Volume 8, Issue 6
December 2019

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

An In-Depth Comparative Study on Feature Extraction Techniques for Biometric Images

[1]Dr. N. Venkatesan and [2]Dr. B. Sree Vidya

[1]Department of Computer Science and IT, Bharathiyar College of Engineering and Technology, Karaikal, Puducherry State, India

[2]PG & Research Department of Comp Sci. Shri Shankarlal Sundarbai Shasun Jain College for Women, Chennai, India

E-mail: [1]envenki@gmail.com, [2]sreevidya.saravanabhavan@gmail.com

ABSTRACT

Features are significant part of an image, that can be used to match one image with another and classify to check if they belong to the same class or a different one. Features represent the image and feature extraction brings out significant features that are more pertinent to perform classification. Feature extraction techniques have a wide range of applications in image processing and pattern recognition. This paper attempts to review the existing feature extraction techniques that are proposed by various researchers. This study also dwells deep to identify the pros and cons in the existing techniques. The paper also identifies scope for improvisation that can lead to a better feature extraction technique which can applied to biometric images to bring out the significant features.

Keywords: *Feature Extraction, Biometric Images, Classification, Pattern recognition, Image Processing*

1. INTRODUCTION

Most biometric systems have applications in forensic and verification systems. In forensic systems, fingerprints are used for identifying culprits in criminal activities. Verification systems include comparing the sample obtained from users with previously registered samples. For this purpose, it is essential to extract features from biometric images in a precise way. In any recognition system, feature extraction process plays a vital role [1] since the extracted features are used in matching the acquired traits with the registered traits. Performing feature extraction on a pre-processed image results in features that are significant, thus, contributing to better accuracy of classification of a sample. Features are extracted based on a number of parameters like texture, shape, contours etc. The choice of the technique depends on the required outcome of applying the technique.

In a biometric authentication system, feature extraction plays a key role since the unique and distinctive features should be precisely extracted from images that can better distinguish one user from another.

In general, authentication system works by acquiring traits from users during registration phase which are then stored. At the time of authentication, traits obtained from users are compared against stored templates

Feature extraction is one of the most active areas of research in computer vision and image processing

1.1 Biometric Traits

Biometrics refer to body measurements and statistical analysis of human's physiological and behavioural traits [2]. No two persons have the same biometric traits, thus make it highly unique among individuals. Due to its discriminative nature, biometrics are used in identification, duplicate checking and verification of individuals which can be applied to authentication system, forensic investigations, access control and fraud detection.

There are variety of physiological traits in human body ranging from commonly used fingerprints, iris, face features, palm print, hand geometry, finger vein to rarely used traits like tongue, ear, retinal scans etc. Behavioural traits include signature, gait, speech and keystroke dynamics.

Authenticating users based on biometric traits warrants for an accurate classification system for discriminating genuine users and imposters. This in turn depends on an effective feature extraction technique. The crux of better authentication relies on the way the features are extracted and feature extraction influences the functioning of classifiers.

1.2 Feature Extraction and its Types

Feature extraction refers to the process of mapping an image from n-dimensional space to lower dimensions by applying certain function to the original image. These smaller dimensions aid in accurate and faster classification. The general functioning of feature extraction techniques includes extraction of features, selection of features and classification. During classification, the extracted features should rightly match with the acquired features.

Feature extraction techniques can be based on spatial, colour, edge, boundary, shape and texture features. Texture is one of the key descriptors of an image. One of the most important statistical measures of texture is entropy, i.e., the information content carried by an image and the local regions of image.

Texture-based extraction has applications in many fields that include machine vision, medical image analysis, visual inspection, personnel identification etc. Effective extraction of features forms the basis for all texture related problems.

Of the various texture-based feature extraction techniques, the most widely applied descriptor is Local Binary Pattern (LBP). Thus, LBP is one of the most powerful tools in the field of texture analysis [3].

1.2.1 Texture Based Extraction

Texture of an image can be characterized by properties like granularity, repetitiveness and coarseness which denote variation of pixel intensities of a gray scale image in a spatial domain. Most texture algorithms extract distinguishing features of image, thus facilitating classification.

Volume 8, Issue 6
December 2019

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

Classification of images based on texture has wide range of applications like fabric classification [4], crops classification [5], medical image analysis [6] and face recognition [7].

There are a number of techniques for texture-based extraction like statistical, model-based, geometrical and signal processing, with each of these techniques adopting different modes of operations.

The different techniques of feature extraction are depicted in figure 1.

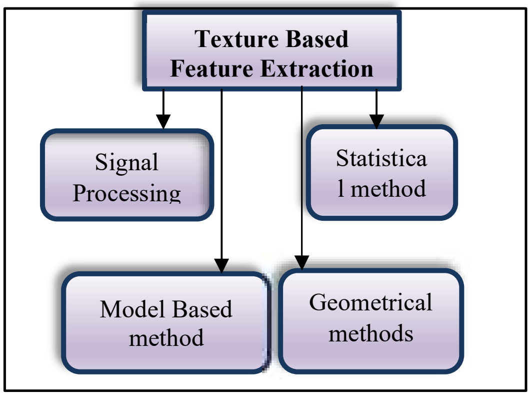

Figure 1Texture Based Feature Extraction

Statistical methods work by considering spatial distribution of pixel intensity values and obtaining local features of the image at each point. Finally, series of statistics are derived from the local features' distribution. These measures can be additionally classified into first, second and higher order methods. When individual pixel value's properties like variance and entropy, are applied, it is said to be first-order. Second order is when estimation is done between a pair of intensity values. Higher order involves considering more than two-pixel values.

Model-based methods provide a general model that is created based on the observation of pixel distribution. Image's structure is used for texture description.

Geometrical methods extract texture information from image by describing texture primitives and organization of those primitives in a spatial domain.

In Signal processing methods, the frequency content of the image is considered. For finding the frequency, a number of filtering models are employed.

2. COMPARATIVE STUDY ON FEATURE EXTRACTION TECHNIQUES

To outline the various feature extraction techniques, this section discusses some of the recent research contributions by various researchers to extract features. These contributions are from varied areas like feature extraction from biometric images like iris, finger knuckles, palm print, finger veins, face and fingerprints; feature extraction on textures; extraction of features from medical digital images and the like

2.1 Local Binary Pattern (LBP)

Local Binary Pattern proposed by Ojala et. al. [3], is a texture-based feature extraction technique that has wide applications in biometric image classification. The captured digital image is partitioned into smaller segments from which the features are extracted. The LBP operator works by thresholding the neighbourhood of each central pixel and this results in a binary number. The LBP operator is defined as follows:

$$LBP_{P,R}(x_c, y_c) = \sum_{p=0}^{p-1} s(g_p - g_c)2^p \qquad (1)$$

where there are P neighbours, with radius of neighbourhood R, x_c,y_c are co-ordinates of pixel at the center of the local region, and g_p,g_c are gray intensity values of neighbouring pixel and center pixel and s(x) is defined as

$$s(x) = \begin{cases} 0, & x < 0 \\ 1, & x \geq 0 \end{cases} \qquad (2)$$

Local Binary Patterns are obtained by sampling pixels in a circular fashion around the central pixel. The operator uses either uniform patterns or non-uniform patterns.

For a uniform pattern, the number of bitwise transitions is no more than two. For example, 00000110 is a uniform pattern where the transitions are 2 when traversed in a circular fashion. In the case of pattern 10101100, the number of transitions is 6, and hence falls under the category of non-uniform patterns.

The pattern of LBP code for each of the pixels in the segmented images are collated into a histogram [8]. All the uniform patterns are assigned individual labels and all non-uniform patterns are grouped together under a single label. Classification is carried out by calculating histogram similarities.

2.1.1 Observation

Local Binary Pattern is one of the significant contributions to the field of feature extraction that performs exceptionally well especially for facial image recognition systems. The key advantage of LBP operator is that it is invariant to illumination and rotation. But on the downside, while constructing histograms from the micro-patterns, it considers only uniform patterns. Though non-uniform patterns add to computational complexity, such non-uniform patterns also significantly contribute to the extraction of unique features especially when applied to biometric images.

2.2 Bilateral Texture Filtering

Cho et al [11] presented bilateral filter as a feature extraction operator. The operator attempts to preserve structure by decomposing the image. The operator uses two kernels viz., a spatial and a range kernel which are functions of gaussian filter. In addition, a weight that is image dependant is also employed. Usage of Kernel along with weights enables the operator to output features that preserve the structure.

2.2.1 Observation

The method clearly distinguishes structures and textures in an image. This was achieved by using patch shift that identified the texture regions and decomposed. Though experimental results proved that the technique could precisely demarcate structure and texture regions, such a precision could be achieved only at the cost of higher computational complexity.

2.3 Co-occurrence of Adjacent LBP

Nosaka et al [12] presented a facial image feature extraction technique that was based on spatial co-occurrence of micro patterns. Instead of clubbing the pattern into bins, as in Local Binary Pattern (LBP), the binary patterns were represented in the form of micro patterns. In addition to this, in order to establish spatial relationship among the patterns, co-occurrence of each pattern was also considered. The LBP of each of the micro patterns in the image were finally combined into histograms. The main aim of this work was to bring out the finest details from images which otherwise is missed out if LBP operator was applied.

2.3.1 Observation

The experimental results proved that combining LBP and Co-occurrence increased identification accuracy and was resistant to poor illumination and change in posture. But on the downside, the computational complexity of the technique increases with increase in input image’s size. The key advantage of LBP operator is computationally simple which is because of the fact that the micro-patterns are combined into one histogram. Since, in order to bring out finer details, the micro-patterns are retained as such without being concatenated into one single histogram. Hence, the technique is not scalable.

2.4 Local Binary Pattern Variance (LBPV)

Guo et. al [9], proposed a LBPV (Local Binary Pattern Variance) descriptor, a joint method of using Local Binary Pattern and contrast distribution. In LBPV, every LBP pattern is assigned the same weight 1. Then the values of variance are used as adaptive weights to adjust the distribution of contrast in histogram calculation.

The use of variance as adaptive weights is attributed to the fact that high frequency regions of texture have higher variance values [10] and hence the discrimination of images is also higher.

2.4.1 Observation

Local Binary Pattern and its variance extract features by comparing the central pixels against the neighbourhood sampling pixels. The radius from the central pixel to the sampling pixel is denoted by R, and the number of neighbouring pixels is denoted by P. Generally, p values are in multiples of 8, starting from 8,16, 24 and so on and the radius can be 1,2,3 etc. In LBPV, it is observed that when P and R values are (8,1) respectively, the accuracy of classification is quite high. But with the increase in P and R values, viz., (16,2); (24,3); the accuracy of classification falls.

2.5 Feature Extraction by Image Sharpening Adjustments

Zhang K. et. al [13] proposed a texture-based feature extraction technique based on the sharpness of biometric images, which in turn contributed to better feature extraction. The biometric images, viz., palmprint and iris were filtered and adjusted to lower sharpness. The sharpness of the acquired biometric images were lowered which aided in better extraction of features.

2.5.1 Observation

The experimental results proved that images with lower sharpness could significantly contribute to better identification, thereby bringing down the error rate. But on the other hand, feature extraction involved a two-step process where initially Gabor filter was applied that enabled bringing down the sharpness of the image and filtered images were texture analysed for extracting features. Hence, the process itself is a composite one.

2.6 Feature Extraction combining SVM and Hamming Distance

Rai et. al [14] put forward a novel feature extraction technique for iris images. This technique was based on texture features of collarette regions of the iris. The dimension of the captured images was reduced by detecting the eyelashes and eyelid regions and filtered using median filters. The method employed step wise feature extraction technique where initially the eyelids and eyelashes are filtered by applying parabola detection and trimming by usage of median filters. This enabled to specifically focus on the iris region alone, thus by enabling feature extraction only in those regions. The extracted features are then classified by combing support vector machine and hamming distance.

2.6.1 Observation

The experimental results showed a substantial increase in accuracy of identification. The observed downside is that the feature extraction technique has lesser scope for applying the same technique to those data that are captured from sensors that acquire iris regions directly. Adding on to that, the feature extraction technique is image specific and image dependent.

2.7 Enhanced Line LBP

Al-Nima et al [15] proposed a novel user authentication mechanism with fingerprint as the validation factor. The features were extracted based on the fingerprint textures by applying enhanced local line binary pattern. Probabilistic Neural Network was used for training and testing purposes. In addition to proposing a novel feature extraction, this method also attempted to salvage the missing portions of finger textures from the trained samples. The feature extraction technique involved an enhanced line LBP (ELLBP) operator which was an extended version of the LBP operator. The given image was divided into horizontal and vertical regions with each window containing 9 cells. Average weighted summation of these regions was obtained which resulted in significant features being extracted from the images.

2.7.1 Observation

The experimental results showed that the method potentially increased the verification rate. But the technique also requires large number of training sets in order to enable better classification.

2.8 Discriminative histograms of local dominant orientation (D-HLDO)

Qian et al [16] proposed a novel feature extraction technique for extracting distinctive features from biometric images. The technique worked by obtaining image's local orientation map and its respective energy map by using singular value decomposition. Histograms features were then generated by concatenating these two values.

2.8.1 Observation

The experiments conducted on finger knuckle, face and palmprint showed higher recognition rate. Though the results showed higher recognition rates, the technique also introduced redundant information which had to be minimized using local mean-based neighbourhood technique.

2.9 Combining Local and Global Feature Extraction Technique

A hybrid feature extraction technique proposed by Eskandari et. al. [17] where local and global feature extractors were employed together to extract features from two biometric traits and then combine the extracted features. Face and iris images were used and on to these, LBP was applied to extract local features and to obtain global features, sub-space Linear Discriminant Analysis (LDA) was used. The obtained features were then combined to get the fused features.

2.9.1 Observation

The results showed increased recognition rate. Since the extracted features were fused and sent as input to the classifier, the space complexity was substantially minimal in addition to providing a better template protection. But on the other hand, LDA which is employed as a global feature extractor fails to bring out the features if the variation among classes of data used are quite high.

2.10 Localized Angular Phase (LAP)

Saipullah et.al. [18] presented a new feature extractor using localized angular phase. This worked by considering Fourier transformation's phase information about the pixel in local space that had a constant radius. This feature extraction was predominantly applied to medical images to efficiently classify images with abnormalities.

2.10.1 Observation

The technique achieved a higher accuracy but failed to achieve invariance because of its local descriptor.

2.11 Scale and Rotation Invariant Feature Extraction

Rahman et.al. [19] proposed a method for retrieval of images based on the content. The features were extracted using circular shift in rotation and scale dimensions. To these, Gaussian window was applied to reduce low and high frequencies. The effectiveness of the algorithm was evaluated using Precision-Recall curve and mean average precision.

2.11.1 Observation

The results showed that the features extracted using the technique yielded better performance for retrieval. But the technique compromises on simpler implementation since for every dimension of scale and angle, circular shift is performed in addition to employing Gaussian window.

2.12 Fuzzy Inference System for Face Expression Recognition

Ilbeygi et. al [20] presented a novel facial feature extraction technique that identified emotions from facial features. The extraction technique used fuzzy logic for defining fuzzy inference system. The fuzzy set's membership function parameters were tuned using genetic algorithm.

2.12.1 Observation

The results showed that precise features were extracted which even brought out emotions from partially captured faces. The technique does not employ any optimization algorithms for optimizing the membership parameters using in the feature extractor which plays a key role in extracting features irrespective of the size of the underlying image.

2.13 Feature Extraction using Binarization of Bit Plane

Thepade et.al. [21] proposed a new feature extraction technique based on binarization of image. The technique worked by binarizing the significant bits of the image. It was a two-step process, wherein in the first step, the image was divided into a number of slices and binarization was applied based on the thresholds of local regions i.e. based on mean and standard deviation of local regions.

2.13.1 Observation

The results showed that the technique improved performance of classification. The technique is limited to be applicable to specific image types rather than varied kinds.

2.14 Stochastic Resonance based Feature Extraction

Ryu et.al. [112] presented a new feature extraction approach from fingerprints. This work particularly focused on extracting significant features from low-quality images. The technique added moderate noise to amplify a weak signal by using Stochastic resonance. For doing so, Gaussian noise.

2.14.1 Observation

The results showed that adding such a small amount of noise enhanced images that were of low-quality and aided in better extraction of features from such images. This enabled better extraction of 10 images out of a set of 11. But on the other hand, the feature extraction completely relies on the amount of noise that is introduced in order to bring out the significant features from low quality images. Higher or lower level of noise can take a significant hit on the extracted features.

2.15 Half Iris Feature Extraction

Rahulkar et.al. [23] proposed a novel feature extraction technique for iris recognition. For this purpose, a triplet half band filter bank was used which aided in extraction of significant features from iris. The extracted features were classified using k-out-of-n classifier

2.15.1 Observation

The experimental results showed higher accuracy in addition to lesser computational cost. On the downside, the feature descriptor is image specific and limited to iris images.

2.16 Local Tetra Pattern (LTrP)

Murala et. al. [24] proposed a new feature descriptor named local tetra pattern. This was in particular used for content-based retrieval of images. The idea was based on local binary and ternary pattern in which relationship between sampling pixel and its neighbours were expressed in terms of differences in their gray levels. In this approach, the relationship was established between sampling pixel and its neighbouring pixel based on the vertical and horizontal directions.

2.16.1 Observation

The effectiveness of the technique was proved based on metrics like precision, recall and retrieval rate. The experimental results showed that the technique brought out significant features. Though a tertra patterns are considered, central pixels' horizontal and vertical directions alone are considered omitting the diagonal axis which otherwise would have aided in improved performance.

2.17 Ridge tracing Based Feature Extraction

Arpit et.al. [25] presented a new fingerprint feature extraction technique that worked by tracing ridges during which, information in the context of ridges were collected. This helped in better identification of noisy regions.

2.17.1 Observation

The experimental results revealed that the features extracted aid in better classification. The technique does not employ any means for calculation of ridge frequency estimation, which could improve the accuracy.

2.18 Oriental Local Histogram Equalization Feature Extraction Technique

Lee et. al. [26] discussed Oriented Local Histogram Equalization (OLHE) where the edge orientations were exploited compensating illumination. This edge orientation was useful for recognition of facial features. Face recognition mechanism included three contributions viz., encoding of edge orientations, better contour preserving capability and better performance even under high illumination conditions. The work presented LBP as a special case of OLHE, and it outperformed LBP for face recognition.

2.18.1 Observation

The results also showed that the computational complexity of OLHE was less in comparison to their previous studies. But the technique does not address adaptive application of varied window sizes with different levels of contrast.

2.19 Feature Extraction using ALBP

Lin et. al. [27] presented a method for retrieval of images followed by classification using Adaptive Local Binary Patterns (ALBP), a texture-based feature extraction technique. Adaptive Local Binary Pattern Histogram (ALBPH) and Gradient for Adaptive Local Binary Patterns (GALBP) were proposed based on texture features. These features described the relationship among the pixels in a local neighbourhood. ALBPH like LBP found the distribution of a texture image by calculating difference between central pixel and pixel values of its associated neighbour values. In the GALBP, the

gradient for each pixel was calculated and total of these gradients was used as an image feature.

2.19.1 Observation

The experimental results proved that the technique yielded better results in terms of retrieval and classification. The technique proved to be effective but not optimal due to its computational complexity.

2.20 Entropy Based Local Binary Pattern (ELBP)

This technique aimed at providing a general feature extraction technique that was employed on multiple modalities like fingerprint, iris and face [28]. Entropy information of the neighboring pixels are described into the micro-patterns of the local binary pattern descriptor. The technique achieved higher accuracy and precision rates when applied to an authentication system.

2.20.1 Observation

Though the technique brought out significant features, calculation of entropy measure and applying it to LBP micropatterns add computational complexity to the technique.

The following table below briefs a quick summary of various feature extraction techniques discussed in the previous sections.

Table 1 Feature Extraction Techniques – Quick View

Sl. No.	Author(s) / Year	Key Feature Extraction Idea
1	Ojala, (2002)	The captured digital image is partitioned into smaller segments from which the features are extracted. The LBP operator works by thresholding the neighbourhood of each central pixel and this results in a binary number
2	Cho H, Lee H, Kang H, Lee S. (2014)	Bilateral filter operator that attempts to preserve structure by decomposing the image
3	Nosaka R, Ohkawa Y, Fukui K.(2011)	A variant of local binary pattern where the binary patterns are represented in the form of micro patterns instead of bins and finally are combined into bins
4	Guo Z, Zhang L, Zhang D(2010)	Joint method of using Local Binary Pattern and contrast distribution
5	Zhang K, Huang D, Zhang B, Zhang D (2017)	Texture based feature extraction technique for biometric images. Features extracted by are filtering images and adjusting to lower sharpness
6	Rai H, Yadav A. (2014)	Features are extracted from iris images based on texture features of collarette regions and applying filtering techniques.
7	Al-Nima RR, Dlay SS, Al-Sumaidaee SA, Woo WL, Chambers JA. (2016)	Local line binary pattern with salvaging missing portions of fingerprint textures based on trained samples
8	Qian J, Yang J, Gao G. (2013)	Feature extraction based on local orientation map and its respective energy map by using singular value decomposition. Histograms features are then generated by concatenating these two values
9	Eskandari M, Toygar Ö. (2014)	Local and global feature extractors are employed together to extract features from two biometric traits and then extracted features are combined
10	Saipullah KM, Kim DH.(2012)	Features are extracted by considering Fourier transformation's phase information about the pixel in local space with a constant radius

11	Rahman MH, Pickering MR, Frater MR, Kerr D. (2012)	Content based feature extraction using circular shift rotation and scale dimensions
12	Ilbeygi M, Shah-Hosseini H. (2012)	Extraction based on fuzzy logic for defining fuzzy inference system. The fuzzy set's membership function's parameters are tuned using genetic algorithm for extraction of features
13	Thepade S, Das R, Ghosh S. (2014)	Bnarizing the significant bits of the image with two steps; 1.the image is divided into number of slices 2. binarization is applied based on the thresholds of local regions
14	Ryu C, Kong SG, Kim H. (2011)	Extraction by adding moderate noise to amplify a weak signal by using Stochastic resonance
15	Rahulkar AD, Holambe RS. (2012)	Feature extraction using triplet half band filter bank
16	Murala S, Maheshwari RP, Balasubramanian R. (2012)	Feature extraction based on the relationship established between sampling pixel and its neighbouring pixel based on the vertical and horizontal directions
17	Arpit D, Namboodiri A. (2011)	Feature extraction from fingerprint based on tracing fingerprint ridges during which, ridge information is collected
18	Lee PH, Wu SW, Hung YP (2012)	Edge oriented feature extraction
19	Lin CH, Liu CW, Chen HY. (2012)	Adaptive weights based LBP
20	Sree Vidya B, Chandra E (2019)	Entropy Information into LBP

3. CONCLUSION

The paper aims at reviewing some of the classical feature extraction techniques with predominant techniques applied on to biometric images that are proposed by various researchers. The paper provides a comprehensive survey of literature in the field od featue extracition.

REFERENCES

[1] Abhishree TM, Latha J, Manikantan K, Ramachandran S. Face recognition using gabor filter-based feature extraction with anisotropic diffusion as a pre-processing technique. Procedia computer science. 2015 Jan 1; 45:312-21.

[2] Jain AK, Ross A, Prabhakar S. An introduction to biometric recognition. IEEE Transactions on circuits and systems for video technology. 2004 Jan;14(1):4-20.

[3] Ojala T, Pietikainen M, Maenpaa T. Multiresolution gray-scale and rotation invariant texture classification with local binary patterns. IEEE Transactions on pattern analysis and machine intelligence. 2002 Jul;24(7):971-87.

[4] Jing J, Xu M, Li P, Li Q, Liu S. Automatic classification of woven fabric structure based on texture feature and PNN. Fibers and Polymers. 2014 May 1;15(5):1092-8.

[5] Kim HO, Yeom JM. Effect of red-edge and texture features for object-based paddy rice crop classification using RapidEye multi-spectral satellite image data. International journal of remote sensing. 2014 Oct 2;35(19):7046-68.

[6] Waugh SA, Purdie CA, Jordan LB, Vinnicombe S, Lerski RA, Martin P, Thompson AM. Magnetic resonance imaging texture analysis classification of primary breast cancer. European radiology. 2016 Feb 1;26(2):322-30.

[7] Rahim MA, Azam MS, Hossain N, Islam MR. Face recognition using local binary patterns (LBP). Global journal of computer science and technology. 2013 May 31.

[8] Huang D, Shan C, Ardabilian M, Wang Y, Chen L. Local binary patterns and its application to facial image analysis: a survey. IEEE Transactions on Systems, Man, and Cybernetics, Part C (Applications and Reviews).2011 Nov ;41(6):765-781.

[9] Guo Z, Zhang L, Zhang D. Rotation invariant texture classification using LBP variance (LBPV) with global matching. Pattern recognition. 2010 Mar 1;43(3):706-19.

[10] Varma M, Zisserman A. Unifying statistical texture classification frameworks. Image and vision computing. 2004 Dec 1;22(14):1175-83.

[11] Cho H, Lee H, Kang H, Lee S. Bilateral texture filtering. ACM Transactions on graphics. 2014 Jul 27;33(4):128.

[12] Nosaka R, Ohkawa Y, Fukui K. Feature extraction based on co-occurrence of adjacent local binary patterns. In Pacific-Rim Symposium on Image and Video Technology 2011 Nov 20. 82-91. Springer.

ITEE Journal
Information Technology & Electrical Engineering

ISSN: - 2306-708X

[13] Zhang K, Huang D, Zhang B, Zhang D. Improving texture analysis performance in biometrics by adjusting image sharpness. Pattern recognition. 2017 Jun 1; 66:16-25.

[14] Rai H, Yadav A. Iris recognition using combined support vector machine and Hamming distance approach. Expert systems with applications. 2014 Feb 1;41(2):588-93.

[15] Al-Nima RR, Dlay SS, Al-Sumaidaee SA, Woo WL, Chambers JA. Robust feature extraction and salvage schemes for finger texture-based biometrics. IET Biometrics. 2016 Sep 9;6(2):43-52.

[16] Qian J, Yang J, Gao G. Discriminative histograms of local dominant orientation (D-HLDO) for biometric image feature extraction. Pattern recognition. 2013 Oct 1;46(10):2724-39.

[17] Eskandari M, Toygar Ö. Fusion of face and iris biometrics using local and global feature extraction methods. Signal, image and video processing. 2014 Sep 1;8(6):995-1006.

[18] Saipullah KM, Kim DH. A robust texture feature extraction using the localized angular phase. Multimedia tools and applications. 2012 Aug 1;59(3):717-47.

[19] Rahman MH, Pickering MR, Frater MR, Kerr D. Texture feature extraction method for scale and rotation invariant image retrieval. Electronics letters. 2012 May 24;48(11):626-7.

[20] Ilbeygi M, Shah-Hosseini H. A novel fuzzy facial expression recognition system based on facial feature extraction from color face images. Engineering applications of artificial intelligence. 2012 Feb 1;25(1):130-46.

[21] Thepade S, Das R, Ghosh S. A novel feature extraction technique using binarization of bit planes for content-based image classification. Journal of engineering. 2014;2014.

[22] Ryu C, Kong SG, Kim H. Enhancement of feature extraction for low-quality fingerprint images using stochastic resonance. Pattern recognition letters. 2011 Jan 15;32(2):107-13.

[23] Rahulkar AD, Holambe RS. Half-iris feature extraction and recognition using a new class of biorthogonal triplet half-band filter bank and flexible k-out-of-n: a post classifier. IEEE Transactions on information forensics and security. 2012 Feb;7(1):230-40.

[24] Murala S, Maheshwari RP, Balasubramanian R. Local tetra patterns: a new feature descriptor for content-based image retrieval. IEEE Transactions on image processing. 2012 May;21(5):2874-86.

[25] Arpit D, Namboodiri A. Fingerprint feature extraction from gray scale images by ridge tracing. In Biometrics (IJCB), 2011 International Joint Conference. Oct 2011; 1-8. IEEE.

[26] Lee PH, Wu SW, Hung YP. Illumination compensation using oriented local histogram equalization and its application to face recognition. IEEE Transactions on image processing. 2012 Sep;21(9):4280-9.

[27] Lin CH, Liu CW, Chen HY. Image retrieval and classification using adaptive local binary patterns based on texture features. IET image processing. 2012 Oct 1;6(7):822-30.

[28] Sree Vidya B., Chandra E, “Entropy Based Local Binary Pattern (ELBP) Feature Extraction Technique Of Multimodal Biometrics As Defence Mechanism For Cloud Storage”, Alexandria Engineering Journal, ISSN 1110-0168 Elsevier, Volume 58, Issue 1, March 2019, Pages 103-114.

AUTHOR PROFILES

Dr. N. Venkatesan is currently working as the associate professor and head, department of information technology, Bharathiar College of Engineering, Karaikal, India. He received his doctoral degree from Madurai Karamaraj University, India in the year 2013. He has authored 5 books, presented papers in national and international conferences and has published 65+ research papers in national and international journals. He also serves as key reviewer in a number of international journals. His areas of interests include data mining, information security, Cloud computing and image processing.

Dr. B. Sree Vidya received her doctoral degree in computer science in the year 2019. She has over 7+ years academic experience. She is currently working as assistant professor in the PG and research department of computer science, Shri Shankarlal Sundarbai Shasun Jain College for Women, Chennai, India. Her areas of interests include image processing, information security and Big data.