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A Novel Algorithm of Person Authentication Using Finger Knuckle Print

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ABSTRACT

The algorithm or techniques of person authentication with the help of biometrics traits are called biometrics. Just because of its usefulness, reliability as well as the accuracy, it has been researched extensively. Some of the common biometrics traits that has been employed so far are hand geometry, fingerprint , iris , palm and face. The above mentioned biometrics traits has been used in the past very effectively. Such types of authentication schemes depends much on the accuracy of the feature extraction algorithm and significant features also. Exatrcted biometrics features must be having some kind of uniqueness in order to be reliable authentication of a person. In this paper present, a very efficient biometrics system which is based on the inner finger knuckle print. Finger knuckle is claimed to have some unique pattern of lines and crease which can be used as the unique identity of the person. Radon transform has been used in this paper for extracting the features of the lines and the crease. The results of the proposed system is able to produce very good accuracy.

KEYWORDS *: knuckle print, Biometrics, finger features, recognition system.*

I. INTRODUCTION

Due to various application 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 biometrics[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.

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. 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.

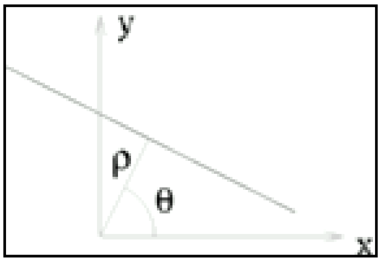


Figure 1 Line parameter using Radon Transform

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.

Using this definition an image containing two lines are transformed into the Radon transform and shown in the figure 2.

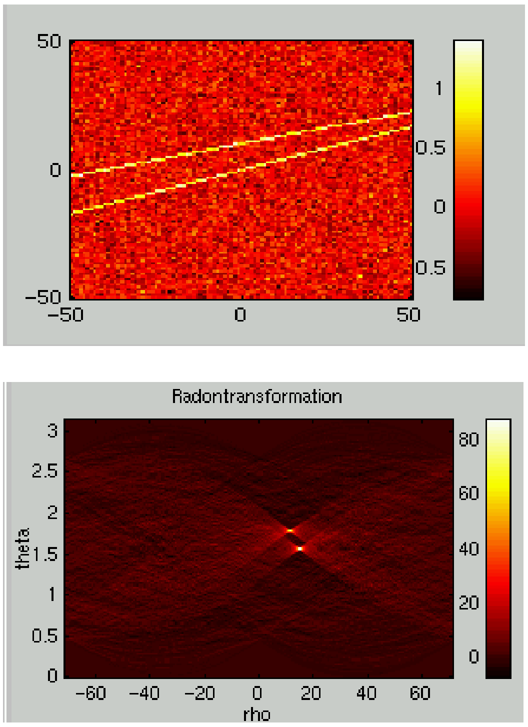


Figure 2 Image with Lines (Upper) and Its Radon Transformed image (Lower)

4.4.1 Feature database Creation

One of the limitation of the Radon transform is that it can not be used for RGB or color image since it is defined for only 2 dimensional signal. Therefore it is essential to convert the image into gray scale before applying the radon transform. This is done with the operation of RGB to gray scale conversion.

Another important facts about any biometrics system is that during the acquisition process the registered image may encounter the inadequate light illumination causing a poor contrast image registration which can hamper the accuracy of the recognition process. There the acquired images is required to be uniform contrast image. This is done with the help of the histogram equalization operation.

It also necessary to mention here that while Taking radon coefficients, a care must be taken to make all the image of same size so that the number of coefficients of all the image are same

4.4.1 Algorithm For database Creation

Step 1 Apply color Finger knuckle print image as the input.

Step 2 Apply RGB to Gray conversion of the input image.

Step 3 Apply the resizing operation on the image obtained from the second step to get the similarity in the size.

Step 4 Elevate the contrast of the image by applying the histogram equalization operation.

Step 5 Compute the Radon coefficient by applying the radon transform of the image to get the radon coefficients at every 3 degree angle.

Step 6 Create the feature database with the help of radon coefficients.

Step 7 End of operation.

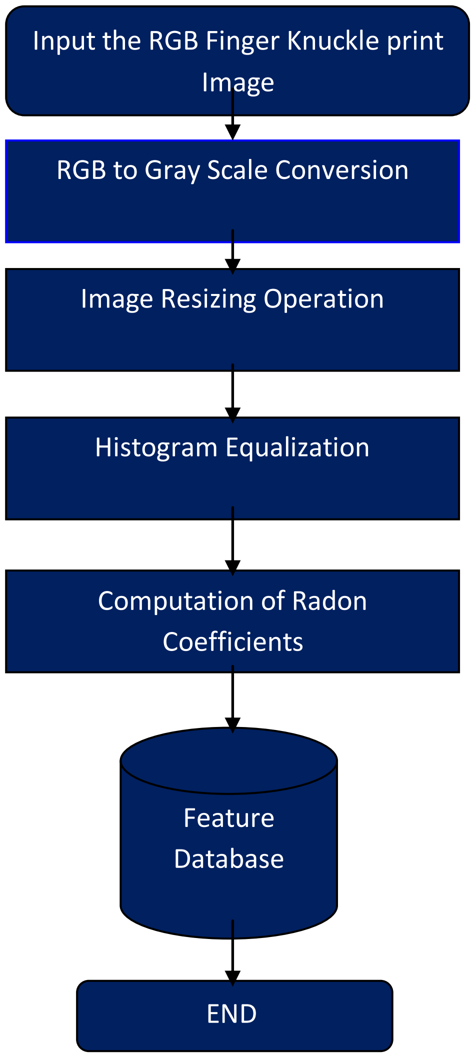


Figure 3 Flow Chart for Database Creation

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

After extracting out all the radon coefficients from all the finger knuckle print images, a feature database is created and stored in suitable variable for future use. In the next and final phase, the matching operation is carried out to check the performance of the proposed system

For matching operation, a query iamge is given to the designed system as the input. The system perform RGB to gray scale conversion, resizing and Histogram equalization preprocessing steps for getting the image ready for radon transform. The radon coefficients of the finger knuckle print image is computed for 3 degree angle steps. Once all the coefficients has been computed then the next step is to compare the feature vector of the candidate image to the feature vector of the database. For this Euclidean distance has been computed between feature vector of the candidate image and the feature vector of the database image. Feature vector of the database which gives the minimum Euclidean distance is considered to be the exact match of the candidate image.

4.4.3 Algorithm for Matching operation

Step 1 fed the Test Finger knuckle print image to the designed system as the input.

Step 2 Apply RGB to Gray scale operation to get the gray scale image.

Step 3 Perform image resizing operation to obtain the standard size image.

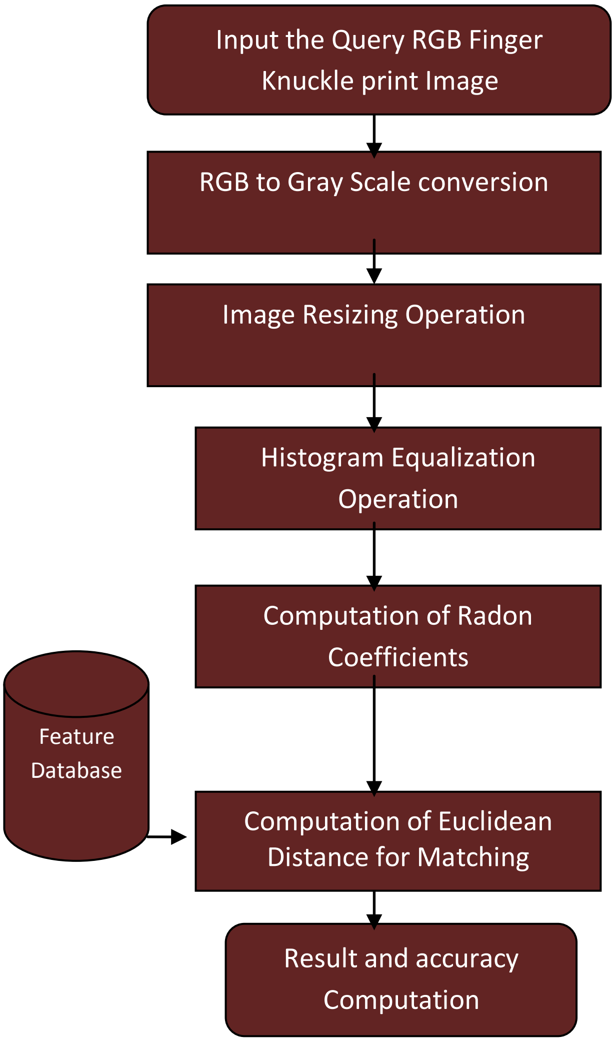


Figure 4 Flow Diagram of Matching or Testing Operation

Step 4 Perform histogram equalization operation for contrast elevation.

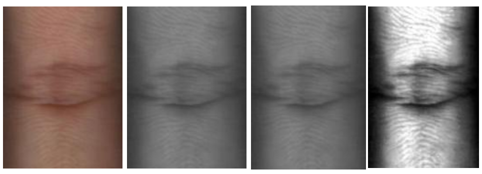
Step 5 Obtain the radon coefficients of the image by applying the radon transform at the step of three degree angle. Anf obtained the feature vector.

Step 6 Calculate the Euclidean distance between the feature vector obtained with the feature vector of the database.

Step 7 Feature vector which gives the minimum Euclidean distance is the match.

III. EXPERIMENTAL RESULTS

For testing the proposed system of finger knuckle print based recognition system, a program is designed and developed under the platform of MATLAB 2010 A. a separate Graphical user interface(GUI) was also designed for making the program more user friendly. In order to check the performance of the proposed algorithm, a Finger knuckle print image database of 50 different people has been collected and stored. Finger knuckle print images of all the 50 subjects has been given to the proposed system which after taking these image as the input, generate the feature database. This database is used at the time of matching process. The system takes the color finger knuckle print image as the input and convert it in to gray scale image. A resizing operation is then performed in the next step for getting the similar number of radon coefficients from each image. For contrast improvement , histogram equalization is then performed to make the lines and crease of the finger knuckle more visible. Radon Transform is then applied on each image and radon coefficients are computed for each 3 degree angle step. Starting from zero to180 degree. This creates the 60 number of column with each represent the one particular angle.



(a) (b) (c) (d)

Figure 5 Various Stage of Finger Knuckle print Image (a) RGB Knuckle Print Image(b) Gray Scale Version (c) After Resizing (d) After Histogram equalization

In the matching process, the radon coefficients of the query finger knuckle image is compared with the radon coefficients of the finger knuckle image of the database with the help of the Euclidean distance. The database image which get the minimum Euclidean distance value is considered to be the closest match.

Figure 5 depicts the values of the radon coefficients for different persons finger knuckle print images at the angle 7^o. The values claearlyrevelas that these values are different for all the three images.

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.

Table 1 Values of Radon Coefficients at angle 7^o for three different person images

Coeff	Image1	Image2	Image3
Coef1	1.473	0.089	0.0
Coef2	11.222	4.744	0.257
Coef3	35.800	22.983	7.078
Coef4	90.110	65.969	33.019
Coef5	182.335	159.184	98.909
Coef6	306.517	282.963	222.694
Coef7	485.651	474.532	394.423
Coef8	755.520	762.480	685.134

For testing the performance of the proposed system in recognizing the person accurately, the computation of the accuracy is also carried out by using the formula given below-

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

In order to compute the accuracy of the system, The system is checked for three groups of random persons with each group carrying 15 random persons. For each group, accuracy is computed. Finally the average of all the accuracy is computed. Table 2 shows the above mentioned process in tabular form

Table 2 Computation of Accuracy

No. of persons	Correctly Recognized	In-correctly recognized	Accuracy (in %)
15	15	0	100
15	14	1	93.33
15	15	0	100
Cumulative Average			97.77

IV. CONCLUSION

Being a new characteristics of the biometrics, finger knuckle print has not been researched adequately and required to be explored more for its ability to recognize the person accurately. Considering the uniqueness of the lines and crease of the finger knuckle for any individuals, it can be used for person authentication. In this project, this ability of the finger knuckle print for person authentication has been addressed and a system is designed and developed to test the accuracy of the finger knuckle for person recognition. The proposed system has given the accuracy of about 98% which is remarkable and proved its ability.

In the future work, some more features of the finger knuckle can also be added to make it more reliable and accurate.

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