Comparative Analysis on Scene Image Classification using Selected Hybrid Features

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ABSTRACT

A comparative analysis on image classification is accomplished on scene image feature set by using various existing classifiers. The classification is performed on conventional feature set, hybrid feature set and selected hybrid feature set for classifying the war tanks from the natural scene images. The features are extracted in three ways; conventional feature extraction methods like gray level co-occurrence matrices features & statistical moment's features; hybrid feature extraction is the combination of color mean, GLCM properties and canny edge count; the proposed selected hybrid feature set. The extracted features are trained and tested with various classifiers like Artificial Neural Network (ANN) using feed forward back propagation algorithm, Support Vector Machines (SVM) using polynomial kernel with p=1, Bayes Net classifier using genetic search and J4.8 decision tree. The results show that classification efficiency of the selected hybrid feature extraction methods (i.e., the combination of GLCM & edge count) surpasses the conventional feature extraction methods in war scene classification problems.

Keywords

Hybrid features, selected hybrid features, classification algorithms

1. INTRODUCTION

Scene classification underlies many problems in visual perception such as object recognition and environment navigation. Scene categorization is one of the important research topic in robotics and computer vision. For scene classification many algorithms are referred for classifying the images into semantic categories (e.g. games, sports, street, bedroom, mountain, or coast) [18]. Classification is one of the several primary categories of machine learning problems [6]. The indoor - outdoor scene retrieval problem, how high-level scene properties can be inferred from classification of low-level image features [1]. An automated method has proposed based on the boosting algorithm to estimate image orientations [18]. The classification of indoor and outdoor images based on edge analysis [4]. Analysis of texture requires the identification of proper attributes or features that differentiate the textures of the image [2][6]. For classification of scene images into war scene and nature scene images, the major tasks are identification feature extraction method and suitable classifier. In this work feature extraction has done in three levels, firstly conventional feature extraction like gray level co-occurrence matrices features and statistical moments, secondly hybrid feature extraction method which is combination of color, texture and edge, Thirdly proposed feature extraction as selected hybrid feature extraction by using wrapper classifier to select the proper feature subset .The extracted features are classified by using suitable classifiers like Artificial Neural Network (ANN) using feed forward back propagation algorithm, Support Vector Machines (SVM) using polynomial kernel with p=1,Bayes Net classifier using genetic search and J4.8 decision tree.

2. CONVENTIONAL FEATURE EXTRACTION METHODS

The texture features are extracted by using Gray Level Co-Occurrence Matrix (GLCM) Features and Histogram based statistical moments.

2.1 Gray Level Co-Occurrence Matrix (GLCM) Features

Gray Level Co-Occurrence Matrix is one the most traditional techniques for encoding texture information. It describes spatial relationships among grey-levels in a image. A cell de-fined by the position (i, j) in this matrix registers the probability at which two pixels of gray levels i and j occur in two relative positions. A set of co-occurrence probabilities (such as, energy, entropy, contrast) has been proposed to characterize textured regions. The Gray Level Co-Occurrence Matrix (GLCM) features are Autocorrelation, Contrast, Correlation, Cluster Prominence, Cluster Shade, Dissimilarity Energy, Entropy, Homogeneity, Maximum probability , Sum of squares, Sum average, Sum variance, Sum entropy, Difference variance, Difference entropy, Information measure of correlation, information measure of correlation, Inverse difference normalized. Among all these features major four describing features like entropy, energy, contrast and homogeneity are selected for classification.

2.2 Statistical Moments

Statistical central moments of image histogram are the texture features. Statistical moments are twelve features like mean, variance, skewness or third moment, smoothness or fourth moment etc to twelfth moment. In this work six major features like mean, variance, skewness, smoothness, uniformity and entropy are considered for classification.

3. HYBRID FEATURE EXTRACTION

Hybrid feature extraction is the combination of primitive features of colour, texture and shape. Any single primitive feature is not sufficient to describe the image. In this hybrid feature extraction intensity mean value, texture measures and edge count features are included. The texture feature such as entropy, energy, contrast and homogeneity are extracted by using GLCM properties. The edge feature has extracted by using the Canny edge detector. The canny edge parameters allow it to be tailored to recognition of edges of differing

characteristics depending on the particular requirements of a given implementation. After extracting edge, the edge count has taken as a describing edge feature. These six features are considered as hybrid features for classification.

3.1 Proposed Selected Hybrid Features

The hybrid features are used to extract the selected hybrid feature for complexity reduction and efficiency improvement. The proposed feature selection algorithms are based on unsupervised attribute selection algorithm. Attribute selection algorithms are two types one is independent filter and other one is learning algorithm (wrapper). In this attribute evaluator and search methods should be defined. Wrapper algorithms are used to learn the filter. Learning should be performed by suitable classifiers like bayes net, ANN, Decision tree, etc. Wrapper algorithms are used to evaluate the attribute sets by using a learning scheme. Cross validation is used to estimate the accuracy of the learning scheme for a set of attributes. Attribute evaluators are two types one is ranked list of attributes and other one is selected subset of attributes. The selected hybrid features are extracted by using wrapper subset evaluator algorithm as Bayes Net classifier, search algorithm as genetic search and estimator as simple estimator. After applying wrapper evaluator for subset selection on hybrid features four features are selected. These selected hybrid attributes are used for classification.

4. CLASSIFICATION METHODS

After feature extraction, the feature set or attribute file is created for classification. In preprocess the data should be normalized and discredited as suitable labels. The data should be divided as two files one is training set and the other is testing set. To train the data various classifiers are used.In this comparative study four classifiers are used. one is multi layer perception using Artificial Neural network classifier as back propagation, second is evolutionary approach using Support Vector Machines classifier as Sequential Minimal Optimization, thirdly probabilistic approach using Bayesian network as Bayes net classifier, lastly Decision Tree approach using J4.8 classifier.

4.1 Artificial Neural Network

ANN Classifier that uses back propagation to classify instances. This network can be built by hand, created by an algorithm or both. The network can also be monitored and modified during training time. The nodes in this network are all sigmoid .when the class is numeric in which case the output nodes become unthresholded linear units

4.2 Support Vector Machines

Sequential Minimal Optimization algorithm is used for training a support vector classifier. This implementation globally replaces all missing values and transforms nominal attributes into binary ones. It also normalizes all attributes by default. The coefficients in the output are based on the normalized data, not the original data .This is important for interpreting the classifier. Multi-class problems are solved using pair wise classification.To obtain proper probability estimates, use the option that fits logistic regression models to the outputs of the support vector machine. In the multi-class case the predicted probabilities are coupled using Hastie and Tibshirani's pair wise coupling method. The difficult task in SVM is defining kernel function. kernel function should be defined by the number of features or attributes and the number of instances to classify. In scene classification the kernel function used is polynomial kernel. It defines as

K(x, y) = <x, y>^p or K(x, y) = (<x, y>+1)^p

4.3 Bayesian Network

Bayesian Network is probabilistic classification approach. In this work Bayes Net classifier has used to train the data. Bayes Net learning uses various search algorithms and quality measures. Base class for a Bayes Net classifier provides data structures like network structure, conditional probability distributions, etc. and facilities common to Bayes Net learning algorithms. Simple Estimator is used for estimating the conditional probability tables of a Bayes Net once the structure has been learned; it estimates probabilities directly from the data. This Bayes Net learning algorithm uses genetic search for finding a well scoring Bayes Net structure. Genetic search works by having a population of Bayes Net structure and allow them to mutate and apply cross over to get offspring. The best network structure found during the process is returned.

4.4 J 4.8 Decision Tree

J4.8 algorithm generates a class by using a pruned or un pruned C4.5 decision tree. C4.5 starts with large sets of cases belonging to known classes. The cases, described by any mixture of nominal and numeric properties, are scrutinized for patterns that allow the classes to be reliably discriminated. These patterns are then expressed as models, in the form of decision trees or sets of if-then rules that can be used to classify new cases, with emphasis on making the models understandable as well as accurate.

5. COMPARITIVE ANALYSIS

The classifiers are trained with 100 instances and tested with 30 instances of war scene and nature scene images. The classifiers accuracy is the no of instances classified correctly. Table 1 shows the classification accuracy of conventional features, hybrid features and selected hybrid features. Among all features, selected hybrid feature has got more accuracy than other features.

Table1. Classification accuracy of set of features by using ANN, SVM, Bayes net, J4.8

	GLCM	Statistical Moments	hybrid	selected attributes
ANN	72.2	72.00	73.3	89.47
SVM	72.2	72.43	73.3	84.21
Bayes Net	77	71.43	80	78.94
J4.8	72	71.43	60	68.42

After applying four classifiers, the multi level input classifiers like ANN got more accuracy than other classifiers. The figure 1 shows the ANN classifier has more accuracy for selected hybrid features. The accuracy was improved from 68% to 84.2% in ANN classification while comparing with other classifiers. GLCM and Statistical moments are texture features, these are not sufficient to classify the data. Hybrid features are combination of color, texture and edge; these are giving better accuracy than texture features. Selected attributes in the proposed feature extraction will give the prominent features for classification with high accuracy.

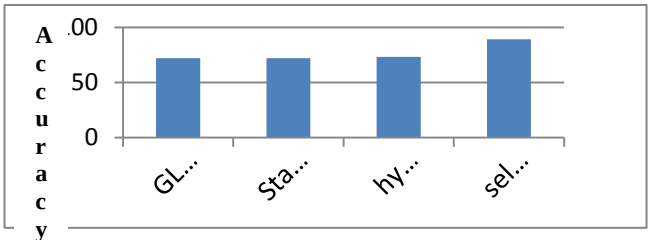

Figure1. Classification accuracy on selected hybrid feature data

The performance analysis for the proposed classifiers was done by using the parameters Precision, Recall, F-Measure and ROC. The precision is the accuracy of a class predicted. Recall is the measure of ability of prediction model of a class. The average values for all classifiers are tabulated in Table2. The precision is more with ANN while comparing with other classifiers.

Table2. Performance analysis on Hybrid Selected Features

	Precision	Recall	F-Measure	ROC
J4.8 tree	0.68	0.684	0.644	0.768
Bayes Net	0.789	0.789	0.789	0.774
SVM	0.874	0.842	0.829	0.786
ANN	0.877	0.842	0.839	0.881

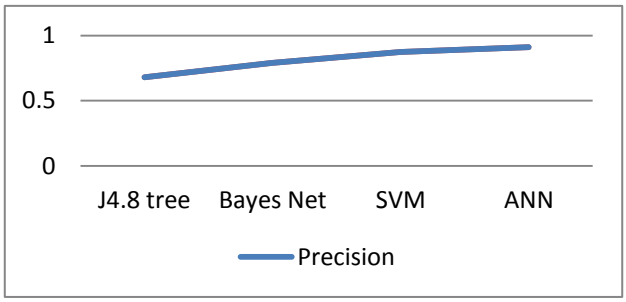

Figure 2. Performance measures of classifiers (J4.8, Bayes Net, SVM, ANN)

In Figure 2 the precision has improved from J4.8 decision tree classification to multi level input classifier Artificial Neural Network classification.

6. CONCLUSIONS

The hybrid features are combination of color, texture and edge features of images. The selected hybrid features has shown high performance than other conventional features for classification of scene images. The results ascertain that the multi level input classifier Artificial Neural Network is prominent for scene classification while comparing with other classifiers like SVM, Bayes Net and J4.8.since ANN is suitable for limited number of features for classification. This work can extend for war scene categories using various feature extraction methodologies.

7. REFERENCES

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