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A study on using image serving technology for high precision mechanical positioning

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A B S T R A C T

This paper focused on using image server technology for high precision mechanical positioning. Rapid and precise positioning systems depend on the correct positions of CCD (Charge Coupled Device) video cameras, as well as on pattern matching modes. This study deals with four different positions captured by an automatic detection system employing a CCD video camera. According to a variety of hybrid image registration systems, this study proposes an entire set of methods for achieving optimal hybrid pattern matching. First, the four different position detections captured by the CCD video camera in low-resolution were examined. Next, the original position detection was carried out in high-resolution, in order to derive a precise set of CCD video camera positions. The fiducial mark (FM) was then divided into two types in the optimal option for pattern matching: the "fiducial mark" and "non-fiducial mark", which were then used for sampling. The automatic detection method is able to achieve the first pattern matching detection for recognized images. Unrecognized images or images that cannot have an FM were subjected to fine pattern matching detection. When it is not possible to find more than one FM after the proposed detection method, this suggests that the position of the CCD video camera should be reset. In this paper, the results of the experiment regarding the CCD camera precision location and the segmentation of fiducial patterns or insignificant fiducial patterns can detect and segment more unique areas and areas with unique features.

1. Introduction

In the past few years, the global demand for precision measuring systems has increased, and *automated optical inspection* (AOI) is becoming a trend in the emerging high-tech industry. The AOI is a high-speed, high-accuracy optical image inspection system; it uses precision automated machine vision as the inspection method to overcome the disadvantages of traditional manual inspection, thereby achieving the objectives of upgrading product quality, productivity and industry competiveness. Specifically, AOI is a non-contact inspection method often used in industrial processes. The relevant inspection technologies include: lens measurement, optic lighting, positional measurement, circuit measurement, image processing, and automated applications.

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Following the development of manufacturing technologies related to the semiconductor and optoelectronics industries, various electrical components are being designed which are smaller, engineered to be more precise, and developed with greater speed, precision and stability. As expected, the manufacturing industry has increasingly higher requirements for precision. As a result, the positioning of very small electrical components depends on artificial operation methodology. This current method first makes alignments using human operators, followed by artificial positioning. Long-term testing has found that the relative stability in this process is poor, and the operation is time consuming. Furthermore, the required inspection equipment is very costly.

Currently, the image servo positioning system is composed of components with high stability: an industrial camera (CCD camera), a CCD alignment system, and a precision alignment feedback control module. The architecture of this positioning system is shown in Fig. 1. The CCD positioning system first manually acquires the specific aligning pattern. This aligning pattern will then be used as the standard for image mark searches. After completing a search, the aligning pattern coordinate at the center point is converted into equipment displacement; it is then sent to the aligning equipment for positioning, thereby achieving the purpose of positioning the aligning plate. The flowchart for this process is shown in Fig. 2.

Image servos have been widely applied in the printed circuit board inspection process [1–5]. A CCD alignment system must artificially cut out the special *fiducial marks* (FMs); these will subsequently be referred to as *reference fiducial marks* (RFMs). This work uses such FMs as the standard in searching for the alignment of other images [6–9]. By using the transmission mechanism to compensate for errors, accurate mark alignment can be achieved. Notably, there are many types of alignment with regard to standard types of FM; some examples of FMs are provided in Fig. 3(a).

Object segmentation is a commonly used method in automatic positioning technology. Accurately differentiating objects and backgrounds in digital images relies on object shape segmentation techniques [10–17]. Usually, these techniques are classified into three types according to the characteristics of the image's individual pixel value. The first method is called the *discontinuous method*. Algorithms belonging to this type include the gradient method [10], Sobel edge detection [10], Canny edge detection [11–13], Laplacian edge detection [10], and Laplacian Gaussian edge detection. The second method, called the *similarity method*, divides an image into similar regions according to a set of predefined rules. Algorithms for this type include: the threshold method [10], area active contour model [14], and region splitting or merging [10,15]. The third method is referred to as the *hybrid techniques method*; it integrates edge detection and the region-based method to improve image segmentation accuracy [16,17]. While these methods have all been used in object segmentation, challenges still arise in the segmentation of uncertain objects in research.

After processing with object segmentation, the FMs of the sample image can be clearly presented. The FM location is then sought according to the FMs. Image matching is the matching of features between images and FM features; the aim is to identify the region most similar to the FM. The features for image matching include color [18], texture [19–21], spatial relation [22], and shape [23]. In the past, studies have employed the gray-scale energy method [24], fast corner search method [25], and Fast Hough Transform [9]. Previously used matching cost computation [26] methods include: *normalized cross-correlation* (NCC), *sum of squared differences* (SSD), *sum of absolute differences* (SAD), and rank and census.

Currently, small delicate electronic devices can be produced and assembled quickly; in addition, each small device is diversified, or may even lack significant features. Therefore, the fiducial pattern represented by the FM cannot be found in each device set; instead, there is a set of different FMs, as shown in Fig. 3. Fig. 3(a) and (b) shows that the FM is no longer a

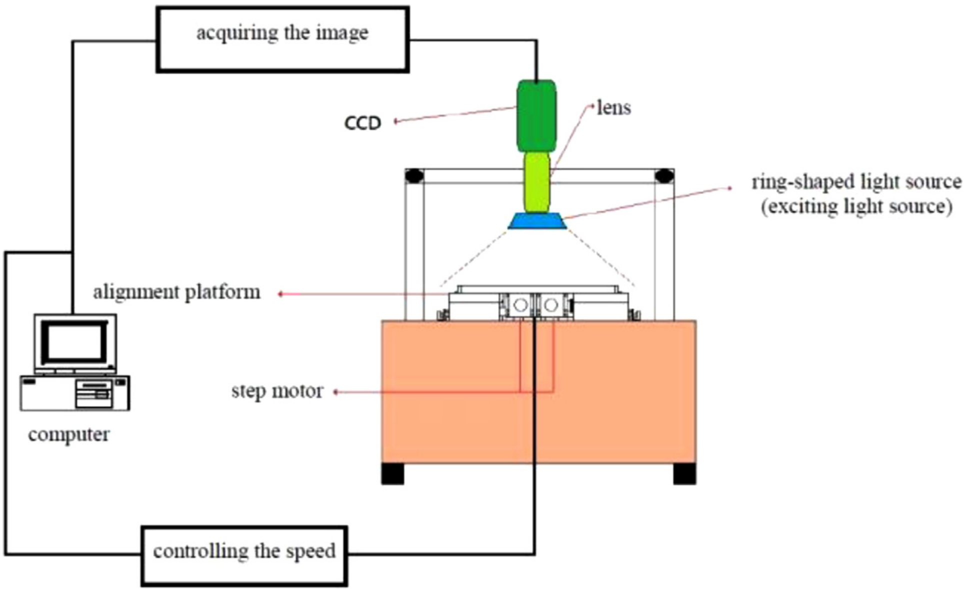

Fig. 1. Image servo positioning platform.