



An Improved Fingerprint-based Document Image Retrieval using Multi-resolution Histogram of Oriented Gradient Features

U. D. Dixit^{*a}, M. S. Shirdhonkar^b

^a Department of Electronics and Communication Engineering, BLDEA's V. P. Dr .P. G. Halakatti College of Engineering & Technology, Vijayapura, India

^b Department of Computer Science and Engineering, BLDEA's V. P. Dr .P. G. Halakatti College of Engineering & Technology, Vijayapura, India

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ABSTRACT

Recently most of the documents are authenticated by using a latent fingerprint impression. Examples of such documents are property registration, banking transactions, insurance documents, etc. The fingerprint-based document retrieval (FPDIR) has emerged to provide an easier way of accessing, browsing, or searching such document images. This paper proposes efficient fingerprint-based document image retrieval by employing multi-resolution Histogram of Oriented Gradient (HOG) features. The preprocessing technique presented in this paper employs a combination of top-hat and bottom-hat filtering operations to enhance the detected fingerprint image. Multi-resolution HOG features are constructed from horizontal, vertical and diagonal directional components of the enhanced fingerprint image. Finally, a standardized Euclidean distance metric is used as a tool for matching, ranking and retrieval of the document images. The proposed system is assessed by experimenting with a dataset of 1200 images. The precision and recall results obtained using the proposed research work have given an improvement of 8% to 14% in retrieval performance compared to earlier methods.

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1. INTRODUCTION

To provide high security and authentication, recently the documents are embedded with fingerprint impressions instead of a signature. Property registration, banking transactions, insurance documents, etc. are some of the examples. Figure 1 shows a sample document image with fingerprint impressions

Fingerprint represents “a unique pattern of ridges and valleys of the surface of the fingers” [1]. The traditional method uses paper-ink whereas; a group of sensors has been employed for producing a finger-print impression in an electronic form. In general, a three-level hierarchy is employed for the representation of the fingerprint friction ridge information. “These include a pattern of fingerprints, minute points and ridge contours. Generally, level 1 features are employed for matching latent fingerprints whereas levels 2 and 3 features are used in fingerprint identification systems” [2].

The major challenges in FPDIR are poor retrieval performance due to the high similarity between the fingerprints and the presence of noise introduced during the digitization process. The preprocessing techniques, feature extraction schemes and application of relevant distance metrics are solutions to overcome the above-

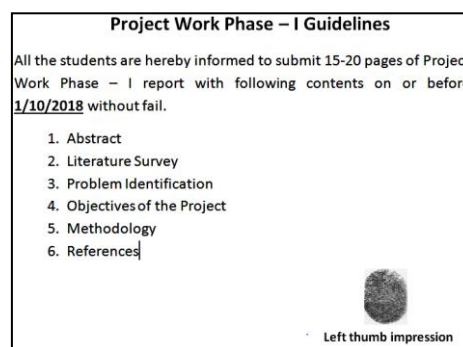


Figure 1. Sample Image

*Corresponding Author Institutional Email: uddixit@rediffmail.com
(U. D. Dixit)

mentioned challenges. This work was carried out to provide an efficient finger-print-based document retrieval. This is achieved by the application of suitable preprocessing techniques and the proposal of multi-resolution HOG features. The contribution of this work is as follows:

- Developed a pre-processing method for enhancing the quality of detected fingerprint impressions.
- Proposing of multi-resolution HOG features to obtain distinguished properties of the finger-print.
- Experimentation of standardized Euclidean similarity metric to match and retrieve the relevant documents.

The rest of this article is structured as follows: Section 2 describes the literature of the work, section 3 briefs about the proposed FPDIR, section 4 explain the results obtained, section 5 highlight the limitations and finally, in section 6 we conclude the work and provide future direction to the proposed research work.

2. LITERATURE REVIEW

This section describes the algorithms and techniques proposed by researchers to match the fingerprints for recognition, verification and retrieval.

Jiang et al. [3] presented the fingerprint retrieval technique by employing the features that are extracted from the orientation field and the dominant ridge distance. They proposed a new similarity measure that finds the average of the unit vector with phase doubled the orientation for matching the features of fingerprints. Fuzzy Feature Match (FFM) based technique for matching the deformed fingerprints was discussed by Chen et al. [4]. To estimate the similarity, the feature vectors are normalized before applying the distance metric. He et al. [5] described a three-stage technique for global comprehensive similarity. In the first stage, they developed a “minutia-simplex comprising of a pair of minutiae with their textures that include a transformation-variant and invariant set of features”. In the second stage, ridge-based relative features associated with minutiae are used for grouping the minutia depending on their affinity with the ridge. In the third stage, they presented the relationship between transformation and the comprehensive similarity of two fingerprint images in the form of a histogram.

A database clustering model-based fingerprint search technique for narrowing the search space was presented by Liu et al. [6]. It employs multi-scale orientation field-based features as the primary set of features and the average ridge distance as secondary features. A modified K-means clustering algorithm was used to divide the orientation feature space into clustering. The fingerprint friction ridge details consist of 3 levels of features. They

are level 1 comprising of pattern, level 2 that include minutia points and level 3 consisting of pores and ridge contours. Jain et al. [7] proposed the use of level 3 features to match high-resolution fingerprints. Zegarra et al. [8] proposed a wavelet feature-based fingerprint retrieval method with 3 important tasks: feature extraction, similarity measurement and indexing of the features. They used different types of wavelets namely Discrete Wavelet Transform (DWT), tree-structured DWT and the Gabor wavelets for the decomposition of the given image. The features are extracted using the energy and standard deviation of decomposed fingerprint images.

Jain and Feng [9] presented a method to match latent fingerprints with rolled fingerprints. The proposed system employs the use of a quality map in addition to minutiae. Nanni and Lumini [10] presented the hybrid fingerprint matching technique using Local Binary Pattern (LBP) based features. Initially, the 2 fingerprints are matched and allied using their corresponding minutiae and then separated into non-overlapping blocks. These non-overlapping blocks are convolved with the Gabor filters to construct LBP histograms. Jung and Lee [11] proposed a method for the classification of fingerprints employing the probabilistic approach using features of ridges. Bharkad and Kokare [12] suggested the use of discrete wavelet packet transform by neglecting horizontal coefficients to obtain redundant features for matching the fingerprint images.

A method for detection of the convex core points of different category of fingerprints was presented by Le and Van [13]. A modified complex filter also known as the semi-radial filter is employed in their method for the detection. The vertical variation feature is used for removing spurious core points. Cappelli and Ferrara [14] developed a method for fingerprint retrieval using the combination of a levels1 and 2 set of features. A hybrid fusion-based technique is used for the evaluation of various scores and ranking of the fingerprints. Shalaby and Ahmed [15] proposed the use of a multi-level structural approach to recognize the fingerprints, by decomposing them into regions using multi-level features. Paulino et al. [16] proposed a technique to match the latent fingerprints. They used descriptor-based Hough transforms to align the fingerprints. The orientation field is used to measure the similarity of fingerprints in the proposed method. Arun et al. [17] proposed a texture-based finger knuckle print recognition method with the help of features formed using LBP variants. They used Local Directional Pattern (LDP), Local Derivative Ternary Pattern (LDTP), Local Texture Description Framework (LTDF) and Modified Local Directional Pattern (MLDN) based feature extraction in their proposed method. Nearest neighbor and Extreme

Learning Machine (ELM) classifiers are used for the classification task. Rodrigues et al. [18] presented a technique to recognize the finger knuckle prints. The Sobel gradient operator was used for detecting the edges. Different similarity metrics are used for the recognition of binarized images. Gray Level Co-occurrence Matrix (GLCM) [19], as well as Singular Value Decomposition (SVD) [20] features were employed for face-based document image retrieval by Dixit and Shirdhonkar. Tzalavra et al. [21] provided the comparative analysis of 3 multi-resolution transform-based features namely DWT, Stationary Wavelet Transform (SWT) and Fast Discrete Curvelet Transform (FDCT) for assessing breast tumors. FDCT based features provided better performance in comparison with the other two. Qayyum et al. [22] employed SWT for feature extraction for the identification of facial expressions. Particularly, the combinations of vertical and horizontal coefficients have been used for obtaining information about muscle movement. Dixit and Shirdhonkar [23] presented two sets of features DWT-based LBP and SWT-based LBP. They used Euclidean distance for similarity matching and also to retrieve the documents.

Cao and Jain [24] presented fingerprint recognition for latent fingerprints using Convolution Neural Network (CNN). Hindi et al. [25] investigated the performance of fingerprint recognition using 3 sets of image features extracted from minutiae, reduced center symmetric local binary pattern (RCSLBP) and C-mean clustering methods. Xu et al. [26] developed a rotation-invariant edge descriptor for fingerprint identification. The descriptor was built by combining the length of the edge, angles between the edges and the orientation of pores. Zohrevand and Imani [27] Presented CNN-based approach for Persian handwritten word images, which were segmented at the character level. A three-stage filtering approach to improve the performance of face recognition was proposed by Ghasemi and Hassanpour [28].

From the literature, it is learned that the major issues in implementing FPDIR were; the development of a suitable enhancement technique, a set of features to extract more accurate attributes and the use of a proper distance metric for matching and retrieval. This paper aims to provide solutions to the above challenges by proposing efficient preprocessing techniques and multi-resolution HOG features to improve the overall retrieval performance.

3. PROPOSED METHODOLOGY

The architecture of the proposed fingerprint-based document retrieval is depicted in Figure 2. The major

blocks of the architecture include fingerprint detection, preprocessing, feature extraction, matching and retrieval of documents from the database. The discussion about these blocks is provided in the subsequent sections.

3. 1. Fingerprint Detection System

We are motivated by the simpler and high detection rate of the fingerprint detection method employed by Dixit and Shirdhonkar [23]. A modified version of the fingerprint detection is presented in this paper. It includes a two-phase approach: a training phase and the testing phase. The first phase employs 140 patches comprising of a variety of text, logos, fingerprints and different symbols are used. These patches are generated from the first 100 document images of the database. Initially, the patches from the submitted query document are obtained using connected component analysis, their DWT [29] based features are extracted and then these patches are classified as fingerprint and non-fingerprint patches using Support Vector Machine (SVM) [30] classifier. The steps used in the process of fingerprint detection are given in Algorithm 1.

Algorithm 1: Fingerprint Detection

1. Begin

Input: Document Image (D), 140 patches generated from 100 document images

Output: Detected fingerprint (DFP)

2. Divide the document (D) into four sub-bands S1, S2, S3 and S4 by applying DWT. Where S1, S2, S3, S4 are approximate, horizontal, vertical and diagonal sub-bands respectively.
3. Compute energy and standard deviation of S2, S3, S4 using Equations (1) and (2).

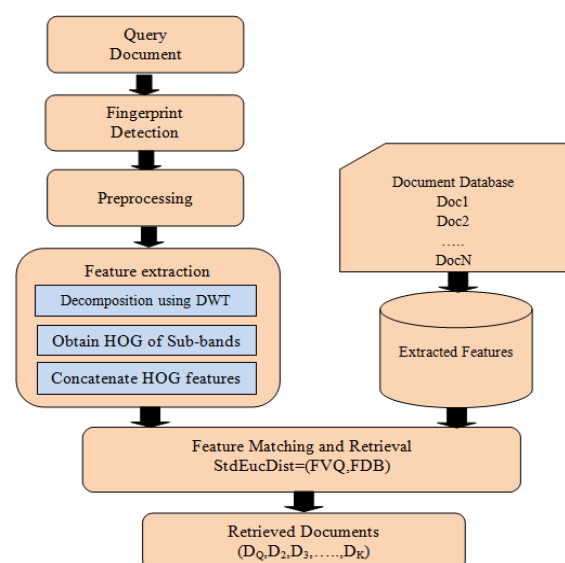


Figure 2. Architecture of the proposed system

$$E_i = \frac{1}{M \times N} \sum_{m=1}^N \sum_{n=1}^N |S_i| \text{ for } i = 2, 3, 4 \quad (1)$$

$$SD_i = \sqrt{\frac{1}{M \times N} \sum_{x=1}^N \sum_{y=1}^N (S_i - \mu_i)^2} \text{ for } i = 2, 3, 4 \quad (2)$$

where E_i is Energy, SD_i is standard deviation and μ_i is the mean of i^{th} sub-band. M and N represent the row and column dimensions of the sub-bands

4. Form the feature vector FV using Equation (3)

$$FV = \{E_1, E_2, E_3, SD_1, SD_2, SD_3\} \quad (3)$$

5. Compute FV for 140 patches and train the SVM.
6. Compute FV for patches of the input document image and detect the patch containing fingerprint using trained SVM.
7. DFP = Patch classified as fingerprint
8. **End**

In the proposed fingerprint detection system instead of four, only the three sub-bands providing directional information are used to compute the features. This has reduced the number of computations required. The detection rate is used for estimating the performance of the fingerprint detection system and is computed using Equation (4).

$$\text{etection rate} = \frac{\text{Successfully detected fingerprints}}{\text{Total number of document imaes}} \quad (4)$$

The image results containing at least 80% of fingerprint impressions are considered as successfully detected fingerprints. The proposed method yielded a detection rate of 99%. Figure 3 shows the sample result. It shows an input query document and the detected fingerprint impression. A marked rectangle indicates the detected fingerprint.

The detected fingerprint images of the document are preprocessed by employing the combination of top-hat and bottom-hat filtering techniques [31]. This step has helped in improving the contrast of the image and also removed the un-even illumination background from the fingerprint impression. Figure 4 shows the steps used during preprocessing.

Algorithm 2 provides the preprocessing operations used in the proposed method.

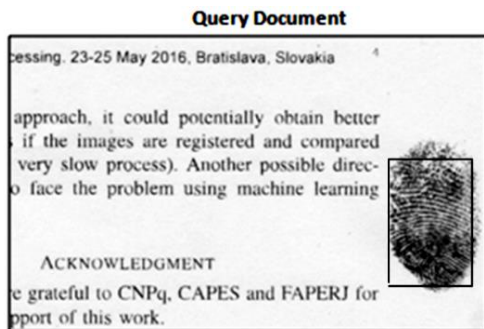


Figure 3. Sample result of fingerprint detection

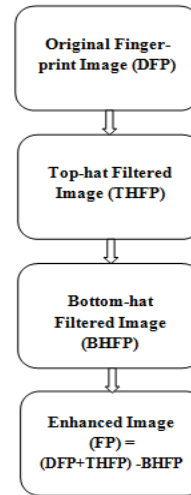


Figure 4. Preprocessing Step

Algorithm 2: Preprocessing steps

1. **Begin**
Input: Detected Fingerprint Image (DFP)
Output: Enhanced Fingerprint Image (FP)
2. Obtain Top-Hat Filtering (THFP) of detected fingerprint image (DFP) using Equation (5)
$$THFP = (DFP \circ SE) - DFP \quad (5)$$
 where SE is the structuring element
3. Obtain bottom-hat filtering (BHFP) of detected fingerprint image (DFP) using Equation (6)
$$BHFP = (DFP \circ SE) - DFP \quad (6)$$
4. Compute the enhanced fingerprint image (FP) using Equation (7)
$$FP = \{DFP + THFP\} - BHFP \quad (7)$$
5. Return FP
6. **End**

The top-hat filtering is used to extract small elements and details of the image. It is achieved by subtracting the morphological opening of an image from its original version. Mathematically the top hat filtering is computed by using Equation (1). However, the bottom-hat filtering is the difference between the original image and its morphological closing. Equation (2) is used for obtaining bottom-hat filtering of the input image. Finally, Equation (3) is used to get an enhanced version of the detected fingerprint image (FP). Empirically, by conducting the experiments, it is observed that a better version of the enhanced fingerprint image is possible with the usage of a disk-shaped structuring element having the size of 12 pixels. Figure 5 depicts the stepwise results of the preprocessed image.

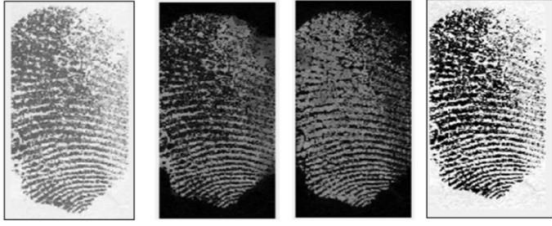


Figure 5. Preprocessing Steps (a) Original image (b) Top-hat filtered image (c) Bottom-hat filtered image (d) Enhanced image

3. 2. Feature Extraction HOG features are found to provide better results in the classification, recognition and retrieval of images [32]. This paper proposes multi-resolution HOG features to improve performance. Algorithm 3 shows the procedure employed in the proposed feature extraction scheme.

Algorithm 3: Proposed Feature Extraction Method

1. Begin

Input: Detected fingerprint image FP

Output: Multi-resolution features FV

2. Convert the detected fingerprint image into grayscale.
3. Resize the fingerprint image FP to 256×256 pixels.
4. Decompose fingerprint image FP into approximate, horizontal, vertical and diagonal sub-bands by using Equation (8)

$$(A, H, V, D) = DWT\{FP\} \quad (8)$$

where, A, H, V and D are approximate, horizontal, vertical and diagonal sub-bands of size 128×128 .

5. Divide H, V and D sub-bands into cells of size 32×32 pixels. This results in (4×4) 16 cells per sub-band.
6. Chose block size as (2×2) 4 cells resulting in 9 non-overlapping blocks per sub-band.
7. Compute the HOG of H, V and D sub-bands with 9 bins, resulting in a total of 324 features per sub-band. Let F_1 , F_2 and F_3 be the HOG features of horizontal, vertical and diagonal sub-bands obtained using Equations (9), (10) and (11).

$$F_1 = HOG\{H\} \quad (9)$$

$$F_2 = HOG\{V\} \quad (10)$$

$$F_3 = HOG\{D\} \quad (11)$$

8. Concatenate the features F_1 , F_2 and F_3 using Equation (12)

$$FV = \{F_1\} \cup \{F_2\} \cup \{F_3\} \quad (12)$$

9. Return FV

10. End

Algorithm 3 has three important steps: Image decomposition by applying DWT, computing multi-

resolution HOG features of sub-bands and concatenation of the features.

3. 2. 1. Image Decomposition by Applying DWT

DWT is widely used in almost all applications of digital image processing. It employs a series of low-pass and high-pass filters and provides a multi-resolution version of an image. Let FP is the detected fingerprint from the document. The image FP is initially resized to 256×256 pixels. Then the resized image is divided into approximate, horizontal, vertical and diagonal sub-bands with the help of DWT using the Equation (1). These sub-bands will have a size of 128×128 pixels. The horizontal (H), vertical (V) and diagonal (D) sub-bands represent the directional components of the input image. As approximate sub-band (A) is similar to the original image with reduced size, it won't provide any directional information and hence it is ignored during the feature extraction. Omission of approximate sub-band for feature extraction also helped in reducing the number of features.

3. 2. 2. Computing Multi-resolution HOG Features

The three sub-bands H, V and D are treated as separate images containing multi-resolution information of the fingerprint and used for feature extraction. Each sub-band is divided into cells of size 32×32 . This resulted in a total of (4×4) 16 cells per sub-band. These cells are arranged to form 9 overlapping blocks of size (2×2) 4 cells to extract HOG features. The numbers of resulting HOG features for an image are provided by Equation (13).

$$\text{Number of HOG features} = \text{BlkSz} \times \text{NOB} \times \text{NHB} \quad (13)$$

where 'BlkSz' is the size of a block, 'NOB' indicates the number of overlapping blocks per image and the 'NHB' is the number of histogram bins used. As in the proposed algorithm, the block size is 4, the number of overlapping blocks is 9 and the histogram bins are chosen 9, which leads to a total of $(4 \times 4 \times 9)$ 324 HOG features per sub-band. The gradients values in this scheme are computed using the Equations (14) and (15) are used to compute the gradients.

$$\text{GRADIENT}_H(X, Y) = FP(X + 1, Y) - FP(X - 1, Y) \quad (14)$$

$$\text{GRADIENT}_V(X, Y) = FP(X, Y + 1) - FP(X, Y - 1) \quad (15)$$

where GRADIENT_H and GRADIENT_V are horizontal and vertical gradients. The GRADIENT_H and GRADIENT_V are computed as the difference of consecutive pixels in the horizontal and vertical directions. The magnitude and orientation of gradients are then computed using Equations (16) and (17).

$$\text{Mag}(X, Y) = \quad (16)$$

$$\sqrt{\text{GRADIENT}_H(X, Y)^2 + \text{GRADIENT}_V(X, Y)^2}$$

$$\Theta(X, Y) = \tan^{-1} \frac{\text{GRADIENT}_H(X, Y)}{\text{GRADIENT}_V(X, Y)} \quad (17)$$

where $\text{Mag}(X, Y)$ and $\Theta(X, Y)$ are the magnitude and orientation of the gradients.

3. 2. 3. Concatenation of the Features The HOG features resulting from the sub-bands of DWT are combined to form the final feature set FV using Equation (12). Feature vector consisting of 324 directional HOG values per sub-band results in a total of 972 features due to the concatenation process. Figure 6 shows the flow diagram proposed feature extraction scheme.

3. 2. 4. Fingerprint Matching and Retrieval A similarity metric is employed to match the features of query fingerprint with fingerprint present in the document images. To speed up the retrieval process a database of fingerprint features extracted from the documents is stored in the repository. Most of the retrieval schemes in the literature employ Euclidean distance for matching the features. However, in the normal Euclidean distance; classification is influenced by features with larger values and the features with lower values contribute very little. This drawback has been removed by normalizing the features in standardized Euclidean distance. Hence a standardized Euclidean distance given by Equation (18) is used for fingerprint matching and retrieval of the documents.

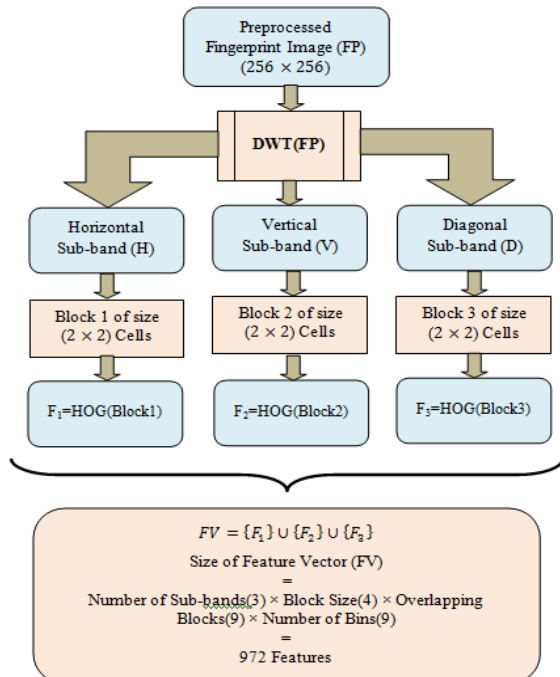


Figure 6. Proposed Feature Extraction Scheme

$$\text{StdEucDist} = \frac{1}{\sqrt{(FVQ - FDB) \times V^{-1} \times (FVQ - FDB)}} \quad (18)$$

where,

- StdEucDist is a vector to hold computed similarity values for ‘N’ documents.
- FVQ is the features of the query image.
- FDB is pre-extracted fingerprint features of documents stored in the database.
- ‘V’ is the n -by- n diagonal matrix whose j^{th} diagonal element is $S(j)^2$ and ‘S’ being the vector of standard deviations.

After computing the distance values, the documents present in the database are indexed based on their distance values concerning the query document. The lowest distance corresponds to the closest match and vice-versa. Now based on the user request top ‘K’ number of documents are accessed from the database and displayed on the user console.

4. EXPERIMENTAL RESULTS AND DISCUSSION

Core-i5/4GB RAM/windows8 machine with MATLAB is used for the implementation of the proposed method. To avoid legal issues and conflict of interest, we created a database consisting of 1200 documents. The details about the database used for experimentation are provided below.

About the database: Right thumb impression of 50 persons is taken on documents for the creation of the database. Each person was asked to provide a thumb impression on 24 printed documents using a black ink pad. Thus, it leads to a dataset of (50×24) 1200 documents. These documents are then scanned by using HP M1005 scanner to get an image database.

The precision, recall and F-measure parameters are employed to evaluate the performance of the proposed system. Precision is the ratio of number of relevant documents retrieved out of the total number of documents retrieved. It is similar to the accuracy parameter used in the classification of images. The recall is the ratio of number of relevant documents retrieved to the total number of relevant documents present in the dataset. However, the F-measure is a performance parameter summarizing both precision and recall. The Equations (19), (20) and (21) are used to compute the evaluation parameters.

$$\text{Precision} = \frac{\text{Number of relevant document retrieved}}{\text{Total number of documents retrieved}} \quad (19)$$

$$\text{Recall} = \frac{\text{Number of relevant document retrieved}}{\text{Number of relevant documents in the database}} \quad (20)$$

$$F - measure = 2 \times \frac{Precision \times Recall}{Precision + Recall} \quad (21)$$

The performance of the system is assessed by conducting an exhaustive set of experiments. In each experiment, the user was asked to choose a query document randomly from each of the 50 classes. The precision and recall values are computed for retrieval of top 1, top 5, top 8, top 10, top 15 and top 20 documents. A total of 300 queries are executed to test the developed algorithm. Figure 7 shows the sample result of FPDIR. The sample result is obtained by giving a query document and the number of documents to be retrieved as 4. Table 1 shows average precision, average recall computed using the proposed method and the state of art techniques.

Figure 8 shows the comparison of average precision values computed using the proposed method and other state-of-art techniques. The comparison of precision values reveals that an improvement of 8 to 14% performance is obtained with the proposed system.

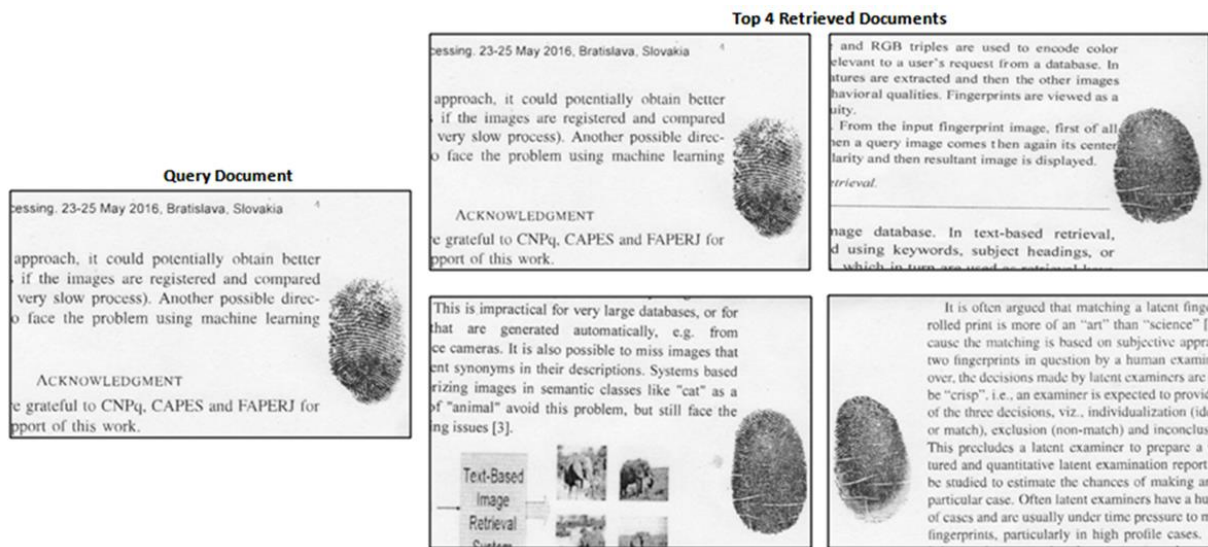


Figure 7. Sample result of FPDIR

Figure 9 shows a graphical comparison of average recall values. The proposed system outperforms by providing better recall results in comparison with earlier methods.

Table 2 shows the F-measure values computed by using different methods and the proposed system. Graphical comparison of F-measure performance for top 1, top 5, top 8, top 10, top 15 and top 20 values are depicted in Figure 10. The graphical comparison ensures that the proposed system provides encouraging results in terms of recall measures.

5. LIMITATIONS OF THE PROPOSED WORK

The limitations of the work are listed below.

- The proposed work in this paper experiments on a database of 1200 documents. We were unable to experiment on a huge dataset due to the non-availability of public database of document images with fingerprint impressions publicly.

TABLE 1. Average Precision and Average Recall Values

Number of Top Matches	LBP Features [33]		RLBP Features [25] (Rotation Invariant LBP Features)		HOG Features [32]		DWT based LBP Features [23]		Proposed Method	
	Average Precision (AP)	Average Recall (AR)	Average Precision (AP)	Average Recall (AR)	Average Precision (AP)	Average Recall (AR)	Average Precision (AP)	Average Recall (AR)	Average Precision (AP)	Average Recall (AR)
TOP 1	100	4.16	100	4.16	100	4.16	100	4.16	100	4.16
TOP 5	75.66	15.85	76.01	15.88	76.34	15.97	86.96	18.16	94.78	19.75
TOP 8	66.85	22.28	67.28	22.36	68.11	22.56	72.83	24.28	86.41	28.8
TOP 10	62.6	26.09	64.26	26.56	65.60	27.37	68.7	28.62	82.61	34.42
TOP 15	53.33	33.33	54.13	33.55	54.38	33.67	58.26	36.41	71.01	44.38
TOP 20	46.52	38.77	46.93	38.91	47.19	39.14	51.74	43.11	60.65	50.54

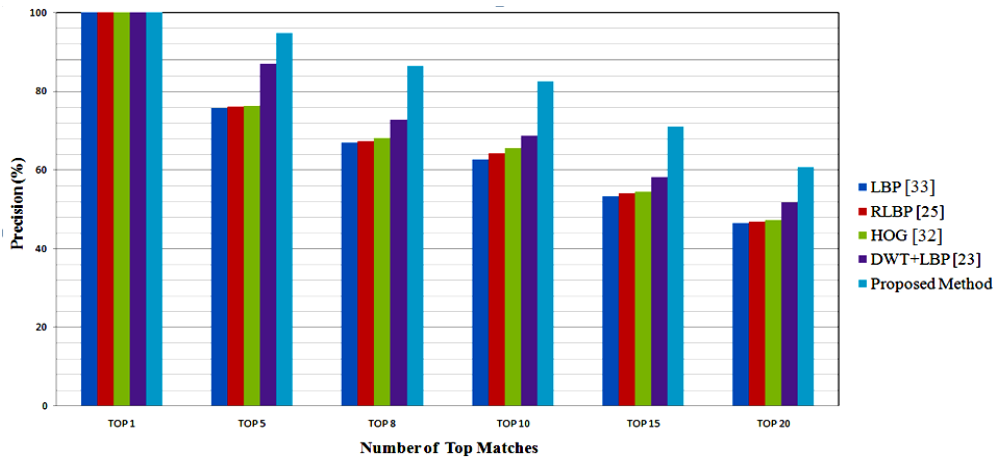


Figure 8. Graphical Comparison of Precision Values

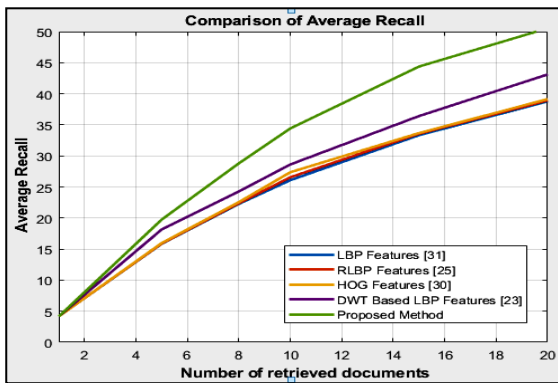


Figure 9. Comparison of Average Recall

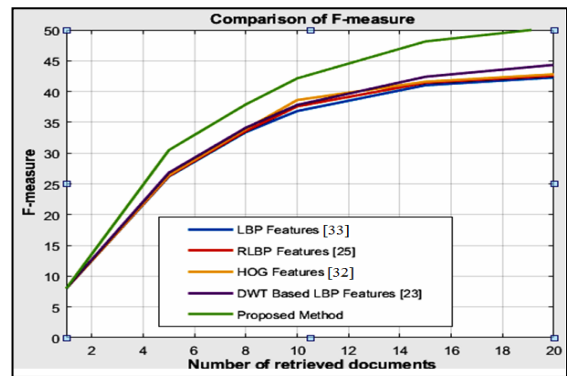


Figure 10. Graphical Comparison of F-measure

TABLE 2. Comparison of F-measure

Number of top matches	LBP Feature [33]	RLBP Feature [25]	HOG Feature [32]	DWT based LBP [23]	Proposed Method
TOP 1	7.99	7.99	7.99	7.99	7.99
TOP 5	26.21	26.27	26.41	26.81	30.48
TOP 8	33.42	33.56	33.89	34.12	37.91
TOP 10	36.83	37.59	38.62	37.82	42.14
TOP 15	41.02	41.42	41.59	42.40	48.14
TOP 20	42.29	42.55	42.79	44.33	50.4

The database used has documents with only left thumb impression. The retrieval performance may vary if a document includes multiple fingerprints.

6. CONCLUSION AND FUTURE SCOPE

This work presented an improved method for FPDIR. The improved performance is due to the use of preprocessing techniques that enhanced the quality of

detected fingerprint images and multi-resolution HOG features proposed in the system. The selection of only the directional components has provided more distinguished HOG features. It also helped in reducing the features as approximate sub-band is not considered for feature extraction. The proposed system is evaluated by testing a database of 1200 document images. It is observed from the results that, there is an increase of 8 to 14% precision with different retrieval results with the proposed algorithms. Both recall and F-measure results also demonstrate the outperformance of the proposed algorithms.

Future Scope: The results show that the performance parameters of the system decrease with an increase in the number of retrieved documents. This is found to be a major challenge in most document retrieval systems. The future design may consider the following to achieve better results.

- Suitable distance metrics
- Experimentation with new feature extraction schemes
- Feature reduction techniques to reduce retrieval time of the documents.

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Persian Abstract

چکیده

اخیراً اکثر اسناد با استفاده از اثر انگشت نهفته احراز هویت می شوند. نمونه‌هایی از این اسناد عبارتند از: ثبت ملک، تراکنش‌های بانکی، اسناد بیمه، و غیره. بازیابی اسناد مبتنی بر اثر انگشت (FPDIR) برای ارائه راه آسان‌تری برای دسترسی، مرور یا جستجوی چنین تصاویر اسنادی پدید آمده است. این مقاله بازیابی تصویر سند مبتنی بر اثر انگشت کارآمد را با استفاده از ویژگی‌های هیستوگرام گرادین جهت‌دار (HOG) با وضوح چندگانه پیشنهاد می‌کند. تکنیک پیش پردازش ارائه شده در این مقاله از ترکیبی از عملیات فیلتر کردن کلاه بالا و پایین برای بهبود تصویر اثر انگشت شناسایی شده استفاده می‌کند. ویژگی‌های HOG با وضوح چندگانه از اجزای جهت‌دار افقی، عمودی و مورب تصویر اثر انگشت بهبودیافته ساخته شده‌اند. در نهایت، یک متریک فاصله اقلیدسی استاندارد شده به عنوان ابزاری برای تطبیق، رتبه‌بندی و بازیابی تصاویر سند استفاده می‌شود. سیستم پیشنهادی با آزمایش با مجموعه داده ای از ۱۲۰۰ تصویر ارزیابی می‌شود. نتایج دقت و یادآوری به دست آمده با استفاده از کار تحقیقاتی پیشنهادی باعث بهبود عملکرد بازیابی ۸ تا ۱۴ درصد نسبت به روش‌های قبلی شده است.
