Thermal Face Recognition using Bag of Words

R. Sumalatha, R. Varaprasada Rao, D. Rajasekhar

Abstract*: *In this paper we use Bag of Words (BoW) to estimate the performance of face recognition system of visible and infrared images. The proposed BoW results compared with six conventional feature extraction methods i.e LBP, FAST, MSER, BRISK, SIFT, SURF. BoW model is tested and analyzed on OTCBVS database under various illumination and expressions of faces. The obtained results gives good precision and recall rates compared with six conventional feature extraction methods.

Index Terms*: *Thermal face recognition, Feature Extraction, LBP, SIFT, FAST, SURF.

I. INTRODUCTION

In current scenario face identification and recognition is an important technique in surveillance applications. Face is one of the important biometric in humans. Therefore face recognition plays a major role in computer vision applications. Unlike other biometric i.e palm, iris, fingerprint etc., face biometrics are captured without users knowledge and later can be used for surveillance systems. Over the past decades of research a lot of face recognition techniques has been proposed to achieve good recognition rate for visible images. But in real time lighting conditions can vary because of various factors, for example, weather conditions, different time of capture and etc. Due to variations in illumination intensity the performance of the face recognition system is not good. To overcome this problem in visible face recognition many researchers use infrared images (IR). Thermal images are captured from the thermal cameras under no light conditions also.

A large amount of the researchers have been proposed different methods for face recognition with fusion of infrared and visible images. However the use of fusion of face images under constant scene doesn't gives better recognition rate, in addition they don't analyze the capture of images at different situations. In this paper we analyze the face recognition methods under different illumination intensity and no light conditions and also considering the face recognition methods that have been designed to be robust to rotation, occlusion, pose and artifacts. To understand and analyze the performance of face recognition system we use Bag of Features (BoF) and compared with the conventional methods i.e LBP, SURF, FAST.In section II discuss about the literature survey. Section III presents proposed system, Section IV and V describes about the SURF feature extraction method and Bag of Words (BoW) model. Section VI explains about Support Vector Machine (SVM). Section VII gives the face recognition experimental results and analysis of different methods. Section VIII presents the conclusion of the work present in this paper.

Revised Manuscript Received on June 05, 2019

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II. LITERATURE SURVEY

Zahid Manhood et al discussed about current methods in face recognition and comparative study of LBP, Ada Boost with LDA and PCA with different pose, resolution and expression [1]. Amal Seralkhatem Osman Ali et al, presented a novel system for face recognition after plastic surgery. For evaluation purpose they used two feature extraction techniques i.e LBP and GIST [2]. Rasha Ragheb Atallah et al, provides a survey of face recognition techniques by considering changes in face under variations in age [3]. S.Choi et al, proposed a technique to create a composite features for face recognition from holistic and local features. These features are extracted using NLDA. The proposed technique gives superior performance compared with using holistic or local features [4]. Jie pan et al, presented single model face recognition technique using Locality Preserving Projection Feature Transfer (FT LPP) and compared the proposed method with the conventional methods like LDA, PCA, LPP. The proposed method gives better recognition accuracy than existing methods [5].Randa atta et al., presented a feature selection technique with a combination of DCT and SPIHT coding for face recognition. The suggested technique has been tested on ORL and FERET databases then compared with wavelet based SPIHT feature extraction method [6]. Hassen Drira et al proposed a novel geometric framework for analyze 3D faces under various conditions. For analyzing of 3D faces they used three database i.e FRGCv2, GaVabDB and Bosphorous [7].

Satyanadh Gundimada et al developed a new kernel Eigen spaces and implemented on the phase. Congruency features are extracted from the visual and infrared images separately. The proposed system provides high recognition rate under partial occlusions, expression and various lighting conditions. The proposed decision level fusion achieves good results compared with visual, thermal and data level fusion [8].Shangfei Wang et al created a database with visible and infrared images with various expressions, which consists of natural and pose expression of images with illumination from three different directions. They analyzed four conventional algorithms i.e PCA, Fisher face, Active appearance for visible expression model (AAM), AAM+LDA for visible face recognition , and two standard algorithms for infrared images [9]. Jang-Gang et al proposed a new method for extracting the face features in an infrared image by proxy, specifically to superimpose the noticeable face onto the objective infrared face [10]. Gabriel Hermosilla Vigneau proposed a new system with fusion of the thermal and visible key points for face recognition. The developed framework acquired the weights from Particle Swarm Optimization (PSO) [11]. D.Rajasekar et al, discussed about gesture recognition for disaster management applications using color feature extraction method [12].

III. PROPOSED MODEL

The proposed model block diagram is given in Fig 1.

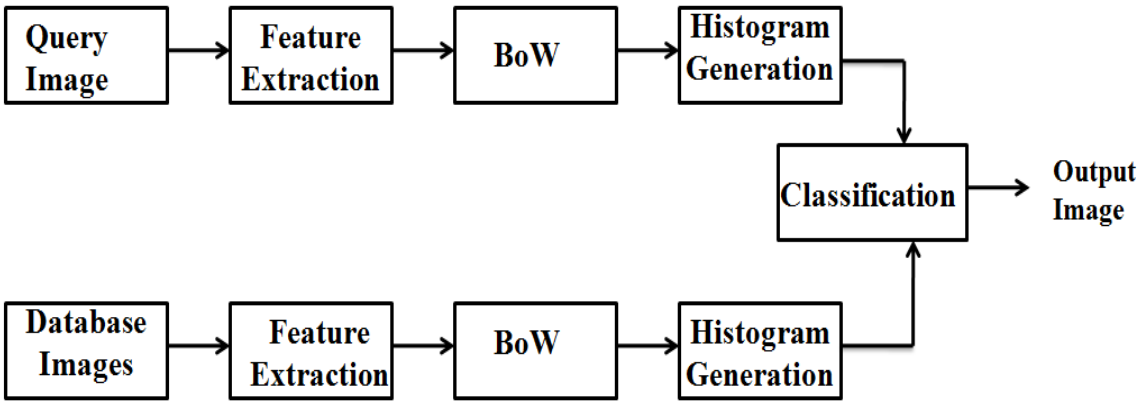


Fig 1. Proposed System Block Diagram

- The Query image and images in database features are extract using SURF feature extraction method.
- The features are generated by SURF are grouped into Bag of Words (BoW).
- Next represent each visual image (word) in histogram bins.
- For classify images the histogram bins are passed through the SVM classifier.

IV. SPEED UP ROBUST FEATURE TRANSFORMATION (SURF)

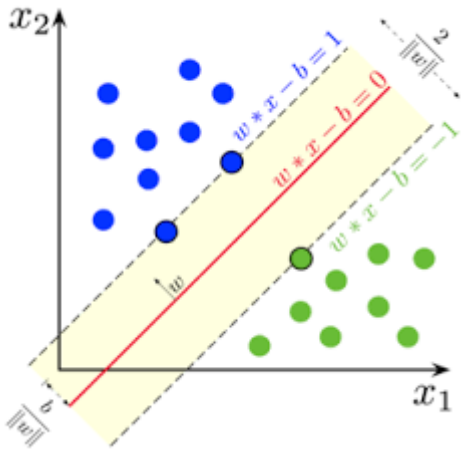
Herbert Bay et al presented a new scale rotation invariant detector. The SURF uses integral images to reduce number of operations for simple convolutions, independent of scale by using Hessian matrix. Hence the speed of the detector is increased. They find out the precision of quick Hessian detector for the use of camera self adjustment and 3D reconstruction [13].

V. BAG OF WORDS

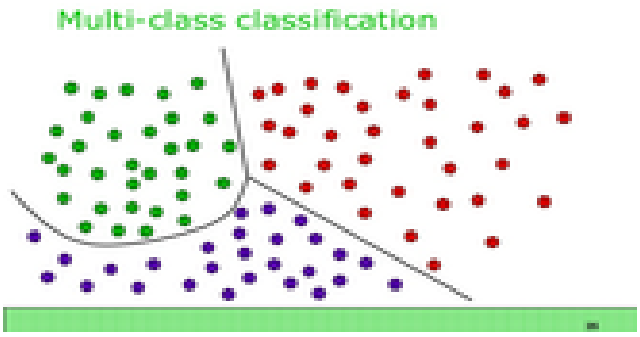
BoW plays a major role in image classification. In general BoW are used to describe every image in terms of frequency of each word occurrence in an image. To generate feature vector we use three methods: K-Means clustering, visual words, Histogram Generation. SURF feature extraction mainly consists of interest point detector and descriptor. The obtained descriptors from SURF are divided into K number of clusters using K-means algorithm. Next find the similar cluster centroid for each and every cluster centroid. Once the nearest centroid is recognized, it is then allotted to that particular centroid. After this, the centers of the clusters are recomputed and with the newly generated centers. Therefore, after K-means clustering, center of each cluster will be used as the visual word. Next feature vector is computed using histogram of visual words. This feature vector gives the information about histogram of visual word occurrence of images [14].

VI. SUPPORT VECTOR MACHINE

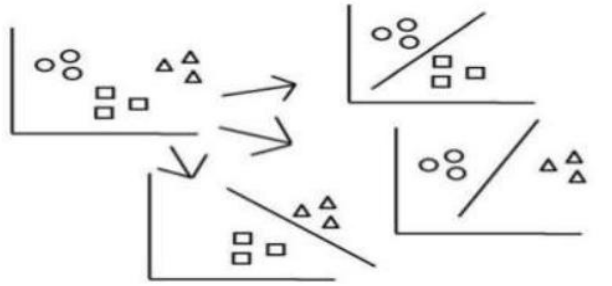
For classification of images we use support vector machine classifier. It is a supervised machine learning algorithm. It builds a hyper plane in space. A fine partition is produced by the hyper plane that has the longest distance to the nearest training-data point of any class (so-called functional margin). A bigger margin induces lower generalization error of the classifier In this paper we use one to one multi class linear SVM [15]. Basic SVM classifier, one to one, one to all , multiclass SVM classifiers are shown Fig.2.



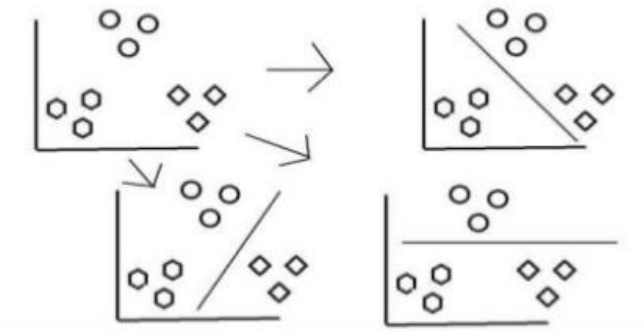
(a)



(b)



(c)



(d)

Fig.2 (a) SVM Classifier (b) Multiclass SVM Classifier (c) One to One (d) One to All SVM Classifiers

VII. EXPERIMENTAL RESULTS AND DISCUSSION

For testing and evaluating the face recognition methods we use OTCBVS Benchmark database. This database consists of infrared and visible face images with various illumination, expressions and different poses [16]. In this section we compare the proposed system results using BoW with different conventional face recognition methods on thermal and visible images using precision and recall rates. The Precision Rate and Recall Rate is given by

$$Precision\ rate = \frac{\{Relevant\ Face\ Images\} \cap \{Retrieve\ Face\ Images\}}{\{Retrieve\ face\ Images\}} \quad (1)$$

$$Recall\ rate = \frac{\{Relevant\ Face\ Images\} \cap \{Retrieve\ Face\ Images\}}{\{Relevant\ face\ Images\}} \quad (2)$$

(a)

(b)

Fig. 3. (a) Visible Face Images (b) Thermal Face Images with various Expressions and illumination intensity

Table 1. Comparison between Six Feature Extraction Methods on OTCBVS Database

	FAST	*LBP*	*MSER*	*BRISK*	*SIFT*	*SURF*	*BoW*
Precision Rate	0.77	0.51	0.64	0.57	**0.85**	**0.95**	**0.98**
Recall Rate	0.63	0.41	0.53	0.46	**0.64**	**0.72**	**0.8**

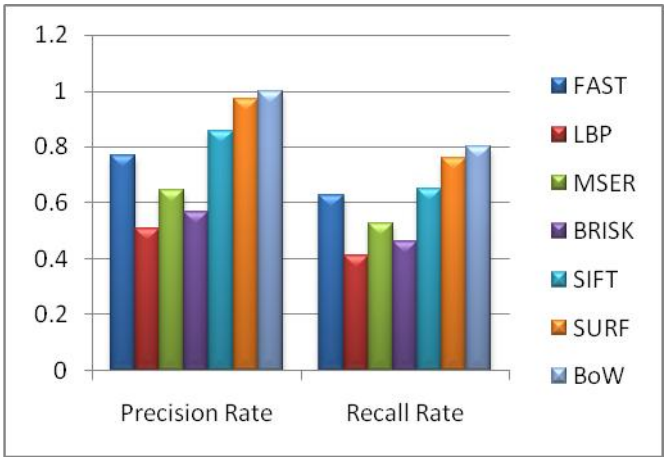


Fig.4 Comparison of precision and recall rate values between six feature extraction methods

VIII. CONCLUSION

In this paper BoW model is used for face recognition. To analyze the robustness of proposed method we perform the BoW model on several expressions and under different lighting conditions of thermal and visible face images. The results obtained by BoW model achieve better precision and recall rates when compared with the other face recognition methods.

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