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Integrated SURF and Spatial Augmented Color Feature Based Bovw Model with Svm for Image Classification

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Abstract: ***In this paper, Bag-of-visual-words (BoVW) model with Speed up robust features (SURF) and spatial augmented color features for image classification is proposed. In BOVW model image is designated as vector of features occurrence count. This model ignores spatial information amongst patches, and SURF Feature descriptor is relevant to gray images only. As spatial layout of the extracted feature is important and color is a vital feature for image recognition, in this paper local color layout feature is augmented with SURF feature. Feature space is quantized using K-means clustering for feature reduction in constructing visual vocabulary. Histogram of visual word occurrence is then obtained which is applied to multiclass SVM classifier. Experimental results show that accuracy is improved with the proposed method.***

Index Terms: Bag-of-visual-words (BoVW), Spatial augmented color features, K-means clustering, SVM.

I. INTRODUCTION

Image Recognition is the vital task of learning visual categories and to classify new images into those categories. In many image classification approaches class instances are represented as feature vectors which are points in a feature space. The bag- of-features (BoF) [4,6,7,8,9,11,13,14] method is the state-of-the-art for image classification. Five steps in this method are Extraction of features, construction of codebook, feature encoding, feature pooling , learning and classification. BoF provides a very compact description of the image that is described as local descriptor histograms. By quantizing the local image descriptors, visual words are acquired. This is achieved by using clustering algorithms such as K-means to cluster a large number of local descriptors. Each cluster represents a visual word and the image represented with Bag of visual words. Extraction of features is done in three steps viz. feature detection, description and matching. Different feature detectors and descriptors such as SIFT, SURF, ORB, FAST, BRIEF and BRISK [1,2,6,7,8] are found in the research. SIFT is the descriptor most commonly used but the elevated dimensionality of the descriptor is an disadvantage in the matching phase [1,2,5,10]. SURF outperforms SIFT with regard to repeatability, distinctiveness, and robustness and it is fast in computation and matching[1], applicable to gray scale images. BoVW model considers histogram, ignores the visual words location in 2-Dimensional image space. Color information leads to the detection of more salient regions [11]. To improve the recognition and classification accuracy, in this paper the SURF features are augmented with average color value of patches augmented with spatial information [3].

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II. METHODOLOGY

In this work , three image detectors/descriptors viz. SURF, BRISK and FAST are investigated, SURF yielded good results. Using SURF and color spatial layout, Bag of features model is developed as shown in Figure 1.

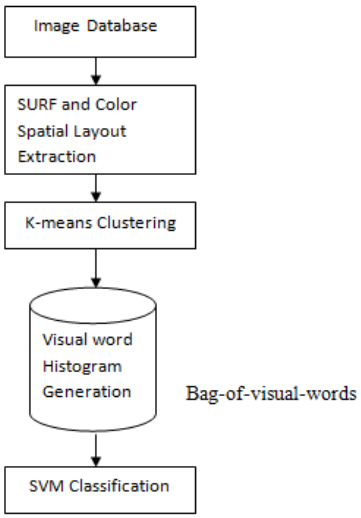

Figure 1 Bag of features Model

a) **Training and validation data:** 70% images are taken for training 30% for testing.

b) **SURF Features:** There are two steps in extracting the features. First, the interest points are chosen in the image at distinct positions. Then, the neighborhood of each interest point is represented by a feature vector. Interest point detector has four stages viz. computing integral image, applying second derivative filters to image, finding local minima and then applying quadratic interpolation. Extraction of the SURF descriptor has four phases. Constructing a square region focused around the interest point, splitting each region into 4 × 4 square blocks.

Then Haar wavelet responses are obtained for each sub region to get four dimensional vector and finally for each region descriptor of length 64 is obtained.

c) **Color Feature with spatial layout:** The average color of L*a*b * is drawn as a color function within the 16-by-16 block. L*a*b * color space can readily quantify distinct colors visually. To integrate spatial data, the color feature is attached to [x y] locations within the image from which the color feature was extracted.

d) **Visual VocabularyConstruction**:
To moderate the features, use K_means clustering to qu antize the feature space. Then the histogram of visual word occurrences is obtained which is the feature vector of image.

e) **SVM Classifier:** Training images function vectors provide for multi-class SVM classification. The classifier performance is evaluated by obtaining confusion matrix. A perfect classification yields in a normalized matrix containing 1s as diagonal elements. Fractional values indicate incorrect classification. Also when a new image is given the classifier predicts its category.

III. RESULTS

Dataset

Two datasets are used

1. Wang database[16] containing 1000 images, 10 classes of 100 images each. These 10 classes have the images of Africa, Beach, Building, Buses, Dinosaurs, Elephants, Flowers, Horses, Mountains and Food.

2. Corel 10k images[15,12] containing 10000 images, 100 classes of 100 images each. These include sunset, beach, flower, fish, building, car, houses, etc.

(a) (b)

Figure 2 (a) Sample images of Wang dataset

(b)Sample images of Corel 10k

Different detector/descriptors are examined, SURF yielded better results as shown in Table 1 for the top 25 images recognized. SURF and Color features are extracted and feature vectors are obtained from histogram of visual word occurrences as shown in Figure 3.

Table 1 No. of images retrieved

S.No	QUERY	SURF	BRISK	FAST
1	Query1	18	17	17
2	Query2	23	21	18
3	Query3	17	13	11
4	Query4	16	1	2
5	Query5	15	3	1
6	Query6	14	2	3
7	Query7	17	17	11
8	Query8	12	2	6
9	Query9	16	1	3
10	Query10	16	14	18

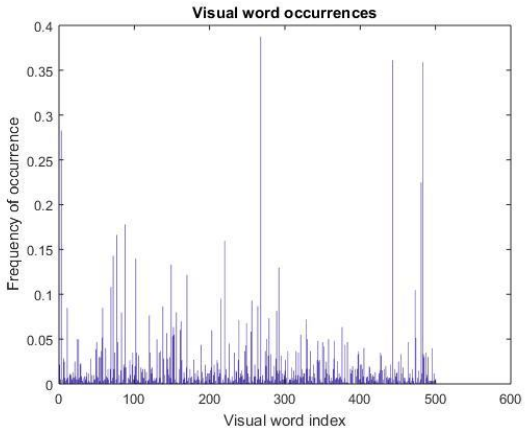

Figure 3 Sample Visual Words Histogram of Image

Experiments are performed on two datasets Figure 4 illustrates classification accuracy. For large dataset the accuracy is improved by 4% with addition of color feature along with SURF features.

Dataset	Features in BoVW Model		
	SURF	Color Spatial Layout	SURF and Color
Wang 1k	85	75	77
Corel 10k	61	37	65

Figure 4 Classification Accuracy

IV. CONCLUSION

Bag of visual words with SURF features augmented with color features is investigated in this work. Addition of color feature increased the image classification performance for large image database. Average color value of 16-by-16 blocks is used as color feature with augmented spatial layout of the block. In case of color dominant images, Bag-of-features with color feature alone is observed to be a good descriptor. Other color descriptors like color histogram , color correlogram , etc could be used for analyzing the possibility of accuracy improvement.

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