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Fingerprint Mosaicing Using Modified Correlation Method: A Review

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Abstract - *In this review study, researchers looked at fingerprint mosaicing using a different way and discovered that solid-state fingerprint sensors' smaller contact area does not give enough information (e.g., number of minutiae) for high accuracy user verification. Furthermore, repeated impressions of the same finger obtained by these sensors may only have a tiny region of overlap, lowering the verification system's matching performance. To address this issue, we created a fingerprint mosaicking approach that uses numerous impressions to create a composite fingerprint template. A composite template saves space, increases matching time, and solves the template selection problem. Two impressions (templates) of a finger are initially aligned using the relevant minutiae points in the proposed approach. This alignment is utilised to generate a transformation matrix that describes the spatial connection between the two impressions using a modified version of the well-known iterative closest point method (ICP). The transformation matrix that results can be utilised in two ways: (a) To create a composite picture, the two templates are stitched together. In this composite picture, minutiae points are recognised; (b) the minutia maps produced from each of the individual impressions are combined to create a bigger minutia map.*

Key Words: Biometric Technology, Fingerprint Identification System (FIS), Fingerprint Verification Competition (FVC), Fingerprint Mosaicking.

1. INTRODUCTION

Due to the high level of uniqueness given to fingerprints and the availability of tiny solid-state fingerprint sensors that can be readily incorporated into a broad variety of devices needing user-authentication, fingerprint-based verification systems have grown in popularity (e.g., laptops, cellular phones). However, only a small fraction of the fingerprint pattern is visible at the tip of the finger with solid-state sensors [1]. We employ an image mosaicking approach to generate a more comprehensive fingerprint template utilising numerous impressions of the same finger to solve the problem of inadequate information in a single fingerprint template [2The following are some of the benefits of using a composite template: (a) If a composite template isn't available, the query picture must be compared to each of the individual template impressions (of the same finger). The amount of overlap between the query picture and any template impression is likely to be modest due to the tiny size of these impressions, leading in a false rejection of the query image. A composite template, on the other hand, minimises the chances of a mistaken rejection. (b) The time it takes to compare the query image to the template is cut in half. Only one comparison is required now that a composite template is available. (c) The template selection conundrum is avoided. The requirement to 'weight' individual templates during the matching process is eliminated since information from many templates is combined into a single composite template [1].

To address the aforementioned issue, a fingerprint mosaicking scheme is being developed in which multiple impressions of the same fingerprint are used as input and a composite fingerprint template is generated that contains more information about the fingertip and takes up less storage space than multiple fingerprint impressions[2]. Because just one template corresponds to a single fingertip, it speeds up the matching process. In figure number-01, you can see an example of a fingerprint.

Figure-1: Examples of (a) Rolled print; (b) and (c) Dab prints; (d) Mosaiced print.

1.1 Types of Fingerprints

For a long time, there have been three types of fingerprints available: exemplar prints, patent prints, and plastic prints [1].

Exemplar prints, also known as known prints, are fingerprints purposely collected from an individual, whether for reasons of enlisting in a framework or while in jail for a suspected criminal offense[1]. These prints may be collected using either Live Scan or ink on paper cards.

Patent prints are unambiguous contact edge imprints created by the exchange of outside material from a finger onto a surface that are visible to the naked eye. Impression of flour and moist earth[1] are two examples of irrefutable images. Because they are now evident and do not require upgrading, they are mostly caught rather than lifted like idle prints are. Materials such as ink, dirt, or blood[2] can leave patent prints on a surface. A plastic print is an impression of a grinding edge left in a substance that preserves the condition of the edge detail. Although few lawbreakers would be so indiscreet as to leave their prints in moist soil, this would result on an exquisite plastic print. Softened light wax, putty discharged from the border of window sheets, and heavy oil storage on vehicle parts are common illustrations[2]. Such prints are now instantly recognisable and do not require an update. In addition to these three types, the fingerprints acquired in this manner may be classified into three categories: Rolled/full, Plain/level, and Latent or halfway[2].

1.2 Different Methods of Fingerprint Development

The different methods of fingerprint development are given that:

A) **Laser Method**: The distinctive mark invention has been transformed by laser light. Ontario Provincial Police and the Xerox Research Center in Canada developed the laser technique[3]. The laser takes use of the fact that perspiration contains a variety of different segments that glow when exposed to laser light. It has been observed that this distinctive mark build-up comprises a variety of natural compounds with inherent brightness capabilities, such as oils, paints, and inks. Inert fingerprints reveal radiance using a long-lasting argon particle laser and acceptable channels[4].

B) **Photographic Method:** Because lone sections in coordinate contact may be shot, the prints obtained by this method are clear; nonetheless, the technology has only limited an incentive in dermatoglyphic inspection and is pricey [5].

C) **New Fingerprint Detection Technology:** In this era of cutting-edge DNA innovation, fingerprint confirmation may appear to be outdated criminology, but it isn't as obsolete as some offenders believe. Fingerprinting technology has advanced to the point where it is now easier and faster to create, collect, and discern unique mark confirmation. Attempting to wipe fingerprints clean from a wrongdoing scene may not always be successful [4].

D) **Advanced Fingerprint Identification Technology:** The FBI propelled its Advanced Fingerprint Identification Technology (AFIT) framework which improved fingerprint impression and idle print preparing administrations. The framework expanded the exactness and day-by-day handling limit of the organization and enhanced the framework's accessibility [6].

E) **Prints from Metal Objects:** In 2008, researchers at the University of Leicester in Great Britain built up a method that will upgrade fingerprints on metal articles from little shell housings to substantial automatic rifles [3].

F) **Color-Changing Florescent Film:** Professor Robert Hillman and his Leicester partners have additionally improved their procedure by adding fluorophores particles to the film which is delicate to light and ultra-violet beams. Essentially, the bright film gives the researcher an additional apparatus in creating differentiating shades of inert fingerprints - electrochromic and brilliance [7].

G) **Micro-X-Ray Florescence:** The Leicester approach was developed in response to a 2005 discovery by University of California researchers at Los Alamos National Laboratory who used miniaturised scale X-beam fluorescence, or MXRF, to make unique finger impression images. MXRF detects the sodium, potassium, and chlorine components found in salts, as well as a variety of other components if they are present in the fingerprints [7].

H) **Non-invasive Procedure:** The procedure has a few focal points over customary fingerprint impression location techniques that include treating the speculate zone with powders, fluids, or vapors keeping in mind the end goal to add shading to the finger impression so it can be effectively observed and captured. Utilizing customary fingerprint differentiation improvement, it is infrequently hard to recognize fingerprints introduce on specific substances [7].

2. LITERATURE REVIEW

The summary of the research studied are given that:

Anil Jain [2002] carried out the "FINGERPRINT MOSAICKING" and the conclusion is given that, By employing a modified ICP algorithm to register the two impressions, we have disclosed a fingerprint template building approach that incorporates information contained in two separate impressions of the same finger. Initial tests show that mosaicking the impressions together and then extracting the (template) minutiae set improves the matching system's performance. Future research will focus on fingerprint non-linear deformation, which will assist in better merging the two impressions. We're also aiming to generate bigger templates by mosaicing three or more impressions [8].

Jinwei [2006] carried out the work "Fingerprint Recognition by Combining Global Structure and Local Cues" and conclusion are given that, By merging the global structure (the model-based orientation field) with the local signals, we propose a framework for fingerprint identification (minutiae). The orientation field, minutiae, single points, and effective area mask all take up less than 420 bytes in the fingerprint format. For fingerprint matching, an ensemble classifier is built utilising the orientation field and minutiae as features [9]. Experiments reveal that our suggested technique outperforms the traditional minutiae-based method as well as other research that used complementary information for matching. We may thus deduce that the model-based reconstructed orientation field is more robust and discriminative than the original orientation field, despite the fact that it requires only a few bytes to store. It may be used for fingerprint matching, indexing, and processing. In addition, combining the minutiae and the orientation field, we developed a unique fingerprint alignment approach [9]. While this process takes significantly longer, it is useful for fingerprints of low quality or partial pieces. It can be used to aid semi-automated identification of latent fingerprints. It is critical to represent fingerprints with a comprehensive set of complimentary properties not only for storage but also for identification. The global-and-local representation framework may be expanded to accommodate additional global or local elements seen in fingerprint photos, such as the ridge density map. The fingerprint matching algorithm's performance limit is governed by fingerprint distinctiveness, according to science. Previous studies, such as [7] and [8,] offered methods for estimating fingerprint uniqueness based on the assumption that each minutia is independent of position and orientation [9]. The assumption, however, is not entirely right, because the minutiae's orientations are linked because they are dictated by global ridge patterns. Using the whole orientation field as a discriminant feature can assist to more precisely measure individuality.

Arun [2006] carried out "Image versus feature mosaicing: A case study in fingerprints" and the conclusion are given that, Image mosaicing and feature mosaicing are two approaches for combining data from several impressions of the same finger. We employed thin-plate splines (TPS) to determine the registration (i.e., transformation) parameters pertaining to a pair of impressions [10]. Both mosaicing approaches rely on the use of an accurate registration procedure for matching two images. The TPS model takes into account the relative elasticity of two fingerprints. On the FVC 2002 DB1 dataset, we tested the performance of image and feature mosaicing [10]. While both mosaicing strategies increase the matching system's performance, our results show that feature mosaicing surpasses picture mosaicing. The match scores obtained after picture and feature mosaicing are also connected, as we discovered. Designing a regularisation approach for determining the appropriate amount of minutiae necessary for predicting the TPS parameters [10] is a future project. Using ridge curve correspondences as well as minutiae correspondences, the TPS model might be made more robust. 7 In addition, a method for selecting the best pair of pictures from a collection of impressions for mosaicing must be created [10].

Chunxiao Ren [2009] carried out "A Novel Method of Score Level Fusion Using Multiple Impressions for Fingerprint Verification" and the conclusion is given, that explored with the notion of improving an unmatched fingerprint system by incorporating a score level fusion mechanism [11]. We devised a wrapper approach to obtain improved identification accuracy and make system configuration easier. The novel method we proposed consists of a series of steps: first, attempt to convert multiple enrolled impressions to points in multidimensional space by analysing one-on-one matching results; second, calculate the distance between the query image and the centroid of multiple enrolled impressions in multidimensional space; and finally, a matching step is completed by calculating the distance between the query image and the centroid of multiple enrolled impressions in multidimensional space [11]. This problem is formulated as a distance calculation in a multidimensional space problem, and we present a way to solve it. Experiments show that the strategy outperforms a system based on a single matcher. We claim that our technique has the same impact as any other fusion process in nature, such as fingerprint mosaicking or template synthesis, because the enhanced performance is derived from the adequate usage of many impressions. However, because our approach is a wrapper method, it is more convenient. The query and template pictures are currently matched using the minutiae-based matching approach [11]. We're developing a correlation-based matching approach that uses information from the orientation field and ridge map to match picture pairings. Our future effort will also be focused on improving distance expression [11].

Sandhya Tarar [2014] carried out the "Fingerprint Mosaicking Algorithm to Improve the Performance of Fingerprint Matching System" and conclusions are given that, Mosaicing fingerprint images increases their quality [12]. With the use of fingerprint mosaicking, the suggested technique shows that the matching process' accuracy is improved. False Acceptance Rate (FAR) and False Rejection Rate (FRR) are used to quantify this [12]. Our trials were conducted using an open-access database called Fingerprint Verification Competition (FVC 2002). Based on different sensors, FVC has four types of databases: DB1, DB2, DB3, and DB4. Each set has 10*8 fingerprint pictures, for a total of 320, which were used in the proposed algorithm's execution. We lowered the False Acceptance Rate to lessen various sorts of mistakes that happened during system operation. We are now working on the algorithm implementation and system installation for our university's security system. FRR is greater after using the proposed approach, whereas FAR is lower [12]. Since FAR has dropped, the matching percentage has grown. The mosaicking algorithm's complexity is O (n2), hence it will have no negative influence on the performance of the fingerprint recognition system [12].

SURESH KUMAR [2015] carried out the "A Novel Model of Fingerprint Authentication System using Matlab" and concluded that, the mosaicking process improves the quality of fingerprint images [13]. The suggested approach demonstrates that facilitating fingerprint mosaicking improves the precision of matching practise. A novel approach for touchless fingerprint sensing pictures is proposed in this work [13]. Three perspectives of a fingerprint are covered by the sensing devices, as well as a way of mosaicing these pictures to increase the fingerprint's effective area. This system consisted of a single camera and two flat mirrors at the time, and it provided an alternative to large multi-camera systems [13]. The three fingerprints are strengthened using the Gabor filter approach, resulting in greater minutiae extraction. On the same premise, feature work may be done. According to the findings, the suggested technique improves touchless fingerprint enhancement better than previous methods [13].

Nishanthini [2017] carried out the "Survey on Fingerprint Recognition Using Minutiae Based Technique" and the conclusion is given thatFingerprint identification is a biometric approach for recognising an individual based on his or her fingerprint pattern, which is unique to each person and makes it simpler to identify them [14]. It also aids in the removal of erroneous minutiae, which can be harmful in accurately matching fingerprints [14]. Biometrics is now widely employed in many businesses for security considerations. Fingerprint recognition systems have been shown to be highly successful at securing data and have a wide range of applications [14].

Arnab Sikidar [2018] carried out "Fingerprint Reconstruction from Cylindrical Objects using Image Mosaicing" and the conclusion is given that, It is observed that the fingerprint mosaicing approach is suitable for conviction and can be used as a tool for attaining complete print and matching it with the convicted person [15]. The accuracy of the matching index is about 80-85% and is high enough for a conviction. Furthermore, the detection accuracy of fingerprints also varies on the span of the image taken [15]. The accuracy of matching decreases as the span is increased. A gradual inclination in the imposter score is seen due to the variation of miniaturized details in the samples of fingerprints from different users and can be discarded for conviction [15].

Raimundo [2019] carried out "Fingerprint Image Segmentation based on Oriented Pattern Analysis" and conclusions are given that, A fingerprint image segmentation approach was tested. The technique estimates the prevalent direction within a particular neighbourhood for each pixel. The strength of anisotropic information may be calculated using statistical techniques [16]. To determine the interest areas, the suggested technique used an unsupervised clustering algorithm. The fingerprint contour may be retrieved after a series of morphological processes [16]. A comparison of the suggested method to two existing ways available in the literature demonstrates its validity. There is no need for training or prior knowledge of thresholding levels, making the evaluation more independent. The proposed approach may be used with a variety of sensors [16]. The evaluation of the directional operator as a fingerprint image quality indicator is one of the future development directions. It, along with other aspects, might be included into a quality evaluation system. Furthermore, in fingerprint classification, a precise estimation of fingerprint orientation picture is required, and this directional operator may be employed for this job [16].

Sagar Singh [2020] carried out " FINGERPRINT RECOGNITION TECHNIQUES" and conclusion gave that, The numerous approaches of fingerprint recognition are discussed, and they are utilised to identify a person [17]. All of the strategies discussed above ensure that the fingerprint is quick and precise, resulting in a more trustworthy and secure system. Minutiae-based matching is a popular and effective approach for extracting the minutiae aspects of a fingerprint [17]. Flow charts are used to illustrate the biometric identification process. Future study will focus on improving the picture quality by using image enhancement methods to increase fingerprint matching [17].

3. CONCLUSIONS

From the above study, there is some conclusion regarding the mosaicing fingerprint, For accurate identification of the fingerprint, provide the maximum surface area of the fringer as well more than 5-time fingerprint images captured by the sensor. The best fingerprint recognition system is a combination of two matching algorithms: elastic minutiae matching and fixed-length feature vector matching. Since the features of both algorithms (minutiae sets and fixed-length feature vectors) are virtually uncorrelated. An improved algorithm for the segmentation of fingerprint images has been proposed that accurately segments fingerprint images into the foreground, background, and low-quality areas. It evaluates the consistency of the extracted minutiae over different prints of the same finger, i.e. it is based on the functional requirements to minutiae extraction algorithms.

REFERENCES

[1] A.M. Bazen and R.N.J. Veldhuis. Likelihood ratio-based biometric verification. In Proc. Prorisc 2002, 13th Annual Workshop on Circuits, Systems, and Signal Processing,

[2] S. Klein, A.M. Bazen, and R.N.J. Veldhuis. Fingerprint image segmentation based on hidden Markov models. In Proc. Prorisc 2002, 13th Annual Workshop on Circuits, Systems, and Signal Processing, Veldhoven, The Netherlands, November 2002.

[3] Veldhoven, The Netherlands, November 2002. A.M. Bazen and S.H. Gerez. Fingerprint matching by thin-plate spline modeling of elastic deformations. Pattern Recognition, 2002. Submitted.

[4] A.M. Bazen and S.H. Gerez. Achievements and challenges in fingerprint recognition. In D. Zhang, editor, Biometric Solutions for Authentication in an e-World, pages 23–57. Kluwer, 2002.

[5] A.M. Bazen and S.H. Gerez. Systematic methods for the computation of the directional field and singular points of fingerprints. IEEE Trans. PAMI, 24(7):905–919, July 2002.

[6] A.M. Bazen and S.H. Gerez. Elastic minutiae matching using thin-plate spline models. In Proc. ICPR 2002, Quebec City, August 2002.

[7] A.M. Bazen and S.H. Gerez. Thin-plate spline modeling of elastic deformations in fingerprints. In Proc. SPS 2002, pages 205–208, Leuven, Belgium, March 2002.

[8] Anil Jain and Arun Ross "FINGERPRINT MOSAICKING" Appeared in Proceedings of IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), Orlando, Florida, May 13 - 17, 2002.

[9] Jinwei Gu, Student Member, IEEE, Jie Zhou, Senior Member, IEEE, and Chunyu Yang "Fingerprint Recognition by Combining Global Structure and Local Cues" IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 15, NO. 7, JULY 2006

[10] Arun Ross, Samir Shah and Jidnya Shah "Image versus feature mosaicing: A case study in fingerprints" Proc. Of SPIE Conference on Biometric Technology for Human Identification III, (Orlando, USA), pp. 620208- - 620208-12, April 2006.

[11] Chunxiao Ren, Yilong Yin, Jun Ma, and Gongping Yang "A Novel Method of Score Level Fusion Using Multiple Impressions for Fingerprint Verification" Proceedings of the 2009 IEEE International Conference on Systems, Man, and Cybernetics San Antonio, TX, USA - October 2009

[12] Sandhya Tarar*, Ela Kumar "fingerprint Mosaicking Algorithm to Improve the Performance of Fingerprint Matching System" Computer Science and Information Technology 2(3): 142-151, 2014 http://www.hrpub.org DOI: 10.13189/csit.2014.020304

[13] V. SURESH KUMAR1, DR. SHAIK MEERAVALI2, G. DEEPIKA3 "A Novel Model of Fingerprint Authentication System using Matlab" International Journal of Scientific Engineering and Technology Research Volume.04, issue no.17, June-2015, Pages: 3264-3269

[14] Nishanthini P1, Blessy Boaz2 "Survey on Fingerprint Recognition Using Minutiae Based Technique" International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization) Vol. 6, Special Issue 11, September 2017

[15] Arnab Sikidar1, Anita Thakur2 and F.A. Talukdar3 " Fingerprint Reconstruction from Cylindrical Objects using Image Mosaicing" International Journal of Computing and applications volume 13, Number 2, (July-December 2018), pp 315-320© Serials Publications, New Delhi (India)

[16] Raimundo Claudio da Silva Vasconcelos1;2 and Helio Pedrini2 "Fingerprint Image Segmentation based on Oriented Pattern Analysis" DOI: 10.5220/0007409104050412 In Proceedings of the 14th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2019), pages 405-412 ISBN: 978-989-758-354-4

[17] Sagar Singh "FINGERPRINT RECOGNITION TECHNIQUES" European Journal of Molecular & Clinical Medicine ISSN 2515-8260 Volume 7, Issue 10, 2020