year month day
2012. 1. 12

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Abstract

Title	Study on Defect Inspection for Curved Surface with Highly Specular Reflection

(800 words)

In most manufacturing processes, the inspection of highly specular reflection (HSR) curved surfaces depends on human inspectors whose performance is generally subjective, variable, and therefore inadequate. An automatic vision inspection system offers objectivity, better reliability and repeatability and is able to carry out defect measurement to evaluate the industrial part's quality. Thus, it is vital to develop an automatic vision system to monitor surface quality on-line. The main purpose of this dissertation is to study a new defect inspection method capable of detecting defects on HSR curved surfaces. And a complete vision inspection system is created for HSR curved surfaces, especially for Chrome-plated surfaces.

In the first part of the dissertation, reflection analysis of HSR curved surface is performed. And a new method is proposed to measure reflection properties of our inspection object. Their strong specular reflection makes traditional inspection method incapable. Moreover, a numerical simulation method is proposed to investigate machine vision applications and it is very favorable to design and make a vision inspection system.

Second, a method is proposed to solve these challenges which result from various defects and complex surface topography on HSR curved surface. Based on the reflection analysis, one concludes that it is impossible to detect all defects in a single image of HSR curved surface. In the image captured under one illumination condition, some defects maybe covered by highlight regions or do not appear because defects shape or position are random. So, a set of images are captured under different illumination directions. A synthetic image is reconstructed from the set of images. The synthetic image appears to have more uniform intensity compared with the original image because those specular areas have been completely removed. Furthermore, all defects are integrated in the synthetic image. So, all defects can be completely extracted only from the synthetic image. In particular, for more complicate curved surface an improved method is proposed and kinds of experiments also validate the method.

Third, a complete vision defect inspection system has been created. The lighting system with diffuse illumination is selected to illuminate the investigation object by a set of optimal directions and it succeeds in reducing the specular reflection while enhancing defects information. System parameters and object pose are determined by comparing defect expressivity and specular ratio in the image. Moreover, all defects can be quickly extracted by combining template matching and morphology techniques. The presented automatic vision defect inspection system has been implemented and tested on a number of simulation images and actual parts (e.g. Chrome-plated curved surface).

In conclusion, this research proposed a defect inspection system for HSR curved surface, and experiments show that this system can reliably detect defects on HSR curved surface and it is robust to the shape, location of the defect.