
[6] Manickam, A., Devarasan, E., Manogaran, G. et al. “Score level based latent fingerprint enhancement and matching using SIFT feature”, Multimed Tools Appl 78, 3065–3085 , https://doi.org/10.1007/s11042-018-5633-1, (2019).
[7] Alejandro Valdés Camejo, Javier Lamar León, “Application of algebraic topology to fingerprint recognition “,2018.
[8] KIMFUNG LIU and WENZHONG SHI ," Computing the fuzzy topological relations of spatial objects based on induced fuzzy topology ", International Journal of Geographical Information Science, September 2006.
[9] Jianjiang Feng, Zhengyu Ouyang and Anni Cai ," Fingerprint matching using ridges ", Pattern Recognition 39, 2006.
[10] Silas KivutiNjeru and Dr. Robert Oboko,” COMPARATIVE ANALYSIS OF MINUTIAE BASED FINGERPRINT MATCHING ALGORITHMS “, International Journal of Computer Science & Information Technology (IJCSIT), December 2016.
[11] Qi J., Yang S & Wang Y," Fingerprint matching combining the global orientation field with minutia",Pattern Recognition Letters, 2005.
[12] P. Singh and L. Kauri, “Fingerprint Feature Extraction Using Morphological Operations”, International Conference on Advances in Computer Engineering and Applications, 2015.
[13] Zhong Wei-bo, Ning Xin-bao and Wei Chen-jian, "A fingerprint matching algorithm based on the relative topological relationship among minutiae", IEEE Int. Conference Neural Networks & Signal Processing Zhenjiang, China, 2008.
[14] NaifAlajlan and Mohamed S.KamelGeorge Freeman, "Multi-object image retrieval based on shape and topology", 2006.
[15] Dong Luo and Xiaorong Chen ," Research of Topology-based Fingerprint Matching Algorithm", Third International Conference on Intelligent Control and Information Processing, 2012.
[16] B.Sudeepthi, Md.Imaduddin and D.Kavitha, "Comparison of Fingerprint Minutiae Matching Technologies ", IOSR Journal of Electronics and Communication Engineering, Nov - Dec. 2014.
[17] Neelima Kanjan, Kajal Patil 2, Sonal Ranaware and Pratiksha Sarokte, "A Comparative Study of Fingerprint Matching Algorithms ", International Research Journal of Engineering and Technology (IRJET), 2017.
[18] T. A. Al-asadi and A. J. Obaid, "Object detection and recognition by using enhanced speeded up robust feature," International Journal of Computer Science and Network Security (IJCNSNS), vol. 16, no. 4, pp. 66-71, 2016.