A cascading fuzzy logic with image processing algorithm–based defect detection for automatic visual inspection of industrial cylindrical object's surface

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Abstract

This paper proposes a cascading fuzzy logic algorithm with image processing technique for defect detection and classification on the lateral surface of industrial cylindrical object using a camera and multiple flat mirrors. The finishing surface of industrial parts such as shafts, bearings, pistons, rings, and pins should be smooth within permissible limits before installation process, as the defects in these parts may damage or reduce the life of the whole machine. The optical surface inspection of cylindrical products and highly curved surfaces is quite challenging in the industrial automation, due to that it needs to be acquired with several views and subsequently combined in one view. Thus, a time–cost-effective visual inspection method with fuzzy logic–based decision making approach is developed to investigate the optical defects on the lateral surfaces of the cylindrical products. The image processing algorithm has been developed to extract the main features of the tested objects such as defects, borders, and noise. A cascading fuzzy logic algorithm with two stages has been implemented to eliminate the effect of the noise in the captured images and thereafter classify the objects into defective and non-defective objects. The 1st stage of fuzzy logic algorithm is used to eliminate the low noise from the captured images; however, the 2nd stage is used to differentiate between the big noise and defects on the objects. Results show that the defects can be detected if the ratio of detection is higher than 0.1 and the accuracy of defectiveness levels is 80%.

Keywords Defect detection · Multiple flat mirror system · Fuzzy logic · Non-destructive testing · Cylindrical object