Journal of Engineering and Applied Sciences 13 (17): 7401-7407, 2018
ISSN: 1816-949X

DFRS-Database for Fingerprint Recognition System Using Ink-On-Paper Technique

Ahmed Subhi Abdalkafor
Career Development Center, University of Anbar, Anbar, Iraq

Abstract: The ink-on paper technique or off-line approach indicates obtained the ink impression from the skin surface of the fingertip on paper, that is still used in daily-life routines like applications of forensic, issuance of passports, personal identification, security card and as well as request permission of residence in countries that have highest security and other issues that require immediately fingerprints on paper. In this study, we built a new Database for Fingerprint Recognition Systems (DFRS) by different participants from the academic staff, students of University of Anbar and others. Each participant rolled ten times of thumbprint, five left and right of thumbs on a form. After scanning all forms by the high-quality scanner, we cropped all the images of fingerprints and applied a number of preprocessing stages. Therefore, the database includes 1700 images for training and testing of fingerprint recognition systems. The DFRS-dataset will be freely available for the purpose of researchers.

Key words: DFRS databases, thumbprint, segmentation, universe of discourse, scanner, system

INTRODUCTION

The word "biometric" is derived from two Greek words "bios" (life) and "metrics" (measure). Biometric ID of a human uses various characteristics such as fingerprint recognition, face recognition, DNA eye and other kinds of biometrics to confirm the human identity and authority because it is easy to use, fast, trustworthy and accurate. Because (for the) rapid development of technology in the world today, people have begun to demand high security for this matter (Ogbanufe and Kim, 2018; Gomez-Barrero *et al*., 2018; Nigam *et al*., 2015). Today mainly focuses on "Biometric" in order to achieve higher security because the set of passwords has become more complex and problematic to people, since, it is easily broken and unreliable. While biometric systems itself characteristics can be summarized not be lent, forgotten or taken (Al-Ani, 2013; Mansouri and Pourreza, 2017; Li and Zhang, 2012; Subban and Mankame, 2013). Fingerprint recognition is a kind of biometric system for identification or confirmation and widely used in the criminal justice of all kinds, especially, when the absence of DNA to check the identity of the offender and also in exchange salaries and to find out times of entry and exit of the staff at universities or other circuits as well as providing ultimate protection by controlling access to the safe areas. It is also used today so much to open access code in the cell phones. A fingerprint pattern is different even for the identical twins (Kouamo and Tangha, 2016). The offline fingerprints or ink-on-paper fingerprint is a way through which you can get fingerprints of any type of fingers using the ink on the tip of finger and then pressure gently on the paper, this method is used currently in the government departments as well as in countries when requiring the residence permanent (Camacho *et al*., 2017; Ibrahim *et al*., 2017).

Several attributes of fingerprints: A fingerprint consists of ridges and valleys in which ridge is the dark part while valley is the white part of fingerprint that occurs between the ridges, it does not change in life-time. The skeleton of the fingerprint collection of five basic classes (Zhang and Yan, 2004):

- Arch: in which the ridges flow from one side to the other and then leave the other side of the skeleton. It consists of four types: plain, radial, tented and ulnar arches
- Loop: in which the ridges flow from one side of a skeleton, create a curve and then leave on that origin side of the pattern
- Left loop: fingerprint that has flow of one left and out of the same side where it have a one core and delta
- Right loop: fingerprint that has flow of one right and out of the same side where it have a one core and delta
- Whorl: in which the ridges create a circular around a center of the skeleton

Figure 1 show the basic classes of the fingerprint.

Delta: Indicate the difference between two types of lines. It has a shape (Δ).

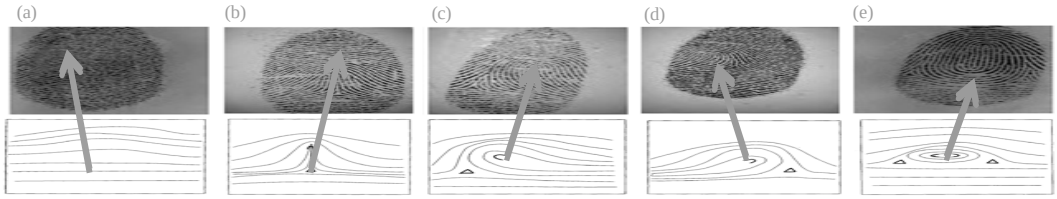

Fig. 1: a) Arch; b) Tented; c) Right loop; d) Left loop and E) Whorl

Core Point: It's founded in the center of circle, in other words founded in the inmost upwardly curve of the friction ridgeline possible contain one or more core points or not contain.

Ridges: Is the curved line on the surface of the finger, some of which are continuous and others end in a fixed points called ridge endings as well as in some times two of them come together called the bifurcation, the bifurcations and the ridge endings and are called the Minutiae. Fingerprint system can operate in two approaches: authentication and identification. In authentication approach, the systems authenticate the person identity after inputting his fingerprint using a one-to-one comparison between input fingerprints and those kept in the record to confirm the valid person. In identification approach, the systems confirm the person identity after inputting his fingerprint and not claiming personality information using a one-to-N comparison between that input and all the fingerprints in database for matching. It is the observed specially with the huge database, the identification approach is more complex than the authentication approach because the first one needs to search all the fingerprints in database for the match (Liu *et al*., 2007). The construction of the proposed database will be used by many researchers who use neural networks and other algorithms (Abdalkafor and Sadeq, 2016; Taher and Subhi, 2018; Abdalkafor *et al*., 2018a, b).

Literature review: Popular databases that are used to evaluate the systems which proposed to enhance the process of recognition are FVC2000/ FVC 2002/ FVC 2004 (Maio *et al*., 2002a, b, 2004) and NIST Special Database: NIST-4, NIST-9, NIST-10, NIST-14, NIST-29, NIST-30 (Watson and Wilson, 1992; Watson, 1993a, b; Watson and Flanagan, 2016; Watson and Watson, 2001; Johnson, 2010). First; The FVC contains three databases, the first one is FVC2000 that collected from eleven participants: seven academic and four industrial while FVC2002 collected from thirty-one participants: six academic, twenty-one industrial and four others as well as FVC2004 database collected by some student volunteers from the University of Bologna. Second; NIST special database consists of some of versions as indicated in the top of a paragraph such as NIST special database (2) that contains 5590 fingerprint images, NIST-4 contains 4000 fingerprint images, NIST-10 contains 5520 fingerprint images with consistent metadata files in each image and NIST-30 contains 6048 fingerprint images.

Jain *et al*. (2017) collected 309 fingerprints from the young children age group (range 0-5) years in hospital of the Saran Ashram, India, The collection of these fingerprints took four different sessions for 1 full year.

Thirty-eight fingerprints were collected by Chen *et al*., 2006) using ink-on paper technique to demonstrate the efficiency of the proposed algorithm, the results demonstrated the efficiency of the algorithm when tested on legacy rolled fingerprint (Jha *et al*., 2015). In this study, the fingerprint of the right finger was taken from 100 volunteers (81 male and 19 female) by the ink on paper technique as in our proposal with the blood group of the volunteer person. The study showed that there is a correlation between fingerprints and blood clots but as mentioned researcher, there should be a large database to obtain more accurate results.

Naim *et al*. (2011) proposed MySQL fingerprint database. This proposed system firstly, execute the histogram equalization to input of the thumbprint images then applied some of methods to enhance the images such as fourier transform, image binarization, image segmentation then minutia extraction via. thinning, minutia marking. Finally, the sample of thirty students thumbprints have been stored in the MySQL database for matching and biometric identification.

Why focus on ink-on-paper technique: The aim of applied this technique in our proposed database to collect number of fingerprint images for following reasons: demonstrate the algorithms work that proposed to improve the recognition process of fingerprint because the offline technique need an efficient methods to enhance the images after taken by a scanner, since, the final resulting image contains some noise and salt

and pepper more than the images by the device sensors, so, the recognition system of images in a first way is harder than the second one (Suman and Kaur, 2012).

Some drawbacks in sensor devices including: any type of devices sensor (On-line technique) may be affected by the quality of the surface finger's skin at far the time-term, probably the outer layer of the skin eroding, so, it difficult to recognize this finger (Sano *et al*., 2006; Suman and Kaur, 2012).

The sensor devices may be easily fooled by using fake fingerprint (offline fingerprint image) to achievement of entry to a system (Memon, 2012). It possible to fooled these sensors by definition one of the fingers of any one to another person, that's what happened in one of the universities when the staff entering to the official working, i.e., input the information for the second person using another finger of the first person such as right thumbprint because most of government departments are used the left thumbprint, i.e., the first person has two of fingerprints one for his and another one for the second person.

MATERIALS AND METHODS

The proposed system consists of four stages:

- Collect the fingerprint images from the various participants
- Segment the images after scanning
- Apply the binarization and universe of discourse methods
- Put the images into two folders

These four stages are illustrated in Fig. 2.

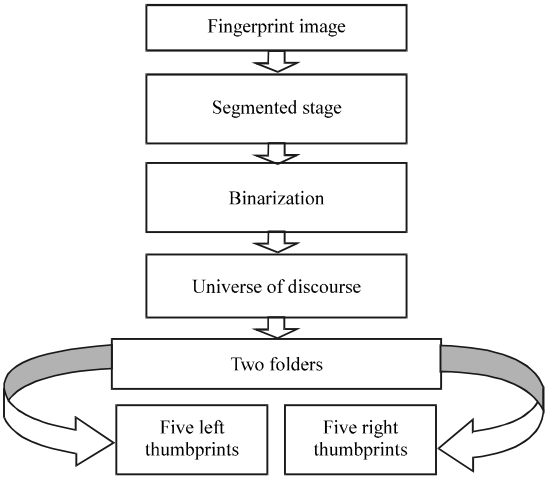

Fig. 2: The block diagram of the proposed system

Data collection stage: The most important stage of any evaluate the performance of the system biometric is the effort to collect the database (Maio *et al*., 2004) and finding an appropriate source is the first step to build a database (Al-Ohali *et al*., 2003). This study aims to collect huge images of fingerprint taken from various ages, genders, education levels and backgrounds. The participants were asked to fill a form that includes: name, age, sex and five squares of thumbprint to the left and five to the right by applying ink to the tip of left and right-hand thumb and place five times on paper with a gently pressure to get an impression of entire tip of the thumbprint. Figure 3 shows the original form of our proposed database.

The form has been distributed among various groups: The academic staff and students of university of Anbar as well as some students of the final stages in the city of Heet in Anbar, Iraq.

Form scanning: All form pages were scanned using HP color scanner with 300 dpi. The scanner scans the forms which include five images each of the right and left thumbprints and output in JPG format. Figure 4 shows the form after scanning.

Segmented stage: Generally, only useful region to recognize each image of fingerprint is a Region of Interest (ROI) (Naim *et al*., 2011).We applied segmenting stage to

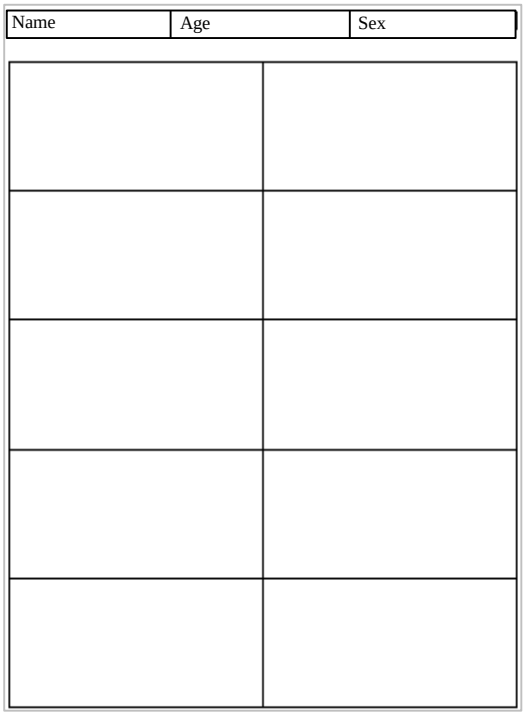

Fig. 3: Original form

Fig. 4: Page form after scanning

segment (manually) each finger from the form page that contains ten fingerprints (five left and right thumbprints), this process completed by the paint software then saved in PNG format. Figure 5 shows the image of five right thumbprints after segmenting stage.

Binarization and universe of discourse methods: The RGB images of fingerprint have some disadvantages of which the time-consuming where the system takes great time in process and analysis, especially, in the system of recognition. Another disadvantage is the large storage space in the memory. So, we applied two methods, first, the binarization method to convert the RGB images into binary image also attempts to reduce all the random sensor noise and ink stains that may exist after the scanning process (Abbood and Sulong, 2014; Conti *et al*., 2002; Otsu, 1979; Abdalkafor, 2017, 2018). The second method, the universe of discourse method to take the shortest universe encloses the image and delete the other parts which do not affect any part of the fingerprint image (Blumenstein *et al*., 2003; Dileep, 2012). By these two methods, we were able to minimize the disadvantage of RGB images. Figure 6 showed the binarization and universe of discourse on the same five right thumbprints in Fig. 6.

Fig. 5: Page form after scanning

Fig. 6: Binarization and universe of discourse methods

Table 1: Statistics of our database

Variables	Values
Number of writers	170
Left folder	850
Right folder	850
Number of images	1700
Training sets	1360
Testing set	340
Type of image	.(.PNG)

RESULTS AND DISCUSSION

After completely the segmenting stage, binarization and universe of discourse methods, these ten fingerprint images put in two separate folders. The first folder contains a five right thumbprints and five left thumbprints in second folder. Since, each fingerprint was printed 5 times for right and left thumbprints by 170 participated and the overall is 1700 images. In our database each folder is separated into 80% for training and 20% for testing. The statistics of our database are shown in Table 1.

CONCLUSION

This study presented a collect database of fingerprints by ink-on paper technique. It is collected from 170 participants filled a form that have the five left and right thumbs of fingerprints. The 1700 finger images have been segmented and applied some suitable preprocessing operations via. binarization and universe of discourse methods to overcome some RGB images disadvantages and the noise that may existing after the scanning process. This database designed for training and testing set the fingerprint recognition systems to match as well as to biometric identification.

RECOMMENDATIONS

For further research, we recommended increasing the sample size of a database through its distribution to the segments of society including universities as well as the schools to obtain more accurate recognition system.

ACKNOWLEDGEMENTS

I would like to thank my father Mr. Subhi Abdalkafor and all those who contributed to complete this study for providing all necessary services to collect the fingerprints images from different academic staff and students of Anbar University.

REFERENCES

Abbood, A.A. and G. Sulong, 2014. Fingerprint classification techniques: A review. Intl. J. Comput. Sci. Issues, 11: 111-122.

Abdalkafor, A.S. and A. Sadeq, 2016. Arabic offline handwritten isolated character recognition system using neural network. Intl. J. Bus. ICT., 2: 41-50.

Abdalkafor, A.S., 2017. Designing offline Arabic handwritten isolated character recognition system using artificial neural network approach. Intl. J. Technol., 8: 528-538.

Abdalkafor, A.S., 2018. Survey for databases on Arabic off-line handwritten characters recognition system. Proceedings of the 2018 1st International Conference on Computer Applications and Information Security (ICCAIS), April 4-6, 2018, IEEE, Riyadh, Saudi Arabia, ISBN:978-1-5386-4427-0, pp: 1-6.

Abdalkafor, A.S., H.M. Taher and K.W. Al-Ani, 2018b. A novel method based on priority for enhancement round-robin scheduling algorithm. J. Theor. Appl. Inf. Technol., 96: 4092-4102.

Abdalkafor, A.S., M.N. Aiman and N.O. Mustafa, 2018a. [Predicting the success rates of schools using artificial neural network (In Preparation)]. J. Theor. Appl. Inf. Technol., 96: 1-11.

Al-Ani, M.S., 2013. A novel thinning algorithm for fingerprint recognition. Intl. J. Eng. Sci., 2: 43-48.

Al-Ohali, Y., M. Cheriet and C. Suen, 2003. Databases for recognition of handwritten Arabic cheques. Pattern Recognit., 36: 111-121.

Blumenstein, M., B. Verma and H. Basli, 2003. A novel feature extraction technique for the recognition of segmented handwritten characters. Proceedings of the 7th International Conference on Document Analysis and Recognition, August 6, 2003, IEEE, Edinburgh, UK., ISBN:0-7695-1960-1, pp: 137-141.

Camacho, V., G. Garella, F. Franzoni, D.L. Martino and G. Carbajal *et al*., 2017. Recognizing Infants and Toddlers over an on-Production Fingerprint Database. In: BIOSIG 2017, Bromme, A., C. Busch, A. Dantcheva, R. Christian and U. Andreas (Eds.). Gesellschaft fur Informatik, Bonn, Germany, ISBN:978-3-88579-664-0, pp: 95-103.

Chen, Y., G. Parziale, E. Diaz-Santana and A.K. Jain, 2006. 3D touchless fingerprints: Compatibility with legacy rolled images. Proceedings of the 2006 International Biometrics Special Session Symposium on Research at the Biometric Consortium Conference, September 19-21, 2006, IEEE, Baltimore, Maryland, USA., ISBN:978-1-4244-0486-5, pp: 1-6.

Conti, V., G. Pilato, S. Vitabile and F. Sorbello, 2002. Verification of ink-on-paper fingerprints by using image processing techniques and a new matching operator. Proc. VIII Convegno AI. IA., 2002: 1-8.

Dileep, D., 2012. A feature extraction technique based on character geometry for character recognition. MSc Thesis, Department of Electronics and Communication Engineering, Amrita School of Engineering, Kollam, India.

Gomez-Barrero, M., C. Rathgeb, G. Li, R. Ramachandra and J. Galbally *et al.*, 2018. Multi-biometric template protection based on bloom filters. Inf.Fusion,42:37-50.

Ibrahim, D.R., A.A. Tamimi and A.M. Abdalla, 2017. Performance analysis of biometric recognition modalities. Proceedings of the 2017 8th International Conference on Information Technology (ICIT), May 17-18, 2017, IEEE, Amman, Jordan, ISBN:978-1-5090-6332-1, pp: 980-984.

Jain, A.K., S.S. Arora, K. Cao, L. Best-Rowden and A. Bhatnagar, 2017. Fingerprint recognition of young children. IEEE. Trans. Inf. Forensics Secur., 12: 1501-1514.

Jha, L., K.D. Das and Z. Ahamad, 2015. Fingerprint pattern examination of right hand thumb in relation to blood group. Janaki Med. Coll. J. Sci., 3: 58-61.

Johnson, S.G., 2010. NIST special database 30. National Institute of Standards and Technology, Gaithersburg, Maryland, USA. https://www.nist.gov/srd/nist-special-database-30

Kouamo, S. and C. Tangha, 2016. Fingerprint recognition with artificial neural networks: Application to E-learning. J. Intell. Learn. Syst. Appl., 8: 39-49.

Li, H. and Z. Zhang, 2012. Unstructured fingerprint database matching method based on Grover's quantum algorithm. JSW., 7: 2301-2308.

Liu, M., X. Jiang and A.C. Kot, 2007. Efficient fingerprint search based on database clustering. Pattern Recognit., 40: 1793-1803.

Maio, D., D. Maltoni, R. Cappelli, J.L. Wayman and A.K. Jain, 2002. FVC2002b: Second fingerprint verification competition. Proceedings of the 16th International Conference on Pattern Recognition Vol. 3, August 11-15, 2002, IEEE, Quebec City, Quebec, Canada, ISBN:0-7695-1695-X, pp: 811-814.

Maio, D., D. Maltoni, R. Cappelli, J.L. Wayman and A.K. Jain, 2002a. Fingerprint verification competition. Proc. IEEE Trans. Pattern Anal. Machine Intell., 24: 402-412.

Maio, D., D. Maltoni, R. Cappelli, J.L. Wayman and A.K. Jain, 2004. FVC2004: Third Fingerprint Verification Competition. In: Biometric Authentication, Zhang, D. and A.K. Jain (Eds.). Springer, Berlin, Germany, ISBN:978-3-540-22146-3, pp: 1-7.

Mansouri, H. and H. Pourreza, 2017. Extreme compression of fingerprint image databases using the model-based transform. Signal Image Video Process., 11: 1543-1550.

Memon, S.A., 2012. Novel active sweat pores based liveness detection techniques for fingerprint biometrics. Ph.D Thesis, Brunel University London, England, UK.

Naim, N.F., A.I.M. Yassin, W.M.A.W. Zamri and S.S. Sarnin, 2011. Mysql database for storage of fingerprint data. Proceedings of the 2011 UkSim 13th International Conference on Computer Modelling and Simulation (UKSim), March 30-April 1, 2011, IEEE, Cambridge, UK., ISBN:978-1-61284-705-4, pp: 293-298.

Nigam, I., M. Vatsa and R. Singh, 2015. Ocular biometrics: A survey of modalities and fusion approaches. Inf. Fusion, 26: 1-35.

Ogbanufe, O. and D.J. Kim, 2018. Comparing fingerprint-based biometrics authentication versus traditional authentication methods for E-payment. Decis. Support Syst., 106: 1-14.

Otsu, N., 1979. A threshold selection method from gray-level histogram. IEEE Trans. Syst. Man Cybern., 9: 62-66.

Sano, E., T. Maeda, T. Nakamura, M. Shikai and K. Sakata *et al.*, 2006. Fingerprint authentication device based on optical characteristics inside a finger. Proceedings of the 2006 International Conference on Computer Vision and Pattern Recognition Workshop (CVPRW'06), June 17-22, 2006, IEEE, New York, USA., pp: 27-27.

Subban, R. and D.P. Mankame, 2013. A study of biometric approach using fingerprint recognition. Lecture Notes Software Eng., 1: 209-213.

Suman, R. and R. Kaur, 2012. Survey on offline finger print verification system. Intl. J. Comput. Appl., 48: 14-19.

Taher, H.M. and A. Subhi, 2018. Artificial neural networks technical transaction for bitcoin (BTC). Proceedings of the 9th International Scientific Academic Conference on Under the Title Contemporary Trends in Social, Human and Natural Sciences, July 17-18, 2018, America Research Foundation, Istanbul, Turki, pp: 1-7.

Watson, C. and P. Flanagan, 2016. NIST special database 14 mated fingerprint card Pairs 2 WSQ compressed images. National Institute of Standards and Technology, Gaithersburg, Maryland, USA.

Watson, C., 1993a. NIST special database 10: Supplemental Fingerprint Card Data (SFCD) for NIST special database 9. CD-Rom and documentation. National Institute of Standards and Technology, Gaithersburg, Maryland, USA.

Watson, C.I. and C.I. Watson, 2001. NIST special database 29: Plain and rolled images from paired fingerprint cards. United States Department of Commerce, Washington, D.C., USA.

Watson, C.I. and C.L. Wilson, 1992. NIST special database 4, NIST 8-bit gray scale images of Fingerprint Image Groups (FIGS). National Institute of Standards and Technology, Gaithersburg, Maryland, USA.

Watson, C.I., 1993b. NIST special database 9, Mated fingerprint card pairs. National Institute of Standards and Technology, Gaithersburg, Maryland, USA.

Zhang, Q. and H. Yan, 2004. Fingerprint classification based on extraction and analysis of singularities and pseudo ridges. Pattern Recognit., 37: 2233-2243.