

## Research Article

### A New Feature Extraction Technique for Person Identification Using Multimodal Biometrics

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**Abstract:** Unimodal biometric systems when compared with multimodal systems can be easily spoofed and may get affected by noisy data. Due to the limitations faced by unimodal systems, the need for multimodal biometric systems has rapidly increased. Multimodal systems are more reliable as it uses more than one independent biometric trait to recognize a person. These systems are more secured and have less enrollment problems compared to unimodal systems. A new Enhanced Local Line Binary Pattern (ELLBP) method is devised to extract features from ear and fingerprint so as to improve recognition rate and to provide a more reliable and secured multimodal system. The features extracted are stored in the database and compared with the test features for matching. Hamming distance is used as the metric for identification. Experiments were conducted with publicly available databases and were observed that this enhanced method provides excellent results compared to earlier methods. The method was analyzed for performance with Local Binary Pattern (LBP), Local Line Binary Pattern (LLBP) and Local Ternary Pattern (LTP). The results of our multimodal system were compared with individual biometric traits and also with ear and fingerprint fused together using enhanced LLPD and other earlier methods. It is observed that our method outperforms earlier methods.

**Keywords:** Ear, fingerprint, LBP, LLBP, LTP, multimodal biometrics, unimodal biometrics

## INTRODUCTION

Single biometric trait is used in unimodal systems to identify a person. Few issues like spoofing, non universality, intra class variations etc., affects unimodal system. To overcome the problems of unimodal systems multimodal systems were introduced which uses more than one biometric trait to identify a person. Any biometric system designed or developed to recognize a person has to go through five stages: Image capture, pre processing, ROI extraction, required features extraction from ROI, matching based on some measure.

Multimodal biometric system was proposed and analyzed by Hong *et al.* (1999). A analysis was made whether multimodal system can improve performance by combining multiple biometrics. It was concluded that these systems will provide more security and can overcome spoofing attacks. Many hand based biometric systems were designed and tested in real world applications and were proved to provide a good identification system. To improve the performance of fingerprint verification system a scheme was presented by Jain *et al.* (1999). The output scores of three different fingerprint matchers were integrated to

improve performance. Fingerprint based recognition systems are very old systems which are in existence for a long period and used in much applications. Storage space for the template is also less when fingerprint is used as biometric trait. Fingerprint consists of ridges and valleys. The two main division of matching with fingerprint as biometric trait are pattern matching and minutiae based matching. In pattern matching the input image and template stored in database is compared to check for similarity. Minutiae based matching deals with extracting the minutiae points and comparing that with the data stored in database. Many multimodal approaches to identify person has been done to improve recognition rate. Ear has stable structure and also it has the advantage that it will not vary when the expression changes. Ear has become a promising field in biometric identification system as this has proven to provide a good matching rate and excellent performance.

Fusion in multimodal system can be done at various levels. The various levels are sensor level fusion, feature level fusion, match score level fusion, rank level fusion and decision level fusion.

- **Sensor level fusion:** Raw data is obtained from multiple sensors.

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- **Feature level fusion:** Feature sets obtained from multiple biometric algorithms or from multiple modalities.
- **Match score level fusion:** The match score output from multiple biometric matchers are combined to generate a new match score.
- **Rank level fusion:** Three methods of rank level fusion were discussed by Ho *et al.* (Year):
  - **Highest rank method:** Each user is assigned the highest rank as computed by different matchers.
  - **Borda count method:** This method uses the sum of the ranks assigned by individual matchers.
  - **Logistic regression method:** The weighted sum of individual rank is calculated.
  - **Decision level fusion:** This is same as score level fusion but here the decision is made to match/non match.

Matching the extracted features can be done by Hamming distance or Euclidean distance:

- **Hamming distance:** This gives a measure of how many bits are same from the two bit patterns that are compared.
- **Euclidean distance:** Distance between two points is given as square root of sum of the squares of differences between the corresponding coordinates of the points.

**Performance of biometric system:** Biometrics system performance can be analyzed by finding false acceptance rate and false rejection rate.

**False Acceptance Rate (FAR):** Falsely accepting the wrong person as right person.

**False Rejection Rate (FRR):** Falsely rejecting right person as wrong person.

## LITERATURE REVIEW

Local Binary Pattern (LBP) looks at the points surrounding the center pixel and checks whether the surrounding points are greater than or less than the center pixel value. If the value is greater than center pixel it is assigned with 1 and if it is less than center pixel it is assigned with 0. Many variants in LBP method was developed and implemented for various applications like face recognition Texture classification, medical image analysis, background subtraction etc. A new texture descriptor called Local Line Binary Pattern (LLBP) was proposed and implemented by Rosdi *et al.* (2011) to extract features from finger vein images. By this enhancement it was shown that the Equal Error Rate (EER) for the LLBP is less when compared with LBP and LDP and the time required to extract the features using LLBP was also proven to be less. Local ternary pattern was presented by Tan and Triggs (2010) to recognize the face with difficult lighting conditions. Elliptical binary pattern was proposed by Liao and

Chung (2007) for face recognition. Another variant of LBP was presented by Nanni *et al.* (2010) for medical image analysis where quinary encoding in elliptical neighborhood was used for the analysis. Later local line binary pattern where the horizontal and vertical directions are used to recognize face was proposed by Petpon and Srisuk (2009).

Local Ternary Pattern (LTP) is an extension of Local Binary Pattern (LBP). This is developed as powerful descriptor for noised images. This is used in many visual recognition tasks. Three values '1', '0', '-1' is used for encoding. The Limitation of LTP (Zhu *et al.*, 2012) is its sensitivity to random and quantization noise and also its reliability decreases for illumination variations.

Here we have proposed and implemented an Enhanced LLBP to extract the features from ear image and fingerprint image.

## METHODOLOGY

The proposal is to improve recognition rate by extracting features from ear and fingerprint using enhanced LLBP. The input image is taken from the database and preprocessed. From the preprocessed image Region of Interest (ROI) is extracted and features from ROI of ear and fingerprint is extracted. The extracted features are stored in database and for recognition the stored are features are compared with test features. Hamming distance is used in this study for matching as the results generated are in binary.

**Region of interest extraction from ear and fingerprint:** The input image for fingerprint and ear is taken from publicly available database. The images of ear and fingerprint are of size 204×272. This image which is of size 204×272 is resized to 256×256. The resized image is converted to gray image. The salt and pepper noise present in the image is removed by applying median filter. Adaptive histogram equalization is done to improve the local contrast of the image. The contrast improved image is then converted to black and white.

The aim of Region of Interest extraction is to consider only the required portion of the image which will cover the maximum unique features in the image. To extract the ROI of the image, the image is labeled and the maximum connected components in the binary image are found. To remove the unwanted portion of the image, cropping is done. The cropping of the image is done by Blob detection which detects the regions in the digital image that differ in properties, such as brightness or color, compared to areas surrounding those regions. Here this is done by tracing the white pixel boundary which is maximum along X and Y axis. Also white pixel boundary is traced for the minimum of X and Y so that it has only the ear region. This cropped image is overlaid on original image (gray image). Figure 1a and b shown is the cropped and overlaid

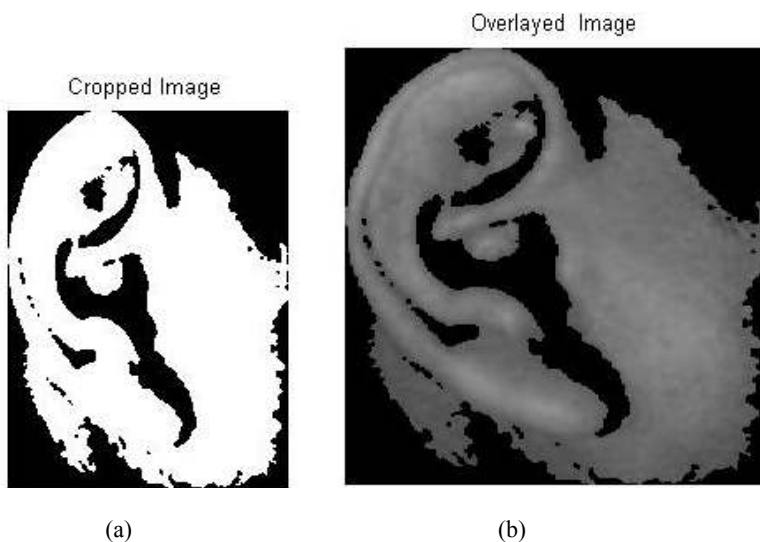


Fig. 1: (a) Cropped ear image (b) overlaid ear image

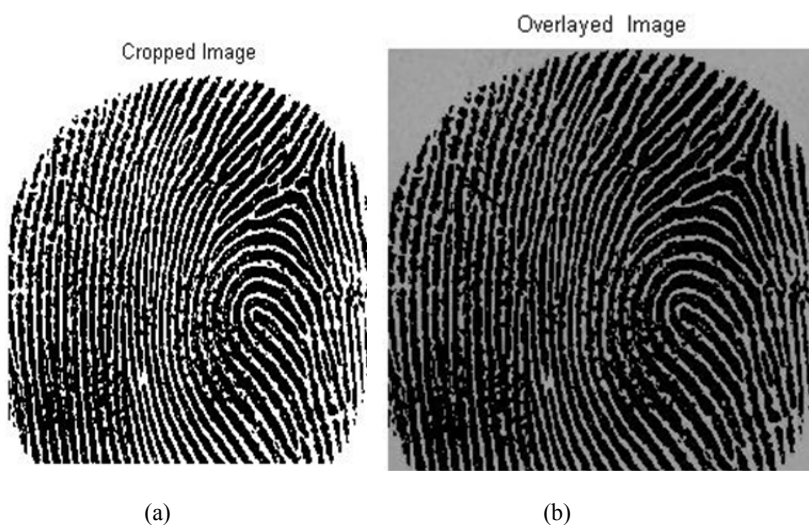


Fig. 2: (a) Fingerprint cropped image (b) overlaid image

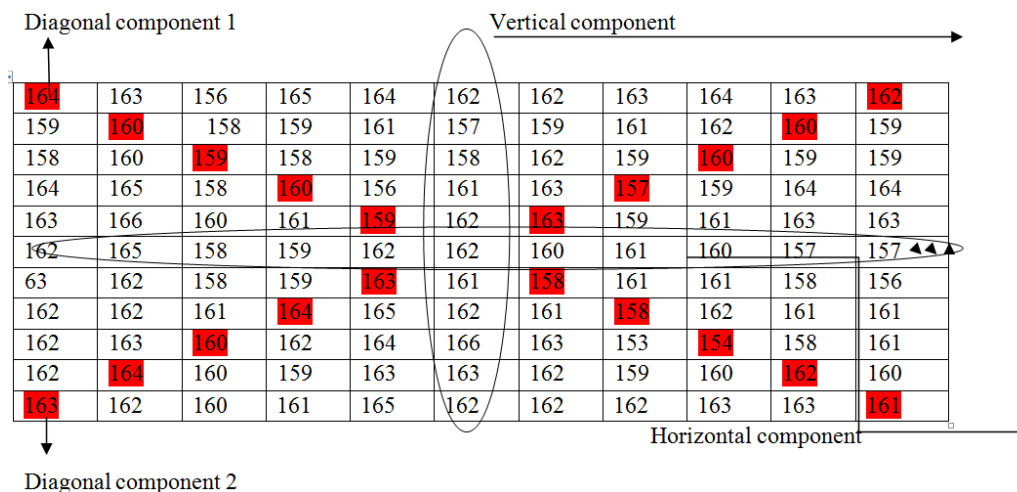


Fig. 3: Horizontal, vertical and diagonal components 1 and 2 of ROI of fingerprint image

Image of ear. The cropped fingerprint and overlaid fingerprint image is shown in Fig. 2a and b.

The original image we have taken is gray image. The output is cropped gray scale image. This image is resized to 257×257.

**Feature extraction from ROI of fingerprint and ear image:**

**Feature extraction by ELLBP:** The required features from ear and fingerprint are extracted by applying the new method Enhanced Local Line Binary Pattern (ELLBP):

In Local Line Binary Pattern (LLBP) binary codes are generated from the image. It is a texture descriptor which generates binary codes with horizontal and vertical component. The magnitude of LLBP is obtained by calculating line binary codes for both horizontal and vertical component. The binary code obtained from horizontal and vertical components are concatenated to get the final binary code. In our paper we have taken horizontal component, Vertical component, Diagonal component 1 and Diagonal component 2. Figure 3 shows the ROI of image with sample horizontal and vertical component marked. The diagonal components are also taken to extract features from the image. The centre value is subtracted with all other values of the components. If the subtracted component value is above zero it is taken as ‘1’ otherwise it is taken as ‘0’. The values extracted by this method are the required features to recognize a person. These features are stored as Mat file.

Pseudocode to Extract features from Ear and fingerprint images using ELLBP:

- Step 1:** Take the input Image
- Step 2:** Preprocess the input image
- Step 3:** Extract the Region of Interest

**Step 4:** Apply ELLBP to the ROI of ear and Fingerprint image and extract the features

**Step 5:** Fuse the Extracted features by Concatenation

**Step 6:** Match the test features with stored features in the database using Hamming Distance

**Step 7:** Identify the person

**Matching:** As the values extracted are binary, hamming distance metric is used for matching. This gives the measure of bits that are same between two bit patterns. If the bit patterns are same the Hamming distance will be Zero. When the bit patterns are compared the Hamming Distance HD is given by Eq. (1). It is the sum of XOR between X and Y over N where N is the total number of bits in the bit pattern:

$$HD = \sum_{j=1}^N X_j \text{ XOR } y_j \tag{1}$$

**EXPERIMENTS AND RESULTS**

The feature matrix consists of 4×257 values. In the first row horizontal component is stored, second row vertical component is stored, third row diagonal component 1 is stored and in fourth row diagonal component 2 is stored. The Match rate for the individual traits and fused traits applied with ELLBP for various thresholds is shown in Table 1.

When the threshold is set to 0.3 this method gives excellent Match Rate. The Equal Error Rate is also less when the new feature extraction technique ELLBP is applied to the system. The Local Line Binary pattern, Local Binary Pattern and Local ternary pattern is applied to the ROI of Ear and fingerprint and performance of the system was analyzed using the metrics Match Rate (MR), False Acceptance Rate (FAR) and False Rejection Rate (FRR) (Table 2).

Table 1: Match rate with ELLBP, LLBP, LBP and LTP applied to ear Method

Threshold	Ear ELLBP (%)	Ear LLBP (%)	Ear LBP (%)	Ear LTP (%)	ELLBP applied to ear and fingerprint (%)
0	0	0	0	0	18
0.05	74	31	100	26	24
0.10	83	50	100	30	33
0.15	85	56	100	40	45
0.20	91	63	100	70	63
0.25	96	73	100	93	77
0.30	100	81	100	100	86
0.35	100	90	100	100	94
0.40	100	100	100	100	98
0.45	100	100	100	100	100
0.50	100	100	100	100	100
0.55	100	100	100	100	100
0.60	100	100	100	100	100
0.65	100	100	100	100	100
0.70	100	100	100	100	100
0.75	100	100	100	100	100
0.80	100	100	100	100	100

Table 2: Match rate with ELLBP, LLBP, LBP and LTP applied to fingerprint

Threshold	FP ELLBP (%)	FP LLBP (%)	FP LBP (%)	FP LTP (%)	ELLBP applied to ear and fingerprint (%)
0	0	0	0	0	18
0.05	72	62	60	60	24
0.10	75	65	100	60	33
0.15	77	67	100	60	45
0.20	80	70	100	60	63
0.25	83	73	100	61	77
0.30	86	76	100	62	86
0.35	90	80	100	68	94
0.40	100	93	100	84	98
0.45	100	100	100	95	100
0.50	100	100	100	100	100
0.55	100	100	100	100	100
0.60	100	100	100	100	100
0.65	100	100	100	100	100
0.70	100	100	100	100	100
0.75	100	100	100	100	100
0.80	100	100	100	100	100

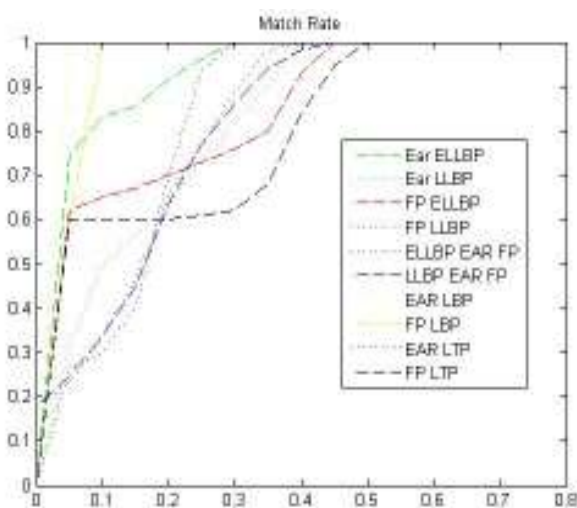


Fig. 4: Match rate with ELLBP, LLBP, LBP and LTP applied to ear and fingerprint

Various methods of feature extraction techniques are applied and the comparison is shown in Fig. 4.

### DISCUSSION

The new method of feature extraction technique gives excellent results when ELLBP is applied to individual traits and also for fused ear and fingerprint features. The system gives 100% Match Rate when the threshold is 0.3 for ear and 100% matching rate when threshold is 0.4 for fingerprint. When ELLBP is applied to fused ear and fingerprint features the system gives 100% Match Rate. Here in this study as Diagonal components are taken in addition to horizontal and vertical components the system is more secured. Since the features are extracted from more components its accuracy is more compared to other methods.

### CONCLUSION

The new enhanced feature extraction technique ELLBP developed gives excellent performance when compared to other methods. The method is tested separately for individual traits and also for ear and fingerprint fused together. The Equal Error Rate (EER) is reduced by this method of feature extraction when ELLBP is applied to fused ear and fingerprint. In this study Diagonal components are taken in addition to horizontal and vertical components which allow the flexibility of having straight-line as well as diagonal features also to be considered as feature points. This will lead to more secured and reliable recognition system. In future we will focus on including images with occlusions and other techniques to reduce storage space. The method can be applied for images with occlusions and can be tested for recognition rate.

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### REFERENCES

- Ho, T., J. Hull and S. Srihari, 1994. Decision combination in multiple classifier systems. IEEE T. Pattern Anal. Mach. Intel. (PAMI), 16(1): 66-75.
- Hong, L., A. Jain and S. Pankanti, 1999. Can multibiometrics improve performance? Proceeding of AutoID'99. Summit, NJ, Oct 1999, pp: 59-64.
- Jain, A.K., S. Prabhakar and S. Chen, 1999. Combining multiple matchers for a high security fingerprint verification system. Pattern Recogn. Lett., 20: 1371-1379.

- Liao, S. and A.C.S. Chung, 2007. Face recognition by using elongated local binary patterns with average maximum distance gradient magnitude. Proceeding of the 8th Asian Conference on Computer Vision. Tokyo, Japan, pp: 672-679.
- Nanni, L., A. Lumini and S. Brahmam, 2010. Local binary patterns variants as texture descriptors for medical image analysis. *Artif. Intell. Med.*, 49: 117-125.
- Petpon, A. and S. Srisuk, 2009. Face recognition with local line binary pattern. Proceeding of the 5th International Conference on Image and Graphics. Xi'an, China, pp: 533-539.
- Rosdi, B.A., C.W. Shing and S.A. Suandi, 2011. Finger vein recognition using local line binary pattern. *Sensors*, 11(12): 11357-11371.
- Tan, X. and B. Triggs, 2010. Enhanced local texture feature sets for face recognition under difficult lighting conditions. *IEEE T. Image Process.*, 19: 1635-1650.
- Zhu, L., Y. Zhang, C. Sun and W. Yang, 2012. Face recognition with multi-scale block local ternary patterns. Proceeding of 3rd Sino-foreign-interchange Conference on Intelligent Science and Intelligent Data Engineering (IScIDE, 2012). Nanjing, China, pp: 216-222.