

Enhancing digital intelligence: A comprehensive approach to detailed recognition of Hand-Drawn circuit diagrams

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Circuit diagrams are graphical representations of electrical or electronic circuits. Hand-drawn circuit diagrams remain crucial for brainstorming and innovation, yet engineers need to redraw them in simulation software for simulations and analysis. Recognizing details in these diagrams bridges this gap and leads to reconstructing circuits, creating better netlists and performing accurate simulations by saving resources. This study presents a comprehensive approach to recognize all the details in hand-drawn circuit diagrams using object detection and optical character recognition (OCR) techniques with raw data of a dataset by applying data converting techniques. Faster R-CNN with a ResNet101 backbone network was trained for circuit components and text bounding box detection was carried out using 1766 hand-drawn circuit diagrams with approximately 148,652 objects related to 58 object classes, including nodes and terminals. MobileNet was trained to recognize textual contents using 31,116 words extracted from the hand-drawn circuit diagrams including unit symbols like omega and micro. An improved approach based on checking overlapping between object bounding boxes was used for correctly assigning words to their nearest objects. An object detection technique was introduced to detect nodes and terminals in circuits. 50 hand-drawn circuit diagrams (including simple and complex) were tested, and we achieved 90% overall accuracy, 94.67% accuracy for components and text box detection, 89.82% accuracy for text recognition, and over 96% accuracy for text box assignment. Printed circuit diagrams were also tested and were more accurate than the hand-drawn ones. This study is the first to recognize all details in hand-drawn circuit diagrams, surpassing prior efforts focused solely on component recognition.

Key words: Hand-Drawn, Circuit Diagrams, Detailed Recognition, ResNet101, MobileNet.

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