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Computer Vision based Defect Detection Algorithm for Tube-type Bottle

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Abstract:-**The paper gives a thorough insight on the various defects that occur in tube-type bottle , Glass bottles and the detection algorithm based on machine vision system. The image is processed and analyzed by image processing technology. On this basis, by comparing the original image with the template image, we can judge whether the tube-type bottle has defects such as cracks, stones, gaps, etc. In order to improve the quality of the glass bottles and the detection efficiency, a method to detect glass bottles based on the connectivity domain feature was presented in this paper. This method extracts the defect features by pre-processing the collected image and threshold segmenting the image of the bottle. The method of analyzing the aperture area and width of the connected area of the bottle mouth is used to detect the image of the bottle mouth. The matching of the connected domain pixels is used to judge whether the bottle mouth is qualified and detect the defect location. The detection rate has reached a high level as it is able to detect the defect range of the bottle with good detection accuracy.**

Keywords--- Machine vision, Connectivity Domain, Tube-Type,Segmentation

I. INTRODUCTION

Machine vision is an interdisciplinary subject involving artificial intelligence, computer science, image processing and other fields. Earlier, we used the manual inspection method for the defect detection. This method was a time consuming method which had a large overhead costs, inefficient results with a high wastage including a large human error factor. Nowadays, this method is replaced by numerous new modern methods which are based on the highly desirable automated inspection systems[3] Machine vision is to use special software to simulate people or reproduce some of the intelligent behavior related to human vision, processing and analysis of the sample images collected by the cameras. Finally, the detection results analyzed will be outputted, the results can be the specific report information, also can directly control the production process and the movement of the object to be detected[11].Glass bottle is widely used in China. Because glass has a good barrier, good appearance and durable characteristics, people preferred glass containers to hold medicines and drinks. Because of its good barrier and convenient and small appearance, the tube-type bottle has an indispensable position in the packaging of medicine and food . But in the process of manufacturing tube-type bottles, bottles on the pipeline often appear the bottle mouth crack ,the bottle body crack and so on. When using these bottles with defects after bottling, due to internal and external bottle pressure difference will bring great risk to the production process . In order to ensure the quality of the tube-type bottle, it is a critical process to test the tube-type bottle. At present, there are three kinds of methods commonly used in glass bottle defect detection at home and abroad: 1,method of the traditional manual detection;2, method of direct contact with glass bottles using mechanical device; 3. method of using machine vision detection. The traditional manual detection method increases the cost of labor and management, and the binocular judgment can easily be affected by debility and emotions, so it is unstable, and cannot guarantee the qualified rate. With the increase of the speed of the pipeline, the human eye will be limited by speed, so the manual detection method cannot meet the production needs. The method of direct contact with glass bottles using mechanical device is the most commonly used method in the early time abroad, although this method can meet the needs of production both in quality and speed, there are some shortcomings such as high equipment cost and poor flexibility, which is not suitable for large-scale manufacturing. Machine vision detection method is mainly based on the machine vision system, it has fast detection speed, high precision, uniform detection standard, it is suitable for all kinds of environmental and own high cost performance[10]. It can be found from the experimental results that the algorithm can identify the type of defects and locate the position precisely. The error detection rate is low, and the robustness is good.[1]

This method can meet the production needs and is also suitable for large-scale manufacturing The proposed approach basically uses feature extraction and feature matching operations[8]. Through analysis and comparison, defect detection of glass bottle by machine vision can improve the production efficiency while maintaining high detection

precision, save the labor force, avoid the accidents caused by the bursting of the glass bottle, reduce crisis, increase the sense of security. At present, the application based on machine vision has gradually become the mainstream in industrial production. Images taken via a real-time camera were analyzed with the image processing algorithm designed within the scope of the study and feature extraction was performed. After performing the same operations on the test images, feature matching method was used and defects on the products were detected .[8]According to the shape and physical optics resolution glass bottle mouth, the principle of shadow less lamp can be used to obtain the image information of the bottle mouth. The annular arrangement LED lamp can meet the requirements of the glass bottle mouth detection system. In the machine vision lighting system, the lighting can be broadly divided into the back lighting, forward lighting, structured light and strobe lighting. For the bottle mouth defects are surface defects ,which includes the surface of the bottle breakage, scratches or blisters and other defects, forward lighting was chosen in this paper.

II. RESEARCH ON SURFACE DEFECT DETECTION ALGORITHM OF TUBE-TYPE BOTTLE BASED ON MACHINE VISION

There are mainly cracks, stones, gaps ,headless and other defects of the tube -type bottle[12].In order to save time and improve detection efficiency, we use 4 tube-type bottles simultaneously to detect defects in the tube-type bottle. The defect detection of the tube-type bottle is done by matching with the template image to determine whether the sample tube-type bottle is abnormal or not. The template picture is a picture of a standard tube-type bottle taken in the same environment. For the generate template picture, we should do some corresponding image processing process, generating template parameters as the processing and contrast basis of follow-up tube-type bottle pictures. Before we can read the template image, we should input tube-type bottle related parameters to the computer, including bottle type, length and diameter before proceeding with consequent image processing operations on the acquired template image. By comparing the sample parameters and the template parameters, determine whether the tube-type bottle is defective. The flow chart of tube-type bottle defect detection algorithm is shown in Figure 6.After the image preprocessed, we extract corresponding parameters (including the every single tube-type bottle's position information, length information etc.).First, the prepared image is administered to the preprocessing operation, and the position information is extracted according to the standard image, and four separate vial images are obtained and numbered. Extracting tube-type bottle length parameter from these 4 images. If the tube-type bottle length parameter is compared with the standard parameter, the difference is larger than the threshold value D, indicating that the length of the tube-type bottle does not meet the standard, then the tube-type bottle is marked as defect, and record the defect sign information of 4 bottles; otherwise there is no defect. Then, the gray image of the picture to be measured is taken out from the gray image of the standard picture, and the contour of the resulting image is extracted. All the contours within each range of the bottle are sorted according to the size of the contour, if the maximum contour area is greater than the threshold S, then the tube-type bottle is a defective bottle and the defect information for the four tube-type bottles is recorded again. Finally, collect all defect position information(as long as there is a defect mark, that is defective bottle).

According to the detection requirements of the tube-type bottle, the standard length is 18.5mm, and the admissible error is ±0.25mm. In the project, the threshold value D = 10 < 20, is used as the criterion to achieve the detection requirements. Similarly, diameter of the stone is not allowed to be greater than 0.5mm, and the pixel size is 50 pixels on the image. In the project, the contour area S=20<50 is used as the judgment criterion to meet the detection requirements.

A. *Image Preprocessing*

Because of the interference of noise, light illumination, the quality of the image will be seriously affected. Through a detailed analysis of the coating defects, a set of image detection algorithms have been given[1].Therefore, it is necessary to preprocess the original image before performing the conventional image detection algorithm. The primary role of the preprocessing process is to improve image quality and reduce workload for subsequent image detection and processing. Image segmentation is done in which a mask is placed on the bearing image to detect pixel in a neighborhood with high pixel value in the image. Thus detection of defect with its location is displayed as a result. [9] Filtering is a commonly used denoising method, and filtering can filter out the noises that changes the image features to blur the image. Because of larger window will multiply the filtering time, and the larger the window, the image edge details lost more, combined with the requirements of the herein subject for the algorithm processing time, and the 5*5 window filter is used in the actual experiment.

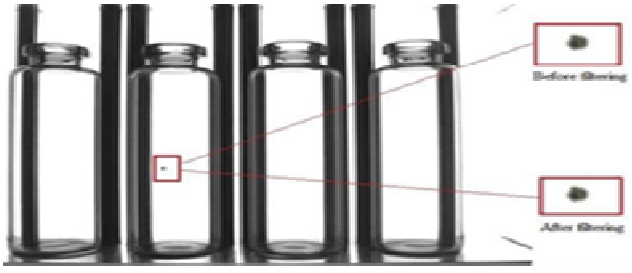


Figure 1.1. Image after filtering and local contrast before and after

B. *Local Segmentation*

The target area in each image has its own characteristics, and the image segmentation is mainly based on these characteristics and their own needs, and we extract target we want to research from it [9].the use of four control bottles at the same time, in the defect detection, you need to locate the

segmentation of four separate bottle image, and number each images which will bring convenience to consequent image processing and defect statistics.

C. Contour Extraction

The contour exists in the non-uniform structure and unstable image pixel, certainly some exists in the signal mutation [10].In the design of the subject, the computer technology and Open CV sequence is used to store the contour information. Each position of the image curve is represented by an element in the sequence. The contour of an object is different from the edge of an object. An Edge in image processing can be described as discontinuities in intensity from one pixel to another. Edge detection is one of the most useful image enhancement techniques to improve the quality of the image analysis process. The principal objective of the edge detection is to identify and classify the discontinuities in an image. However, it is very difficult to perform edge detection in noisy images since it is uphill task to distinguish both the edges and noise in the image because both of them having high frequency components[4] In short, the contour of an object is the shape of the object, which can be made up of a series of points. Edge detection highlights sharp or gradual discontinuity in the pixel intensity. Thus amount of data to be processed is significantly reduced and irrelevant information is being filtered out[9] The contour extraction of tube-type bottles is an important part of defect detection process

D. Result

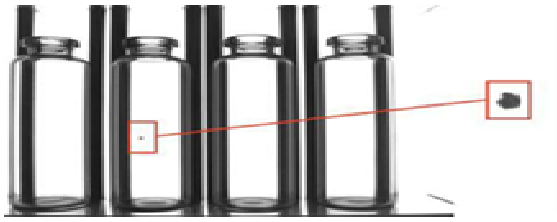


Figure 1.2. Stone defect detection drawing of tube-type bottle body

Figure 1.3. Crack defect detection drawing of tube-type bottle body.

III . THE METHOD FOR GLASS BOTTLE DEFECTS DETECTING BASED ON MACHINE VISION

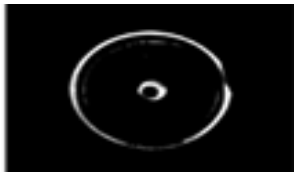
Due to the limitation of experimental conditions, different hardware and lighting factors, there are a lot of random noise in the images collected by the glass bottle mouth image acquisition device, and there are more defects in glass bottle mouth recognition. By pre-processing the image to enhance the image region of interest and highlight the image features, attenuation of random noise generated in the image, to ensure that the subsequent defect image of the bottle when the algorithm analysis to obtain a high accuracy.

Image pre-processing is an important part of image analysis. The main process includes image gray-scale transformation, binarization , image enhancement, edge detection, threshold segmentation[3][8]. The image transformation function is used to convert the image into gray scale image to meet the requirement of subsequent image processing, as shown in Figure 2 (b). Binarization makes the image appear obvious black and white effect, easy to follow the regional division, as shown in Figure 2 (c). Image enhancement mainly involves morphological processing of images[10]. After image segmentation, there will be many holes in the image of the bottle to extract the interference of the follow-up feature parameters[10]. Using open and close algorithms can effectively solve with the bottle mouth image, making the bottle profile features enhanced ,Numerous techniques of image filtering and purification have been performed to obtain the greatest amount of reliable information for the diagnosis; there are still deficiencies in the digitization and processing of data that need to be taken into account[5] To improve the detection accuracy of the bottle, as shown in Figure 2 (e).Thresholding can divide image into annular and non-circular regions by function. The white noise in the middle of the image is removed by setting the threshold median[6-8]. The impact of travelling surface acoustic waves on plasmonic devices is analyzed with a novel stroboscopic technique[7].

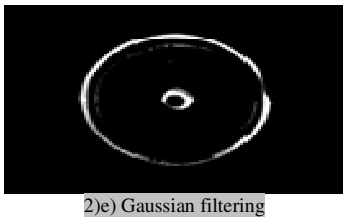
2(a) Original bottle finish image

2(b) After grayscale

2)c)After Binarization



2)d)After Morphological operation

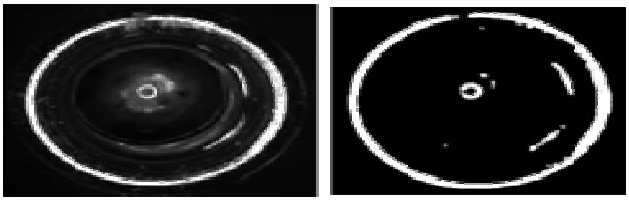


2)e) Gaussian filtering

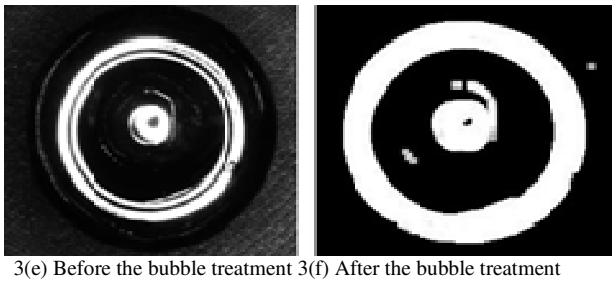
The basic principle of Connectivity Domain analysis is to determine the two detection parameters, through the detection of the parameters to determine the glass bottle breakage. The parameters are the area and the aperture Width. . Most computer vision's inspection methods exploit visual texture analysis, as texture is an important feature for surface characterization[2]. The area refers to the sum of the pixels of all the pixels in the aperture in the connected area. Intact aperture image in the aperture area of the largest connected area, if the bottle is damaged and so on, then its area will be reduced. Normal aperture should be a fixed range within a certain value. At first, to determine the mouth area, and then detect the inner and outer circle [12]. The pixel values of each point are read one by one from the outermost side. When the pixel value is 255, it is the outer ring of the aperture at this time, until the pixel value becomes 0, which is the inner circle of the aperture, record the number of pixels between this.to determine whether the bottle is normal . A method of detecting the breakage of the bottle mouth is obtained by comparing the two parameters

We select three different defective types of bottles for analysis and testing. The method of this paper is used to detect three kinds of bottle mouths: big crack, small crack and bubble. Define the detection accuracy and defect range of two evaluation criteria to analyze the algorithm. To achieve the above algorithm by Visual Studio programming.

3(a)Before the big crack treatment 3(b) After the big gap treatment



3(c)before Small cracks treatment 3(d) after Small cracks treatment



3(e) Before the bubble treatment 3(f) After the bubble treatment

Figure.3 The results of three kinds of defective bottle finish image processing

A. Results

In the experiment, 20 bottles and 50ml bottles were used for the defect detection. The test was repeated 3 times per bottle .The detection results are shown in Table 1.

Table 1 Test data for bottle finish testing

Types of bottles	Quantity	Number of successful tests	Number of detection errors	Detection Rate %
20mlQualified bottle	141	140	1	99.3
20mlDefect bottle finish	6	6	0	100
50mlQualified bottle	136	133	3	97.8
50mlDefect bottle finish	14	13	1	92.9

Through the data in the chart, the bottle detection test on the bottle of the detection rate reached 97.3%.There are some examples of unsuccessful detections, because part of the defect due to the bottle when taking pictures there are some problems, the number of bottles detected is not a great base, affecting the detection rate. Errors are the inescapable quantities which must be resolved in order to achieve an efficient result and best quality[3].

Using the above method to detect the defect location, respectively, the scope of the three gaps, as shown in Figure 4.

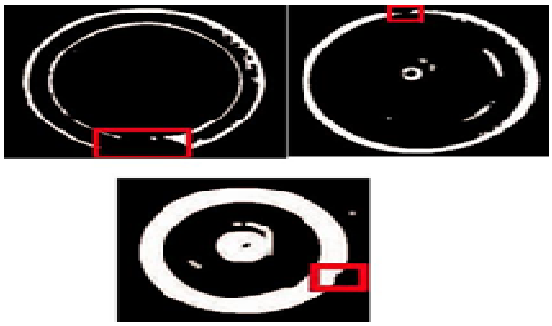


Figure 4 The range of defects detected by the rapid detection Method

V. CONCLUSION

Through a large number of experimental contrasts proposed based on the connectivity domain feature-based visual measurement method for high detection rate, repeated detection of 20ml and 50ml glass bottles, the normal detection rate reached 99.3% and 97.8%, 20ml bottle defect detection rate reached 100%.The visual measurement system ,which based on the connectivity domain features has high accuracy and high speed to meet the requirement of glass bottle detection, has a certain economic value.

The paper mainly studies the defect detection algorithm of tube-type bottle, and clarifies the working process of tube-type bottle defect detection. According to the standard template tube-type bottle images and the corresponding parameter information, the image processing algorithm carries out a series of processing on tube-type images which collected by camera and to be detected. By comparing the parameter information between the template tube-type bottle and the detection tube-type bottle, the defective bottles are finally detected and the defect types and the location of the tube-type are determined, the result is also output.

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