International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-11, September 2020

Hybrid Feature based Classification of Images using Supervised Methods for Tag Recommendation

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Abstract: ***Recent advancement in digital technology and vast use of social image sharing websites leads to a huge database of images. On social websites the images are associated with the tags or keywords which describe the visual content of the images and other information. Theses tags are used by social image sharing websites for retrieval of the images. Therefore, it is important to assign appropriate tags to the images. To assign related tags, it is necessary to choose appropriate classifier for automatic classification of images into various sematic categories with respect to the classification accuracy which is important step for image tag recommendation. In this paper, three supervised classifier algorithms are implemented for image classifications which are SVM, kNN and random forest and its performance is analyzed on Flickr images. For classification of images, the features are extracted using color moment and wavelet packet descriptor.***

Keywords: ***Image classification, Color Features, Texture Features, Supervised Classifier.***

I. INTRODUCTION

Classification is a supervised technique which maps the data into predefined class. It is referred as supervised because the classes known in advance before examining the data. For classification of images into different class, it is necessary to extract image features and stored them into the database along with the class label. The images stored in the database are divided into two sets-training images and testing images. The classifier learns from image features along with the label associated with the training images and predicts the class label of test image. Since image features requires huge amount of computation for retrieval operations and storage, it is necessary to have to choose good classification technique which will reduce the searching time and improve the retrieval performance of image retrieval system. In this paper, we have classified the images using kNN, SVM and Random Forest classifier by training the classifier using color and texture features.

Revised Manuscript Received on September 30, 2020.
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II. WORK DONE

In [2] the method is proposed for annotation of images using weighted kNN classifier. The method first extracted features using convolution neural network and weight was assigned to each features. Finally, weights were used to identify k nearest neigbhor from each category and predict the class label of an input image. The MW-kNN method was proposed in [3] for classification of documents by calculating probability of each category and finally predict the class with the highest probability score. The method was proposed for classification of images using Random forest classifier which were trained using color and texture features of images [4]. In [5], the method was proposed for image annotation by identifying nearest neighbor based on label and image features. The method was proposed for tag recommendation using k nearest neighbor and tag co-relation in [6]. The classification of fruit images by training multiple SVM classifiers for different features was proposed in [7]. Image annotation using improved SVM classifier was proposed in [8]. The multiple SVM classifier were trained using different features and weights are each SVM classifier Given an input image, k nearest neighbors based tags are recommended for images in [9,13]. Given an input image, the methods first finds the semantic neighbors using random forest and annotate images using the labels of the same neigbhors [10]. In [11] the performance of random forest classifier is evaluated for land cover classification.
The method was proposed to capture the probabilistic relation between an image feature and a label using random forest [12]. The tags for product images were predicted using tradition kNN classifier in [14]. The SVM based method was proposed in [15] to identify the group to which an input image belongs and for tag recommendation.

III. IMAGE FEATURE EXTRACTION

The features plays very important role in classification. Image features requires a vast memory and processing power, otherwise classifier will overfit using training images feature vector and results into poor classification performance. So, it is necessary to extract efficient features. For classification, the color and texture features are extracted. In order to extract color features, the color moment technique is used. The image color space is first converted into L*a*b* color space. The image divided into four regions along with centralized part of the image.

The first, second and third moment is extracted of each region for each color channel as feature vector. To extract texture features, an image is converted into gray scale and represented as sub-bands using wavelet packet transforms. The images are decomposed upto level three using daubechies wavelet.

The mean and standard deviation of coefficients of each sub-bands are extracted as feature vector. Finally, the weights are assigned are assigned to color and texture features and merged.

IV. CLASSIFICATION METHODS

i) k Nearest Neighbour (kNN):

The kNN classifier is a lazy learner since it memorizes the training data. It is also called as memory based classifier. In kNN classifier the distance between query sample and training samples are calculated. Once the distances are calculated, select the k training samples which are closed to the query sample. The class label of the query sample is predicted by majority voting of class label from k training samples. The k is the number of nearest training samples which need to be specify for this algorithm in advance. The small value of k results in overfitting and large value of k leads to outlier and would result in misclassification.

The steps of traditional kNN algorithm are as follows:

1. Extract feature of the query image and calculate the distance between query image feature vector and feature vector of the training images
2. Arrange the distance in ascending order and select first k training images
3. Count the voting of each class from top k training images
4. Determine the class with the maximum vote
5. Assign the class to the query image which has maximum vote

$$vote(q,c) = \sum_{i=1}^{k} sim(x_i - q) \qquad (1)$$

Where $sim(x_i, q) = |x_i - q|$ and $class(x_i) = c$

ii) Support Vector Machine (SVM):

SVM classifier is used to classify linear and nonlinear data by defining hyperplane. SVMs are basically two class classifier. For multi-class classification, it uses one vs all method in which a separate classifier is created for each class and choose the class which are selected by the most classifiers. The advantage of this classifier is it provides accurate classification and classifies non-linearly separable data by selecting best kernel function.. The regularization parameter (C) needs to set when applying the SVM with linear kernel. The C parameter decides the size of misclassification allowed for non-separable training data, which makes the adjustment of the rigidity of training data possible.

The steps of SVM algorithm are as follows:

1. Create separate SVM classifier for each category
2. Get the majority voting from each classifier
3. Return the predicted class

iii) Random forest (RF) classifier:

RF classifier is an ensemble learning algorithm. It consists of a large number decision trees. It uses bagging approach in which random samples are selected N times with replacement from training data set for each decision tree and remaining data is used to check error rate of classification. Here, each tree is grown and not pruned. The RF uses Gini index for attribute selection which can be used for generation in decision tree. Given a test data, each decision tree predicts class and random forest chooses the class with the majority voting from individual decision trees. The advantage of the random forest classifier is it can run on large database and robust to outlier and noise.

The steps of random forest algorithm are as follows:

1. Build each tree using steps 2 to 4
2. Draw a bootstrap sample from the training data.
3. Create a random-forest tree F_b using bootstrapped data, by using following steps repeatedly for each terminal node of the tree, until the minimum node size is reached.
    a. Select m variables at random from the p variables.
    b. Select best m variables among p variables using Gini index
    c. Split the node into left and right subtree nodes.
4. Output the ensemble of trees
5. Give an input image, the class label is predicted as follows:

$$c(x) = majorityvoting(c_b(x)_i^B) \qquad (2)$$

V. PERFORMANCE METRICS

The performances of three classifiers are evaluated using confusion matrix on a test data. The confusion matrix consists of True Positive (TP), False Positive (FP), True Negative (TN), and False Negative (FN). According to the value of these elements, the precision, recall, and F1-score are determined to estimate the performance score of classifier.

$$P = \frac{TP}{TP + FP} \qquad (3)$$

$$R = \frac{TP}{TP + FN} \qquad (4)$$

$$F1 - Score = \frac{2 * P * R}{P + R} \qquad (5)$$

VI. DATASET

The images are downloaded from Flickr image sharing website using public API.

The images are belongs to six different categories actor, clover, fish, autumn, butterfly and aeroplane.

The images are used for training and testing after 10 cross validation.

VII. EXPERIMENTAL RESULTS AND DISCUSSION

The value of k plays very important role in the performance of kNN classifier. The parameter k was determined using a bootstrap procedure. In this study, we examined k values from 1 to 50 to identify the optimal k value for all training sample sets. Figure 1 shows the results of kNN classifier error. The lowest error rate was achieved with k=12.

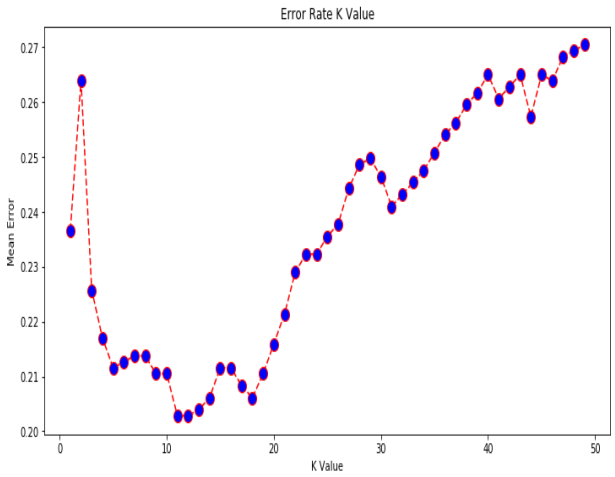

Fig 1: Mean error of w-kNN at different value of K

The figure 2 shows the accuracy of weighted KNN classifier at different value of K. The optimum value of k was chosen as k=12 as it yields the maximum recognition efficiency.

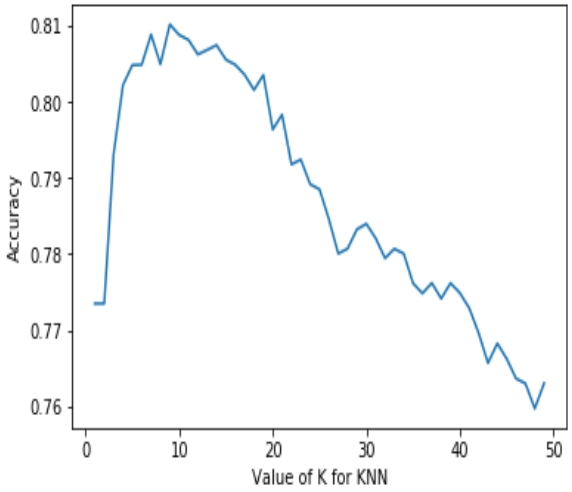

Fig 2: The accuracy of w-kNN at different value of K

The RF classifier only needs the definition of two parameters for generating a prediction model: the number of classification trees desired (k), and the number of prediction variables, (m), used in each node to make the tree grow.

In other words, to classify a new dataset a constant number of k random predictive variables is used, and each of the examples of the dataset is classified by a k number of trees defined by the user.

This way the final value of the class assigned to each example will be equal to the most frequent value for the total number of k trees generated.

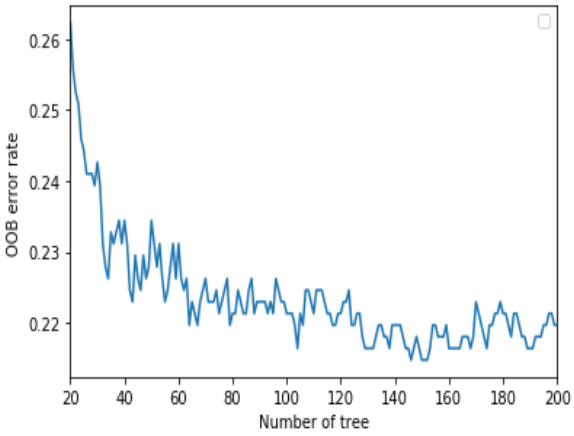

Fig 3: OOB error rate of RF for number of trees

Figure 3 shows the out-of-bag (OOB) error for number of trees ranging from 20 to 200. The OOB error rate was less when the value of k=110. The figure 4 shows the accuracy of random forest classifier for different value of number of trees.

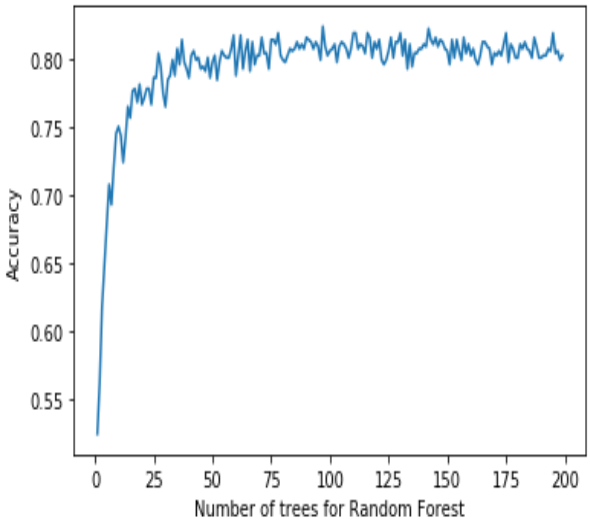

Fig 4: The accuracy of RF for number of trees

For SVM, one vs all method is used and composed n*(n-1)/2 binary classifiers where n is the no of categories and n=6. The linear kernel is used to implement the SVM algorithm.

Table 1: Performance of Classification Algorithms (%)

Classifier	Precision	Recall	F1-Score
SVM	84.83	84.5	84.5
kNN	80.5	79.66	79.6
RF	86.33	85.66	85.5

The table 1 shows the performance of different classification algorithms. It is observed that random forest has good classification accuracy whereas kNN has the lowest classification accuracy.

The figure 5 shows the classification error rate of SVM, kNN and random forest classifier.

The classification error rate of random forest, SVM and kNN classifier is 14.34%, 15.38% and 20.39% respectively.

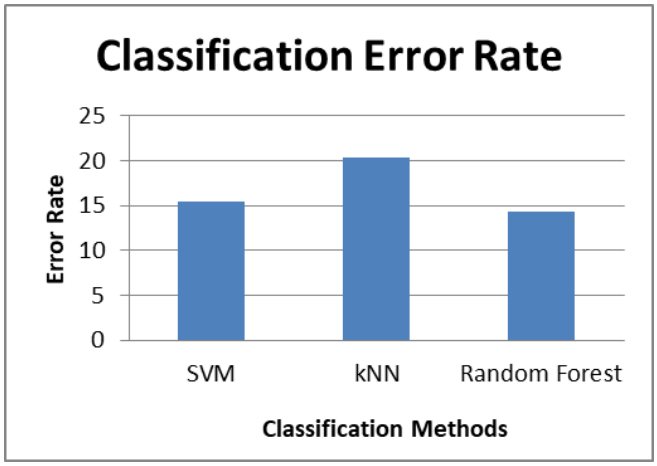

Fig. 5 Error rate of classification using different algorithms

VIII. CONCLUSION

In this paper three supervised classifiers are implemented for classification of images. It is observed that random forest and SVM classifier gives good accuracy as compared to the k nearest classifier. The random forest, SVM and kNN gives 85.66%, 84.62% and 79.61% accuracy respectively.

In future we need to develop classification method which improves the accuracy of kNN by considering many factors: different distance metric for similarity between test and training samples, selection of k value, weight to features/neighbors of the samples. Also, we need to develop a method for image tag recommendation based on classification.

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