Optimization Research on Server Detection Based on RGB Maximum Mean Features and Deep Belief Network Model

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Abstract. The intelligent detection about the running state of server equipment in computer room is a very important research field. In general, the state recognition research of signal lamp mainly includes the color and shape characteristics of signal lamp, and machine learning models. At present, the research results in this respect are not ideal for the recognition of signal lamps, Due to the small size and high density of the detected server lamp source, its shape characteristics cannot be accurately obtained, and state information is difficult to be perceived. This paper proposes a RGBMM features algorithm and a DBN network model algorithm, which is different from the traditional signal state recognition algorithm. According to the characteristics of server signal lamp, the color state image data of signal lamp is extracted effectively by RGBMM features algorithm, then the DBN network model algorithm is used to evaluate and identify the sampled signals, so as to judge whether the server is working normally. The experimental results show that the state recognition accuracy of the signal lamp is up to 98%, while the recognition rate of the signal lamp color state image using HSV( Hue, Saturation, Value ) transformation is 90.7%. The difference between the three is different the algorithms used. So the RGBMM features algorithm and the DBN network model algorithm have a wider use for the signal lamp color status recognition.

Keywords: Server Equipment; State Recognition, RGBMM, Machine Learning Model; DBN Model

1. Introduction

In the more and more intelligent power system, it is very important to design a detection system that can monitor the running state of each equipment in real time and accurately. It is very important to design a set of inspection system which can monitor the running status of each equipment in time and accurately. At present, the research of signal lamp state recognition mainly includes two aspects: (1) The color and shape characteristics of the signal lamp, The main research results are color spaces based on HSV [1], RGB (Red, Green, Blue) [2], HIS (Hue-Saturation-Intensity) [3] et al. For example,
Salti et al.\cite{4} have researched and developed a set of traffic lamp detection and recognition system, which adopts the method of extracting RGB color feature data in the effective area of the signal lamp state image, but the effect of color detection and recognition is not very good.;(2) The machine learning mode used by the signal lamp. For example, Qian H et al.\cite{5} proposed a fast detection and recognition algorithm of traffic lamps based on deep learning aiming at the technical difficulties such as the minimum proportion of the images in the detection data set. Using the different color, direction, and shape information of traffic lamps, we can detect the status of traffic lamps.\cite{6}. However, due to the impact of server size, the server signal lamp is small and dense, and the shape features cannot be obtained, so it is more difficult to perceive its state information. The inspection system of the information machine room developed by State Grid Lishui company needs manual collection for the detection data of the equipment lamp Status, and then the background system is used for intelligent analysis, so the work intensity of personnel is high and the efficiency is low. At present, Comprehensive recognition method\cite{7} are still used for traffic signal lamp identification, with low accuracy.

We designed a set of the safety intelligent inspection system of the signal lamp status detection. The algorithm to extract the color state image information of the signal lamp adopts the RGBMM (RGB maximum mean value) feature algorithm. The algorithm to classify and recognize in the signal lamp image is the DBN (depth confidence network) algorithm, and these two algorithms are embedded in the hardware system. A large number of experimental data prove the effectiveness of this method, the accurate recognition rate of the signal lamp state processed by the combination of these two algorithms can reach more than 98%.

2. The Recognition Methods

2.1. Extraction of RGBMM Features of Signal Lamp State Image

The operation of the server equipment in the machine room is indicated by the green, red and yellow lamps on the server. The green lamp represents the normal operation of the equipment, the red lamp represents the failure of the equipment, and the yellow lamp represents the equipment to be inspected. Therefore, the on and off of the three color lamps are the main indicators to judge the operation of the equipment. Because these three kinds of signal lamps on the server are small and lamp-emitting, they will interfere with the images taken by the industrial camera; on the other hand, the reason why an image cannot be focused is interfered by multiple signal lamps, and the color of the image is affected by the external lamp, so it is difficult to obtain accurate signal lamp status information from the image. At present, the HSV color space, HIS color space eigenvalue, RGB eigenvalue and color histogram algorithms for the recognition of the status information of the signal lamp have many shortcomings. Therefore, the RGBMM feature algorithm proposed in this paper is more accurate and effective in extracting the state information of signal lamp. After the signal lamp image denoising, the data extraction process of RGBMM feature algorithm is as follows:

(1) Using Kalman tracking algorithm\cite{8}, pixel points are extracted by segmentation of a signal color region of interest(ROI).

(2) The software system calculates the number of ROI pixels and reads the R, G, and B binary luminance values of each pixel (data range 0-255).

(3) The RGB three primary colors luminance values of each pixel are arranged in order from large to small. The luminance maxima of the first 20% RGB three primary colors in RGB arrangement are read and stored in RM, GM and BM maxima sequences respectively.

(4) The RGB average value of RM, GM, BM maxima sequence is calculated and recorded as R_{Ma}, G_{Ma} and B_{Ma} respectively.

(5) Using the maximum average value of R_{Ma}, G_{Ma} and B_{Ma}, the RGB maximum ratio of the ROI is calculated, which is recorded as MR_r, MR_g and MR_b respectively

\[ MR_r = \frac{R_{Ma}}{R_{Ma} + G_{Ma} + B_{Ma}} \] (1)
\[ MR_g = \frac{G_{Ma}}{R_{Ma} + G_{Ma} + B_{Ma}} \]  
\[ MR_b = \frac{B_{Ma}}{R_{Ma} + G_{Ma} + B_{Ma}} \]  

3. Results

3.1. Get Input Data Set

The experiment is carried out in the information room of a power supply company, which is equipped with 50 sets of cabinets of various types. The signal lamp identification system which completes the patrol inspection function mainly includes the track, the rail car, the platform installed on the rail car and the industrial camera fixed on the top of the machine room. During the experiment, the platforms first received the signal lamp automatic inspection instruction, and then the industrial camera captured 89 server image photographs with the cloud platforms moving freely in orbit. The segmented signal lamp image photographs are different in distance, brightness, color and size, which are in line with the actual inspection situation. Kalman tracking algorithm is used to separate and extract data from the interested signal lamp color state image area.

In a single segmented signal lamp image, 200 green lamp images, 200 red lamp images and 200 blue lamp images are randomly selected as training samples, and their RGBMM eigenvalues are extracted as the initial training data set for DBN pre training. In addition, 100 green, red and yellow lamp images are selected to extract the RGBMM eigenvalues, which are then used as test samples. According to the RGBMM images of green, red and yellow lamps, it is found that the average values of \( MR_g \), \( MR_r \) and \( MR_b \) of green lamp images are 0.484±0.0048, 0.311±0.0031 and 0.205±0.0021, respectively, and the maximum mean values of red, green and blue of RGBMM of green lamp images are quite different; the average values of \( MR_g \), \( MR_r \) and \( MR_b \) of red lamp images are 0.33±0.0033, and the difference among the mean values of red, green and blue is small; the average value of \( MR_g \) and \( MR_r \) of yellow lamp image is about 0.36±0.036, and the difference between the average values of red and green base color is small, but the average value of \( MR_b \) is 0.269±0.027, and the average value of blue base color is obviously different from that of red green base color. Therefore, the distribution of RGBMM average of red, green and yellow lamp images is obviously different. It is easy to distinguish these three kinds of images by using RGBMM features.

3.2. DBN Model Establishment and Evaluation Identification[^12-13]

The \( MR_g \), \( MR_r \) and \( MR_b \) of the red, green and yellow lights calculated by the RGBMM feature algorithm are used as the input nodes of DBN. Since the DBN model is used to evaluate the recognition image state, the number of output nodes is set to 1. The number of hidden nodes in the DBN model determines the ability to obtain useful information. In general, too few hidden nodes cannot give the data model, and too many hidden nodes may over fit the data, resulting in the deterioration of the final evaluation performance. The number of initial training data sets for DBN pre training is 120, RMB structure adopts 3 layers, according to the structure characteristics of DBN, the architecture of the DBN model is set to DBN[3;100,100,50,10;1]. Then we input the training input data set into the DBN pre-training model, and input the test data set into the DBN pre-training model for detection, we get a clear and stable detection result image, as shown in Figure 1. By observing the RGBMM detection result image shown in Figure 2, it is found that the DBN evaluation value of the green lamp sample is stable near 0.8, the DBN evaluation value of the red lamp sample is stable near 0.4, and the DBN evaluation value of the yellow lamp is stable near 0.5, and the DBN evaluation value of the three types of images is significantly different. Therefore, according to the evaluation value of the DBN model, the color of signal lamp can be accurately identified.
Figure 1. the RGBMM average distribution

Figure 2. Detection results of RGBMM combined with DBN model

\[
\text{Color} = \begin{cases} 
\text{Green}, & \text{DBNvalue} \in [0.75, 0.85] \\
\text{Red}, & \text{DBNvalue} \in [0.35, 0.45] \\
\text{Yellow}, & \text{DBNvalue} \in [0.45, 0.55] \\
\text{unknown}, & \text{other DBNvalues}
\end{cases}
\] (4)

By analyzing the small red circle mark in Figure 7, it is found that there are two samples in the green lamp area, one sample in the red lamp area, and three samples in the yellow lamp area, totally six samples are not accurately identified, accounting for about 1% of the sample number, that is, 99% of the samples can be accurately identified.

4. Discussion

In order to further prove the superiority of the method based on the RGBMM feature and DBN network model to the recognition of the signal lamp, the experiments of the combination of the RGBMM feature with the HSV feature and the combination of the RGBMM feature with the hidden Markov model (HMM) are carried out respectively, and a comparative study is carried out.

HSV (hue, saturation, and brightness) color space is an intuitive color model close to human visual perception, which is widely used in image classification and recognition. However, there is no significant difference in the state representation of different signal lamp images in HSV space, so extracting the mean and variance of H and s features can be used for image recognition. After analyzing a group of experimental data, the structure of DBN model with HSV color space feature is DBN2[4;100,100,50,10;1]. Through the analysis of the detected image results (as shown in Figure 5), it is found that the DBN evaluation value of the green lamp area image is in the [0.6, 0.9] range, and the recognition accuracy of the green lamp image can reach about 93%; the DBN evaluation values of the yellow lamp and red lamp area image are in the [0.9, 1.2] range (as shown in Figure 6), so the yellow lamp and red lamp image samples cannot be recognized by the DBN model.
Table 1. RGBMM Comparison of HSV recognition results

| Recognition algorithm | Recognition rate |   |   |   |
|-----------------------|------------------|--|--|--|
|                       | Green light      | Red light | Yellow light | comprehensive |
| HSV-DBN               | 94%              | 91%       | 87%          | 90.7%          |
| RGBMM-DBN             | 98%              | 99%       | 98%          | 98.3%          |

The experimental results show that the server detection method based on RGBMM features and DBN network model has the ability of fast and accurate recognition of the color state of the signal lamp.

5. Conclusion
We have developed a set of intelligent detection system algorithm for server equipment in the computer room. The core of this algorithm is the algorithm of signal state image recognition-RGBMM feature combined with the DBN network model algorithm. Firstly, the input data of feature training is obtained by using rgbmm features, and then the acquired DBN network model is used to evaluate and classify the signal lamp images. Compared with the HSV color space feature combined with the DBN model, the algorithm is proved to be effective and can be used to detect the running state of the server room. In future research, we need to optimize the algorithm to make it faster and more accurate for the on-line detection of the signal lamp state image.

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