



Original research

LED ring array light source design and uniform illumination properties analysis



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ABSTRACT

For requirements of light source on tiny parts measurement system, this paper puts forward a single wavelength LED to design uniform light of multiple ring. According to detection principle of tiny parts, the design method of ring source is set up, as well as luminescence radiation calculation model of LED ring source. The calculation model of light illumination properties of LED ring array light source are set up and analyzed, light illumination calculation functions of ring source are derived; based on design characteristics of ring source, illumination model and calculation principles of uniform light source are analyzed, the derivation process is established in detail. Through calculation and experimental analysis, illumination uniformity distribution curve of LED ring array light source were given under different detecting plane and the horizontal distance of LED, and the contrast results of illumination uniformity in the x axis and y axis also were given, the results show that when the distances between detecting plane and LED plane are 80 mm and 100 mm, illumination uniformity of LED ring array light source can reach 0.96.

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1. Introduction

With the development of manufacturing industries, detection on tiny parts has become a research in numerous areas, especially high precision measurement on multiple processes and multiple profile parts, it has an influence on development of assembly industry such as aviation, aerospace, weapons [1,2]. To improve manufacturing and size detection of tiny parts, currently, machine visual online detection method is often used, with appropriate background light, and through image capture and processing, related size of tiny parts can be obtained. However, during detection processing on tiny parts, uniform and brightness of background light have an effect on image sharpness of machine visual system, if background light is not uniform or brightness can not meet requirement, then, detection parameters will exist errors [3], in one word, performance of background light will affect the whole system. Usually, background light contains light-emitting diodes (LED), based on properties of tiny parts, it can be square, round or ring source, by unique advantages like luminescence efficiency, compactness, security and stability of LED, it is more and more widely used in the vision field, which needs uniform illumination conditions [4,5]. In tiny parts testing system, uniform illumination and brightness of background light sources will affect the imaging resolution ratio and contrast, high contrast of detecting parts can simplify imaging algorithm, as well as improve the reliability of visual system, therefore, according to detection requirements of tiny parts, studying uniform high contrast of test system is necessary. According to seal parts image detection system, this paper studies array model on LED uniform lighting and luminescence properties of ring source.

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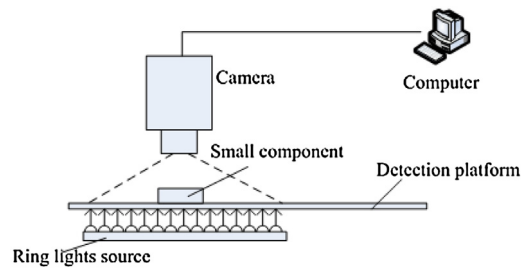


Fig. 1. Basic principle detection of tiny parts.

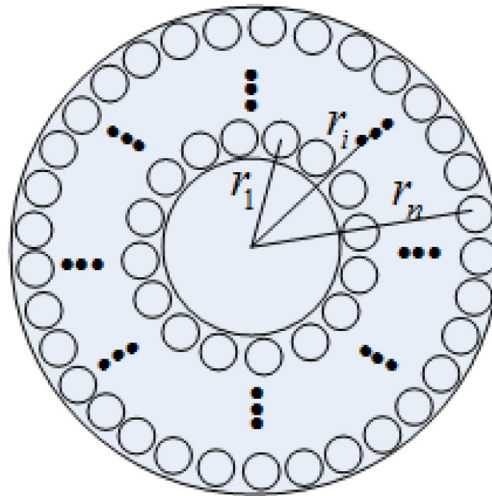


Fig. 2. Ring source.

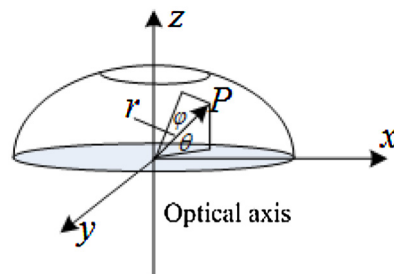


Fig. 3. Diagram of ring LED source placed in the x-y plane.

2. Array model on LED uniform lighting

2.1. Detection principle of tiny parts and ring source design

Array uniform illumination source consists of multiple light emitting diodes, according to demand, luminescence surface of source can be made ring, linear, square and spherical shape. Tiny parts are mainly round in detection, background light should be ring source to meet detection of round parts, detection principle is shown in Fig. 1, tiny parts are transferred to ring source by belt, through synchronization capture, tiny parts are shoot, size and flaws and other parameters can be obtained by image processing.

From Fig. 1, ring source need to radiate the entire component, the contrast of imaging systems is determined by uniformity and brightness of light source. To get a high-contrast image, LED with 680 nm as its wavelength is used. In Fig. 2, it is a n-ring LED, assume the LED number of every ring is l , radius is r_i , i is the number i LED, $3 \leq i \leq n$, the number of ring can be chosen according to size of tiny parts. In order to analyze uniformity of ring source, light source distribution model is built for two dimensional direction. In Fig. 3, ring LED source is placed in the x-y plane.

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