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Rubber hose surface defect detection system based on machine vision

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Rubber hose surface defect detection system based on machine vision

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Abstract. As an important part of connecting engine, air filter, engine, cooling system and automobile air-conditioning system, automotive hose is widely used in automobile. Therefore, the determination of the surface quality of the hose is particularly important. This research is based on machine vision technology, using HALCON algorithm for the processing of the hose image, and identifying the surface defects of the hose. In order to improve the detection accuracy of visual system, this paper proposes a method to classify the defects to reduce misjudegment. The experimental results show that the method can detect surface defects accurately.

1. Introduction

In order to ensure the quality of production, defective inspection of the rubber hoses on the production line and elimination of non-conforming products is required in the automotive hose production process. In the automotive hose production enterprises, the evaluation of the quality of the rubber hose is mainly based on the manual detection. According to their own experience, they determine whether there are defects and what kind of measures is needed. There is an impact of manual factors on the online production.

With the rapid development of computer technology, machine vision technology has been widely used in the measurement of industrial online detection [1]. The machine vision method to detect defects is the focus of current research, and in practice it has been well applied [2]. Because of the variety and size difference of the surface defects of the hose, the existing traditional method has the following drawbacks, 1) algorithm is not strong adaptable, and the error rate of the defect is high, 2) It requires high ambient light, which needs the suitable light source environment, 3) the recognition accuracy is poor which cannot the identify a particular flaw.

In this paper, a method of detecting surface defects of rubber hoses based on machine vision is proposed. To identify the different kinds of defects of the rubber hose, this paper defined two kinds of surface defects (bright spot, scratches), classified and quantified the above defects. The experimental results show that the method has high accuracy and validity.

2. Design of the detection system

According to the production characteristic of the automobile hose, the defect detection system is designed on the rubber hose production line, and the image acquisition of the rubber hose surface is

carried out by using the stable characteristic of the production line to realize online detection. The system includes two parts of hardware system and software algorithm.

The quality of the image will be affected by the quality of the light in the axial component such as the hose. The annular illumination is arranged around the hose to detect surface defects effectively. In addition, because the angle of the CCD camera is not enough to the image quality of the edge of the axis component, the image is collected in four directions, and the image is processed in each direction by the high-quality part of the image, in order to improve the detection accuracy [4]. The system is shown in Figure 1.

Figure 1. The inspection equipment's appearance.

2.1. Hardware system composition

The hardware system mainly includes industrial camera, light source and computer. The overall structure of the detection system is shown in the Figure 2. The image quality of object in machine vision system depends on the light environment, background and other factors [4]. In order to meet the requirement of accuracy and detection speed, it is very important to select the hardware parameters.

(1) CCD camera. According to the inspection requirements and operating conditions, the selected CCD camera is Dalsa A-CAM-GM1280-03. Its Pixel size is 3.75 μm. And its resolution ratio is 1280*960.

(2) Light source. In order to get a clear and contrast-high picture, and to meet the structural design requirements of testing equipment, the red ring light source is used, where hose through the middle of the light. After adjusting the distance according to the actual installation condition, the system can obtain the image which conforms to the expectation.

(3) computer. As the carrier of the image processing software, the computer mainly completes the processing process of the algorithm and the display result. As the terminal of detection system, in order to improve the acquisition and processing speed, high performance industrial computer should be chosen.
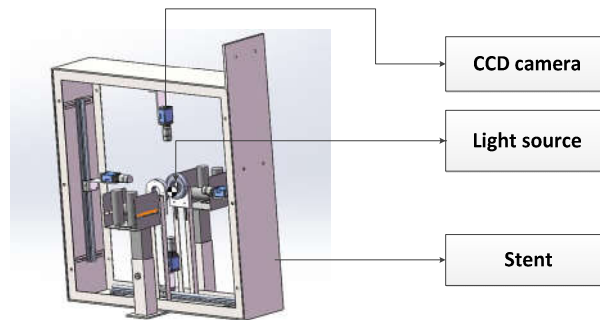
Figure 2. CCD cameras layout diagram

2.2. Image processing

This system adopts Halcon and C + + programming to realize the process of image acquisition and processing. Image processing algorithm is the core of detection system, which includes image filtering, morphological denoising, threshold segmentation and defect recognition [5]. The system software flow chart is shown in Figure 3.
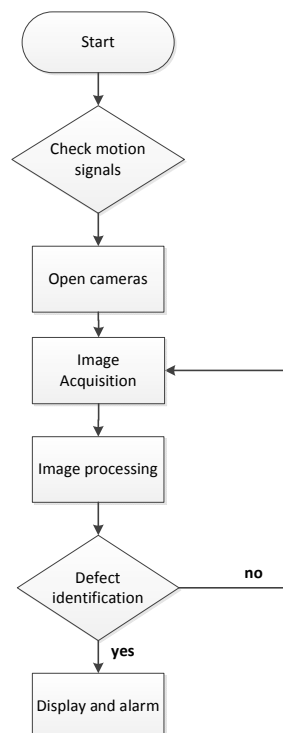

Figure 3. System software flow chart.

In the processing of the burr and noise of the hose, the morphological operation of the image after pretreatment is an effective method [6]. The morphological operation of the image mainly includes expansion and corrosion. In this paper, the corrosion method is used for morphological treatment.

After analysis, it can be found that the junction of the mandrel of the rubber hose is connected with the knot. Compared to the regular shape of the hose, the width of the hose junction will become small, and will affect the identification of the rubber hose defects. Therefore, an important process is to realize the extraction of the hose area and eliminate the influence of the junction on the image processing. The method used in this paper is to identify the width of the hose by means of a line scan,

and when the width is reduced to 4/5 of the original, it is considered to be at the junction, and the rest part is to be treated with a rubber hose image.
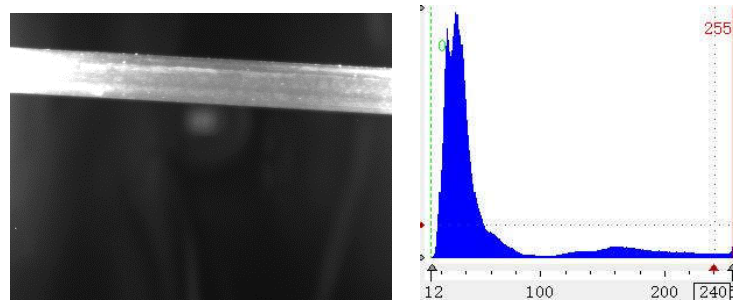

Figure 4. Image of the hose and its gray distribution

In the image segmentation algorithm, the threshold processing uses the difference of the gray value size to realize the separation of the target and the background [7], it is an intuitive and simple image segmentation method. Image of the hose and its gray distribution is shown in Figure 4. According to the actual gray effect of the image, different threshold segmentation is carried out on the surface of the rubber hose to identify different defects [8]. For the two defects of bright spot and scratches, the gray level of the bright spot and the background occupy different gray levels [9], so the threshold segmentation can be recognized directly. According to the experimental results, the threshold value of the bright spot is appropriate with 219-255. For scratches, if the image is segmented using only a fixed global threshold, the segmentation effect will be affected by the inability to take account of different images. Therefore, the method of dynamic threshold is adopted for the recognition of scratches after mean filtering. This method can select different thresholds in the bright and dark areas respectively, so that the overall segmentation effect is more accurate. According to the result of the experiment, the result of selecting the area in 200-14000 pixels is identified as scratch defect (Figure 5).
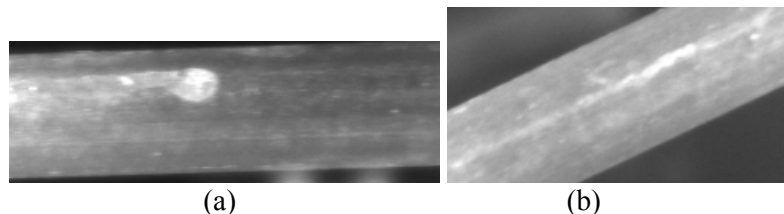

(a)   (b)

Figure 5. detects of the hose. (a)bright spot, (b)scratch

3. Results

In order to verify the correctness of the system, the hose was randomly selected as the test object, and the system was used for testing. The test results for some of these flaws are shown in Table 1.

Table 1. results of image processing

No.	Number of spot	Area of spot	Number of scratches	Area of scratches
1	2	113	0	0
2	1	186	0	0
3	55	4587	3	396
4	14	312	0	0
5	2	28	0	0
6	29	222	1	164
7	16	127	2	210
8	4	254	21	269

From the above results, it can be seen that the machine vision detection system in the detection of defects in the rubber hose is more accurate. Because of the good stability of the detection system and the single standard of the defect detection, this system can effectively avoid the subjective influence of the artificial detection. The experimental results show that the machine vision system can be applied to actual detection and has a good effect.

4. Conclusion

The traditional method of artificial detection is not only inefficient but also poor in accuracy. In this paper, a machine vision detection method for automobile rubber hose production site is put forward, which can avoid the disadvantage of manual inspection by setting up the parameters of the system. The experimental results show that compared with the artificial test, the system has the advantages, and also provides a new method for the rubber hose detection.

The system can also be ameliorated in some respects. The goal of future research is to improve the accuracy and improve the online detection speed by optimizing the detection parameters.

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