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Classification of Different Textures Using SVM and Fuzzy logic

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Abstract

Texture classification is used in various pattern recognition applications that possess feature-liked appearance. Basically, it aims at classifying textured images into classes with the same texture features. Now a day's classification based on wavelet transform is being very popular. This project has conducted a study on texture classification, by using wavelet transform as feature extraction method. The wavelet toolbox in MATLAB has been used to calculate the features for the textures. The features calculated are mean, maximum, standard deviation, median and mode. The features are found using haar transform with level 1 decomposition. The classifications methods used are SVM and fuzzy logic. Finally the accuracy of each classifying method is tested.

Keywords

svm, fuzzy logic, texture classification

1. Introduction

Texture classification is the process to classify different textures from the given images. Although the classification of textures itself often seems to be meaningless in its own sense, texture classification can however be implemented a large variety of real world problems involving specific textures of different objects. Some of the real world applications that involve textured objects of surfaces include rock classification, wood species recognition, face detection, fabric classification, geographical landscape segmentation and etc. All these applications allowed the target subjects to be viewed as a specific type of texture and hence they can be solved using texture classification techniques. Texture classification techniques are grouped up in five main groups in general, namely 1) structural; 2) statistical; 3) signal processing; 4) model-based stochastic, and; 5) morphology-based methods . Out of the five groups, statistical and signal processing methods are the most widely used because they can be directly applied onto any type of texture. The rest are not as widely used because the structural methods need to implemented on structured textures which are naturally rare, the model based stochastic methods are not easily implemented due to the complexity to estimate the parameters and morphology-based methods are relatively new and the process are very simple, they may not promise very good textural features.

2. Feature Extraction Methods

There are many different feature extraction methods that were introduced and used for texture classification problems. Most of these methods that were popularly used in recent years were statistical and signal processing methods.

GLCM

Grey Level Co-occurrence Matrices (GLCM) is an old feature extraction for texture classification that was proposed by Haralick*et al.* back in 1973. It has been widely used on many texture classification applications and remained to be an important feature extraction method in the domain of texture classification. It is a statistical method that computes the relationship between pixel pairs in the image. In the conventional method, textural features will be calculated from the generated GLCMs, e.g. contrast, correlation, energy, entropy and homogeneity. However in recent years, the GLCM is often combined with other methods and is rarely used individually. Other than the conventional implementation, there are a few other implementations of the GLCM, e.g. by introducing a second-order statistical method on top of the textural features in the original implementation, one dimensional GLCM and using the raw GLCM itself instead of the first-order statistics. The GLCM can also be applied on different colour space for colour co-occurrence matrix.

Wavelets and Other Transform Methods

Wavelet transforms is another signal processing method that have been implemented in image processing and pattern recognition for the last two decades. It is currently an important feature to be

used in texture classification and has been very popularly used. The Discrete Wavelet Transforms (DWT) is among the most popularly used wavelet transforms, some basic discrete wavelets include the Haar wavelet and Daubechies wavelets. Like the Gabor filters, the wavelet transform are performed on the frequency domain of the images rather than the spatial domain. The information on the frequency domain is usually more stable than the spatial domain. Therefore, they often produces better features that leads to a higher accuracy despite being more complex and slower. Some other transforms that were used includes the contour let transform and curvelet transform as well as a few other transforms that were less popularly used, e.g. ridgelet transform, log polar transform, Radon transform and etc.

3. Classification Methods

There are three major groups of classifiers are popularly used, including fuzzy logic, Artificial Neural Networks (ANN) and Support Vector Machines (SVM).Besides them, there are also other less popularly used classifiers or classification algorithms.

SVM

SVM are the newer trends in machine learning algorithm which is popular in many pattern recognition problems in recent years, including texture classification. SVM is designed to maximize the marginal distance between classes with decision boundaries drawn using different kernels. SVM is designed to work with only two classes by determining the hyperplane to divide two classes. This is done by maximizing the margin from the hyperplane to the two classes. The samples closest to the margin that were selected to determine the hyperplane is known as support vectors. Multiclass classification is also applicable, the multiclass SVM is basically built up by various two class SVMs to solve the problem, either by using one-versus-all or one-versus-one. The winning class is then determined by the highest output function or the maximum votes respectively. This may cause the multiclass SVM to perform slower than the MLPs. Despite that, SVM is still considered to be powerful classifier which was replacing the ANN and has slowly evolved into one of the most important main stream classifier. They are now widely used in the research of texture classification.

Fuzzy logic

Over the past few decades, *fuzzy logic* has been used in a wide range of problem domains. Although the fuzzy logic is relatively young theory, the areas of applications are very wide: process control, management and decision making, operations research, economies. Dealing with simple ‘black’ and ‘white’ answers is no longer satisfactory enough; a *degree of membership* (suggested by Prof. Zadeh in 1965) became a new way of solving the problems. A *fuzzy set* is a set whose elements have degrees of membership. A element of a fuzzy set can be full member (100% membership) or a partial member (between 0% and 100% membership). That is, the membership value assigned to an element is no longer restricted to just two values, but can be 0, 1 or any value in-between. Mathematical function which defines the degree of an element's membership in a fuzzy set is called *membership function*. The natural description of problems, in *linguistic* terms, rather than in terms of relationships between precise numerical values is the major advantage of this theory. Behind this idea was also the question if the possible promising results can give the answer to the question of diminishing the influence of person dealing with supervised classification.

4. Result and Discussions

TABLE I
THE ACCURACY WHEN SVM IS USED =48/60=80%

Class	Wood	Sand	Leaf
Wood	**12**	8	0
Sand	0	**20**	0
Leaf	0	4	**16**

TABLE II
THE ACCURACY WHEN FUZZY LOGIC IS USED =52/60=86.67%

Class	Wood	Sand	Leaf
Wood	**19**	1	0
Sand	0	**20**	0
Leaf	0	5	**15**

Finally the accuracy of different classification methods has been tested. The classification has been done for three classes namely sand, wood and leaf. For each class 30 textures are taken for training and in total 90 textures are given for training. In testing phase 20 textures are tested in each class. So in total 60 testing textures are considered. Lastly the three classifiers namely SVM, fuzzy logic and neural

networks are used for texture classification and the accuracy for each method is calculated. From the results we can say that a fuzzy logic is most accurate classifier.

5. Conclusions and future scope

Conclusions:
In this project, we have classified the textures based on statistical features, wavelet statistical features and wavelet cooccurence features using Haar wavelets.Bytaking different classes of textures from databases, we calculated the above mentioned features and considered them as training data. Unknown features for a set of textures are taken and its prediction has been obtained by using SVM classifier. We used SVM classifier in which testing data is classified by comparing with those that of the training data and by assigning the best matched class. Proper methods to classify textural features are few of the other things that we have learned through this project.

Future scope:
In addition to wavelets, we can use ridgelets and curvelets so that more features can be obtained which in turn increase the accuracy. There is also scope to classify input textures into sub classes of various datasets. Also limitation of this project which is overlapping of extracted features can be overcome by developed algorithms. In addition to SVM, algorithms like k-NN, k-means etc can also be used for texture classification.

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