A Novel Algorithm for Finger Knuckle Print Recognition

Nikita Runijha, Abhishek Shrivastava

Abstract: Biometrics is the technique of authentication of a person on the basis of biometrics traits. Due to its reliability and accuracy it has been explored extensively. Fingerprint, iris, hand geometry, palm, face etc are some of the common biometrics traits that can be used successfully for authentication of a person. The accuracy and reliability of the biometrics based authentication system depends on the various important features and feature extraction techniques. Extracted features from the biometrics must be having uniqueness for making biometrics system reliable. This paper present a finger knuckle print based biometric system for person authentication. Radon transform is used for extracting the features of the inner knuckle print image. Simulation results reveals that the proposed system perform very well in recognizing the person with good accuracy.

Keywords: knuckle print, Biometrics, finger features, recognition system.

I. INTRODUCTION

Due to various applications like computer security, banking and law enforcement etc. one of the common concern in both industries and academics is the authentication of the person. Biometrics which reflects the physiological and behavioural characteristics of human can be utilized to distinguish different person and hence can be used as an ideal solution to this type of problem. Due to the rapid increase in applicability of the computer techniques in the last few decades, researcher have turned their attention to the number of biometrics based techniques for person authentication and investigated various techniques of biometrics. Fingerprint based biometrics [1-3], face based biometrics [4-5], iris based biometrics [6-7], retina based biometrics [8-9], palm print based [10-16], hand geometry based[17-19], hand vein based biometrics[20-21], finger surface based biometrics[22-27], voice based biometric s[30], ear based biometrics[31], gait based biometrics [32] and signature based biometrics[33] etc. Though the research on various biometrics is going on and still under the process, some of the biometrics system have been used in large scale. For example in HONGKONG, government is used fingerprint recognition system as the passenger clearance system[35] Among the different kind of biometrics, biometrics based on the hand characteristics is attracting the attention of the researchers. Biometric system based on the fingerprint[1-3], palmprint[10-16], hand geometry[17-19], hand vein[20-21] and inner knuckle print based system[28 29], have been proposed and investigated in the literature.

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The popularity of the hand based biometrics is due to its very high user acceptance. In fact the lines and crease pattern in the inner knuckle print is very unique can be used as a biometrics identifier. Woodard and Flynn[22-23] were the first scholars who exploited the finger knuckle print in biometrics system. In their work, they prepared a database of finger knuckle print. Curvature based shape index has been used in their work for feature extraction. Their work has set up the uniqueness of the outer finger surface for biometric identification. But their work fail to implement it practically in efficient way. The limitation of this theory to be implemented practically is due to the cost, size and weight of the Minolta sensors 900/910 along with the time consuming image acquisition and processing. Apart from this they have not fully utilized the finger knuckle texture information in feature extraction.

In this paper, a novel technique of finger knuckle print recognition has been proposed which is based on the radon transform.

II. PROPOSED METHODOLOGY

As mentioned earlier that Radon transform can be used for detecting the unique line and crease in the finger knuckle print image even for noisy image therefore in this project work, radon transform is used to extract the features i.e. Radon transform coefficients which are unique for unique lines and crease. Though hough transform can also be used in place of the radon transform because it is also able to detect the lines and crease in the image but in case of noisy image its performance is poor.

A. Radon Transform

In recent years the Hough transform and the related Radon transform have received much attention. These two transforms are able to transform two dimensional images with lines into a domain of possible line parameters, where each line in the image will give a peak positioned at the corresponding line parameters. This have lead to many line detection applications within image processing, computer vision, and seismic.

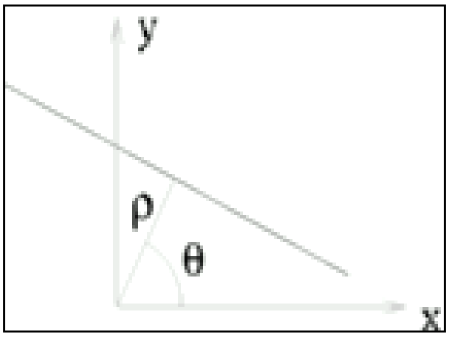

Figure 1 Line parameter using Radon Transform

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Several definitions of the Radon transform exists, but are related, and a very popular form expresses lines in the form

$$\rho = x \times cos\theta + y \times sin\theta$$

Where theta is the angle and rho the smallest distance to the origin of the coordinate system. As shown in the two following definitions (which are identical), the Radon transform for a set of parameters (rho,theta) is the line integral through the image g(x,y), where the line is positioned corresponding to the value of (rho,theta).

$$\breve{g}(\rho,\theta) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} g(x,y)\delta(\rho - x\cos\theta - y\sin\theta)\, dx\, dy$$

or the identical expression

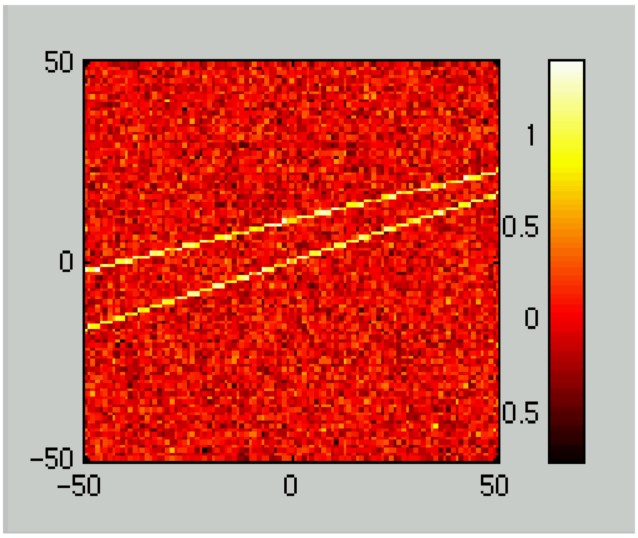
$$\breve{g}(\rho,\theta) = \int_{-\infty}^{\infty} g(\rho\cos\theta - s\sin\theta, \rho\sin\theta + s\cos\theta)\, ds$$

The delta() is the Dirac delta function which is infinite for argument 0 and zero for all other arguments (it integrates to one), and in digital versions the Kronecker delta is used.

4.4.1 Feature database Creation

Image acquired by the camera now a days are mostly color camera and Radon transform can be used in gray scale image only as it is defined for only two dimensional signal. Therefore it is emperative to convert the acquired color image in to the gray scale image. The process of converting the color image in to a gray scale image is called RGB to gray scale conversion. When image is acquired during the acquisition process then there is the possibility of acquired image is contrast-wise not uniform which again pose the problem of poor recognition accuracy therefore it is necessary to make the contrast of the image uniform, this work is accomplished by the histogram equalization operation. Number of radon transform coefficients are same for the image of the same size and different for the different size of the image.

Using this definition an image containing two lines are transformed into the Radon transform and shown in the figure 4.2.



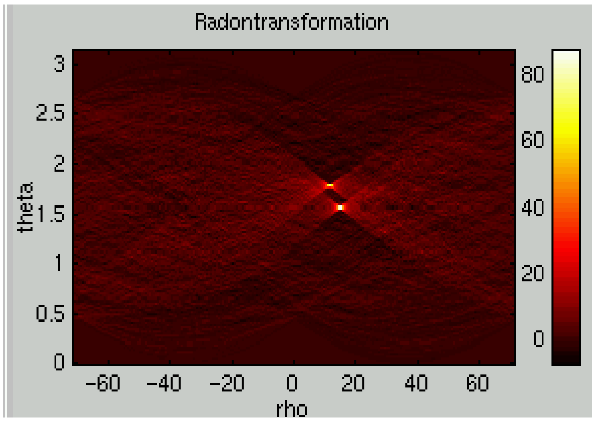


Figure 2 Original Image with Line (Upper) and Its Radon Transform (Lower)

4.4.2 Algorithm Steps of feature Database Creation

Step 1 Input the colour Finger Knuckle print image.

Step 2 Convert the image from colour to gray scale image by using colour to gray scale operation.

Step 3 Resize the image for getting the same number of radon coefficients.

Step 4 Apply Histogram operation to Make the contrast elevation.

Step 5 Apply the Radon transform and compute the Coefficients for the step of three degree angle. And store the coefficients corresponding to the each angle in the database.

Step 6 Store the Coefficients of each Image in the feature database.

Step 7 End of operation.

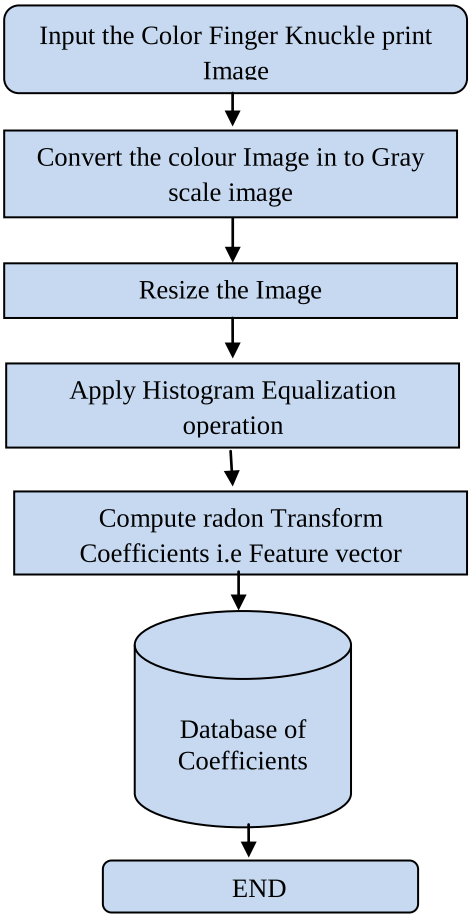


Figure 3 Block Diagram of Database Creation

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Different number of coefficients i.e features creates the different dimensional size database which pose a problem of matching therefore in this project work image is first of all resize to some standard dimension size so that we can get the same number of radon transform coefficients.

4.4.2 Recognition or Matching Operation

Once all the features of all the images are extracted and stored in the feature data base then the next step is to perform the matching operation for judging the performance of the proposed system.

In order to perform the matching operation, first of all a finger knuckle print image is given to the system as a input. This input finger knuckle print image is then underwent the colour to gray scale image operation. In the next step, this gray scale image is resized to make the same number of radon transform coefficients. This resized image is then made up of uniform contrast by applying the histogram equalization operation. Radon transform is applied on this image to get the coefficients for each three degree step. This step gives the feature vector of the test finger knuckle print image. Euclidean distance is used in this project for performing the matching operation. Matching operation is performed by computing the feature vector of test finger knuckle print image and feature vector stored in the database. Feature vector of the database which gives the lowest distance is assumed to be the right match and its corresponding image is the right match for the test image. Block diagram of the Recognition or matching phase of this project is shown in the figure 4.9.

4.4.3 Algorithm steps of Matching or Recognition process

Step 1 Input the test Image to the system.
Step 2 Convert it into gray scale image.
Step 3 Resize the image.

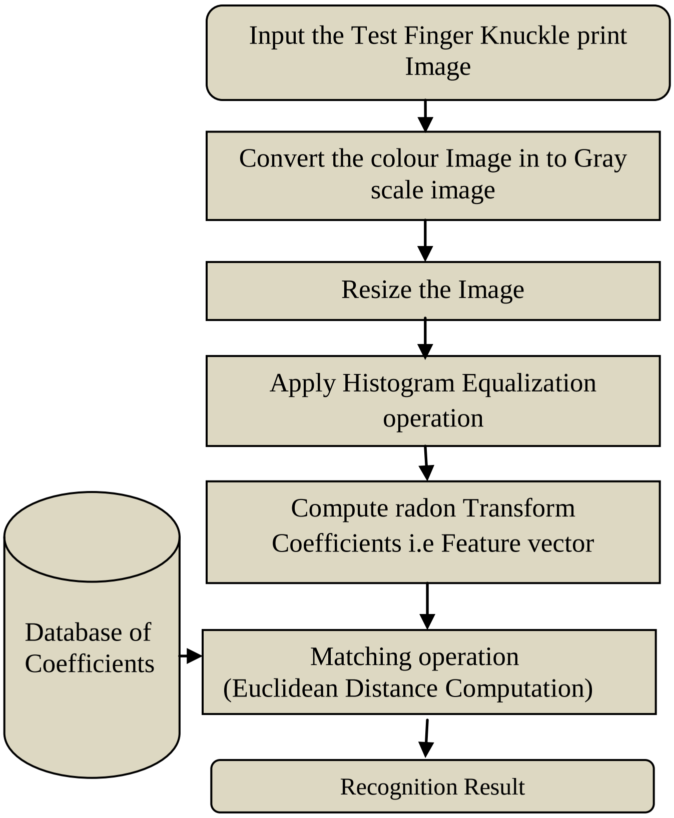
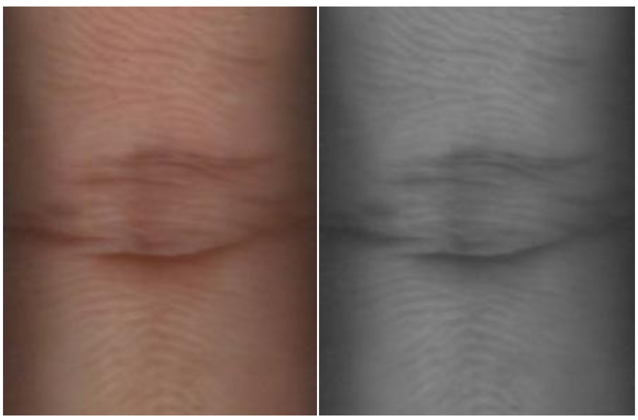


Figure 4 Block Diagram of Recognition process Matching

Step 4 Apply the histogram equalization operation.
Step 5 For the step of three degree angle, compute the Radon transform coefficients of the test image and store it in a variable i.e. feature vector.
Step 6 Compute the Euclidean distance between feature vector extracted out from the test image and the feature vector stored in a database.
Step 7 Compute the minimum of all the distance.
Step 8 Finger knuckle print image whose feature vector gives the lowest distance is assumed as the Match.

III. EXPERIMENTAL RESULTS

In order to test the finger knuckle based recognition system using above mentioned methodology, we have designed and developed the simulation program under the MATLAB 2009B plate form. First of all we have prepared our own database by taking as many as 50 different subjects and formed the finger knuckle print database. This database is then applied in the recognition system to generate the feature data base. This feature database in then stored in the variable in MATLAB for using during the matching phase. Finger knuckle print image is first of all taken and converted in to a gray scale image. This gray scale image is then resiezed for uniform number of RADON transform coefficients. Histogram equalization is then applied on this image to make the crease and line pattern more visible. In last stage of database creation, we applied the RADON transform by rotating the angle in a step of three degree starting from the zero degree. In this way obtained the total 60 different column with each column representing the radon coefficients for particular angle. In this experiment we have resize the image in the dimension of 180x120. So we get 121 coefficients for each angle. If we resize the image in some other dimension then we get different number of coefficients. So in order to make the number of coefficients same, we have to resize the image in to particular dimension and keep this dimension for all the database image and for matching image. Various stages of feature extraction phase is shown in the figure 5. Table 1 represent the Radon transform coefficients of three different finger knuckle print images for angle one degree. It is clear from this table is that the coefficients are different in all the three different images so it can be utilized for recognition purpose.



(a) **(b)**

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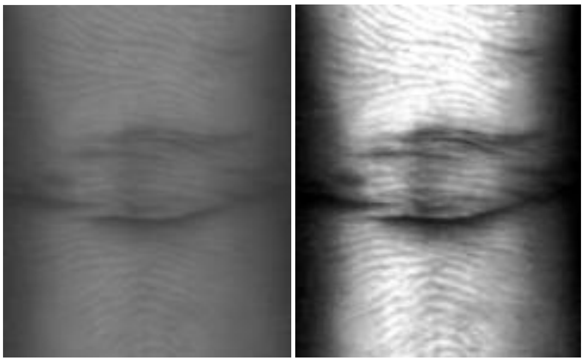

(a) (d)

Figure 5 (a) Original Knuckle Print Image(b) Gray Scale Image (c) Resize Image (d) Histogram Equalization Image

Table.1. Radon Transform Coefficients for different Images for angle θ=1^0

	Image1	**Image2**	**Image3**
Coef1	9237.46	9432.73	9983.14
Coef2	10294.28	10662.16	11051.96
Coef3	11357.59	11959.07	12124.01
Coef4	12482.65	13182.93	13332.31
Coef5	13750.28	14326.92	14399.92
Coef6	15178.79	15359.97	15333.42
Coef7	16619.60	16475.90	16355.74
Coef8	17624.36	17740.46	17226.18
Coef9	18509.60	18795.42	18066.39
Coef10	19337.02	19536.53	18818.75

In order to check the validity of the system for recognition of a person we have also calculated the accuracy of the system using the formula mentioned below-

$$Accuracy = \frac{Total\ Number\ of\ correctly\ recoonized\ person}{Total\ number\ of\ recognition\ attempted} \times 100$$

The accuracy of the system in three different instances have been taken and then overall average has been computed as shown in the table 2 to get the cumulated average. In Each instances 60 different subjects has been taken and tested by applying them in to a proposed system. Figure 6 shows the snap shot of the proposed system.

Table 2 Accuracy calculation

No. of subjects	**Correctly Recognized person**	**In-correctly recognized person**	**Accuracy (in %)**
60	60	0	100
60	59	1	98.33
60	59	1	98.33
Cumulative Average			98.86

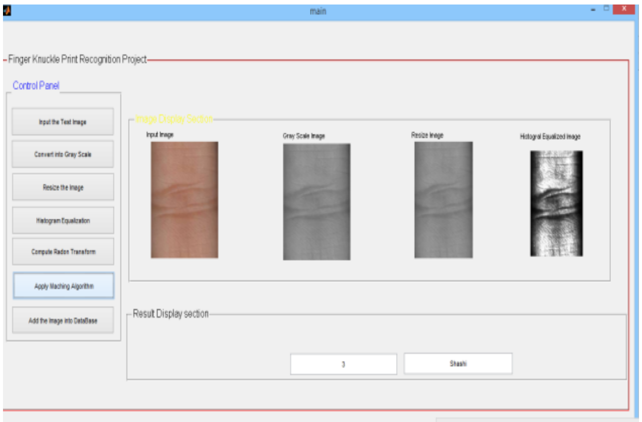

Figure 6 Snapshot of the proposed system.

IV. CONCLUSION

Finger knuckle print is comparatively new biometric characteristics of the human being which is being explored by many researchers for recognition and authentication purpose. It was earlier established that the crease and lines pattern formed in the finger knuckle is unique in great sense. This has made the researchers to investigate the recognition aspect of the finger knuckle print by extracting the important features from the finger knuckle image. Radon transform is one of the important tool which can be used to detect the lines patteren in any image. This property of the Radon transform is used in this project for exatrcting the features of the finger knuckle print image and then utilized it for person recognition. Accuracy of about 98.86 is obtained by using this methodology which is exceptionally well and proved it as a very good tool for the recognition of a person.

REFERENCES

1. A.K. Jain, P. Flynn, A. Ross, Handbook of Biometrics, Springer, 2007.
2. D. Maltoni, D. Maio, A.K. Jain, S. Prabhakar, Handbook of Fingerprint Recognition, Springer, 2003.
3. N. Ratha, R. Bolle, Automatic Fingerprint Recognition Systems, Springer, 2004.
4. K. Delac, M. Grgic, Face Recognition, I-Tech Education and Publishing, 2007.
5. H. Wechsler, Reliable Face Recognition Methods - System Design, Implementation and Evaluation, Springer, 2006.
6. J. Daugman, High confidence visual recognition of persons by a test of statistical independence, IEEE Trans. Pattern Analysis and Machine Intelligence 15 (11) (1993) 1148-1161.
7. J. Daugman, How iris recognition works, IEEE Trans. Circuits and Systems for Video Technology 14 (1) (2004) 21-30.
8. R. B. Hill, Retinal identification, in Biometrics: Personal Identification in Networked Society, A. Jain, R. Bolle, and S. Pankati, Eds., Kluwer Academic, 1999.
9. H. Borgen, P. Bours, S.D. Wolthusen, Visible-Spectrum Biometric Retina Recognition, in: Proceedings of the International Conference on Intelligent Information Hiding and Multimedia Signal Processing, 2008, pp.1056-1062.
10. Z.H. Guo, D. Zhang, L. Zhang, W.M. Zuo, Palmprint verification using binary orientation co-occurrence vector, Pattern Recognition Letters 30 (13) (2009) 1219-1227.
11. D. Zhang, W. K. Kong, J. You, M. Wong, Online palmprint identification, IEEE Trans. Pattern Analysis and Machine Intelligence 25 (9) (2003) 1041-1050.
12. W. K. Kong, D. Zhang, Competitive coding scheme for palmprint verification, in: Proceedings of the ICPR'04, 2004, pp. 520-523.
13. Kong, D. Zhang, M. Kamel, Palmprint identification using feature-level fusion, Pattern Recognition 39 (3) (2006) 478-487.
14. Z.N. Sun, T.N. Tan, Y.H. Wang, S.Z. Li, Ordinal palmprint representation for personal identification, in:

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Proceedings of CVPR'05, 2005, pp. 279-284.
15. D.S. Huang, W. Jia, D. Zhang, Palmprint verification based on principal lines, Pattern Recognition 41 (4) (2008) 1316-1328.
16. W. Jia, D.S. Huang, D. Zhang, Palmprint verification based on robust line orientation code, Pattern Recognition 41 (5) (2008) 1504-1513.
17. A.K. Jain, A. Ross, S. Pankanti, A prototype hand geometry-based verification system, in: Proceedings of the 2nd International Conference on Audio- and Video-based Biometric Person Authentication, 1999, pp. 166–171.
18. R. Sanchez-Reillo, C. Sanchez-Avila, A. Gonzalez-Marcos, Biometric identification through hand geometry measurements, IEEE Trans. Pattern Analysis and Machine Intelligence 22 (10) (2000) 1168-1171.
19. A.K. Jain, N. Duta, Deformable matching of hand shapes for verification, in: Proceedings of ICIP'99, 1999, pp. 857–861.
20. J.G. Wang, W.Y. Yau, A. Suwandy, E. Sung, Personal recognition by fusing palmprint and palm vein images based on "Lapacianpalm" representation, Pattern Recognition 41 (5) (2008) 1531-1544.
21. Kumar, K.V. Prathyusha, Personal authentication using hand vein triangulation, in: Proceedings of SPIE Biometric Technology for Human Identification, vol. 6944, 2008, pp. 69440E-69440E-13.
22. D.L. Woodard, P.J. Flynn, Finger surface as a biometric identifier, Computer Vision and Image Understanding 100 (3) (2005) 357–384.
23. D.L. Woodard, P.J. Flynn, Personal identification utilizing finger surface features, in: Proceedings of CVPR'05, vol. 2, 2005, pp. 1030-1036.
24. Ravikanth, A. Kumar, Biometric authentication using finger-back surface, in: Proceedings of CVPR'07, 2007, pp. 1-6.
25. Kumar, C. Ravikanth, Personal authentication using finger knuckle surface, IEEE Trans. Information Forensics and Security 4 (1) (2009) 98-109.
26. Kumar, Y. Zhou, Human identification using knucklecodes, in: Proceedings of BTAS'09, 2009.
27. Kumar, Y. Zhou, Personal identification using finger knuckle orientation features, Electronic Letters 45 (20) (2009) 1023-1025.
28. H. Hollien, Forensic voice identification, Academic Press, 2002.
29. M. Burge, W. Burger, Ear biometrics, in: Biometrics:Personal Identification in Networked Society, A.K. Jain, R.Bolle, S. Pankanti, Eds., pp. 273-286, Kluwer Academic, 1999.
30. M.S. Nixon, T.N. Tan, R. Chellappa, Human Identification Based on Gait, Springer, 2006.
31. R. Plamondona and G. Loretteb, Automatic signature verification and writer identification — the state of the art, Pattern Recognition 22 (2) (1989) 107-131.
32. M.S. Nixon, T.N. Tan, R. Chellappa, Human Identification Based on Gait, Springer, 2006.
33. R. Plamondona and G. Loretteb, Automatic signature verification and writer identification — the state of the art, Pattern Recognition 22 (2) (1989) 107-131.

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