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Partial Application of Defect Detection in Industry

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Abstract

At present, with the development of artificial intelligence technology and the improvement of industrial product quality requirements, defect detection is more and more important in industrial development, especially the application of defect detection technology based on image processing in industry is very extensive. This paper studies the defect detection of image processing technology in smart meters, wood, PCB boards, and wires of distribution lines. The advantages and disadvantages of various detection methods are summarized and compared, and future development trends are discussed.

Keywords

Image Processing; Defect Detection; Artificial Intelligence.

1. Introduction

In the current industrial production, the appearance of defective products is unavoidable, and this problem has gradually become the core problem of poor product quality. The traditional methods of manual defect detection are costly, low in efficiency, and cannot meet the needs of modern mass production. Therefore, the defect detection method based on image processing was born. Compared with the traditional manual defect detection method, the image defect detection is a combination of artificial intelligence, neurobiology, computer science, image processing, pattern recognition and other fields [1,2]. It not only has low detection cost and high accuracy, but also can adapt to modern mass production. Image defect detection technology has been widely applied in industrial online detection, and has achieved huge economic and social benefits [2].

2. Application of image defect detection in smart meters

2.1 Principle

According to the color display characteristics of the electric meter, use back projection (chromaticity back projection, histogram back projection), straight line detection and other methods to locate the characteristic area; and use the projection method combined with the character position distribution law to improve the accuracy of character segmentation; finally, comprehensively consider the calculation speed and matching accuracy use the normalized template matching method to judge the existence of defects. This method can uniformly recognize the missing strokes or radicals of characters, words, letters and special symbols.

2.2 Steps

The first step is to preprocess the image. The preprocessing of the image is to appropriately transform the collected image, improve the image data, enhance some key information that is important for post-image processing, remove or weaken useless information, and improve features Reliability of extraction, matching and recognition.

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The second step is to locate the feature area. In other words, to obtain the region of interest in the image, the Canny operator is selected to extract the contour. The Canny operator is usually based on the sobel isogradient operator. It can adjust the threshold according to the actual situation. The work process includes extracting an edge image by using a high threshold and a low threshold respectively, and then combining the two edge images to generate an optimal contour image[3].

The third step is to perform Hough transform to eliminate the interference information and obtain a more precise and clear area.

In the fourth step, edge detection removes the background of the picture, and canny extracts the edge.

The fifth step is to split the characters vertically and horizontally.

Finally, the image is recognized, and the square difference matching method is used as the template matching algorithm in the recognition process. There are problems such as missing strokes in the picture. The minimum squared difference will be obtained when two characters overlap, but the squared difference obtained in these two cases will obviously be different from the case where there is no defect. This will be used to judge the existence of the defect.

3. Application of image defect detection in industrial wood

3.1 Principle

The traditional method of wood inspection is manual inspection and judgment. However, after a long time of manual inspection, it is easy to cause visual fatigue, easy to make mistakes or missed inspections, the inspection efficiency is low and the inspection quality is difficult to guarantee. With the development of image technology, automatic detection and judgment of wood defects through machine vision technology to improve the efficiency of wood production and processing is an important development direction of the current wood processing industry.

According to the digital image processing technology, the location and category information of the wood surface defects can be detected, and then the defect information can be analyzed through the intelligent search algorithm.

3.2 Steps

The first step is to obtain sufficient samples of wood surface defects, and enhance the contrast of wood pictures through preprocessing. Using Ostu algorithm and mathematical morphology processing, a smooth and complete defect area is obtained.

The second step is to train the Adaboost cascade classifier based on LBP features to locate wood surface defects [4].

The third step is to select four types of pictures of live section, dead section, worm eye, and background to establish a sample set. After extracting the feature vector of the gray-level co-occurrence matrix, select KNN, SVM, and BP neural network as classifiers to classify and compare their misidentifications rate.

The fourth step is to use convolutional neural networks to classify wood surface defects[4]. Increasing the number of convolution kernels in each layer, selecting smaller convolution kernels, using deeper network layers, and selecting the Relu function as the activation function can all improve the classification performance of the model.

The fifth step is to locate and classify wood defects by combining the two methods of Adaboost cascade classifier and CNN [4].

4. Application of image defect processing on PCB board

4.1 Principle

Using computer vision instead of human eyes to detect PCB board defects can save a lot of manpower, speed up the detection efficiency, and increase the success rate. Using the image processing

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capabilities in MATLAB, you can get the situation of the traces and solder joints, and judge whether the traces and solder joints are defective.

4.2 Steps

The first step, the image collected by the camera has Gaussian noise due to some reasons. Therefore, the system uses the mean filter of the 3×3 template to preprocess the detection PCB board.

The second step is the positioning and circle detection of the PCB board. The hough transform function is used to detect the round holes in the PCB board design (usually used for the fixed position of the PCB board, that is, screw holes).

The third step is the extraction and processing of wiring and solder joints. The contents of the PCB board mainly include: one is the wiring, copper film wrapped by green paint; the second is the silver solder joints, called solder joints; the rest; The backplane is a green paint layer, but its color is darker, which is different from the trace color. The colors of these three parts are different, so segmentation and extraction are performed based on this difference, the RGB color image collected by the image sensor is converted into a Lab color model, and clustering (K-means) segmentation is performed to extract detection points.

The fourth step, PCB board defect detection, PCB board defect detection is divided into trace detection and solder joint detection. The system adopts a matrix operation method to successfully display the defect positions of the detected traces and solder joints on the PCB board.

5. Application of image defect detection in distribution line conductors

5.1 Principle

Aiming at the detection of broken strands and loose strands of distribution lines, a wire defect detection method based on image processing technology is proposed. The shape and gray-scale features of the wires are used to extract the wires in the complex background, the wire defect features are manually extracted, and the support vector machine classifier is trained to detect the broken strands and loose strand defects in the wire region.

5.2 Steps

The first step is image preprocessing. The discontinuity of the grayscale of the edge pixels in the image is an important basis for image segmentation [5]. In order to facilitate subsequent processing, save storage space and speed up detection, 256 gray levels are used to grayscale the original image. Taking into account the influence of uneven illumination in the same image on the wires, image preprocessing is performed, filtering transformation is performed to estimate the distribution of brightness, and then the influence of illumination is eliminated, and finally the subsequent image segmentation work is performed to obtain a binarized image.

The second step, image segmentation, image segmentation is performed on the gray image after image preprocessing to obtain a binary image, where white represents the wire part and black represents the background part.

Three segmentation methods, edge detection, average gray threshold, and artificially designed threshold are used, and then fused after graphics processing to obtain a fused binary image. The edge detection method can be used to obtain the edge information of the image, which contains the straight line information needed to monitor the wire. Use Canny operator as the edge detection method to get the edge information of the image. The maximum between-cluster variance algorithm is used to find the optimal threshold in the grayscale image, and the binary image is obtained by binarization according to the threshold, thereby obtaining the wire segmentation image [5,6].

The third step is defect detection. The wire defect detection method based on the support vector machine transforms the broken wire and loose strand defect detection problem into a two-classification problem, the two-classification task of each area image without defects and containing defects , Using SVM as the classifier.

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Compared with the sliding window averaging method to delimit the threshold of normal or defective areas, SVM has machine learning capabilities and can automatically learn the inherent characteristics of defective areas. The traditional manual feature selection method is used to extract image features, then the SVM classifier is trained, and finally the trained model is used to complete the defect detection task. If there are no defects, the small images of normal wires are recorded as positive samples, and the small images containing wire defects are recorded as negative samples. Since the normal area of the wire is far more than the defect area, in order to avoid the imbalance of the positive and negative sample ratio. Using the data enhancement method, fine-tune the location of the broken strands and loose strands for multiple cropping, to obtain negative sample images with slight differences in the same defect.

For positive and negative samples, feature extraction and labeling are performed to construct a feature matrix. Using the feature matrix of the training set to train the SVM classifier, find the parameters that make the loss function reach the optimal solution, and get the SVM classification model. A positive sample in the area image indicates that the wire is normal in the area, and a negative sample in the area image indicates that there is a wire breakage defect in the area. Finally, record the coordinates of the defect area and mark the location of the defect in the original image.

6. Conclusion

With the continuous maturity of image processing technology, defect detection based on image processing technology is also widely used, not only in the fields mentioned above, but also in aerospace, agriculture, and military. In the aerospace industry, the defect detection of some sophisticated aerospace equipment cannot be done manually. At this time, more advanced scientific detection technology is needed to support it. For different detection objects, the algorithms used for image defect detection are also different.

The same algorithm may be suitable for different objects; the same object may also have different detection algorithms. Therefore, the performance of the detection system will be affected by many factors. The hardware module involves a variety of image processing algorithms. Each step of the algorithm directly affects the reliability of the detection system. Finding a suitable and useful algorithm is of challenge for researchers. Continuously improving the accuracy and execution efficiency of the algorithm, making the image defect detection technology more automated and intelligent is still the current researcher's research institute.

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