Image Classification Optimization Algorithm based on SVM

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Abstract—With the rapid development of computer technology and multimedia technology, there are a large number of images data in our daily life. If we cannot effectively manage the images, a lot of image information will be lost. As a result, people can’t timely and quickly retrieve the needed image data. At present, for the image classification optimization algorithm it mainly includes neural network, Bayesian and Fuzzy sets, etc. But these algorithms have high training complexity, low convergence speed, etc. In view of this, this paper proposed an image classification optimization algorithm based on support vector machine (SVM). When does the image classification, this study followed the following steps (1) Select the proper kernel function. (2) Determine the parameters of the kernel function through the grid search method. (3) Give the feature extraction for the image based on color and texture which will be as the input to achieve the image classification. The experimental results show that the proposed method in image classification optimization has the very high accuracy.

Keywords: Support Vector Machine (SVM); image classification; feature extraction; grid research;

Index Terms—Support Vector Machine (SVM); Image Classification; Feature Extraction; Grid Research

I. INTRODUCTION

With the rapid development of network and multimedia technology, people have entered into the era with rapid expansion of digital information, such as image, video, sound and so on. There are always a lot of pictures all the time in our daily life. Meanwhile, as the multimedia information, which has intuitive and visual expression, image has been paid more and more attention by people [1]. If image data can’t be managed effectively, a great deal of information will lose, thus image can’t be retrieved in a timely and effective manner when needed. Therefore, that how to make users quickly find images meeting their needs and achieve the effective management to images has become a growing concern of researchers [2].

However, as the important tool in understanding the real world, classification, which has become an important tool to understand, analyze and handle the real world, plays an increasingly important role in people’s life. In recent years, with the development of digital image processing technology, the scale of image data base is getting larger and larger [3-4]. Many scholars begin to use classification technology in image management. The process of classifying images with the help of computer is just the process of pattern identification. What’s more, that managing images with classification technology can effectively improve the accuracy and effectiveness of image retrieval results [5-6].

In the 1970s, people performed image classification mainly with the manner of manual annotation. With the development of computer technology, in the virtue of which people can make a high effective, rapid and normative classification management to data, such as image, sound, video and so on [6-8]. The classification management of image includes a variety of technologies, such as database technology, computer vision, image processing, and pattern identification and so on. However, the effective classification method is the key to effectively manage images. At present, the representative classification methods mainly include: neural network, rough set, Bayesian and SVM. What’s more, neural network classification method easily produces some defects, such as local minimum, slow convergence speed and so on. And rough set classification method, which hasn’t been used in text and continuous image processing, is applicable to classify problems given by data. But for native Bayesian classification method, it’s difficult to meet the hypothesis of class conditional independence and select the needed evaluation function when processing large-scale classification problems. In addition, there is a relatively large complexity of training and learning [9]. The degree of membership of fuzzy sets classification method shall be given by specialists or other people according to experience, so that there is a high degree of subjectivity. So for learning problems of fuzzy system, accuracy and comprehensibility are the chief problems to be solved. That how to effectively manage the image data can make people retrieve required information effectively and accurately when needed [10].

To overcome the limitations of the above-mentioned method, this paper presents a method basing on SVM, which is a problem of convex optimization, so we can know from features of convex optimization, the local optimum solution solved by the method must be the
global optimum solution, which doesn’t exist in other methods. In addition, in the aspect of realization of autonomous learning classification and automatism, support vector machine shows the effectiveness in image classification. Inspired by these observations, in this paper we proposed an optimization algorithm of image classification based on SVM, on the basis of analyzing each of the above-mentioned classification method [1]. This algorithm is finished mainly by the following steps: (1) select the proper kernel function; (2) confirm parameters of kernel function with the method of grid-search; (3) make a feature extraction basing on color and vein to images, which can be taken as input to achieve the classification of images; (4) the experiment shows the effectiveness of optimization algorithm of image classification based on SVM proposed in this study.

The contributions of this paper are threefold: (1) we proposed a set of image feature extraction methods which could capture the images information as features to identify given images. The features are very informative in image classification; (2) we proposed an optimization approach for image classification. The idea is to find the optimum parameters for the given dataset and classifiers.

Support vector machine, which was first proposed by Vapnik in 1995, shows the particular advantage when solving the small sample, nonlinear and high dimensional pattern identification as well as being generalized and used in learning problems of other machines, such as function fitter. Support vector machine is built on the basis of structural risk minimization principle of statistical learning theory and VC-dimensional theory. Based on the limited sample information, support vector machine can fit $H_1$, $H_2$ in the above figure is named as support vector. In the above figure, classification interval determined by classification surface $B_1$ and classification line $b_{12}$ and $b_{14}$ is wider than that determined by classification surface $B_2$ and classification line $b_{12}$ and $b_{11}$. Therefore, $B_1$ is just the optimal classification surface, and plane determined by $H_1$, $H_2$ is the optimal hyper plane.

We assume that sample sets are $\{(x_i, y_i)\}_{i=1}^N$, where $x_i \in \mathbb{R}^n$, $y_i \in \{-1, 1\}$. The hyper plane makes positive and negative inputs in training sample respectively locate at two sides of this hyper surface. That is to say, there exists parameter $(w, b)$, which makes $f(x) = \text{sign}(w^T x + b)$. So the optimal hyper plane shall make the margin $2\|w\|$ between two classes be maximum. And the problem of optimal classification surface can be ultimately expressed as optimization problem of constraint as follows:

$$
\begin{align*}
\min_{w, b} & \|w\|^2 \\
\text{s.t.} & \ y_i(w^T x_i + b) \geq 1, i = 1, ..., N.
\end{align*}
$$

(1)

Lagrange function can be definite as:

$$
L(w, b, \alpha) = \frac{1}{2}\|w\|^2 - \sum_{i=1}^N \alpha_i(y_i(w^T x_i + b) - 1)
$$

(2)

where $\alpha_i$ are Lagrange multipliers, which shall meet the non-negative condition. This can be solved by solving partial derivatives of the three parameters $w, b, \alpha$.

II. PROPOSED SCHEME

A. Nonlinear SVM and Multi-class SVM

SVM can map the input vectors of nonlinear samples into a high-dimensional feature space through introducing a kernel function when solving nonlinear classification problem, in order for achieving the transformation from linearity to nonlinearity, and then construct one optimal classification hyper plane in the above feature space. The changed spatial classification surface is:

$$
w^T \phi(x) + b = 0
$$

(3)

And the optimization objective functions are:

$$
Q(\alpha) = \sum_{i=1}^N \alpha_i - \frac{1}{2} \sum_{i=1}^N \sum_{j=1}^N \alpha_i \alpha_j y_i y_j \phi(x_i)^T \phi(x_j)
$$

(4)

$$
\sum_{i=1}^N \alpha_i y_i = 0 \quad \alpha_i \geq 0 \quad i = 1, 2, ..., N
$$

(5)

Note that Eq. (4) is the objective function to be maximized, subject to the constraints in Eq. (5). We shall construct a kernel function $K(x_i, x_j)$ in original space, and then make it be equal to the changed inner product operation $\phi(x_i)^T \phi(x_j)$. Kernel functions widely used in nonlinear classification problem are mainly the following four types:

1. Linear function

$K(x_i, x_j) = x_i \cdot x_j$

2. Sigmoid kernel function

$K(x_i, x_j) = \tanh(y(x_i^T x_j) + c)$

3. Radial basis kernel function:

$K(x_i, x_j) = \exp(-|x_i - x_j|^2/\sigma^2)$
(4) Polynomial kernel function:

\[ K(x_i, x_j) = (\gamma x_i \cdot x_j + c)^d \]

If it is linear separable, support vector machine (SVM) can use the hyper plane directly to classify. When dealing with most problems, however, it is nonlinear. In this case, we need to use the core functions to form transformation, and convert raw data from low dimension space to high dimension space, so that it can achieve the goal of linear separability. As shown in the figure below [15-16].

Support vector machine (SVM) is a binary classifier. When solving multiple-class problem, we need to combine with multiple binary classifiers to complete multiple classification purposes. In general there are two ways of dealing with the multiple classification problems:

(1) one-against-all. When one-against-all is in dealing with k kinds of problems, it will produce k support vector machines. Among them, the way of producing the-th support vector machine is to marked the-th data to "1", the others are marked as "-1". We consider a set of training data \( \{(x_i, y_i)\} \) of categories, where \( x_i \in \mathbb{R}^d \) and \( y_i \in \{1, \ldots, k\} \).

This classification method is given as follows:

\[ (w^i) ^T \Phi(x_j) + b^i \geq 1 - \zeta^i_j, \quad \text{if} \quad y_j = i \]
\[ (w^i) ^T \Phi(x_j) + b^i \leq 1 - \zeta^i_j, \quad \text{if} \quad y_j \neq i \]

where \( \zeta^i_j \geq 0, j = 1, 2, \ldots, N \). After the above calculating, the decision functions of the k categories are follows. In the test step for a given input data \( x \), its category is the category which takes a maximum decision value:

\[ y = \text{arg max}_{1 \leq i \leq k} (w^i) ^T \Phi(x) + b^i \]

(2) one-against-one. When the one-against-one method processes the classification problem, every binary data will create a SVM. Therefore, for the classification problems which have k categories, it will have \( k(k-1)/2 \) support vector machines. Namely, if there are five types of data, it will be divided into 10 support vector machines. Given \( \zeta^i_j \geq 0 \), the decision rule is:

\[ (w^i) ^T \Phi(x_j) + b^i \geq 1 - \zeta^i_j, \quad \text{if} \quad y_j = i \]
\[ (w^i) ^T \Phi(x_j) + b^i \leq 1 - \zeta^i_j, \quad \text{if} \quad y_j \neq i \]

B. Selection of Kernel Function

Analysis shows that different kernel functions have very large impact on performance of SVM, and kernel function is also one of the adjustable parameters in SVM. Meanwhile, selection of kernel function has a decisive influence on classification ability and type of SVM classifier [17]. Kernel functions, nuclear parameters and high-dimensional mapping space have a one-to-one relationship, so only select the proper kernel functions, nuclear parameters and high-dimensional mapping space when solving classification problem, we can get the separator with excellent learning and generalization ability. In this paper, several common kernel function forms are proposed in the above study. What’s more, RBF kernel function has excellent learning ability under the circumstance of large sample and low dimension, so it has been widely used. The rewrite of RBF kernel function is shown as above [18].

C. Selection of Nuclear Parameters Optimization

We shall optimize parameters of kernel function after selecting. Error penalty factor \( C \) and \( \sigma \) are critical factor impacting on performance of SVM, so these parameters have great influence on classification accuracy and generalization ability of support vector machine. Moreover, it’s great difficulty to select parameters and error factors when we take RBF as the selected kernel function. Generally speaking, it needs to have the aid of genetic algorithm to achieve traditional parameters selection [19-22]. However, genetic algorithm, which shows many advantages when solving optimization problem, has some shortcomings, which can’t be overcome by it and includes the following aspects. On the one hand, genetic algorithm redesigns operators (such as variation, selection, crossover and so on) when dealing with different problems. On the other hand, genetic algorithm has a very complex operation and very low efficiency in most cases. In view of the above shortcomings of genetic algorithm, in contrast the grid-search method is introduced to optimize and select nuclear parameters in this paper when selecting SVM parameters. For this method is easy to be understood, it’s widely used in optimization problems.

In this paper, grid-search method is selected to optimize and select parameters, and the steps are as follows: First, we shall select the scope of parameter \( C \) and \( \sigma \). Generally speaking, select \( C \in (2^{-5}, 2^{-3}, ..., 2^{15}) \) and \( \sigma \in (2^{-15}, 2^{-13}, ..., 2^3) \) on experience, which can meet demand. Second, make a coarse grid-search. We shall set the step length 2, so that a two-dimensional grid can be constructed in coordinate system of parameter \( C \) and \( \sigma \). In each group of parameter values of the grid, there is only one group of potential solutions, which expresses only one group of SVM parameters. Third, according to validation method of k-fold cross, the mean of accuracy rate of parameters in each group can is drawn from contour, when being predicted. So we can get one contour map, with which nuclear parameters \( C \) and \( \sigma \) can be determined. Forth, in order to get more accurate search results, a fine grid-search shall be done after a coarse-search. That is to say, we shall select one area to be searched on the contour map. Generally speaking, we shall select area with high accuracy rate of prediction, which is equivalent to reduce step length to make a secondary search. For example, for given sample sets, the optimal nuclear parameters \( C \) and \( \sigma \) can be got after a coarse search with a step length of 2. And now, \( C = 2^{10}, \sigma = 2^{-3} \) so scope of grid-search can be reduced to \( C \in (2^8 \sim 2^{12}), \sigma \in (2^{-4} \sim 2^1) \), and the step length is 0.1 [6].
D. Image Feature Extraction

In this section, the above methods are used in image classification experiment [24]. Pictures used in this experiment are all from Corel picture base and internet, including 2000 pieces of pictures, about 9 categories. For the large quantity of collected images, it can not only get vectors with very large dimension, but also bring very troublesome classification when directly operating on original images. Therefore, that extracting some features from image bottom before classifying images has been the relatively important step in process of image classification. In study of this paper, it’s the primary converge to extract the color and some vein features of images, which can be input of images.

1) Feature Extraction of Image Color

In features of images, color is one of the most important and intuition is the perception features in image vision. Compared with other image features, it’s easy to extract color, and in most cases, we can get satisfactory results. So in the progress of image identification, it receives great attention to classify with color features.

We shall first definite the concept of degree of gray level difference when extracting color of images. Now, the square root of quadratic sum, forming by three values of each image RGB in images and their distance is denoted by d. Then the mean value of d can be definite as degree of gray level difference D, and their formulas are as shown below:

\[ d = \sqrt{(R - \text{ave})^2 + (G - \text{ave})^2 + (B - \text{ave})^2} \] (11)

where \( \text{ave} = (R + G + B)/3 \), \( D = \frac{1}{N} \sum_{i=1}^{N} d_i \), where N is the number of pixels in image.

When the three values of RGB are equivalent, the image is pure gray, and common black–white photograph with unmixed colors is just this type. We can see from the formula that image is near colorless when the three values are very close. Conversely, images will presents color of a certain degree when the three values are distant. Then color richness of images can be denoted by following formula:

\[ E = \sum_{i=0}^{256} I(C_i \neq 0) \]

Now we shall first transfer the space of colors into HSV, which corresponds to people’s feelings, so we can express them with three components. They respectively represent hue H, brightness V and saturation level S. This transformation can be represented with another form, as shown below:

\[ T : RGB \rightarrow HSV \]

Finally, we can uniformly quantize HSV space to 256 colors. Meanwhile, H can be quantized to 16 levels, S and V can be both quantized to 4 levels. For purpose of calculation, the three-dimensional space HSV can be denoted by one-dimensional feature space [25-26]. The expressing process is:

\[ Q : HSV \rightarrow C \]

where \( C = \{c_i | i = 0,1,\ldots,255\} \) is the quantized color in the \( i \)-th.

2) Feature Extraction of Image Vein

Vein is a common concept when analyzing images, is the gray level of the pixel or some kind of change of colors. In this paper, we mainly study how to obtain the vein features of images, in order to analyze, understand and classify images better. There are mainly three ways in extracting vein features of digital images: extraction of vein features basing on signal processing, extraction of vein features basing on structuring and extraction of vein features basing on statistics. What’s more, the six components of vein features respectively correspond to the six attributes of psychology when extracting vein features. They are regularity, orientation, roughness, contrast ratio and alignment.

3) The Evaluation Criteria of the Algorithm

In order to give a comprehensive and credible evaluation about the method in this paper, this paper it used the generic guidelines to evaluation. As for the classification experiments, it used the accuracy as the evaluation criteria:

\[ \text{Accuracy} = \frac{tp + tn}{tp + tn + fp + fn} \] (12)

where \( tp \) (true positive) said the positive samples that the classifications are right; \( tn \) (true negative) said the negative samples that the classifications are correct; \( fp \) (false positive) said the positive samples that the classifications are wrong; \( fn \) (false negative) said the negative samples that the classifications are wrong. Although it also has the recall rate (recall) and other standards to assess the classification algorithm, the classification accuracy is one of the most widely and intuitive evaluation criteria. Here consider two classes classification problems, the two types of samples were recorded as positive samples, and negative samples. The molecular is the sum about the \( tp \) and the \( tn \) and the denominator is all the test samples.

III. EXPERIMENTS RESULTS

To validate the image classification proposed in the above section, we design a set of empirical experiments. For the robustness of the results given by the proposed method, we repeat the experiments for several rounds and report the average results. For repeatability, we present the experiment procedures and the parameters used in the experiments. In this section, we first give the evaluation criteria of image classification. Second, we provide the results of five experiments. For each experiment, we give the experiment purpose, experiment method, experiment parameters, experimental results, result analysis.

Pictures used in this paper are all from Corel image base and internet, which is a standard database that is popular in area of image identification and labeling up to now. This database has collected 9 categories of images, a total of 2000 images, which are respectively buildings, birds, flowers, figures, trees, elephants, white clouds, mountains, cars and so on. Meanwhile, the database has a
relatively wide range of images, buildings and cars are man-made objects or scenes; birds, flowers, figures, trees and elephants are natural objects; white clouds and mountains are typical natural scenes. Images in this database are taken from different locations, angles and luminance, so this database, which can reasonably estimate the extracted image identification method, is typical and relatively challenging.

Respectively extract color and vein features of each image. And the extraction methods of color and vein features are respectively described in Section 3.4.1 and Section 3.4.2. Express images with features, which shall be delivered to SVM classifier for image identification experiments. And each experiment shall be repeated for 20 times, whose average result will be the final result. In each experiment, we take 2/3 of images from each category of image as training sets, and the rest 1/3 can be test sets. What’s more, the nuclear parameters of support vector machine shall be selected with method shown in Section 3.

In the first experiment, we provide an illustrative example to demonstrate how the image feature extraction methods and SVM classifiers work. In this experiment, we first extract multiple image features from two classes of the Corel dataset, using the extraction methods as shown in Section 3.4. Second, few image samples and their features are randomly chosen from the datasets for demonstration. Third, the image features with classes label are delivered to SVM for classification. The parameters of SVM are obtained by two schemes: hand-configured parameters and grid-search parameters. The results are shown in Figure 2. As we can see, most images are classified correctly, while only few image are classified in wrong. It validated the effectiveness of grid search method in parameter selection and the SVM algorithm in image classification.

In the second experiment, we evaluated the proposed method on image classification. For a comprehensive evaluation, we use five different evaluation criteria which are \( tp, tn, fp, fn \) and accuracy. And to obtain a robust conclusion, we repeat the test for 10 rounds and present the results of 5 rounds. This experiment contains three procedures. First, we extract multiple image features from the images of the Corel dataset, using the extraction methods as shown in Section 3.4. The feature extraction methods include RGB, HSV and vein. Second, partition image samples into training set and test set. Specifically, we randomly select 1000 image samples for training and rest for test. Third, the image features with classes label are delivered to SVM for classification. The parameters of SVM are obtained by two schemes: hand-configured parameters and grid-search parameters.

The experimental results are shown in Table 1. We could find several interesting facts. First, the proposed method which is denoted as ours consistently show superiority over the compared method SVM under five evaluation criteria. The five evaluation criterion evaluates the results in different aspects. For instance, under the criteria of accuracy, the proposed method outperforms SVM about 3%~13%. Second, as shown in Table, our proposed method outperform the compared method SVM on all 5 rounds of test, which means that, the proposed method is very stable with respect to the random tests. The reasons accounting for the above facts are twofold:

1. The image feature extraction methods are effective in capturing useful information in images. That is, by using three distinct features, we could obtain rich information;
2. The optimization method for image recognition could find the optimum parameters effectively and adaptively. Grid-search based parameter selection method is much more adaptive than hand-specified parameters.

### Table I. The SVM and GMKL Compared to the Experimental Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Algorithm</th>
<th>Evaluation criteria</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SVM</td>
<td>( tp, tn, fp, fn )</td>
<td>0.738</td>
</tr>
<tr>
<td></td>
<td>Ours</td>
<td>( tp + tn + fp + fn )</td>
<td>0.958</td>
</tr>
<tr>
<td>2</td>
<td>SVM</td>
<td>( tp, tn, fp, fn )</td>
<td>0.859</td>
</tr>
<tr>
<td></td>
<td>Ours</td>
<td>( tp + tn + fp + fn )</td>
<td>0.915</td>
</tr>
<tr>
<td>3</td>
<td>SVM</td>
<td>( tp, tn, fp, fn )</td>
<td>0.607</td>
</tr>
<tr>
<td></td>
<td>Ours</td>
<td>( tp + tn + fp + fn )</td>
<td>0.744</td>
</tr>
<tr>
<td>4</td>
<td>SVM</td>
<td>( tp, tn, fp, fn )</td>
<td>0.747</td>
</tr>
<tr>
<td></td>
<td>Ours</td>
<td>( tp + tn + fp + fn )</td>
<td>0.802</td>
</tr>
<tr>
<td>5</td>
<td>SVM</td>
<td>( tp, tn, fp, fn )</td>
<td>0.901</td>
</tr>
<tr>
<td></td>
<td>Ours</td>
<td>( tp + tn + fp + fn )</td>
<td>0.958</td>
</tr>
</tbody>
</table>

In the third experiment, we further evaluate the proposed method on image classification task. We use the comprehensive evaluation criteria, e.g., accuracy, for evaluation, which is different with the second experiment. Also, we repeat the test for 10 rounds to obtain a robust conclusion. The complete experiment is composed of three procedures. First, the image feature, color histogram is extracted from the images of Corel dataset, as described in Section 3.4. Second, we partition image samples into training set and test set for each category. Specifically, we randomly select 1000 image samples as the training set and the rest as the test set. Third, the extracted image features with classes label are delivered to classifiers for classification. The parameters of SVM are obtained by two schemes: hand-specification based scheme and grid-search based scheme.

The experimental results are shown in Table 2. This table presents the parameters obtained by grid-search.
That is $\alpha = 0.145, C = 10$. We find several interesting facts. Especially, the proposed method which is denoted as grid search method outperforms the compared method SVM which is denoted default parameter. The accuracy of the proposed method is 74.35% while the accuracy of the compared method is 70.35%. Note that, these results are the average results over 10 rounds of tests. Therefore the outperformance of the proposed method over the compared method is significant in the statistics. The reasons accounting for the above facts are twofold: (1) the optimization method for image recognition is able to effectively find the optimum parameters which can be highly adaptive to dataset and data distribution; (2) the image feature extraction methods are effective and can capture useful information in images. Also, the image feature extraction method can work with optimization method well.

In the fourth experiment, we evaluate the proposed method on image classification under different setting. We use accuracy as the evaluation criteria, which is same with the third experiment. The complete experiment is composed of three procedures. First, three image features are extracted from the images. See Section 3.4 for details. Second, we partition image samples into training set and test set. Third, the extracted image features with classes label are delivered to classifiers for classification. Two schemes are used to determine the parameters of SVM: hand-specification based scheme and grid-search based scheme. We repeat 20 rounds of test respectively under the fixed kernel parameter and the grid search method. And it put the average recognition rate of the 20 times as the evaluation index. The experimental results are shown in Table 3.

From the Table 3, we can see that the recognition rates under the grid research are much higher than the results in the fixed parameters. And the accuracy can reach nearly 85.52%. From the classification results, it can see the effectiveness of the grid search to determine the kernel parameters. We can see from Table 3 that the nuclear parameters of support vector machine can’t be optimized in experiment plan 1, but optimized with grid-search method. Moreover, accuracy rate of images classification of plan 2 is obviously higher than that of plan 1, and the improvement is nearly 7%. Seen from classification results, grid-search method can determine the effectiveness of parameters of support vector machine. Grid-search method can improve reserve ratio of image classification of support vector machine, the reason is that grid-search method can select the nuclear parameters of support vector machine according to distributed intelligence, so that nuclear parameters of support vector machine has better adaptability than the defaulted nuclear parameters.

### Table II. Classification Accuracy Comparison of Color Histogram

<table>
<thead>
<tr>
<th></th>
<th>$\sigma$</th>
<th>$C$</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default parameters</td>
<td>Default</td>
<td>Default</td>
<td>70.35%</td>
</tr>
<tr>
<td>Grid-search method</td>
<td>0.145</td>
<td>10</td>
<td>74.23%</td>
</tr>
</tbody>
</table>

In the fifth experiment, we evaluate the proposed method on image classification, by performing multiple rounds of parameter search and test. In evaluation, we use accuracy as the evaluation criteria. We perform parameter search for three rounds. The experiment contains three procedures. First, the image feature, three image features are extracted for each images of Corel dataset, using the methods in Section 3.4. Then, we partition image samples into training set and test set. Specifically, we randomly select half image samples as the training set and the rest as the test set. Third, the extracted image features with classes label are sent to classifiers for classification. The parameters of SVM are obtained by hand-specification based scheme and grid-search based scheme.

The gray level co-occurrence matrix of sample image is calculated with gray level co-occurrence matrix method previously described in this paper, such as contrast ration, inverse difference moment, energy and relativity of four directions of $0, 45, 90, 13$. Then, take the mean of each feature and variance of the four directions as vein features of images, the classification results are shown in Table 4 [37]. Experiment results and conclusions. The final experiment results show that: (1) compared the experiment result under condition of default nuclear parameters with that under circumstance of nuclear parameters got from optimizing with grid-search method, we can find that the later can greatly improve accuracy rate of classification results. (2) Taking color features as the input has higher accuracy of classification than taking vein features formed by gray level co-occurrence matrix method as the input. (3) Only taking vein features as the input has little influence on accuracy of classification results.

### Table III. The Recognition Accuracy

<table>
<thead>
<tr>
<th>Test times</th>
<th>Recognition rate (fixed parameters)</th>
<th>Recognition rate (grid search)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.682</td>
<td>0.839</td>
</tr>
<tr>
<td>2</td>
<td>0.763</td>
<td>0.915</td>
</tr>
<tr>
<td>3</td>
<td>0.731</td>
<td>0.958</td>
</tr>
<tr>
<td>4</td>
<td>0.684</td>
<td>0.8</td>
</tr>
<tr>
<td>5</td>
<td>0.365</td>
<td>0.744</td>
</tr>
<tr>
<td>Average rate%</td>
<td>64.50</td>
<td>85.52</td>
</tr>
</tbody>
</table>

In classification results of the experiments, it has a low accuracy rate to classify images with gray level co-occurrence matrix, but accuracy of determining parameters of kernel function with grid-search method is higher than that of classifying images with defaulted parameters method.

### Table IV. Classification Accuracy Rate (Grey Level Co-occurrence Matrix)

<table>
<thead>
<tr>
<th>Default parameters of SVM</th>
<th>Grid-search based parameters</th>
<th>Accuracy (%)</th>
<th>$\sigma$</th>
<th>$C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>43.89</td>
<td>0.0451</td>
<td>2940</td>
<td>53.34</td>
<td></td>
</tr>
<tr>
<td>43.31</td>
<td>0.0610</td>
<td>2453</td>
<td>54.47</td>
<td></td>
</tr>
<tr>
<td>44.67</td>
<td>0.0597</td>
<td>2576</td>
<td>54.01</td>
<td></td>
</tr>
</tbody>
</table>

Seen from classification results of the experiments, it has a low accuracy rate to classify images with gray level co-occurrence matrix, but accuracy of determining parameters of kernel function with grid-search method is higher than that of classifying images with defaulted parameters method.

## IV. Conclusion

Introduction of method mentioned in this paper. In this paper, classification optimization management of images is achieved, including the following steps: (1) Select...
Different kernel functions have different influence on classification ability of SVM. Compared with other forms of kernel functions, this paper selects the form of RBF kernel function, which has excellent learning under the circumstance of large sample and low latency. (2) Optimization of kernel parameters. Kernel parameters $C$ and $\sigma$, which are critical factor impacting performance of SVM, have great influence on separating accuracy and generalization ability of SVM. Therefore, grid-search method is used in this paper when optimizing images. Meanwhile, this method can be understood easily. (3) Extraction of image features. In this paper, color and vein of images, which can be deemed as image features and input when processing images per category, are extracted. In many features of images, color is the most important and intuition is tic perception feature. Compared with other features, it’s easy to extract colors. Moreover, vein features bring great convenience for analysis, decomposition and classification of images.

Shortcomings of method mentioned in this paper and the follow-up work. It has great advantage for SVM when managing images per category. However, it’s very difficult to construct multiple classifiers, so constructing SVM classifier is still focus of the next step’s study.

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