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A Novel Finger Knuckle Print Recognition Algorithm Using Radon Coefficients

[1]ChandrakiranSahu, [2]Prof.YogeshRathore
[1,]M.Tech Research Scholar,Computer Science Department,RITEE,Raipur
[2,]Asst. Prof,Computer Science Department, RITEE,Raipur

Abstract:

Person authentication is one of the main concerns in industries as well as in the academics because it is used in these area for various application such as Computer security, banking enforcement, law enforcement physical access control etc. Biometrics is basically referred as the unique behavioral and psychological characteristics of human which can be used for distinguishing the individuals and hence can be served as one of the optimum solution to this problem.In this thesis, inner knuckle surface and its pattern are used for developing a system for person identification. A database of the finger knuckle containing 7920 samples collected from 660 individuals that is publicly made available by the Hong Kong Polytechnic University is used in this work. Radon transform is used here to extract the features of the inner knuckle surface as it is most widely used for detection of lines and crease. A database of these extracted feature is prepared and various techniques of classification is used for classifying these pattern and hence identification of person. Comparison has also been made between various classification technique to find out the most accurate identification.

Keywords — **Biometrics, finger knuckle print, features, recognition system.**

I. INTRODUCTION

Biometric recognition or simply biometric refers to use of distinctive anatomical and behavioral characteristicsfor automatically recognizing an individual. Automatic human identification has become an important issue intoday's global information society. Due to increasing security concerns, large number of systems currently requiredpositive identification before allowing an individual to use their services. During the last decade there has been asteady research effort toward providing user friendly and reliable methodologies for access to facilities, research andservices. Automatic biometric systems have emerged as a more reliable alternative to the traditional personalidentification systems[1][2]. Different techniques have been developed each of them having its own advantages anddisadvantages Now a day's authentication is based on the unique physiological and behavioral characteristics of human being.It is generally accepted that physical traits like iris, fingerprints, finger knuckle, finger vein, DNA finger print canuniquely define each member of large population which makes them suitable for large scale identification. Reasonof attraction of such traits is social acceptance and easy to use. Finger knuckle (FK) is user centric, contactless andunrestricted access control. Its texture and statistical features are available and easily extracted. It is independent toany behavioral aspect[3-8].

Woodward and Flynn are the first scholars who made use of the finger knuckle surface in their work. They set up a 3D finger back surface database with the Minolta 900/910 sensor.

C.Ravikanth et al.[19] developed a system for acquiring the finger back surface images. This imaging system uses a digital camera focused against a white background under uniform illumination.
Lin Zhang et al. [1] development a system for FKP acquisition. This consists of four components FKP image acquisition, ROI (region of interest) extraction, feature extraction and feature matching.

Some of the noteworthy contribution can be found in the paper [2, 3, 14, 27] that can create spatially localized features are receiving increasing attention in the literature. Jun et al.[14] proposed a new linear feature extraction approach called Weighted Linear Embedding(WLE).

Yang et al. [2] inspired by the work that Gabor wavelets have been applied successfully in image analysis and pattern recognition, used it for feature representation in FKP. Jing et al.[3]simultaneously considered distances and angles between image data vectors to measure data similarities in hope of more sufficiently capturing the manifold structure. Different coding based algorithms arealso proposed in the literature. [5, 13, 15, 17] and basically iris code is the foundation of these coding algorithms. These coding techniques have been used widely for palmprint recognition [21, 22, 23, 24, 25, 29] and have provided good recognition results. Ajay Kumar [17] in his work exploited the local information in comparison to the global information for reliable performance. Lin et al.[13] designed a system to capture FKP images and proposed a method to align the FKP images by adaptively constructing a local coordinate system for each image. Lin et al. [15] proposed a fast feature extraction and coding method called the Monogenic code based on the Monogenic signal theory and is used for FKP recognition. Lin Zhang et al. [5] used coding method because they have the merits of high accuracy, robustness, compactness and high matching speed. Hence, based on the findings that Riesz transform can well characterize the visual patterns this work proposes to encode the local patches of FKP images by using second order Riesz transform. Some other noteworthy other methods can be found in the literature [7, 8, 9,11, 16] various image processing techniques are employed either independently or combined to extract the texture, local, global or line feature from the finger knuckle print.

Fusion is a promising technique that is used to increase the accuracy of the biometric systems [2,4,6,8,20,27].

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. RADONTRANSFORM

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 processing, computer vision, and seismic. detection applications within image

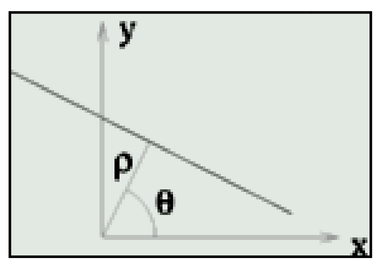

Figure 1 Line parameter using Radon Transform

Several definitions of the Radon transform exists, but the are related, and a very popular form expresses lines in the form $\rho = x \times cos\theta + y \times sin\theta$

B. CREATION OF FEATURE DATABASE

Image acquired by the camera now a days are mostly colour camera and Radon transform can be used in gray scale image only as it is defined for only two dimensional signal. Therefore it is imperative to convert the acquired colour image in to the gray scale image. The process of converting the colour 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. 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. Following are the Algorithm Steps of feature Database Creation

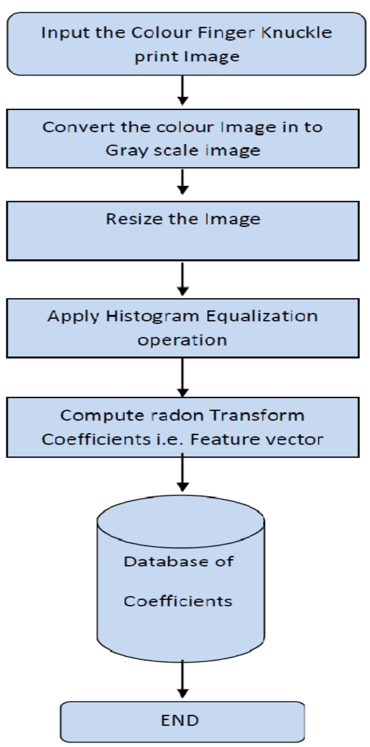

Figure 2 Block Diagram of Database Creation

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.Once all the features are extracted then the next step is to classify all the features and hence recognize the person on the basis of the classification. Though there are so many classification method, but in this work we have concentrated on 4 different classification methods. Out of four classification methods two are neural network based and two are the pure classifier. Block diagram of the classification is shown in the figure 4. Following are the steps of classification and identification

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.
Step 6 Perform the classification Task using BPN neural network and compute the accuracy.
Step 7 Perform the classification task using RBFN neural network and compute the accuracy.
Step 8 Perform the classification task using

the KNN classifier and compute the accuracy.**Step 9** Apply the naïve bias classifier for the classification and compute the accuracy.

Step 10 Compare the performance of the above mentioned classifier with the base paper classifier and draw the conclusion

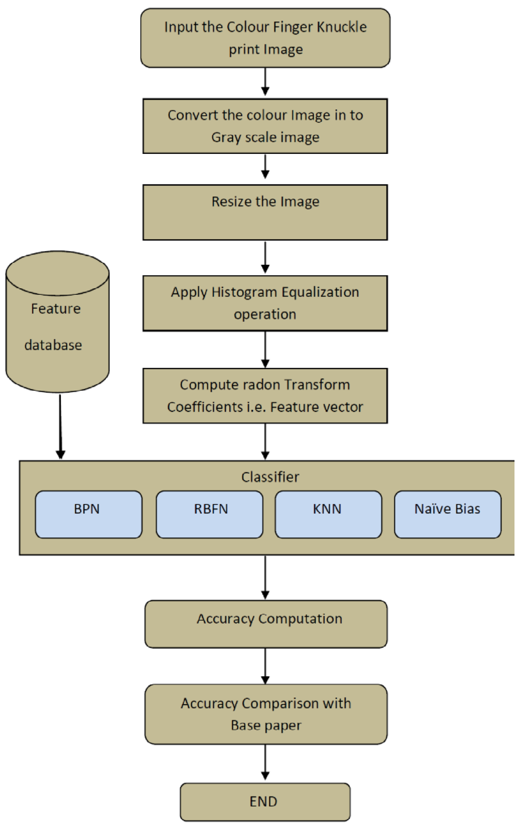

Figure 3Block Diagram of classification & Recognition Task

III. EXPERIMENTAL RESULTS

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. 10 features of the finger knuckle are extracted out from the finger knuckle. Each of these 10 feature actually represent the average radon coefficient taken for angles which are 18 degree apart. This created total 10 feature(180/18). Therefore for each finger knuckle print, 10 features are extracted. Feature database id prepared. Back propagation neural network is designed for classification these radon coefficients.Neural network is then trained. Supervised learning is used to train the neural network. Since in supervised learning, target vector is used therefore target vector is also designed for the training. Feature vector is given to the neural network as an input and target vector is given to the network as the output. Once the neural network is trained it is hen tested for different finger knuckle print.test image.

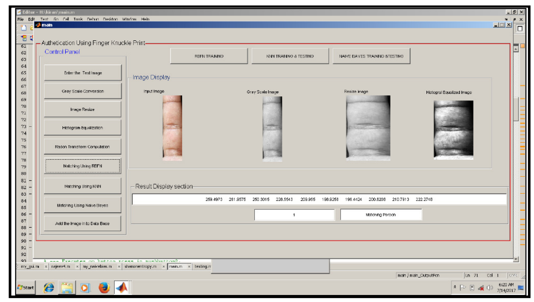

Figure 4 GUI Designed for the FKP recognition System

Once the feature are extracted then classification is performed using BPN neural network, RBFN neural network, KNN classifier, and Naive Bias classifier for the classification and compute the accuracy.

Table 1Ten- different Radon coefficient for different value of Theta

Radon Coefficients for different value of Theta(in step of 18)									
O=1	O=19	O=37	O=55	O=73	O=91	O=109	O=127	O=145	O=163
923.3025	12818.48	14531.92	16251.75	16076.81	10520.58	15256.09	11234.69	7232.517	5345.132
2788.716	13354.28	14567.67	16955.77	15076.55	9899.956	14047.95	11648.42	7563.162	5578.742
4816.324	13753.51	14665.13	17377.89	14477.71	8299.384	12707.94	11961.62	7894.701	5815.328
7217.858	14174.45	15003.39	17626.01	14122.7	6120.443	11871.01	12164.18	8213.01	6060.287
10384.28	14671.61	15565.32	18173.64	13356.58	6103.346	11286.12	12412.38	8648.933	6284.941
15008.54	15198.37	15873.2	18935.54	13036.5	6986.623	10966.66	12774.46	9137.712	6481.616
19358.24	15639.5	16069.97	19547.98	12601.02	7977.054	10594.35	13063.73	9674.693	6751.155
21984	16042.03	16279.02	19751.41	12017.27	8961.822	10699.43	13395.69	10067.34	7031.675
23881.35	16442.97	16285.53	20101.15	11895.3	9741.699	10645.6	13700.26	10277.85	7308.142
25710.26	16796.46	16233.07	20365.96	12075.65	10515.44	10438.02	14119.82	10575.09	7580.357

For performance comparison, accuracy is computed which is defined as

$$Accuracy = \frac{Numberofcorrectlyidentifiedpersonintest}{Totalnumberofpersonintest}$$

It very important to see that how the different classification method perform for the similar number of features therefore apart from the BPN network, three more classification methods were also tested i.e. RBFN network(Radial basis Function Network) , KNN (k-nearest neighbourhood), and Naïve bias method for the similar number of the feature and the accuracy obtained is tabulated in the table 2

Method	No. of Feature	Accuracy (in %)
Paper [31]Implementation	10	94.33
Method with RBFN network in this work	10	97.25

Table 2 Accuracy Table for different classifier

S. No.	No. Features	Classification Method	Accuracy (in %)
1	10	BPN	94.5
4	10	RBFN	97.25
7	10	KNN	93.25
10	10	Naïve Bias	91.25

From the table 2it is clear that RBFN is found to be the best classifier with accuracy of the 97.25%. rest of the classifier are found to be lesser accurate in recognizing the finger knuckle print and hence the person.

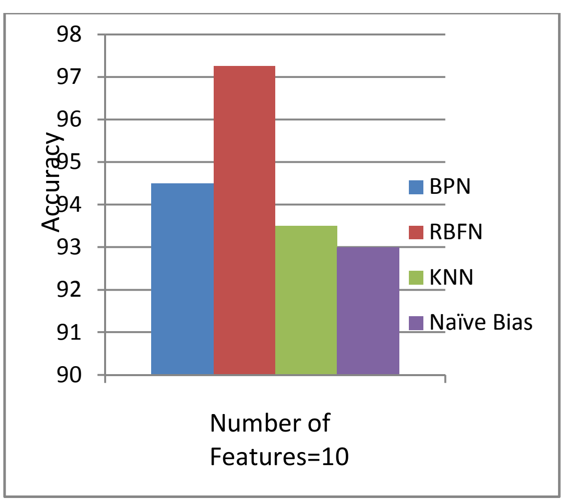

Figure 6 Accuracy Comparison for different

ClassifierFrom the above graph it is clear that RBFN network perform better than rest of the classification method. Table 2compare the performance of the best classifier in the proposed work to the best performer classification method of the paper[31].l

Table 3 Comparison of method with the Method Proposed in the paper[31]

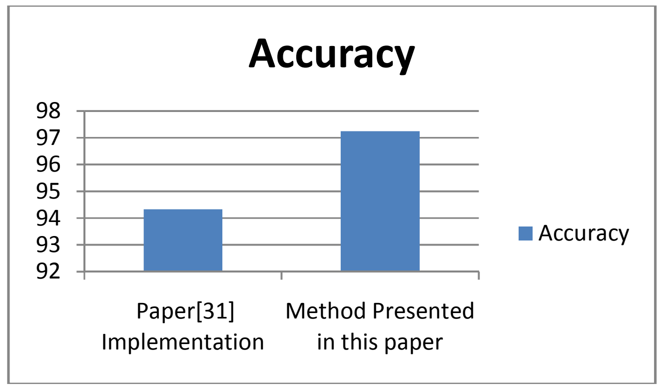

Figure 5.12 Comparisons Graph of Accuracy Between paper[31] and method implementation

III **CONCLUSION**

Finger knuckle print is comparatively new biometric characteristics of the human being which is being explored by many researcher for recognition and authentication purpose. Radon transform is one of the important tool which can be used to detect the lines pattern in any image. This property of the Radon transform is used in this project for extracting the features of the finger knuckle print image and then utilized it for person recognition. **Accuracy of about 97.25** is obtained by using this methodology which is exceptionally well and proved it as a very good tool for the recognition of a person. This work also present the performance comparison of various classifier i.e. BPN, RBFN, KNN and Naïve Bias.From the result obtained it is evident that RBFN is best in term of accuracy of recognition among all the above mentioned classifier and therefore is most suitable for classification purpose.

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