

Research on Visual Inspection Technology of Automatic Medicine Packaging Machine under the Background of Great Health

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Abstract

Machine vision is an interdisciplinary subject involving many fields. Compared with traditional manual inspection, visual inspection has the advantages of high detection accuracy, high efficiency, safety, low cost and nondestructive inspection, so machine vision technology has received great attention and attention in the industrial field. Firstly, this paper analyzes from the background of great health, and has a full understanding of the research status of machine vision technology in the field of drug packaging by reading a large number of documents. Then, the paper briefly introduces the function and system structure of the automatic medicine packing machine, and on this basis, expounds the structure and principle of the visual inspection system of the medicine dispensing machine. Finally, the future development trend of machine vision is prospected.

Keywords

Machine vision; Automatic medicine packing machine; Visual inspection technology; image processing.

1. Introduction

With the development of the domestic pharmaceutical market and people's increasing attention to health, the pharmaceutical industry has ushered in unprecedented development, which has intensified the competition in the pharmaceutical industry and improved the level and quality of the whole industry, thus driving the development of the pharmaceutical packaging industry, making pharmaceutical packaging a very active branch with high technical content and good economic benefits.

In the process of packaging, there will be cases such as drug missing, defect, stain and mosquito adhesion, so the quality inspection of drug packaging has become an important link in the production process of pharmaceutical industry. At present, many domestic pharmaceutical manufacturers still use manual monitoring to detect the quality of drug packaging. Manual selection method requires human eyes to keep an eye on the dense drugs on the assembly line, which is labor intensive. Because manual visual inspection will inevitably be affected by personal eyesight, emotion, light and other factors, it has great personal subjectivity, so it is difficult to unify the detection standards, with low detection efficiency and great sorting differences.

With the development of artificial intelligence field becoming more and more mature [1], it is bound to spread all over the fields of human life, and machine vision, as an important part of artificial intelligence, as the eyes and brain of artificial intelligence, is bound to be one of the key directions of future development [2]. Machine vision technology is a high-tech integrating modern computer, optics and electronics technology, which uses computers to process the images collected by the system, analyze the information and make corresponding judgments

and controls [3-4]. The function of machine vision is to simulate human vision, and it can simulate a part of functions of human brain, objectively check images and obtain information, so as to achieve the function of detection. The most important thing is to eliminate subjective factors of manual detection and reduce detection errors. In this paper, the visual inspection technology of automatic medicine packaging machine under the background of great health is summarized.

2. The Concept of Machine Vision

Machine vision is a technology that realizes the image acquisition process through sensing technology or other non-contact technologies, and then obtains signals after image processing, and then controls PLC and other control modules to make processing. Machine vision is an interdisciplinary subject involving computer science, image processing technology, artificial intelligence, pattern recognition, photoelectric sensing technology and control theory [5]. A complete industrial machine vision inspection system should include industrial cameras, industrial lenses, industrial light sources, photoelectric sensors, image processing devices and reject devices, etc. [6-7].

3. Advantages of Machine Vision Technology

Due to the slow development of machine vision technology in China, most drug manufacturers still stay in the traditional manual inspection stage. Manual inspection can not really meet the needs of industrial production lines in terms of inspection accuracy and speed, and because of the large consumption of manpower, the production cost of enterprises is increased. The defects of traditional manual inspection are as follows:

- (1) Manual detection is easy to be influenced by human subjectivity, and it is easy to have missed detection and false detection, and the accuracy of drug detection results cannot be guaranteed;
- (2) In the pharmaceutical production industry, the industrial production line is running at high speed for a long time [8], and the traditional manual detection method can not meet the real-time detection requirements of the production line at all, nor can it achieve the level of industrial automation;
- (3) General industrial production lines are built indoors, and the on-site environment is harsh. Manual work on the production line continues to be high-intensity, and the eyes will be affected by light sources, which will also do great harm to human health;
- (4) The cost of manual labor is increasing, and the trend in recent years is doubling. The traditional manual testing method will also double the manufacturing cost of pharmaceutical manufacturers;

Machine vision technology uses non-contact method to obtain image information in real time and quickly, and uses image processing algorithm to detect and judge the products in industrial production line [9]. Its advantages completely make up for the defects of manual detection. The advantages of machine vision technology are summarized as follows: accuracy, high efficiency, objectivity, repeated detection and low cost.

4. Structure Principle and General Design Requirements of Visual Inspection System for Automatic Drug Packaging Machine

4.1. Structure Principle of Vision Inspection System

The inspection system based on machine vision is a non-contact, high-precision and high-speed inspection system, which is widely used in the industrial field. Different components are used

in different systems, but the inspection system usually consists of industrial cameras, light sources, optical lenses, image acquisition cards, industrial computers, intelligent inspection software, actuators, and products to be inspected. The schematic diagram of the inspection system is shown in Figure 1.

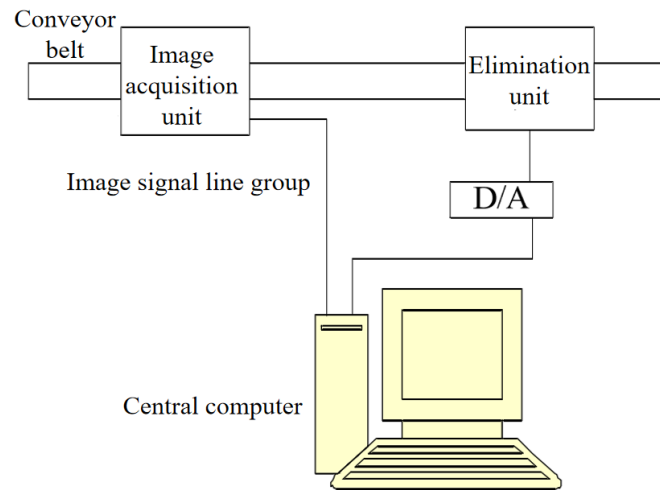


Figure 1. Schematic diagram of detection system structure

4.2. Design Requirements of Visual Inspection System for Automatic Drug Packaging Machine

According to the requirements of the project and the actual pharmacy packaging environment, the design requirements are mainly considered from four aspects, namely, testing speed, testing accuracy, light source illumination and testing stability. Specific design requirements are as follows:

- (1) The detection speed is not only determined by the speed of computer, but also influenced by the speed of production line and the performance of recognition algorithm and optical imaging system. Comprehensive consideration is needed to optimize the system performance.
- (2) In order to improve the detection accuracy, it is necessary to adjust the angle between the center line of the camera and the center line of the light source, the height of the camera and keep the camera perpendicular to the packaging bag.
- (3) Light source and lighting conditions are the key to the success or failure of visual inspection system. According to the actual requirements of the project, aiming at the reflective characteristics of pharmaceutical packaging bags, CCS diffuse reflection coaxial lighting source can be designed to reduce the reflective performance of packaging bags and improve the accuracy of algorithm operation.
- (4) The stability of detection requires not only the timely packaging of drugs by the actuator, but also the proper and accurate collection of information by the camera and the stable operation of detection software.

5. Analysis of Key Technology of Vision Inspection

5.1. Tablet Image Preprocessing

The result of image preprocessing has a very important influence on the later image recognition and understanding. Image denoising is an important research content of image preprocessing. Statistically speaking, noise can be regarded as a random variable expressed by probability density function, which can be divided into Gaussian noise, impulse noise, and classical filters for removing the above noise are as follows:

- (1) Gaussian filtering

Gaussian filter is a kind of linear smoothing filter, which is widely used in image processing, especially for eliminating Gaussian noise. To put it simply, Gaussian filtering is the process of neighborhood weighted average of an image, and the value of each pixel in the image is obtained by weighted average of all pixel gray values in the neighborhood including itself. The specific operation is as follows: scan the pixels in the image in turn with a specific template, and use the gray weighted average value of pixels in the neighborhood calculated by the template as the value of pixels in the image in the template, which is also called mask or convolution. The template used by Gaussian filter is Gaussian kernel, whose mathematical basis is two-dimensional Gaussian function and discrete $(2k+1) \times (2k+1)$ -dimensional Gaussian convolution kernel H , and its element calculation is calculated according to the following formula:

$$H_{i,j} = \frac{1}{2\pi\sigma^2} e^{-\frac{(i-k-1)^2 + (j-k-1)^2}{2\sigma^2}} \quad (1)$$

(2) Mean filtering

There are many forms of mean filter, such as arithmetic mean filter, geometric mean filter, harmonic mean filter and inverse harmonic mean filter. The arithmetic mean filter is the most commonly used one, and its main idea is to use the gray mean value of pixels in the template as the gray value of the current pixel. For the center point (x, y) , the image window S_{xy} with the size of $m \times n$ template, and the value of the point (x, y) after average filtering is:

$$g(x, y) = \frac{1}{mn} \sum_{(s,t) \in S_{xy}} f(s, t) \quad (2)$$

Mean filter can suppress noise by simply smoothing the local image, but it also inevitably blurs the image.

(3) Median filtering

Median filter is a typical nonlinear filter based on neighborhood gray order statistics. The basic idea is to sort the gray levels of pixels in the template area, and use the median gray level of pixels in the template area as the center and the gray level of pixels. The mathematical expression is:

$$g(x, y) = \text{median}_{(s,t) \in S_{xy}} \{f(s, t)\} \quad (3)$$

Median filter causes less blur than linear smoothing filter in the same size. Median filter can suppress all kinds of random noises well, especially for unipolar or bipolar noises, so it has been widely used.

5.2. Image Segmentation and Edge Detection

Since the detection object of the automatic medicine packaging machine is the packaged blister tablets, the quality problem in the packaging process is mainly the breakage and missing of the packaged tablets, and the feature that can best reflect its defects according to the shot images is the edge information of the tablet images. Therefore, the adoption of appropriate image segmentation and edge detection methods directly affects the detection efficiency and success probability of the system, has a great impact on the subsequent detection and classification

methods, and is also one of the important factors for the operation of the whole detection system.

5.2.1 Image segmentation

Image segmentation is a processing technology that divides an image into several meaningful regions, and its essence is the process of classifying each pixel [10]. Image segmentation algorithms are generally based on two basic characteristics of gray value: discontinuity and similarity. Such as thresholding, region growth, region separation and polymerization. Therefore, image segmentation algorithms can be divided into two categories: gray threshold segmentation method based on metric space and segmentation method based on spatial region growth. For machine vision system, the gray threshold segmentation method based on metric space is more suitable [11].

Image thresholding segmentation is one of the most commonly used and simplest image segmentation methods, which is especially suitable for images where the target and background occupy different gray levels [12-13]. It can not only greatly compress the amount of image data, but also greatly simplify the analysis and processing steps. Therefore, in many cases, it is a necessary image and processing process before image analysis, feature extraction and pattern recognition.

The purpose of image thresholding is to divide the pixel set according to the gray level, and each subset obtained forms an area corresponding to the real scene, with consistent attributes in each area, while the layout of adjacent areas has such consistent attributes. Such division can be realized by selecting one or more thresholds from the gray level.

Let the original image be $f(x, y)$, find the characteristic value t in $f(x, y)$ according to certain criteria, and divide the image into two parts. The divided image is:

$$g(x, y) = \begin{cases} b_0 & f(x, y) < t \\ b_1 & f(x, y) \geq t \end{cases} \quad (4)$$

If we take $b_0 = 0$ (black) and $b_1 = 1$ (white), then $g(x, y)$ becomes a segmented binary image. The commonly used methods to select thresholds are: p- quantile method, iterative method, maximum variance between classes method and so on.

5.2.2 Edge Detection

The edge refers to the part where the local intensity changes most significantly. Edge mainly exists between target and target, target and background, region and region (including different colors), which is an important basis of image texture features and shape features. The essence of edge detection is to use some algorithms to extract the boundary between the object and the background in the image. There are three common edges: step edge, pulse edge and roof edge. Generally speaking, the gray level change along the edge direction is gentle, while the gray level change along the edge normal direction is sharp. When the gray value transition at the edge is sharp and the noise in the image is small, the detection effect of the first-order differential operator is better. The second-order differential operator has high accuracy in edge location, but it is more susceptible to noise than the first-order operator.

Color image edge detection based on Canny algorithm: A color image has three channels, and each color channel has 8 bits. Three channels of RGB color image are separated into R channel, G channel and B channel, each channel has 8 bits, and then Canny edge detection based on the maximum variance between classes is carried out for each channel. Finally, the three channels after edge detection are fused by combination operator to obtain the final image.

Three-channel images are combined by 2- norm (Euclidean norm) to form the final image. Euclidean norm can be adopted, which is defined as follows:

$$\|f(i, j)^2\| = [f_R^2(i, j) + f_G^2(i, j) + f_B^2(i, j)]^{1/2} \quad (5)$$

In which $f(i, j)$ is the final fusion image, f_R is the R channel image, f_G is the G channel image and f_B is the B channel image.

5.3. Geometric Feature Extraction of Target

Feature extraction refers to obtaining various useful measures or attributes from the target itself, and feature selection refers to how to find out the most effective features for classification from various features describing the object, while reducing the dimension of feature space, making the training and decision-making process fast and efficient.

In automatic vision inspection, it is a common task to extract objects with known shapes and sizes. In the visual inspection of blister drugs, the ideal single qualified tablet is a regular circle, and its radius, perimeter, area and circularity are all known information. Hough transform (HT) is a method for describing the shape of region boundary. Classical HT is often used to detect straight line segments, circles and ellipses. Generalized HT can be extended to detect arbitrary shapes [14]. It can be considered as a one-to-many mapping: one point in the image space is mapped to multiple points in the parameter space, and then the cumulative statistics are completed in the parameter space to get the local maximum.

Circle Hough transform is the most widely used circle detection method at present. The most important feature of this method is its high reliability, and it can still achieve ideal results in the state of noise, deformation and partial area loss. However, because the parameter space is a three-dimensional space, the problems of large amount of computation and large amount of storage have become the bottleneck of its application in real-time processing.

The basic circular Hough transform completes the detection task by accumulating and counting the three-dimensional parameter space coordinates (a, b, r) in formula (6).

$$(x - a)^2 + (y - b)^2 = r^2 \quad (6)$$

In which: x, y represents the coordinate of a pixel in the image, and a, b, r is the coordinate of parameter space. It is necessary to discretize the parameter space and divide it into a finite number of cells, and this cell array is called accumulation array. The circle in the image can be detected as the high value accumulation unit of the accumulation array, and the detected circle parameters are given by the coordinates of the accumulation unit. Circle detection in visible image is transformed into local extremum detection of accumulated array in parameter space.

6. Development Trend of Machine Vision

In recent years, machine vision has been applied in all walks of life for many reasons, such as business costs, technical requirements and so on. But the key point is that the visual demand in manufacturing field is the most extensive. The automation demand in manufacturing industry brings opportunities for the development of machine vision, and also injects vitality into machine vision.

At present, machine vision has a clear development route in China. First of all, in the electronic industry such as semiconductors, the demand for machine vision will show a sustained growth; In addition, compared with foreign countries, the domestic advantage lies in the large demand

for machine vision product types, which also means that the standards of machine vision are more open. As far as the visual products themselves are concerned, the image processing will depend more and more on the PC, that is to say, the traditional board products will be gradually eliminated, and the embedded machine vision products will become more and more popular [15]. The ultimate trend of the development of machine vision in China is definitely to provide integrated solutions, and the integration of software and hardware is the only way for vision.

7. Summary

In this paper, we analyze from the background of great health, and have a full understanding of the research status of machine vision technology in the field of drug packaging by reading a large number of documents. In this paper, the function and system structure of automatic medicine packing machine are briefly introduced, and the structure and principle of visual inspection system of medicine dispensing machine are expounded. Aiming at the defects of current visual inspection technology in the field of drug packaging, the algorithm to improve the inspection accuracy and efficiency is studied. Finally, the development trend of machine vision is prospected.

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