Research on Industrial Online Detection Based on Machine Vision Measurement System

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Abstract. Machine vision based on image processing has played a huge function in promoting the level of online monitoring of industrial products. It has a broad utilization prospect in the field of industrial online detection, so it has important research value. Based on this, this paper first analyses the principle of machine vision measurement system, then studies the industrial on-line detection utilization of machine vision measurement system, and finally gives the utilization and development prospect of machine vision measurement system in the field of industrial online detection.

Keywords: Industrial Online Detection, Machine Vision Measurement System, Computer

1. Introduction

With the iterative progress and development of computer tech represented by machine vision, it has been widely and deeply studied and applied in many fields, especially in the field of industrial automation detection, which greatly promotes the improvement of online detection tech. Traditional industrial on-line monitoring mainly relies on manual visual judgment, which is not only difficult to adapt to the high-speed production process, but also vulnerable to the influence of workers' mental state, work experience and other factors [1]. Therefore, there will be a high error rate and is not conducive to the improvement of detection efficiency. In this context, the emerging technologies represented by industrial image processing, computer vision and automatic recognition have been deeply studied and applied due to their outstanding advantages of high precision, high efficiency and practicability in industrial on-line detection.

In addition, with the iterative progress of high definition, digital image and pattern recognition tech, machine vision based on image processing has played a great function in promoting the level of online monitoring of industrial products [2]. Therefore, machine vision tech has broad utilization prospects and research hotspots in the field of industrial online detection. Machine vision tech integrates many disciplines and fields as shown in Figure 1, so it can effectively simulate and analyze human visual function, so as to extract and analyze effective image info from objective things [3]. The utilization of machine vision tech to online detection and measurement in industrial production can significantly promote the development of industrial production process with the advantages of high efficiency, big info and multi-function.
Figure 1. Subject and field of machine vision tech integration

The machine vision measurement system mainly realizes the signal conversion of the target image and the transmission and processing of the signal image with the help of the camera. And the machine vision system can realize the conversion of digital signals and the capture of features based on the image brightness and pixel distribution, so as to further complete the industrial online detection field control [4]. In addition, CCD camera is used to collect image features and transmit them to the image processing system, so as to realize the detection of image key info and improve the accuracy, speed and efficiency of image processing. In a word, the machine vision measurement system based on modern optics, computer graphics and intelligent signal analysis has greatly promoted the efficiency and quality of industrial online detection. Therefore, it is of great practical value to study the industrial online detection based on machine vision measurement system.

2. Research on machine vision measurement system

2.1. Image sensor and image measurement system of machine vision measurement system

The main parameters of the system, such as the sensitivity of the camera, the signal-to-noise ratio (SNR) and the image to dark ratio (CCD) are the key parameters of the system [5]. At the level of image measurement system, it mainly includes image acquisition, central control, image processing and image sensor and other related components. The system architecture is shown in Figure 2 below.

Figure 2. Framework of machine vision measurement system
2.2. Image lighting system for machine vision measurement

First of all, at the light source level, the direction of illumination can be divided into two types: direct light with small incident angle and shadow on the illuminated object, and scattered light from multiple directions without obvious shadow. Secondly, at the level of spectral composition, the composition of light, such as sunlight, consists of all the spectra from UV to IR, depending on the type of light source and the optical filter.

In addition, in the light source intensity level, the light intensity will affect the camera exposure, insufficient light will cause contrast reduction, excessive noise; too strong light will cause image saturation, energy waste and heat dissipation and other issues [6]. In all machine vision utilizations, uniform illumination is required. The illumination intensity will decrease with distance and angle deviation, which needs special consideration. And the types of light sources can be divided into different types according to the differences of light-emitting devices, geometric shapes, luminous characteristics and illumination angles. In recent years, with the advantages of rich color, high luminous efficiency, fast response, small size, small heat, low power consumption and long life, LED light source has gradually become an important part of lighting system of machine vision strategy.

2.3. Image acquisition of machine vision measurement system

The image acquisition unit of machine vision measurement system is mainly composed of imaging surface, field of view, depth of field and so on [7]. Among them, the imaging plane is the plane range of the object and its background projected to the two-dimensional image sensor plane through the lens; the range of the scene plane corresponding to the field of view and the imaging surface; the depth of field is centered on the best focus of the lens, and there is a range before and after, and the objects in this range can be clearly imaged. The lens of the original image acquisition system of machine vision measurement system can be divided into wide-angle lens, long focal length lens and medium focus lens; according to the functions of the lens, it can be divided into zoom lens, zoom lens, telecentric lens, macro lens, micro lens, UV lens, infrared lens, etc.

2.4. Video components of machine vision measurement system

As the key of machine vision system, video is related to the cooperation of camera and acquisition card, the design and debugging of video system. Video can be divided into video signal, which is the key of machine vision system, which is related to the cooperation of camera and acquisition card, the design and debugging of video system [8]. The vision system of nonstandard video signal is mostly used in industrial field, and the scanning mode of video signal is mainly in the form of progressive scanning and interlaced scanning. In addition, the important component image acquisition card transmits the image and video signal output by the sensor to the computer for processing, storage or display. Image processing tech mainly includes filtering tech, image enhancement, edge detection, feature extraction, image compression and image coding.

3. Utilization of machine vision measurement system in industrial on-line inspection

3.1. Dimension measurement of machine vision

Firstly, in the length measurement level of industrial on-line detection, the tooth length area to be measured is set in the workpiece, and the edge of the image in the area is extracted. Secondly, the edge points of the upper and lower edges are obtained by scanning the edge line by line. Then, based on the obtained edge points, the upper and lower lines are fitted respectively, and the distance between the two lines is calculated as the result of tooth length [9]. In the line measurement level, Harris corner method is used to determine the corner points; the edge is obtained by contour extraction method, and the diagonal points are accurately located with the contour info, so as to calculate the line length. In addition, at the level of circle measurement, the least square method, Hough transform method and acceleration algorithm are mainly used to measure the circle. In angle measurement, the included angle is obtained according to the slope.
3.2. Target detection and machine vision tracking system
The pattern recognition tech of machine vision measurement system is mainly the classification and description tech of various physical objects in the image [10]. Among them, for the target tracking, it is mainly to detect, extract, identify and track the moving target in the image sequence to obtain the motion parameters of the moving object, which lays the foundation for the next processing and analysis and realizes the behavior understanding of the moving target. Moving object detection in static background is mainly carried out by using the difference between adjacent frames or background difference method. The former takes the region with large gray difference between two adjacent frames, while the latter needs to establish background model and update background in advance. Its architecture is shown in Figure 3.

![Moving object detection architecture in static background](image)

**Figure 3.** Moving object detection architecture in static background

3.3. 3D reconstruction tech of machine vision measurement system
The 3D reconstruction tech of machine vision measurement system includes contact and non-contact 3D measurement. Among them, the utilization of visual 3D reconstruction method mainly includes industrial automation production and product detection, medical image 3D reconstruction and analysis, visual 3D navigation, etc. the architecture principle of the reconstruction is shown in Figure 4 below.

![The principle of machine vision measurement system 3D reconstruction](image)

**Figure 4.** The principle of machine vision measurement system 3D reconstruction

4. Development trend of machine vision measurement system in industrial on-line inspection
4.1. Utilization status of machine vision measurement system in industrial on-line inspection
In particular, the development of modern machine inspection is an indispensable part of modern industry. With the development and maturity of machine vision tech department, the training system and standards related to machine vision tech are constantly improved, and its products occupy a
pivotal position in the utilization. As an important part of modern manufacturing industry, the development of industrial on-line detection tech plays an important function and influence on improving the productivity level and production efficiency of manufacturing industry. Therefore, machine vision measurement system has a broad utilization space and scene.

4.2. Utilization trend of machine vision measurement system in industrial on-line inspection
Thanks to the unique advantages of machine vision in industrial online detection and other repetitive work, its association and organic integration with light sources, embedded systems, 3D images and other related disciplines will further enhance its development potential, and further expand its utilization space and scene. On the other hand, there is an urgent need for the tech represented by machine vision to be applied to the on-line inspection and quality control of products. In the future, with the increase of machine vision products, technological breakthrough and innovation, its utilization scenarios and the ability to deal with complex problems and scenes will also be further improved.

5. Conclusion
In summary, the machine vision system can realize the transformation of digital signal and the capture of features based on the info of the core elements such as brightness and pixel distribution of the image, and realizes the control of industrial on-line detection field. In addition, the tech can also detect the key info of image and improve the accuracy, speed and efficiency of image processing. In this paper, through the research of the machine vision measurement system, the image sensor and the key components of the image measurement system are analyzed. Through the analysis of the industrial on-line inspection utilization of machine vision measurement system, the target detection and tracking and 3D reconstruction tech of machine vision measurement system are studied. Finally, the development trend and utilization prospect of machine vision measurement system in industrial online detection are given.

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