**TELKOMNIKA**, Vol. 11, No. 7, July 2013, pp. 3585 ~ 3589
e-ISSN: 2087-278X



# The Color Extraction and Support Vector Machine Recognition Algorithm for Moving Plate Recognition System

**Yu Chen*, Jun Cao, Aifei Wang**
Mechanical Engineering Post-doctoral Research Stations Northeast Forestry University, Harbin , China, 150040
Northeast Forestry University, Haibin, China, 150040
*Corresponding author, e-mail: lg_chenyu@.yahoo.com.cn*, zdhcj@126.com, wangaifei@nefu.edu.cn

***Abstract***

*According to the shortcomings of long time and big errors about the moving plate recognition system, we present the moving plate recognition algorithm based on color extraction and support vector machine. On the basis of the analysis of moving plate recognition system's basic principles, it introduces the basic principles and calculation steps about color extraction and support vector machine algorithm, and discusses the feasibility of applying the algorithm to PRS in the paper. The experimental results show that the algorithm has the advantages of faster speed and higher accuracy of recognition. The algorithm provides a new thought for the research on the moving plate recognition algorithm.*

***Keywords:*** *plate recognition, color extraction, support vector machine*



## 1. Introduction

Plate recognition technology has developed into a new type of machine vision technology in recent years, and become one of the current hot research topics on image processing [1-2]. Detecting plate surface and sorting is an important process during the production of sawn timber, solid plate and engineering wood materials, and directly affects product quality and production efficiency. In machine vision systems, the surface of solid wood boards is scanned through the high-resolution camera. Through the computer processing and analysis, the relevant graphical information which comes from scanning is used for recognition and classification of defect applying artificial intelligence technology [3]. It can achieve the best optimization. The technology of testing and optimization based on machine vision is very important for completing automatic identification and classification of defect, optimizing graded plate and achieving the technological transformation and innovation about automatic detection and classification in the production of solid wood boards, especially for wood production and other materials (such as bamboo) products which make use of plantation having more natural defects at present.

The plate recognition system is significantly depending on the accuracy and speed of the recognition algorithm [4-5]. At present, the more common methods used for the plate recognition system include the spatial frequency method, the color moment algorithm, gray level co-occurrence matrix analysis method and so on [6]. The characteristic of the spatial frequency method is that the algorithm is simple, but the efficiency of the algorithm is very low, and the recognition error is big. Color moment is a representation of simple and effective color features, including the first-order moment (mean), second-order moment (variance) and third-order moments (slope). But the recognition efficiency of the method is relatively lower, and thus, it is often used to filter the image to narrow search range in practical applications. Gray level co-occurrence matrix is a common method to describe the texture by researching related properties of gray level space. The algorithm first obtains a gray level matrix through calculating each pixel of the current image frame. So the algorithm is relatively time-consuming, and it is not suitable for the moving plate recognition system.

This paper presents a moving plate recognition algorithm based on color extraction and support vector machines which can greatly shorten the time of the plate image recognition and

*Received January 10, 2013; Revised April 3, 2013; Accepted April 15, 2013*

improve the recognition accuracy. The experimental results show that the algorithm is effective, so it provides a new effective method for the moving plate recognition problem.

## 2. The Composition of the System

The plate recognition system mainly consists of data acquisition systems and embedded recognition platform. Data acquisition system is responsible for collecting the image frame and sending the collected frame to the embedded image processing platform; The platform mainly completes measurement data pre-processing, image acquisition, feature extraction, plate classification and real-time display and so on. The overall structure of the PR system is shown in Figure 1.

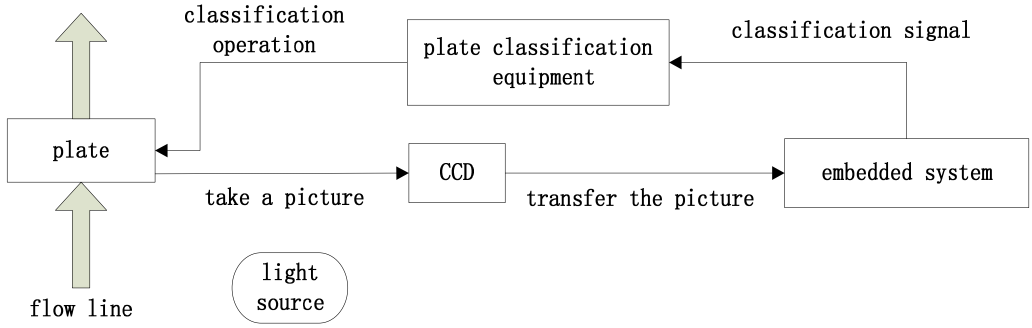


Figure 1. The overall structure of the PR system

## 3. Algorithm Principle

The support vector machine (SVM) was originally put forward to research linearly separable problems. Assuming that training sample set $\{(x_i, y_i), i=1,2,\cdots,l\}$ whose size is 1 consists of two categories, if $x_i$ belongs to the first category, remember $y_i=1$; if $x_i$ belongs to the second category, remember $y_i=-1$.If there is a classification hyperplane as follow:

$$wx+b=0 \quad (1)$$

which can divide the samples into two categories, then the sample set is linearly separable. It meets the following formula:

$$\begin{cases} xw_i+b\geq 1, & y_i=1 \\ wx_i+b\leq -1, & y_i=-1 \end{cases} \quad (2)$$

where $i=1,2,\cdots,l$.Define the interval from sample points $x_i$ to classification hyperplane referred to in the formula (1):

$$\varepsilon_i = y_i(wx_i+b)=|wx_i+b| \quad (3)$$

Normalize w and b in the formula (1), and define the normalized interval as the geometric interval as follow:

$$\delta_i=\frac{wx_i+b}{\|w\|} \quad (4)$$

At the same time, define a interval from a sample set to classification hyperplane as the geometric interval from classification hyperplane to the sample point which is nearest to classification hyperplane in the set.

$$\delta = \min \delta_i , \quad i = 1,2,\cdots,l \tag{5}$$

The relationship between the number of the misclassification N and the distance from the sample set to the classification hyperplane is

$$N \le \left( \frac{2R}{\delta} \right)^2 \tag{6}$$

Where R=max$\|x_i\|$, $i = 1, 2, \cdots, l$ ,v, is the maximum value of the sample set vector length.

It need to choose an optimal classification plane among numerous classification hyperplanes which meet the equation (2), making the distance from sample set to classification hyperplane maximum. The target is to find the optimal classification plane under the constraints of equation (2). It shows by the following formula:

$$\begin{cases} \min \frac{\|w\|^2}{2} \\ s.t. \quad y_i(wx_i + b) \ge 1, \quad i = 1, 2, \cdots, l \end{cases} \tag{7}$$

The formula (7) can be obtained by solving the Langrange function. It means to solve as follow:

$$\varphi(w, b, a_i) = \frac{1}{2}\|w\|^2 - \sum_{i-1}^{l} a_i \left[ y_i(wx_i + b) - 1 \right] \tag{8}$$

Where $a_i > 0, i = 1, 2, \cdots, l$, is Langrange coefficient.

According to Langrange duality theory, the formula is transformed into the dual problem. That is

$$\begin{cases} \max Q(a) = \sum_{i=1}^{l} a_i - \frac{1}{2}\sum_{i-1}^{l}\sum_{j=1}^{l} a_i a_j y_i y_j (x_i x_j) \\ s.t. \quad \sum_{i=1}^{l} a_i y_i = 0, \quad a_i \ge 0 \end{cases} \tag{9}$$

Use quadratic programming to solve. Assuming that the obtained optimal solution after solving is $a^* = \left[ a_1^*, a_2^*, \cdots a_l^* \right]^T$ , it can obtain the optimal $w^*$ and $b^*$:

$$\begin{cases} w^* = \sum_{i=1}^{l} a_i x_i y_i \\ b^* = -\frac{1}{2} w^*(x_r + x_s) \end{cases} \tag{10}$$

Where $x_r$ and $x_i$ are any a couple support vector in two categories.The resulting optimal classification function is

$$f(x) = \text{sgn}\left[\sum_{i=1}^{l} a_i^* y_i (x x_i) + b^*\right] \quad (11)$$

Further, in order to solve the problem that is minority sample can't find the optimal classification hyperplane, it introduces the slack variables and corrects the optimal objectives and constraints. That is

$$\begin{cases} \min \frac{\|w\|^2}{2} + C\sum_{i=1}^{l}\xi_i \\ s,t, \quad \begin{cases} y_i(wx_i + b) \geq 1 - \xi_i \\ \xi_i > 0, \quad i = 1,2,\cdots,l \end{cases} \end{cases} \quad (12)$$

Where C is penalty factor, the solution is the same as (8). Transform it into dual matrix, constraint becomes

$$\begin{cases} \sum_{i=1}^{l} a_i y_i = 0 \\ 0 \leq a_i \leq C, \quad i = 1,2,\cdots,l \end{cases} \quad (13)$$

The sample object uses color component of HSV space. Firstly, convert an RGB image to HSV space, and normalize R,G and B, 0<=R,G,B<=1. The range of H transformed is set 0-360, 0 <= S, V <= 1.

Take 20 pixel from the moving plate, calculate the H value of 20 pixel in HSV space. Regard these 20 H values as a color characteristic value of each frame, and use the SVM algorithm to train.

## 4. Tests and Experiments

The experimental hardware platform host uses embedded IPC (Industrial Personal Computer) with 3.06 dual-core and 4G memory. CCD camera uses CCD industrial camera (MV-VD078SC) with 700,000 pixel.

Take 20 pixel from the moving plate, calculate the H value of 20 pixel in HSV space. Regard these 20 H values as a color characteristic value of each frame, and use the SVM algorithm to train. The following figure 2 shows two types of floor color bar graph of the HSV values. Its can be seen from this figure is very different from the maximum value of two sets of data distribution. A data is 42.254, while the maximum value of the group B data is up to 352.5.

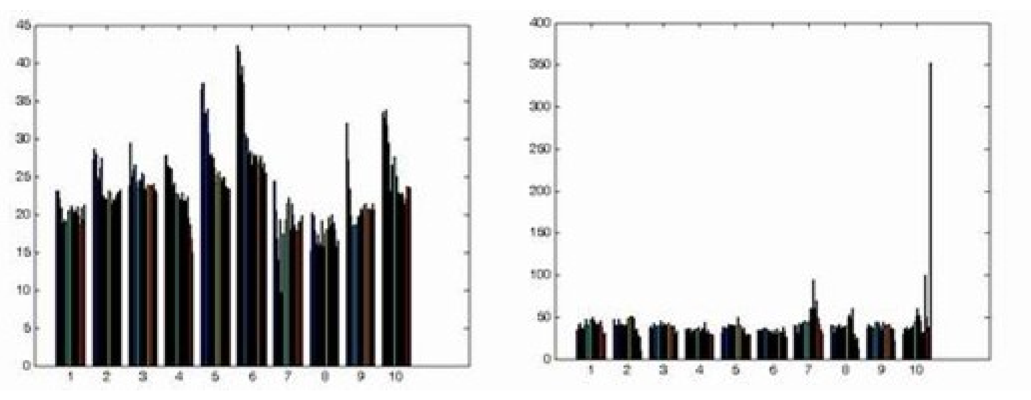


Figure 2. The HSV values of two types of floor

This experiment selects 40 piece of plate, including 20 piece of the same kind plate and another 20 piece of another plate, both are similar in color. The plate of A class is selected as the original plate. Then 20 piece of A class plate and 20 piece of B class plate are identified. As a result, 37 pieces are correctly identified, 3 pieces are misidentified because of the large area boils and stains on the plate surface. So the recognition rate is 92.5%.

From the test results of the plate recognition system platform, the color extraction and support vector machine algorithm which is proposed in the paper can recognize the color of plate. The plate recognition has the advantages of high precision, fast speed, simple method, small amount of calculation, and it can also accurately recognize the plate whose color is very similar. In order to obtain better recognition results, the special recognition of boils can be added to recognition algorithms. This is also the follow-up research work.

## 5. Conclusion

The paper presents a plate recognition algorithm based on color extraction and support vector machine. The algorithm firstly extracts color characteristics of moving image, further uses SVM classification algorithm to achieve the plate classification. The algorithm has the advantages of faster speed and higher accuracy of recognition, and provides a new thought for the research on the plate recognition.

## Acknowledgements

This work is supported by National Forestry Bureau of the 948 project (2011-4-04), Central Colleges basic scientific research projects special fund (DL12CB02), national natural science foundation of China (60972127), Heilongjiang Provincial Department of Education Science and Technology Research Project (12513016), Postdoctoral Fund of Heilongjiang Province.

## References

[1] Wang Han, Bai Xuebing, Wang Hui. Wood Texture Classification and Recognition Based on Spatial GLCM. *Forest Engineering*. 2007; 23(1): 32-36.
[2] Wang Keqi, Chen Lijun, Wang Hui, Xie Yonghua.The Exraction of Wood Texture Features Based on Spatial GLCM. *Engineering*. 2006; 22(1): 24-29.
[3] Wang Han, Bai Xuebing, Wang Hui. Classification of wood surface texture based on wavelets transform. *Journal of Harbin Institute of Technology*. 2009; 41(9): 232-236.
[4] Zhao Jinchuang, Ye Chenguang, He Yirui, He Huaguang. Construction of Embedded Electrical Capacitance Tomography System Software Platform. *Computer Measurement & Control*. 2011; 19(9): 2289-2293.
[5] Liu Meng, Zheng Xuan, li Guo. Design of Embedded Remote Intelligent Video Surveillance System Based on ARM. *Electrical Automation*. 2011; 33(5): 51-55.
[6] Xu Chunmei, Wang Chunyao, Liu Yue. The color recognition research based on machine vision system. *Machinery Design & Manufacture*. 2011; (8): 257-261.