Enhancing stencil printing in PCB production using deep learning based approach for residue classification and optimization

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Abstract

Surface-mount technology (SMT) is the technology used in the production of printed circuit boards (PCB) plays a vital role in PCB manufacturing for applications ranging from communication devices to medical systems. A significant challenge in the stencil printing process, a critical step in PCB production, is solder paste buildup in stencil apertures, contributing to 57%–71% of soldering defects. To address this issue, this study presents a convolutional neural network (CNN)-based framework for categorizing solder paste residue

levels into three classes: low, moderate, and high. The methodology involves cropping and pre-processing images of stencil apertures, which are then fed into the CNN model for classification. To enhance model robustness and prevent overfitting, data augmentation techniques, including aperture rotation, are applied, effectively increasing the dataset size and promoting generalization. The model achieves a classification accuracy of 87% during testing, with precision and recall values provided for each residue class. This approach aims to optimize the stencil printing process by enabling accurate residue categorization and facilitating targeted cleaning cycles, ultimately reducing soldering defects and improving PCB production efficiency.