Research on Machine Vision Monitoring Scheme of Ship Sulfur Emission Based on Convolutional Neural Network

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Abstract: Aiming at the problem of low accuracy of traditional image processing methods in the detection of sulfur liquid in the on-site environment with complex equipment structure, many types of debris and serious ground wear in ships, this paper proposes a sulfur liquid detection algorithm based on CNN. By analyzing the problem of sulfur liquid detection, making a data set, establishing the VGG16 model and combining the training samples of the early stop algorithm to avoid the over-fitting state, the rapid automatic detection of sulfur liquid in complex pipelines is realized. This method can be accurate and accurate in the ship site. Identify sulfur liquid and reduce the influence of noise interference. Finally, the superiority of the algorithm in this paper is verified by comparing with various image processing methods. The results show that the test accuracy of the algorithm can reach 99.44%, and the prediction accuracy can reach 97.0%. Compared with the accuracy of traditional image processing algorithms, and the prediction time of a single image is about 0.2 s, it can meet the detection needs of the ship site.

In the research of ship target detection, the target detection method based on radar images is not very suitable, and the detection effect of weak and small targets is not ideal; in the target detection of infrared images, the infrared imaging system itself suffers from strong noise interference. There are great difficulties in target detection; in the target detection of visible light images, it is difficult to detect targets in low-visibility weather such as fog and rain and in nighttime environments. Compared with this target detection method, the method of ship target detection through convolutional neural network in deep learning is better. In this regard, a ship target detection method based on an improved convolutional neural network is proposed. By designing a multi-strategy convolutional neural network model, and introducing two commonly used network models in the target detection method, the experimental results are compared with them to verify the improved volume. The effect of the cumulative neural network model.

1. Convolutional Neural Network Theory

Convolutional neural network theory belongs to the category of neural network. As a classic structure that is widely used in the field of deep learning technology, it has proved its efficient ability in a variety of image recognition and classification fields. A typical convolutional network generally has three layers. The first layer is a convolutional layer, which can be used alone as a convolutional neural network; the second layer is a pooling layer, which can reduce the size of the model, improve the calculation speed, and improve the extracted features. Robustness; the last layer is a fully connected layer, each layer is a tiled structure composed of many neurons, integrates the features together, and outputs a value to reduce the influence of the feature position on the classification (see Figure 1) .

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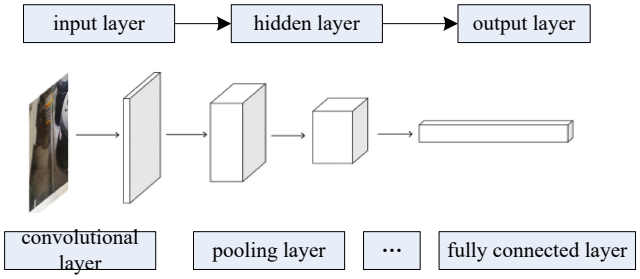

Figure 1 Convolutional neural network structure

2. CNN-VGG16 model

The convolutional neural network model used in this paper is VGG16. The VGG16 model was first proposed at the ICLR2015 conference. The model can achieve a test accuracy of 92.7%, ranking in the top 5 of ImageNet. Its dataset includes 14 million images and 1000 categories. When the process is running, the activation function of the convolutional layer uses Relu, and the activation function is represented by f (), and the convolution calculation with a depth greater than 1 is shown in formula (1).

$$y_{i,j} = f\left(\sum_{d=0}^{D-1}\sum_{m=0}^{F-1}\sum_{n=0}^{F-1}\omega_{d,m,n}x_{d,i+m,j+n} + b\right) \tag{1}$$

In the formula: D represents depth; F represents the size of the convolution kernel; b represents the offset,

The pooling method of the pooling layer is a max pooling method with a scale of 2 and a stride of 2. This method is used because the image is static, and useful features in one area may be applicable in another area. Therefore, in order to describe For larger images, the maximum value of a specific feature on the image can be calculated to represent the features of this region and max pooling can retain more texture information. The Relu activation function is shown in formula (2).

$$f(x) = \max(0, x) \tag{2}$$

The activation function is to add nonlinear factors to the model. The Relu function has the advantages of unilateral inhibition, relatively wide excitation boundary and sparse activation, and is the most widely used activation function. In classification problems, the fully connected layer often uses sigmoid or softmax. In the binary classification problem, sigmoid is used as the final activation layer; in the multi-classification problem, softmax is used as the final activation layer, and the sigmoid activation function is shown in formula (3).

$$f(x) = \frac{1}{1+e^{-x}} \tag{3}$$

3. Model Evaluation

After the training is completed, the model should be judged whether it is good or bad. Usually, two values are used to judge whether the model is good or bad, including the accuracy rate and the loss function.

According to formula (1), it can be found that y in the formula is the value of the ideal output, that is, the predicted value, but there is a certain error in practical engineering applications. The error is represented by the loss function in the neural network. The process of neural network training or optimization is actually the process of minimizing the loss function. The smaller the loss function, the closer the predicted value of the model is to the true value.

In the classification problem of sulfur liquid detection, the accuracy rate is to see whether the predicted category is consistent with the real category. For a classification problem of N-class tasks, the output is an N-dimensional vector, each vector represents a class, and the corresponding value

represents the probability that the predicted target belongs to this class. When outputting the prediction result, the program automatically selects the highest probability. The label corresponding to the index is used as the final predicted result label.

Two values are used to judge the model because for the accuracy, as long as the prediction result is greater than 0.5, it can be judged as sulfur liquid, but for the loss function, it is hoped that the model can predict 100%. Therefore, these two indicators are used to judge the model , which can make the obtained weight model have better robustness.

3.1 Building the model

The sulfur liquid monitoring system is composed of a video ring network, network switching equipment, platform server and sulfur liquid monitoring and management platform. The gigabit video ring network completely covers the monitoring points, and the monitoring images are collected regularly and uploaded to the platform server for early warning analysis of sulfur liquid. The monitoring model is deployed on the platform server, and the images are captured regularly to analyze whether there is sulfur liquid at the current monitoring point, and the analysis results are pushed to

Send it to the sulfur liquid monitoring and management platform. When the analysis result is sulfur liquid, the monitoring and management platform will issue an early warning to the on-site operators, and push the location information of the monitoring points. processing, so as to ensure the safety of the ship site.

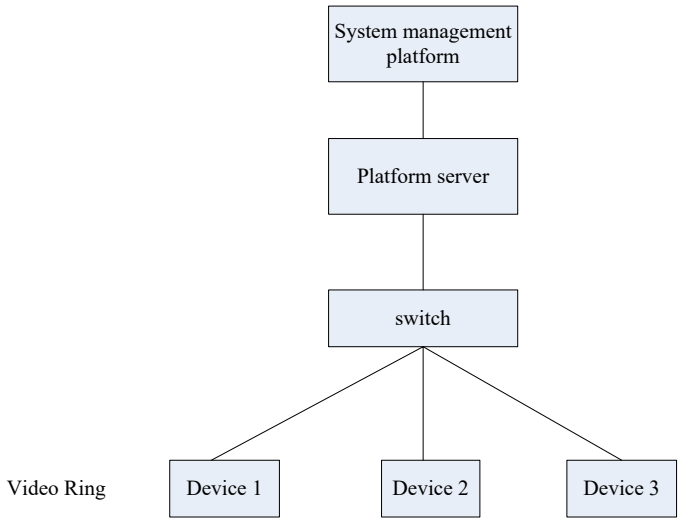

Figure 2 Leak detection system process

3.2 Analysis of traditional image processing results

The traditional image processing method used in this paper: firstly based on threshold segmentation, and segment the region of interest from the background by setting the size of the threshold, but this method is easily affected by environmental factors, and generally needs to be used in combination with other segmentation methods. On this basis, the k-means algorithm is used to perform cluster segmentation according to the similarity of distances. Further, considering that the gray value of the boundaries of different regions varies greatly in general, this paper also combines the edge segmentation method with the Canny operator to pass It can detect the boundary of the area to achieve the purpose of segmenting the image. At present, among several operators for realizing edge segmentation, the Canny operator has been widely used because it is not easily disturbed by noise and can detect real weak edges. An ideal edge detection algorithm.

Using the above traditional image processing method to detect the sulfur liquid, it can be seen that there is a clear boundary between the sulfur liquid and the ground when k = 4. The combination of segmentation and edge detection is used to detect the ground image containing many interfering objects such as pipelines. In addition, the processing speed is slow and there is no continuity. Therefore, when the on-site working environment is complex, the target is irregular, and the color

difference is small, the traditional image processing method cannot Extract exactly the information you need.

3.3 Image processing technology based on CNN-VGG16 model

This paper uses python to enhance the data of the original image. In the image classification task, simple translation, scaling, color transformation, etc. of the input image will not affect the image category, which can enrich the image training set and extract image features. , to prevent overfitting and improve the generalization ability of the model. In this experiment, a total of 1780 ship sulfur surface images were used, including 1300 images with sulfur liquid and 480 images without water stains. The two classified images were scrambled and reordered, and 70% of them were randomly selected as training samples. 20% of the images are used as model quality verification samples, and 10% are used as test samples. Category 1 represents images with sulfur liquid, and category 2 represents images without sulfur liquid.

This computing computer is configured as Intel Core i9-900k, 32 memory, VGG16 model, which is completed by python language. According to the specific operation process, it can be seen that with the pooling layer as the boundary, VGG1 6 has 6 block structures, each block The number of channels in the structure is the same. The number of channels in the convolutional layer is 64, 64, 128, 128, 256, 256, 256, 5 12, 5 12, 5 12, and no longer increases until 5 12. As the number of channels increases, more image information can be extracted .

After pooling (block5_pool), Flatten is used to compress the dimension into 1 dimension, and the transition to the fully connected layer is completed. The last two layers are the fully connected layer activated by Relu and the fully connected layer activated by sigmoid.

Since the number of final output categories is 2, that is, it is judged whether there are water spots in the field of view area, so this paper uses sigmoid as the activation function of the final fully connected layer, and the output is category 1 or category 2.

In this paper, the VGG16 model is combined with the early stopping method during training. When the loss function of the validation set reaches 10 tolerance cycles without falling, the training stops automatically, avoiding the overfitting of the weight model due to the excessive number of parameters caused by the excessive training times. In a certain range, the number of samples selected each time becomes larger within a certain range, and the more accurate the determined decline direction, the faster the model converges, and the smaller the training shock is caused . When the number of samples required for each training is the same, the more iterations, the more stable the overall trend of the model, and the closer it is to the ideal state in the end, the better the robustness of the model in this paper. The number of samples selected each time is 40, the iteration When the number of times is 83, the accuracy of the training set is the highest, the loss function is the smallest, and the accuracy of the test set is the highest, that is, the trained model has the best performance.

To sum up, the training set accuracy and loss function value of VGG1 6 model are good, and the validation set and test set have reached the best. Detect the sulfur liquid condition on the ship site.

4. Conclusion

To sum up, the image processing method is suitable for the extraction of targets with few objects and simple backgrounds within the field of view. This method is intuitive to a certain extent, but when it is applied to images with complex backgrounds and lighting effects, the algorithm is cumbersome to implement. Difficulty. This paper proposes a deep learning model based on CNN, which can complete the detection of liquid leakage in complex environments, which can greatly improve the detection accuracy.

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