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Implementation of Image based Flower Classification System

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ABSTRACT
In today's world, automatic recognition of flowers using computer technology is of great social benefits. Classification of flowers has various applications such as floriculture, flower searching for patent analysis and much more. Floriculture industry consists of flower trade, nursery and potted plants, seed and bulb production, micro propagation and extraction of essential oil from flowers. For all the above, automation of flower classification is very essential step. However, classifying flowers is not an easy task due to difficulties such as deformations of petals, inter and intra class variability, illumination and many more. The flower classification system proposed in this paper uses a novel concept of developing visual vocabulary for simplifying the complex task of classifying flower images. Separate vocabularies for color, shape and texture features are created and then they are combined into final classifier. In this process firstly, an image is segmented using grabcut method. Secondly, features are extracted using appropriate algorithms such as SIFT descriptors for shape, HSV model for color and MR8filter bank for texture extraction. Finally, the classification is done with multiboost classifier. Results are represented on 17 categories of flower species and seem to have efficient performance.

Keywords
MR8 filter bank, Multiboost classifier, SIFT descriptors, Visual Vocabulary, HSV color model.

1. INTRODUCTION
Object recognition has always been a difficult problem to tackle for the computer scientists due to the numerous challenges involved in it. It is possible that the image of any object taken from different view appears in a different way for each individual. Considering the natural object such as flower, various species of flowers exists in the world. Some of the categories are Daffodils, Buttercups, Dasils, Iris, Dandelions, Paisy, Sunflowers, Windflowers, Lily valleys, Tulips, Tiger lilies, Crocus, Bluebells, Cow clips etc. The categorization of flower images is challenging due to variances in geometry, illumination and occlusions. The problem of classification becomes more complex because of the large visual variation

between images of same flower species known as inter-class variability and variation between images of different flower species called intra-class variability. Figure1 depicts the three different kinds of flowers having similar shape and appearance thus showing the inter-class variability.

Figure1. Flower images for inter class variability

Hence, there is a need to create a classification system that captures the important aspects of a flower and also address issues such as variation in illumination, occlusion, view angle, rotation and scale. This paper focuses on proposing a system that can classify flower images by developing a visual vocabulary that represents different distinguishing aspects of flower. This system thus can overcome ambiguities that exist between flower categories.

The rest paper is organized as follows: Section 2 briefs about the work done till now related to this area. The implementation of flower classification system using visual vocabulary is discussed in Section 3. Results of various techniques implemented are discussed in section 4. Section 5 concludes this paper.

2. RELATED WORKS

Many researchers have worked on the various methods and algorithms for the flower image classification. Nilsback and Zisserman have proposed a novel concept of visual vocabulary in order to address the issue of ambiguity [5]. Wenjing Qi, et al. has suggested the idea of flower classification based on local and spatial cues with help of SIFT feature descriptors [8]. Yong Pei and Weiqun Cao has provided the application of neural network for performing digital image processing for understanding the features of a flower [10].Regional feature extraction method based on shape characteristics of flower is proposed by Anxiung Hong, Zheru Chi, et al.[7]. Salahuddin et al. have proposed an efficient segmentation method which combines color clustering and domain knowledge for extracting flower regions from flower images [4]. D S Guru et al. have developed an algorithmic model for automatic flowers classification using KNN as the classifier [3]. Nilsback and Zisserman has also computed four different features for the flowers, each describing different aspects such as the local shape/texture, the shape of the boundary, the overall spatial distribution of petals, and the color. Finally they combined the features using a multiple kernel framework with a SVM classifier [6].

4. METHODOLOGY

Recently, bag of visual words model [1] has gained tremendous success in object classification. Visual Vocabulary [5] concept is based on the same model. The most distinguishing characteristics of a flower image are the shape, color and texture. Based on these features it becomes easy to classify the flower images. Since the system is based on the concept of visual vocabularies, separate vocabularies are created for color, shape and texture features and the results are combined into final classifier. Detailed description about the flow of the system is depicted in Figure.3.The entire system works in two phases:-the training phase and secondly the testing phase.

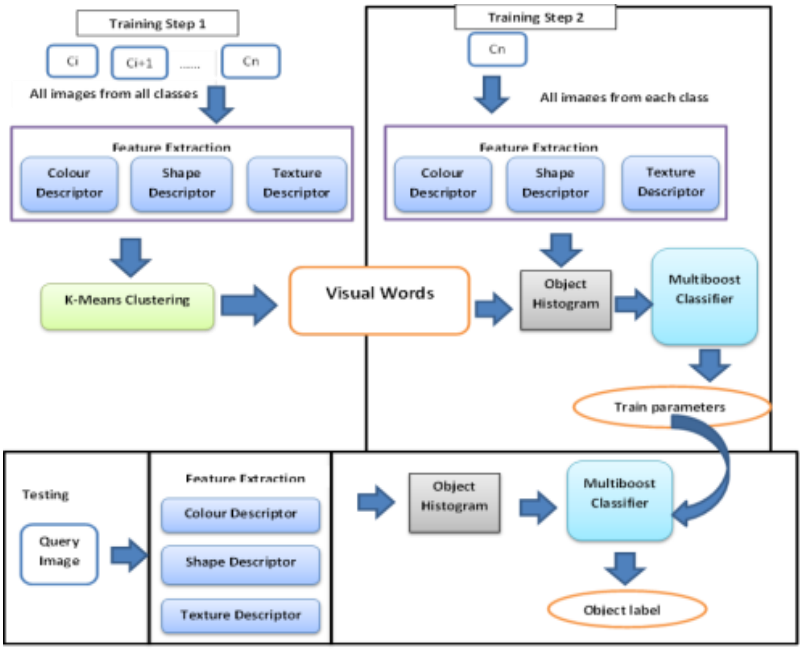


Figure 2. Block diagram of flower classification system

In training phase, all the images from all classes are selected and then their color, shape and texture features are extracted with their respective extraction techniques which are discussed later. The outcomes of this are the descriptors which are provided as an input to k-means clustering algorithm in order to form visual words. Using visual words, object histogram are created .These histogram are given to the final multiboost classifier in order to train them. In testing phase, when user provides the query image, firstly feature extraction is performed then object histogram is created and given to the classifier which with the help of trained parameters classifies the image and provides it with the appropriate label.

The implementation of Visual vocabulary is explained below:-

1. SEGMENTATION-

The flower images that are taken from the dataset should be segmented first in order to achieve the higher rate of accuracy. In this system, grabcut method is used for segmentation and it yields good results. Grabcut is a segmentation technique that uses region and boundary information in order to perform segmentation. This information is gained through significant difference between the colors of nearby pixels.

(a)Original image **(b)Segmented image**

Figure 3. Segmentation with grabcut method

Above figure (a) depicts the input flower image randomly selected from dataset.Figure (b)shows the result of segmented flower image through the grabcut method.

2. CREATING A VOCABULARY FOR FLOWER-

In order to create a flower vocabulary, we need to extract the feature descriptors from the flower images using relevant methods and create vocabularies of those.

A. SHAPE VOCABULARY-

Shape is the most important characteristic of flower. However, the natural deformations of flowers and the variations of viewpoint and occlusions change the original shape of the flower. To create rotation and scale invariant shape descriptors, SIFT (Scale Invariant Feature Transform) descriptors are the best method so they are extracted from flower images which forms 128 dimensional vector. SIFT descriptors found in all training images are clustered to create shape visual words.

Figure 4. SIFT keypoints extraction

To represent an image, a histogram is created based on the distance between the observed SIFT descriptors [18] in the image and the computed cluster centers. Figure 4 shows the keypoints calculated for the shape feature extraction of a segmented flower image.

B. COLOR VOCABULARY-

Color helps us to simplify the task of categorization. The effect of varying illumination has an adverse effect on the measured color, which may lead to confusion. HSV (Hue, Saturation and Value) color model hence is the most efficient way of describing color. HSV color space is less sensitive to illumination variations. Color visual words are created by clustering the HSV value of each pixel in the training images. The computed cluster centers represent the color visual words which comprises the color vocabulary.

C.TEXTURE VOCABULARY-

Flowers can have distinctive or subtle textures on their petals. The texture is described by convolving the images with filters from an MR8 (Maximum Response) filter bank which is rotational invariant.MR filter bank generally contains 38 filters. An MR8 filter consists of an edge and a bar filter at six orientations and three scales, and two rotationally symmetric filters.

Figure 5. Convolving images with the MR8 filters

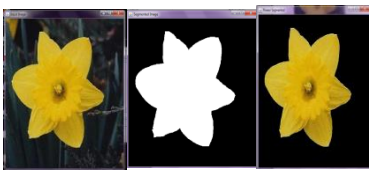
The 38 responses are summarized into eight maximum responses (three scales for edge and bar filters, one each for Gaussian and Laplacian of Gaussian).Figure 6 describes the results after convolving segmented image with the MR8 filter bank.

D.COMBINED VOCABULARY-

The discriminative power of color, shape and texture varies for different flower species. Some flowers can be more easily distinguished by their shape, color and texture. However, it is better that, flowers are distinguished by combination of these aspects. In order to distinguish a flower by these 3 aspects, they are combined in the classification system. They are combined by assigning weights to their separate classification and not averaging them. The Multiboost classifier [2] is used as it reduces variance and is less sensitive to noise. Multiboost is an implementation of an extension of the multi-class Adaboost algorithm.

5. RESULTS

Considering the overall flower classification system,some of the implementation results are discussed below.Firstly, when an input image is selected for the categorisation purpose it is necessary that the image is segmented.Following figure depicts the result shown by grabcut segmentation method.



(a) **(b)** **(c)**

Figure 6. Segmentatation with grabcut method

Figure.(a) shows an input image randomly selected from database.Fig.(b)shows segmented image through the grabcut technique wherein background part is represented by black pixels and foreground part by white pixels.Finally the white pixels are replaced by original color pixels which is shown in fig.(c).It is the final segmented image of flower which is to be used for further processing.

After segmentation,next step is feature extraction.First is the shape feature extraction done through SIFT descriptors.Below figure descibes how keypoints are calculated and stored.

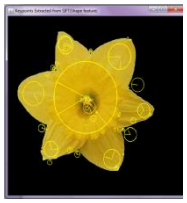


Figure 7. SIFT keypoints detection

For the above flower image the numbers of keypoints calculated are: 65.

HSV color model is used for color feature extraction. The figure given below is the HSV representation of original segmented flower image.

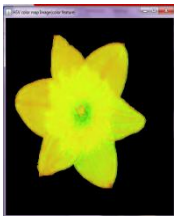


Figure 8. HSV color map

Finally, the texture feature is extracted by MR8 filter bank. The result after convolving a segmented flower image with MR8 filters is described in below figure.

Figure 9. Result of convolving image with MR8 filter bank

After the feature extraction process, bag of visual words will be created by k-means clustering. Based on visual words histograms will be created and provided to multiboost algorithm for training and then finally testing will be performed through the query image from the user.

Considering single feature, classification does not prove to be as efficient as by combining the three features together.12 images are considered as training images and 3 images are taken for testing purpose. Below shows the classification of flowers based on single feature. Whole data set is divided into training and testing set for better classification purpose.

1. Classification based on Color feature-

It is sometimes not possible to classify the flower image just on the basis of color .It is possible that two flowers have same color. For instance say, daffodils and dandelions have same color yellow. For our classification system when LilyValley was given as a query image the classified image was of Snowdrop just purely based on white color.

Figure 10. LilyValley classified as Snowdrop based on white color

2. Classification based on Shape feature-

Shape helps to narrow down the flower species. Given a test image of daffodils it was classified as daffodils only.

Figure 11. Daffodils classified as Daffodils based on shape

3. Classification based on Texture feature-

Texture feature helps to improve the classification efficiency of a flower image. When LilyValley was given as input result was the Snowdrop based on the pattern.

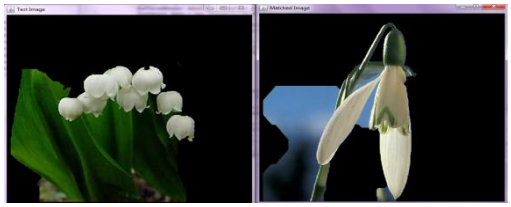


Figure 12. LilyValley classified as Snowdrop based on texture

4. Classification based on combined feature-

Since it is not sufficient to classify flower images based on single feature only, categorization based on combined features helps to improve the performance of classification.

Figure 13. Daffodils classified as Daffodils based on combined (Color+Shape+Texture) features

If we consider the classification based on individual features, accuracy for each is described in the following graph. Highest accuracy of shape feature is achieved of 77.27% with 25 folds.

Color feature achieves the accuracy of 85.50% with 20 folds. Texture feature achieves the highest accuracy with 25 folds of 72.29%.

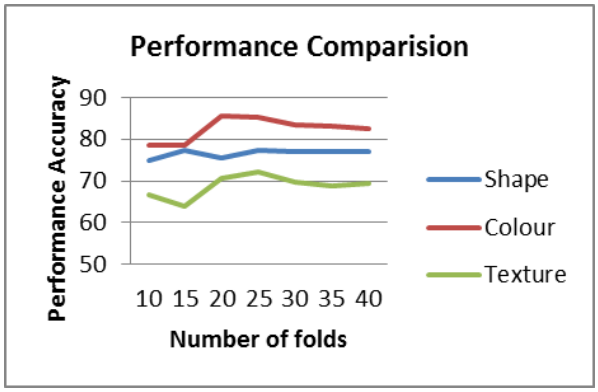


Figure 14. Performace analysis of Shape, Color and Texture features

Considering the low efficiency of classification based on only the individual features, combined features with multiboost classifier provides the best results. Performance accuracy of85.98% is achieved with the combined features.

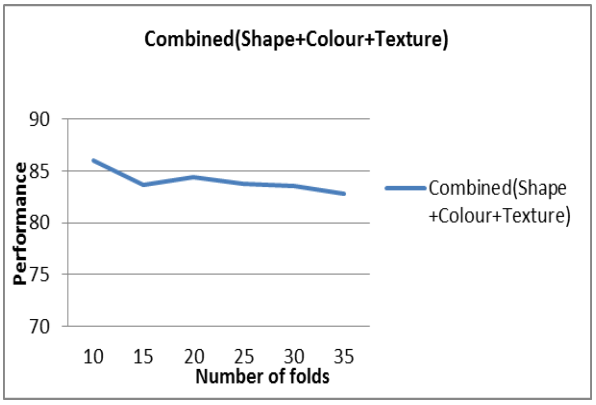


Figure 15. Performace analysis of Combined (Shape, Color and Texture) features

6. CONCLUSION

Flower classification is slowly becoming the popular area owing to its importance for botanists and in floriculture. Flower classification system which is discussed in this paper will provide efficient classification accuracy owing to the idea of visual vocabulary. Developing and combining vocabularies for several aspects (color, shape and texture) of a flower image boost the performance significantly. Moreover the final classifier adds to the superiority of the performance. Thus, the tedious task of classifying various flower images into appropriate categories is simplified in effective manner. Performance analysis shows that combining features into final classifier boosts the performance of flower classification rather than classifying based on individual features.

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