CNN Based feature extraction

from existing PCB design and reconfiguration of PCB layout design.

EXPERIENTIAL LEARNING CENTRE
TIET, PATIALA

OBJECTIVE:

To develop a system using Convolutional Neural Networks (CNNs) for extracting critical features from existing PCB designs (e.g., from images or files) and then use these features to guide automated reconfiguration or redesign of the PCB layout.

Problem Faced:

- IMBALANCED DATASETS
- OVERLAPPING COMPONENTS AND LABEL NOISE

TECH. USED:

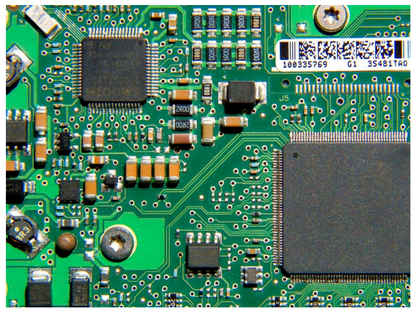
- **PYTHON :** Model training and code implementation
- **ROBOFLOW :** Image annotation and dataset generation
- **CNN :** Component detection from PCB images
- **PYTORCH :** Deep learning model framework
- **YOLO v8 :** Object detection of PCB components

Introduction

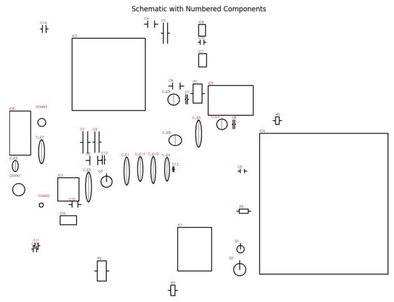
In the electronics industry, companies often design PCBs from scratch for each new product, resulting in repeated effort, time consumption, and high costs. Despite the availability of previously manufactured PCBs, the lack of tools to extract usable schematics from existing boards limits design reusability. This project aims to develop a deep **learning-based software tool** that can **identify** and **localize** components from PCB images to assist in reverse engineering. The goal is to accelerate schematic reconstruction and enable engineers to reuse legacy designs for rapid development.

Methodology

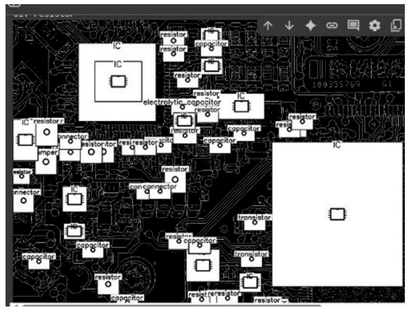
1) Input PCB Image
2) Innotation via Roboflow
3) YOLOv5 Training
4) Detection of Components
5) Extraction of Positions



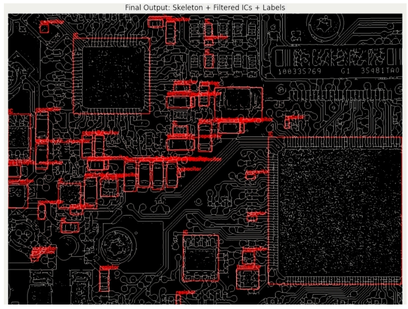
INPUT PCB IMAGE



Schematic with no. Components



COMPONENTS DETECTION



SKELETON + FILTERED ICs + LABELS

Dataset Summary

Total Images: 672 annotated PCB images
Total Classes: 8 electronic component types
Annotation Format: YOLO
Annotation Tool: Roboflow
Types of Components: Resistors, Capacitors

Model Summary

Model Used: YOLOv8-m (Medium)
Training Epochs: 150
Batch Size: 4
Framework: Ultralytics YOLOv8 (built on PyTorch)
Total Parameters: 25,844,392

Challenges Faced

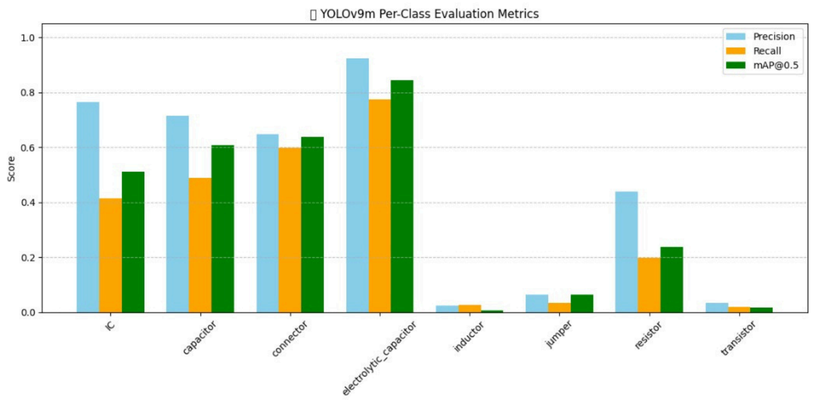
Component Overlap: Closely packed components made it difficult for the model to distinguish boundaries.

Class Imbalance: Some components (e.g., resistors) appeared far more frequently than others, affecting training fairness.

Visual Similarity: Components like resistors, capacitors, and jumpers looked visually alike, confusing the model.

Low-Quality/Blurry Images: A few images lacked sharpness, reducing annotation accuracy and model confidence.

Annotation Noise: Inconsistent annotations from Roboflow affected ground truth quality in some samples.



Conclusion

This work shows how deep learning can help detect and classify PCB components using **YOLOv8**. The model supports reverse engineering by analyzing images of real circuit boards. Despite challenges like class **imbalance** and **visual similarity** between parts, the system performs well and has practical use in industry and education.

Applications :

1) Reverse Engineering
2) Fault Detection
3) Service Centers
4) Educational Labs
5) Defense Hardware Validation

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