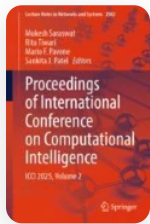


Vision-Based PCB Defect Detection Using YOLOv5 and MobileNetV2 with Grad-CAM

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Abstract

Printed Circuit Board (PCB) defects such as mouse bites and missing holes significantly impact the reliability of electronic devices. Traditional PCB defect inspection technique relies on worker experience and unreliable in accuracy and scalability. This paper presents a hybrid vision-based approach that integrates YOLOv5 for defect detection, MobileNetV2 for defect verifying and reducing false positives, and Grad-CAM for generating visual heatmaps that highlight critical defect regions. YOLOv5 efficiently identifies potential

defect locations, while MobileNetV2 acts as a lightweight classifier to ensure only true defects are identified. Grad-CAM provides interpretability by visually explaining the model’s decisions, aiding quality control operators. Performance metrics including precision, recall, and F1-score are employed to evaluate detection performance comprehensively. Additionally, a severity index is computed based on the nature of the defects according to their effect of the PCB’s function. The proposed method’s advantage in detection accuracy, false positive minimization, and effective interpretability are demonstrated. This work improves vision-based PCB defect inspection systems through a reliable and interpretable 3-level machine vision method for PCB defect detection.

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