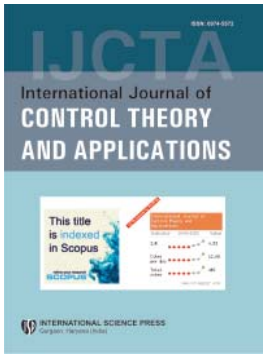

International Journal of Control Theory and Applications

ISSN : 0974–5572

Volume 9 • Number 40 • 2016

Enhanced Annular Iris recognition using Bag of Vocabulary Models

Alice Nithya. A[a] Lakshmi. C[a] and R. Rani Krithiga[a]

[a]*School of Computing, SRM University, KTR Campus, Tamilnadu, India a.alicenithya@gmail.com*

Abstract: Iris recognition is a desirable biometric identification system, providing promising results in the access control and identity authentication systems. In this paper, SURF based Bag of Vocabulary Model a novel and promising feature analysis methodology with Gaussian kernel multi-class SVM classifier is used for iris recognition. This method when applied directly on segmented iris region of interest faces some shortages like feature loss and noisy interest point introduction. An enhancement technique is applied to the segmented annular iris roi for improving the performance of the system. Experimental results on CASIA V1 shows that, by enhancing the iris roi and choosing appropriate vocabulary size of 700, the performance in terms of accuracy is 96.83% with an EER of 3.17%. Experimental results demonstrate that enhancement steps are crucial for this Model to improve the recognition accuracy.

Keywords: *Iris recognition, SURF, Bag of Vocabulary, Enhancement.*

1. INTRODUCTION

Human physical or behavioral features have been used the purpose of identification and authentication in several application areas like Banking, Military, Border security forces, immigration checks, and so on. IRIS recognition is considered to be one of the most auspicious biometric technologies among others like face, finger print, palm print and so on. It provides a highly reliable and positive human identification system for noncontact biometric models [1]. Iris is a small annular muscle present inside a human eye, with rich and unique textural pattern information, used in positive human authentication or identification [2]. In recent years, several studies have been made related to the use of iris models to support biometric based experiments [3]. A generic iris recognition work flow involves iris segmentation from the input eye image; iris feature extraction and code generation, followed by matching of two iris codes to perform positive identification or authentication.

Several feature extraction methods have been developed to deal with cooperative users under controlled environment. Results exhibited by these methods in controlled environment are amazing In [4], feature extraction techniques for iris recognition are broadly classified into the following methods: (*i*) Phase and texture based methods, (*ii*) Zero-Crossing representation, (*iii*) Key point Descriptors, and (*iv*) intensity variation analysis. Among the above mentioned techniques, key point descriptors based techniques like SIFT [5] and SURF [6], provide robust scale, rotation, and translation invariant features for recognition, even with the annular segmented

iris region of interest (roi). This helps in overcoming the aliasing effect caused by the normalization stage of iris recognition process. Basically, SIFT and SURF were algorithms developed and highly recommended for object detection. But when used for iris recognition, though it provides robust and reliable results there is a considerable reduction in recognition accuracy as the features obtained from intra-class, and inter-class samples are highly non-linear.

In this paper, to overcome the difficulties like feature loss and redundant features of [5] and [6], we employed a bag of vocabulary model along with SURF feature extraction technique. In this model, segmented annular iris roi is enhanced using Contrast-Limited Adaptive Histogram Equalization (CLAHE) and given as input to the SURF feature extraction technique and a 64 dimension L2- normalized feature vector is created. Then to reduce the dimension of the feature vector to improve the system performance, K-means clustering technique is applied, and bag of vocabularies with highly reduced dimension with discriminated feature is created. During training phase, created bag of vocabularies are stacked as a knowledge base using Gaussian kernel based multi-class SVM classifier [7] for recognition purpose. When a sample query image is given to the model, it classifies the class to which the sample image belongs to. The bag of vocabulary model when tested with CASIA V1.0 is proved to give improved results when the segmented iris roi is enhanced.

The paper is organized as follows. Section 2 explains the proposed experimental methodology with validates the strategy used along with the factors influencing unpredictable data. Section 3 analyzes the experimental results of proposed work with its parameters and strategies. Finally, paper concludes, and future work is discussed in Section 4.

2. ENHANCED BAG OF VOCABULARY MODEL

The proposed methodology and work analysis are discussed in this section. In this work, design and analysis of training and testing phase is proposed using strong and stable feature extraction techniques solving both optimization and dimension reduction problems involved in the key point based descriptor techniques when used on iris images. Proposed methodology provides high level of abstraction for ensuring the positive identification of the person.

2.1. Training Phase

In training phase, 70 % of iris samples belonging to different subjects were chosen from the iris datasets using random sampling techniques. Training phase involves iris localization, feature extraction, bag of vocabularies creation and training the Gaussian kernel based multi class SVM classifier. During iris localization, using Circular Hough Transform (CHT) [8] technique, iris-sclera outer boundary was detected. A minimum rectangular boundary (MRB) is defined using the outer radii obtained. This steps helps in removing the sclera portion from the iris images without any processing thus helps in reducing the processing time involved. An adaptive statistical based iterative thresholding technique is used to remove the pupil portion, eyelashes and specular reflections present in the MRB to obtain the annular iris region of interest (roi). Contrast-Limited Adaptive Histogram Equalization (CLAHE) technique [9] was then applied on the annular iris roi, to enhance the contrast which helps in reducing the feature loss problem that could occur in the feature extraction technique due to bad image quality of iris images taken in uncontrolled environment.

This enhanced annular iris roi is then given directly to SURF [6] feature extraction technique without performing the normalization process involved in traditional methods [2]. By eliminating the normalization stage, the aliasing effect [10] could be avoided. Since SURF provides a scale, rotation and translational invariant feature vector, annular iris roi could be given as input.

In the SURF technique [11], key points were extracted using a Hessian matrix and Haar wavelet response distributions from a window around each of the key points extracted was described as feature descriptors. Though these descriptors were very distinct and stable, the size of the descriptor was 64-dimensions, based on the number of key points identified. These descriptors, define the color, texture and shape properties of each

of the patches extracted around the detected key points and found to have some redundant features as well. To reduce the dimension of this descriptor, so that the recognition system could be optimized, Bag of Vocabularies (BoV) model is proposed in this paper. This BoV model was derived from the popular text retrieval approach Bag of Words (BoW) model [12]. BoV model represents each descriptors using a histogram of visual vocabulary. This model creates an order-less collection using k-means clustering technique. called visual vocabularies. One of the major challenge in designing a BoV model is defining the cluster centers representing the size of the final feature vector. The vocabulary size should be chosen very carefully as small size could mislead to less discrimination, and very larger size could slower the process and generalize the features. A good trade off should be maintained between discrimination and generalization by choosing appropriate vocabulary size. For faster and easier identification process, a unique identity training label was assigned to each iris image BoV features. Thus this BoV model combined with SVM is capable of learning the non-linear features for classification. As an outcome trained model is developed with all information required for classification and features are stored as a knowledge base. Gaussian kernel based multi-class SVM classification technique [7] was employed to identify the class of individual subjects.

Figure 1. shows the block diagram of the proposed training phase using BoV model.

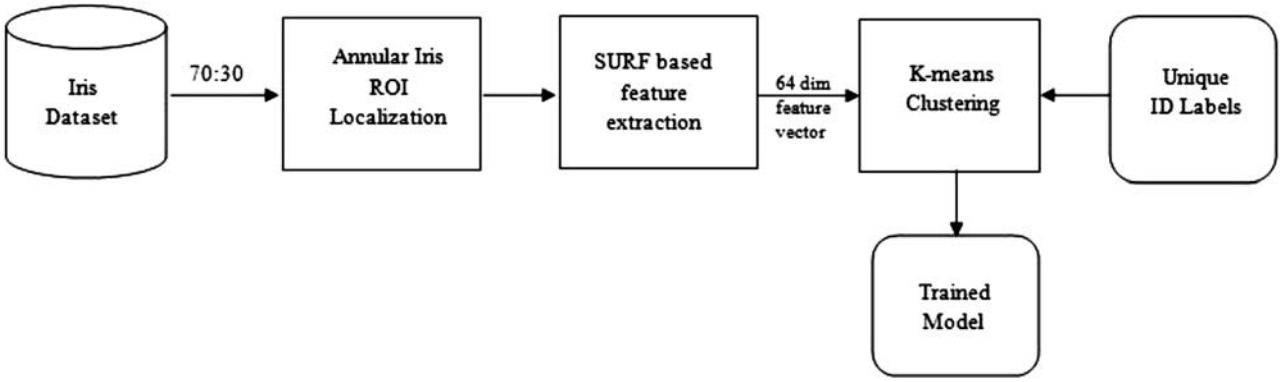

Figure 1: Block Diagram of BoV Model's Training Phase

Training_Phase

```
Img   = load(training dataset);
U     = Unique Identity Training labels;
L     = length(u); (number of classes)
N     = Measure_No_of_Images ();
For Loop i = 1 to N
IROI  = Localization(Img(i));
E_IROI = CLAHE(IROI(i));
SFD   = SURF_Feature_Extraction(E_IROI(i));
Bag   = Bag_of_Vocabulary(SFD(i));
End Loop
Initializing Gaussian Kernel SVM ();
Trained_Model = [SVM(Bag) U];
Save Trained_Model;
```

2.2. Testing Phase

Testing phase designed in this methodology is similar to the training phase. In the testing phase, the remaining 30% images obtained using random sampling were given to the trained model as input query image. Bag of Vocabulary for the input query image will be extracted as discussed in the training phase. A closest match was found using the SVM classifier using the trained model. Figure 2. shows the process flow of testing phase.

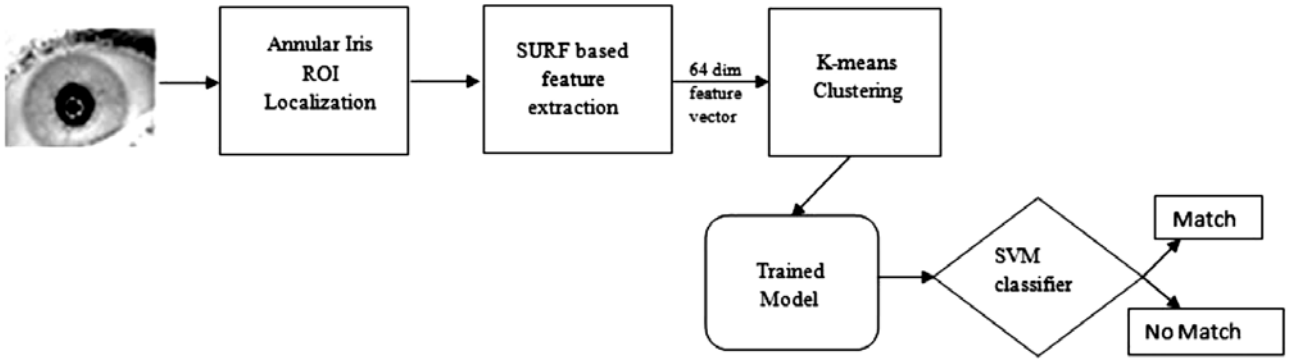

Figure 2: Block Diagram of Testing Phase

Testing_Phase

```
                    Test_Img   =  Select_Query_Image (30% Samples)
                    IROI       =  Localization(Test_Img);
                    E_IROI     =  CLAHE(IROI);
                    SFD        =  SURF_Feature_Extraction(E_IROI);
                    Bag        =  Bag_of_Vocabulary(SFD);
Load Trained_Model; test_label =  Trained_Model (SFD);
if  test_label== train_label
Display “Match found.”
else
Display “Match Not found.”
end
```

3. RESULTS AND DISCUSSION

In this proposed iris recognition system, we performed an analysis of the BoV model accompanied with Gaussian kernel multiclass SVM classifier to prove the system efficiency in terms of performance improvement and secure authentication. CASIA V1.0 publicly available iris dataset samples were used to check the efficiency of this methodology. BoV model extracted strong and stable features and was combined with the unique identity label for training the samples. When the iris recognition system get a query image, it results an identity label along with match or no match for providing secure identification or authentication. It is proved that BoV model provides better accuracy with high recognition accuracy when the annular iris roi is enhanced using CLAHE. Similarly to ensure dimension reduction, an analysis was done with varied Vocabulary sizes, and a comparison is made. Based on random sampling 7 percent of data were taken for training and 30 percent for testing for every class of the dataset. In this model we have made a comparison for 54 subjects and 108 subjects with varying vocabulary sizes ranging from 100 to 1000. The parameters comparison between the varied vocabulary size and for varied class size is shown in Figure 3 and Figure 4 for both segmented annular iris roi and enhanced roi.

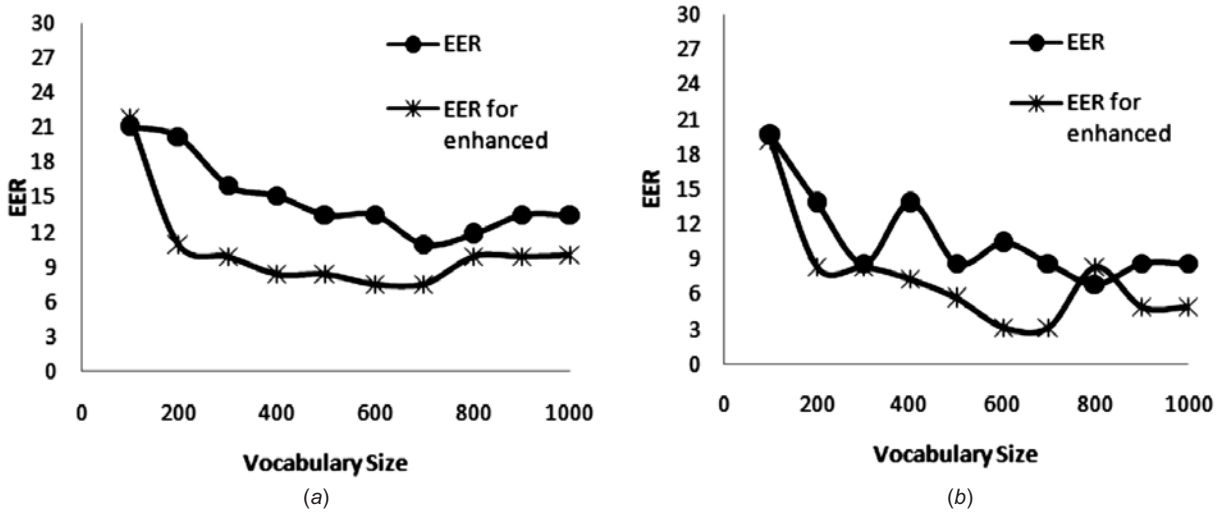

Figure 3: (*a*) Equal error rate (EER) for 54 subjects and (*b*) EER for 108 subjects

4. CONCLUSION

In this paper, a novel BoV modeling approach utilizing the SURF image region descriptor along with Gaussian kernel multiclass SVM classifier is proposed for iris recognition. Enhancing the annular segmented iris roi followed by SURF feature extraction even without performing normalization has shown some important advantages. It helps in reducing feature loss and redundant feature creation while helps in discriminative and 64-dim L2 normalized features. The experimental results showed that the proposed model using SURF descriptor has achieved better accuracy when the annular iris roi is enhanced using CLAHE. From the experimental results its is observed that when the vocabulary size is 700, proposed model is able to achieve an accuracy of 96.83 % with an equal error rate of 3.17%. Though the proposed model shows competitive performance in iris recognition, the discriminative power can be further improved, and feature vector size could be further reduced using some ordered method other than K-Means. That will be focused in the future work of this paper.

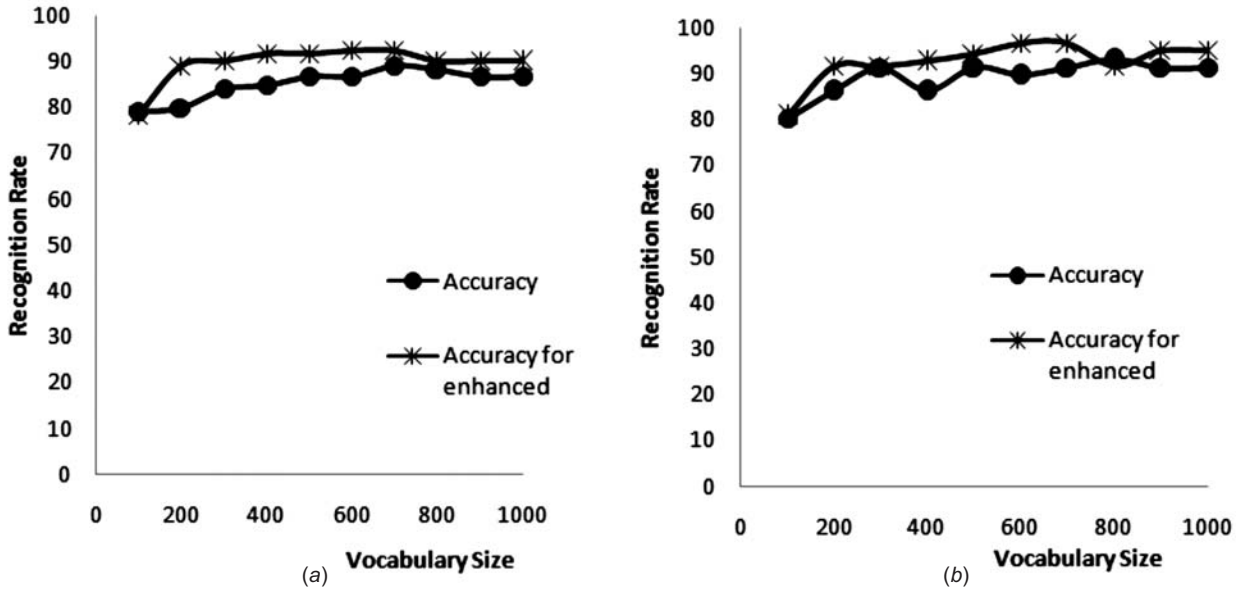

Figure 4: (*a*) Recognition Rate for 54 subjects and (*b*) Recognition Rate for 108 subjects

REFERENCES

[1] Si, Y.L., Mei, J.Y. and Gao, H.J. (2012) Novel Approaches to Improve Robustness, Accuracy and Rapidity of Iris Recognition Systems. IEEE Transactions on Industrial Informatics, 8, 110-117. http://dx.doi.org/10.1109/TII.2011.2166791

[2] Daugman, John. "How iris recognition works." *IEEE Transactions on circuits and systems for video technology* 14.1 (2004): 21-30.

[3] Alice Nithya A, Lakshmi C. Iris Recognition Techniques: A Literature Survey. International Journal of Applied Engineering Research. 2015 Jul; 10(12):32525-46.

[4] Alice Nithya A, and C. Lakshmi. "Feature Extraction Techniques For Recognition Of Iris Images: A Review." I J C T A, 9(28) 2016, pp. 87-92

[5] Wang, Hongye, and Ning Deng. "Efficient Iris Recognition Based on Optimal Subfeature Selection and Weighted Subregion Fusion." *The Scientific World Journal* (2014).

[6] Mehrotra, Hunny, Pankaj K. Sa, and Banshidhar Majhi. "Fast segmentation and adaptive SURF descriptor for iris recognition." *Mathematical and Computer Modelling* 58.1 (2013): 132-146.

[7] Dogan, Urün, Tobias Glasmachers, and Christian Igel. "A unified view on multi-class support vector classification." *Journal of Machine Learning Research* 17.45 (2016): 1-32.

[8] R.O. Duda, P.E. Hart , 'Use of the Hough transformation to detect lines and curves in pictures Commun. ACM, 15 (1) (1972), pp. 11–15

[9] Zuiderveld, Karel. "Contrast Limited Adaptive Histograph Equalization." *Graphic Gems IV*. San Diego: Academic Press Professional, 1994. 474–485.

[10] H. Proenca, L. Alexandre, Iris recognition: an analysis of the aliasing problem in the iris normalization stage, in: International Conference on Computational Intelligence and Security, vol. 2, 2006, pp. 1771–1774.

[11] Bay, Herbert, et al. "Speeded-up robust features (SURF)." *Computer vision and image understanding* 110.3 (2008): 346-359.

[12] Sivic, J., and Zisserman, A., Video Google: A text retrieval approach to object matching in videos. In Computer Vision, 2003. Proceedings. Ninth IEEE International Conference on, 2003. p. 1470-1477.