IOSR Journal of Computer Engineering (IOSR-JCE)
e-ISSN: 2278-0661,p-ISSN: 2278-8727, Volume 23, Issue 4, Ser. II (Jul. –Aug. 2021), PP 56-63
www.iosrjournals.org

Person Authentication using Finger Knuckle Surface

Nandini S. Gore[1], Dr. Ganesh S. Sable[2]
[1,3] *Department of Electronics & Telecommunication Engineering, Maharashtra Institute of Technology, Aurangabad, India*
[2] *Department of Electronics & Telecommunication Engineering, Maharashtra Institute of Technology, Aurangabad, India*
Corresponding Author: Dr. Ganesh S. Sable,
Department of Electronics and telecommunication Engineering,
Maharashtra Institute of Technology,
Aurangabad,Maharashtra,India.

ABSTRACT
The various biometric traits are used to accurately identify a person. Personal identification is more popular because it is more reliable. Many traits like fingerprint, face, palm print, vein, DNA and many others used personal authentication. Now- a-days finger knuckle surface is used for personal authentication and identification. The texture pattern produced by finger knuckle bending is highly unique and make surface as biometric identifier. The image processing used for recognition of collected data, increasing matching accuracy. The motivation of this topic is to develop system for biometric purpose with high accuracy and with less consuming time. This review papers represents survey on various methods are used for database collection and technique used for recognition.
In proposed system algorithm for person identification and classification using SVM as well as PCA-LDA is described. Image processing includes image resizing, conversion RGB to Grayscale. After that feature extracted using gabor filter and classification is done using SVM and PCA-LDA. The ECOC model is created for classification.
The main objective of proposed system is to improve matching accuracy, During image acquisition use uniform illumination of under black background and development of finger knuckle print as biometric using more accurate and simple algorithm.

Keywords:
Biometric
Database Collection
Recognition
FKP
SVM

Date of Submission: 25-08-2021 Date of Acceptance: 09-09-2021

I. Introduction

The recognition of person using different characteristics is called as biometrics. Human recognition system consists of identification and authentication. The line features on finger can be taken as personal identifier.

Finger Knuckle Anatomy: Every person has four finger and thumb in hand. The each of them finger contains 3 bone segment and 3joints. Thumb contains 2 bone segment and 2 joints. And segments are called as phalanges. The bones in finger called as proximal phalanges, central phalanges and distal phalanges. The first joint where finger join the hand is called proximal phalanx. The second joint is proximal interphalangeal joint and third one is distal interphalangeal joint.

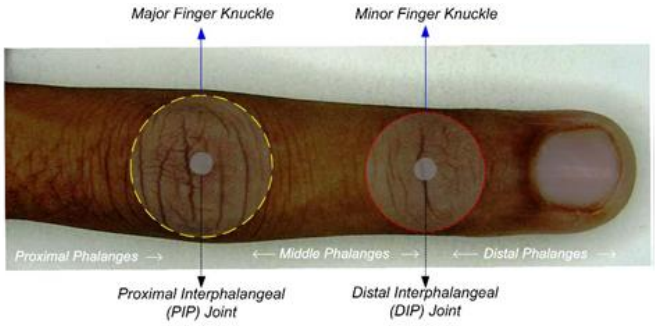

Fig.1 Finger knuckle Anatomy

Fig.1 shows finger knuckle anatomy which consist of major finger knuckle, minor finger knuckle.

II. Literature Review

The finger surface posses unique patterns that have been utilized in the personal identification. Woodard and Flynn authors have presented promising results by using curvature and a shape-based index from finger surface features extracted from finger images. For hand data collection the Minolta 900/910 sensor was used by author.

However, the work detailed in does not exploit the texture information that can be simultaneously extracted from the intensity images of hands.[1]

Ribaric and Fratric employed appearance based features from the finger and palm surface images for personal identification. However, the authors in have employed a scanner for imaging which is very slow and, hence, not suitable for online user authentication.[2]

S. Malassiotis combines finger geometry features and color information to authenticate user hands in the cluttered background. The finger shape information is generally believed to be less discriminative and only suitable for small-scale user identification.[3]

Michael K.O. Goh and Connie Tee employed a bimodal palm and knuckle print recognition system using inner surface of palm and finger knuckle. Authors presented a palm print and knuckle print tracking approach to automatically detect and capture these features from low resolution video stream. No constraint is imposed and the subject can place his/her hand naturally on top of the input sensor without touching any device. The palm print and knuckle print features are extracted using Wavelet Gabor Competitive Code and Rid get Transform methods. Several decision level fusion rules are used to consolidate the scores output by the palm print and knuckle print. The work, detailed in and is promising but it relies on crease and wrinkle details on the palm side (inner surface) of the fingers which are quite limited.[4]

Ajay Kumar and Ravikanth investigates a new approach for personal authentication using finger back surface imaging. Author uses texture pattern produced by the finger knuckle bending for identification as it is highly unique and makes the surface a distinctive biometric identifier. Finger geometry features are also extracted from the same image at the same time and integrated to further improve the use identification accuracy of such a system.[5]

Lin Zhang, Lei Zhang and David Zhang constructed data acquisition device to capture the Finger Knuckle Print images, and then an efficient FKP recognition algorithm is presented to process the acquire data .The local convex direction map of the FKP image is extracted based on which a coordinate system is defined to align the images and a Region of Interest (ROI) is cropped for feature extraction. A competitive coding scheme, which uses 2D Gabor filters to extract the image local orientation information, is employed to extract and represent the FKP features. To match two FKPs, they present a Band-Limited Phase-Only Correlation (BLPOC) based method to register the images and further to evaluate their similarity. An FKP database was established to examine the performance of the proposed system.[6]

Rui Zhao presents an approach which use single knuckle-print image only to implement personal identification. Unlike most previous work, there is no need to collect a large amount of images to train the classifier.[7]Michal Choras and R.Kazil evaluated texture-based knuckle features using IIT Delhi knuckle image database. G S Badrinath, Aditya Nigam and Phalguni Gupta presented an Efficient Finger knuckle-print based Recognition System Fusing SIFT (Scale Invariant Feature Transform) and SURF (Speeded up Robust Features) Matching Scores. Corresponding features of the enrolled and the query FKPs are matched using nearest neighbour-ratio method and then the derived SIFT and SURF matching scores are fused using weighted Sum rule.[8]

Lin Zhang, Lei Zhang, David Zhang, Hailong Zhu proposed Ensemble of local and global information for finger–knuckle-print recognition. Shoichiro Aoyama, Koichi Ito and Takafumi Aoki proposed Finger-Knuckle-Print (FKP) recognition algorithm using Band-Limited Phase-Only Correlation (BLPOC)-based local

block matching. The phase information obtained from 2D Discrete Fourier Transform(DFT) of images contains important information of image representation. The phase-based image matching, especially BLPOC-based image matching is successfully applied to image recognition tasks for biometric authentication applications.[9]

A. Kumar, senior member, IEEE**,** This paper has successfully investigated the likelihood of employing minor finger knuckle images for the identification. The coarse-to-fine segmentation strategy developed in this paper has been quite self-made because it has been able to achieve higher matching accuracy. The experimental results illustrated during this paper, on the info of 503 subjects, can achieve promising performance (EER of 6.29% and 12.6% under two protocols) from solely mistreatment contactless minor finger knuckle images. The experimental results according during this paper conjointly recommend that the synchronous use of major and minor finger knuckle images will help to considerably improve the performance which will not be attainable by victimization either minor or major finger knuckle images alone.[10]

Kumar and C. Ravikanth details an online system using the hand dorsal surface images which can simultaneously exploit the finger knuckle patterns from the multiple fingers and also their geometrical shape characteristics. Better results were found out with different fusion of basic techniques as Principal Component Analysis (PCA), Linear Discriminate Analysis (LDA) and Independent Component Analysis (ICA).This method overcome problem due to finger rings and black background. Previous method used black background problem of using dark background is that the finger surface can be dark, so they used white background which requires simple

pre-processing as compared. The disadvantage of this method is the speed of working is less as it uses scanner for imaging.[11]

A. Kumar, in this paper they work on a new approach to enhance the performance of finger vein identification System. The projected system at the same time acquires the finger vein and low resolution finger print images and combines these two evidences employing a novel score level combination strategy. The utility of low resolution fingerprint pictures non inheritable from a digital camera is examined to establish the matching performance from such pictures. They developed and investigated two new score level combos, i.e., holistic and nonlinear fusion, and relatively assess them with additional well-liked score level fusion approaches to establish their effectiveness in their projected system. They presented the information of 6,264 pictures from 156 subjects illustrate vital improvement within the performance, each from the authentication and recognition experiments.[12]

KamYeun Cheng, Ajay Kumar, This paper details the development of a smart phone based online system to automatically identify a person by using their finger knuckle image. The key objective is to exploit user-friendly biometric, with least privacy concern, to enhance security of the data in smart phone. The developed system application can operate on any smart phones which use android OS and contain an embedded camera (with at least 2MP resolution). This paper uses 1D log-Gabor filter to extract the finger knuckle templates which are matched using Hamming distance.[13]Ferrer and Travieso [IEEE magazine] proposed biometric on the basis of knuckle crease of hand. System extracts wrinkles of hand knuckle and uses these images for identifying subject. In this verifiers checked on basis of HMM and support vector machine.[14]

A. Kumar [IEEE]this paper is about development of system using peg free imaging. The developed system automatically extracts knuckle texture and acquires finger geometry features. For collection of data requires minimum seven months in two phases with an interval of four weeks. The finger back surface images are collected from male and female within 18-60 years group. The majority of data collected from adults between 20-25 ages. In image acquisition finger back surface captured by digital camera focusing against white background under uniform illumination. The white background is choose because finger back texture is dark which requires difficult pre-processing. In pre-processing thresholding operation used to obtain binarized image. The morphological erosion operation is used to remove sporadic dots. This operation helps smoothen the counter. The localizations of finger pixels are used to extract knuckle region for feature extraction. The region of interest is the region having maximum knuckle creases. It is necessary to construct a local coordinate system for each FKP image. With such a coordinate system, an ROI can be cropped from the original image for reliable feature extraction and matching. Two methods are used for extracting knuckle regions from segmented fingers. in first method, fixed size of knuckle region of finger extracted based on finger length. In another method edge detection technique is used. The canny edge detection is applied on extracted finger image. The local and global features are used for matching knuckle images. These features are quite stable. The information from knuckle image is independent of any judgment of any lines or creases. PCA, LDA, ICA image processing techniques used for comparing matching scores.[15]

III. Research Method

Proposed system includes different stages such as image acquisition, image preprocessing, feature extraction, feature matching and authentication process. Following figure2 shows block diagram of proposed system. firstly, image can be acquired using specific camera and saved in .jpg format. Then step by step image preprocessing, feature extraction, feature matching and personal authentication can be done.

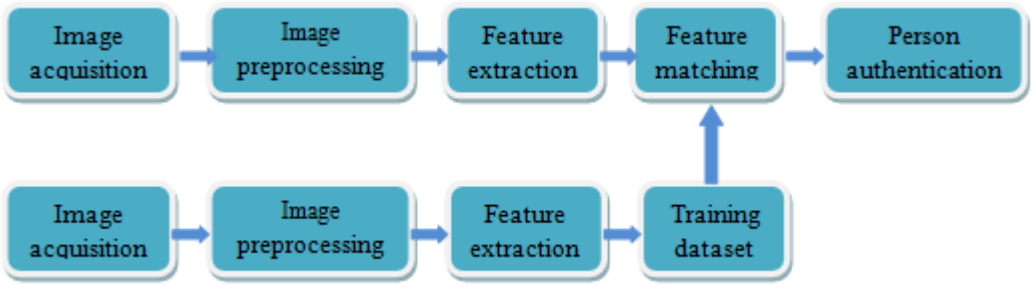

Fig.2 Block Diagram Of Personal Authentication Using Finger Knuckle Surface

Step1: Image acquisition

This is first step of proposed system. Images are captured from PC camera and stored in .jpg format which is used for further procedure. Total 200 images are captured from college student, family and relatives. this captured image is going through image resizing, conversion of RGB to grayscale, edge detection knuckle detection, feature extraction, and classification.

Step2: Image Preprocessing

The captured images are resized in 480×640pixel format. This resized image converted into grayscale. The `rgb2gray` function converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance. It uses weighted sum of the R, G and B components as follows

$$0.2989*R+0.5870*G+0.1140*B\text{……..}(1)$$

Step3: Extraction of knuckle

This step involves different operations perform on grayscale image such as edge detection, knuckle detection which includes ULEA process, clearance operation, cropping operation. Sobel edge detection is used calculate areas of different intensities of an image It is a discrete differentiation gradient-based operator. It computes the gradient approximation of image intensity function for image edge detection. At the pixels of an image, the Sobel operator produces either the normal to a vector or the corresponding gradient vector.

To find the knuckle region we can use unwanted line elimination algorithm considered as morphological operations. A 3 × 3 mask is used for performing ULEA process. Black pixel values in the threshold image alone are tested. If the current pixel value located at the mask centre is black, then the neighboring eight pixel values are tested. If the two corresponding values are white together, then the current pixel is changed to a white pixel.

In our project knuckle image open by line 5 degree 0 horizontally. After that image dilated using disk structuring element with length 5.white pixel area becomes wide as compared to first image. Again we are opening image by line 5 degree 90.white pixel area is increased vertically. By using clearance operation border of grayscale image cleared. The grayscale image is converted into RGB to find final knuckle region.

Step4: Feature Extraction

For feature extraction we are using gabor filter. To extract feature on knuckle region we are going to use bank of 16 gabor filter at an orientations of 0degree, 22.50degree etc. The filter has a real and an imaginary component representing orthogonal directions. The two components may be formed into a complex number or used individually. The equations are given below:

Complex

$$g(x,y;\lambda,\theta,\Psi,\sigma,\gamma) = \exp\left(-\frac{x'^2+\gamma^2y'^2}{2\sigma^2}\right)\exp\left(i\left(2\pi\frac{x'}{\lambda}+\Psi\right)\right)\text{……...}(2)$$

Real

$$g(x,y;\lambda,\theta,\Psi,\sigma,\gamma) = exp\left(-\frac{x'^2+\gamma^2y'^2}{2\sigma^2}\right)cos\left(2\pi\frac{x'}{\lambda}+\Psi\right)\text{……}(3)$$

Imaginary

$$g(x, y; \lambda, \Theta, \Psi, \sigma, \gamma) = \exp\left(-\frac{x'^2+\gamma^2 y'^2}{2\sigma^2}\right)\sin\left(2\pi\frac{x'}{\lambda}+\Psi\right) \quad \text{.....(4)}$$

Where

$$x' = x\cos\Theta + y\sin\Theta \quad \text{.....(5)}$$

And

$$y' = -x\sin\Theta + y\cos\Theta \quad \text{.....(6)}$$

In the above equation,

λ — Wavelength of the sinusoidal component.

Θ — The orientation of the normal to the parallel stripes of Gabor function.

Ψ — The phase offset of the sinusoidal function.

σ — The sigma/standard deviation of the Gaussian envelope

ɣ— The spatial aspect ratio and specifies the ellipticity of the support of Gabor function.

The above mentioned five parameters controls the shape and size of the Gabor function. Some other color features are for analysis. Mean, standard deviation, Skewness, rms and median are used for classification. Padding operation is used for Gabor array which helps for classification and identification of person on the basis of knuckle features.

Step 5: Classification

For classification we are using SVM classifier and PCA-LDA. The learner is created and ECOC model is used for matching process. For classification database is divided into 70% trained and 30 %test image of each group. All the training database images are processed through all these steps and finally feature vector is saved by labeling the class. Test image going through all these steps and its feature vector will get compared with the trained feature vector for the person identification.

IV. Results And Discussion

The objective of our proposed system is to develop the algorithm for person authentication that achieves the high recognition accuracy & high recognition speed. The results of real time and standard database are compared using svm as well as PCA-LDA. For real time 200 images and standard database 500 images are taken.Fig.3 shows some real time images which step by step undergoes through preprocessing and post processing. System results are also given below**.**

Fig.3 Real Time Database

Fig.4 Image resizing (a) Original image (640×480) (b) Resized image(480×640)

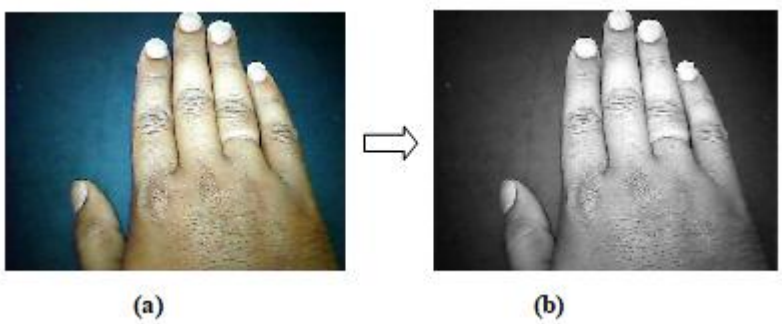

Fig.5 Conversion of image (a) resized RGB image (b) grayscale image

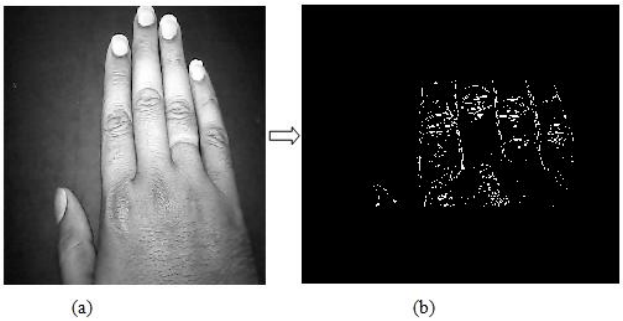

Fig.6 Edge detection (a) grayscale image (b) edged image

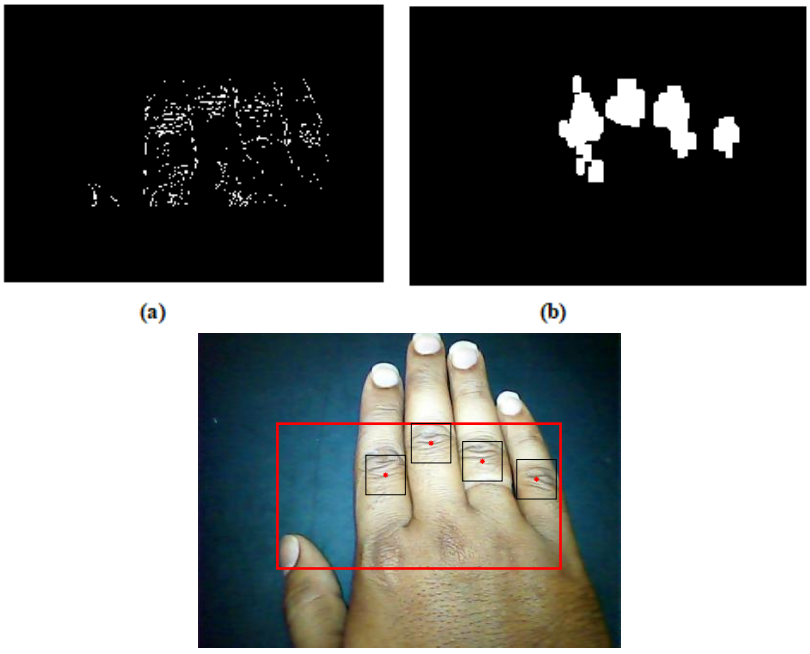

Fig.7 Knuckle extraction (a) edged image (b) suspected knuckle blobs (c) final knuckle region

We studied about feature values for all of finger of each image. After that we calculate average feature values for each class and all knuckle. The average values for each feature of all finger knuckle in single group are given in table1

Table.1 Average Extracted Feature Values for Abhay

Before Normalization(average values)						After Normalization(average values)				
Images	**Mean**	**Std.dev.**	**Skewness**	**Rms**	**Median**	**Mean**	**Std.dev.**	**Skewness**	**Rms**	**Median**
FK1	2.362159	1.645251	1.178347	2.916996	0.537000	1.886	1	1.1783472	1	0.538686
FK2	2.149484	1.541144	1.301263	2.686918	0.564419	-0.034	1	1.302233	1	0.4948426
FK3	2.201009	1.529408	1.186920	2.716797	0.799254	1.478	1	1.186910	1	0.524909
FK4	1.694160	1.265540	1.561095	2.146844	0.6153	2.856	1	1.561095	1	0.504393

A. Recognition Accuracy

It is ratio of number of correctly classified test images by total number of test images.

$$\text{recognition accuracy} = \frac{number\ of\ correctly\ classified\ test\ images}{total\ number\ of\ test\ images} \times 100$$

Some of test samples with results using PCA-LDA are given table 2:

In above we are discussing result about only 10 class. Result of remaining classes were studied. T represents person correctly identified and F represents misclassified. Accuracy for per class is given in table2. Overall accuracy of system using PCA-LDA for real time database is 89.65%

Table.2 Result for Real Time Database Using PCA-LDA

Sr. no.	Class	Total images	Test images	Person correctly Identified	Accuracy (%)
1	Abhay	5	2	T	100
2	Abhishek	5	2	T	100
3	Akshara	6	1	T	100
4	Amrata	5	1	T	100
5	Atharv	5	2	F	50
6	Baby	6	1	T	100
7	Bhagyalaxmi	5	2	T	100
8	Dnyaneshwar	5	2	T	100
9	Ganesh	5	1	T	100
10	Gauri	5	2	T	100

Table.3 Result for Real Time Database Using SVM

Sr. no.	Class	Total images	Test images	Person correctly Identified	Accuracy (%)
1	Abhay	5	2	F	50
2	Abhishek	5	2	T	100
3	Akshara	6	1	T	100
4	Amrata	5	1	T	100
5	Atharv	5	2	T	100
6	Baby	6	1	T	100
7	Bhagyalaxmi	5	2	T	100
8	Dnyaneshwar	5	2	F	50
9	Ganesh	5	1	T	100
10	Gauri	5	2	T	100

The recognition accuracy for every class using SVM is shown in above table3. Average recognition accuracy of the system using SVM for real time database is 74.13%.

B. Computational time for system

Computational time required for image of every class is calculated. Average recognition time required for system with classifier change. The calculated time is in min and second format.

Table4. Computational Time

Sr. No.	Method used	Average Time
1.	PCA-LDA	2.435sec.
2.	SVM	22 min and 12sec.

V. Conclusion

From literature survey, the study of different types of features extraction technique and classification is done. After studying number of techniques, gabor filter is used for feature extraction and SVM, PCA-LDA for classification is in proposed system. The proposed system tested on real time as well as standard database. The performance of proposed method in terms of recognition accuracy and recognition is done. The recognition accuracy is high using PCA-LDA as compared to SVM. The accuracy for real time database using PCA-LDA is 89.65% and SVM is 74.13%.For standard database PCA-LDA result is 73.54 but due to large dataset we cannot get output. Hence PCA-LDA is more effective for large dataset. Algorithm used for system is very simple with high accuracy and cost free.

ACKNOWLEDGEMENTS

I sincerely thankful to my guide.we thankful to Hong Kong Polytechnique University for their kind support. We thankful to HOD E&TC, Director of MIT college for providing us necessary facilities.

References

[1]. Ajay Kumar, "Personal Authentication Using Finger Knuckle Surface" *IEEE Transactions On Information Forensics And Security*, Volume(4), No. 1, March 2009.

[2]. Miguel A. Ferrer, Carlos M. Travieso"Using Hand Knuckle texture for biometric identification" *IEEE A&E Systems Magazine*. June 2006.

[3]. Prof. V. U. Kale, Prof. R. A.Wakode, Rinky L. Batra," Finger Knuckle System for Human Identification: A Literature Survey" ,IJETAE, volume(5),issue 1,january 2015.

[4]. Lin Zhang, "Online finger-knuckle-print verification for personal authentication", *Pattern Recognition 43* (2010) *2560–2571*.

[5]. Shubhangi Neware, "Finger Knuckle Surface Biometrics", IJETAE, Volume 2, Issue 12, December 2012.

[6]. Kelani Nitesh, Nimodiya, "Finger Knuckle Print: A Biometric Identifier" *Journal of pattern intelligence*, volume(2),issue1,2012,*ISSN:2230-9330,PP.26-29*.

[7]. Esther Rani P, Shanmugalakshmi R, "Finger Knuckle Print Recognition Techniques-A Survey" *THE International Journal of Engineering and Science*, volume(2),issue11, November2013,*ISSN(e):2319-1813*

[8]. P Diviya, K Logapriya, "Identification of Suspects using Finger Knuckle Patterns in Biometric Fusions ",*International Journal of Research in Computer Science*, volume(2),issue2,2015, *ISSN:2349-3828*.

[9]. Mrs. S.S. Kulkarni, Dr. Mrs. R. D. Rout, "Secure Biometrics: Finger Knuckle Print", *International Journal of Advance Research in Computer and Communication Engineering*, volume(1),Issue 10,December2012,*ISSN(P):2319-5940*.

BIOGRAPHIES OF AUTHORS

	**Nandini S. Gore** post graduate research student Of Electronics And Telecommunication Engineering, Maharashtra Institute of Technology, Aurangabad, India. B.E. in Electronics and Telecommunication Engineering in 2014. She has one international Journal publication.
	**Dr. G. S. Sable** professor and examination head at Maharashtra Institute of Technology, Aurangabad, India. PhD from Dr. Babasaheb Ambedkar Marathwada University, Aurangabad. M.E. and B.E. from J.N.E. college, Aurangabad. He has more than 40 publications to his credit development.He has more than 20 years of teaching experience.