Chess-Board Squares Classification

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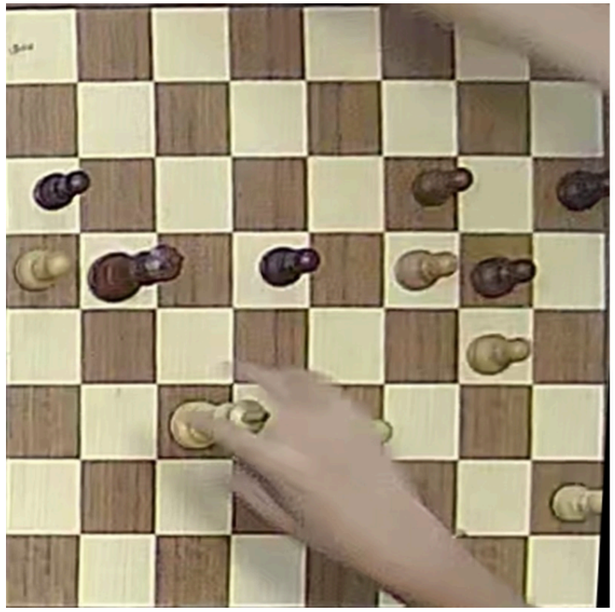
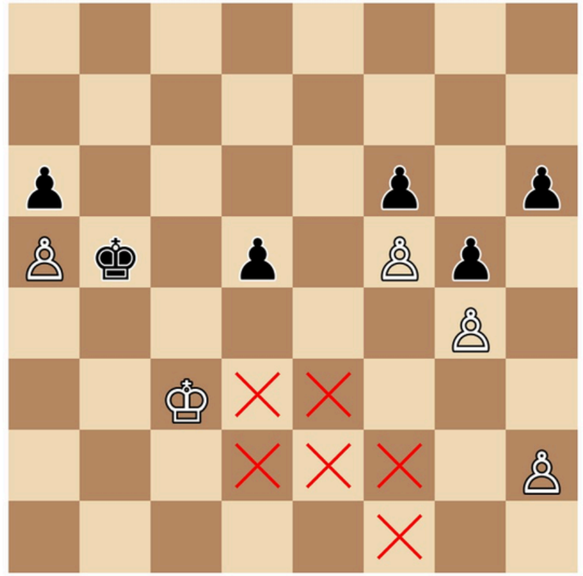
The Problem Statement

The Goal: Image → Digital Representation (FEN)

The Challenge:

- Lighting conditions: Shadows and glare.
- Image Quality: Low resolution, and motion blur reducing fine details.
- Occlusion: Hands blocking the board and the pieces.





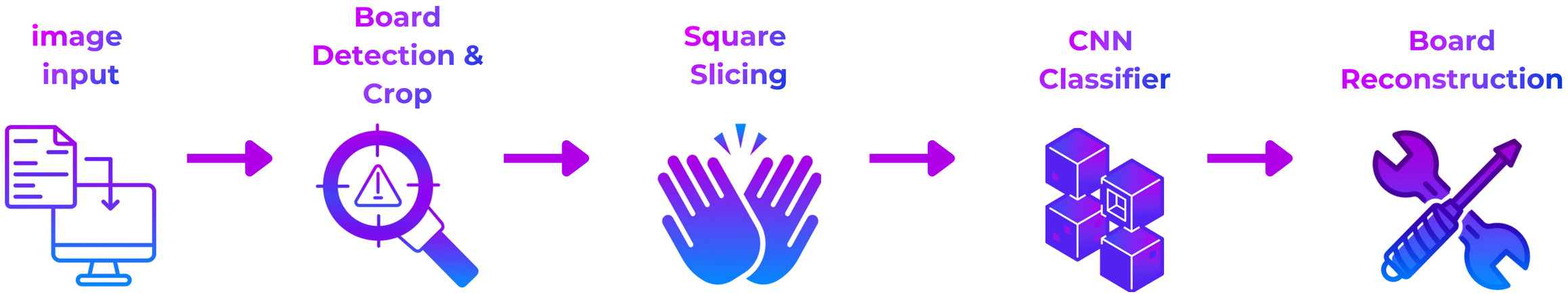
Method & Solution

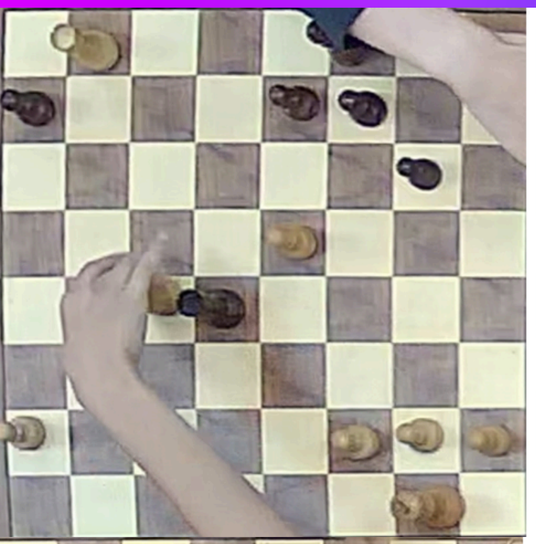
Pre-processing:

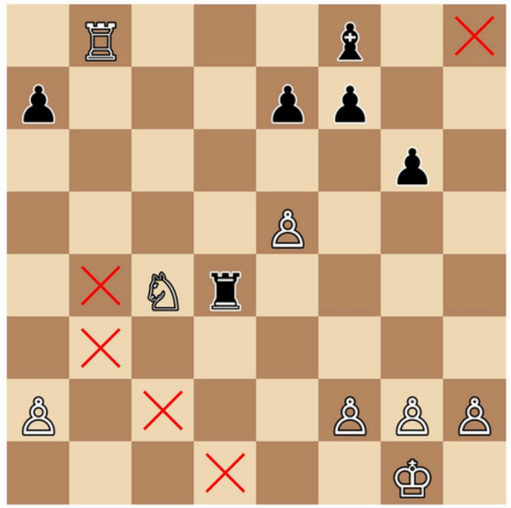
- Detect board corners using image processing contours.
- Apply Perspective Transform to "flatten" the board.
- Slice into 64 sub-images.

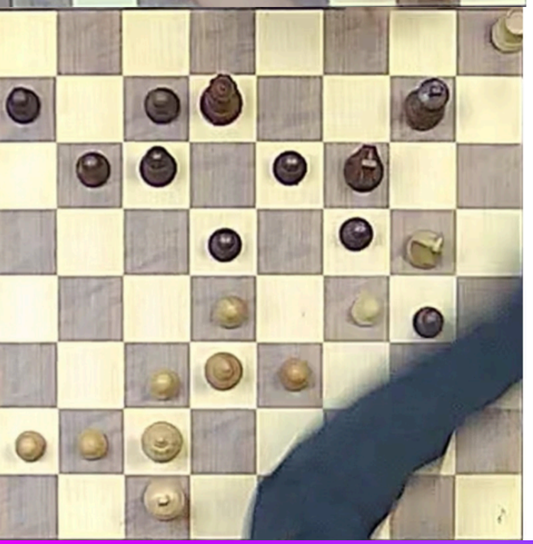
Inference:

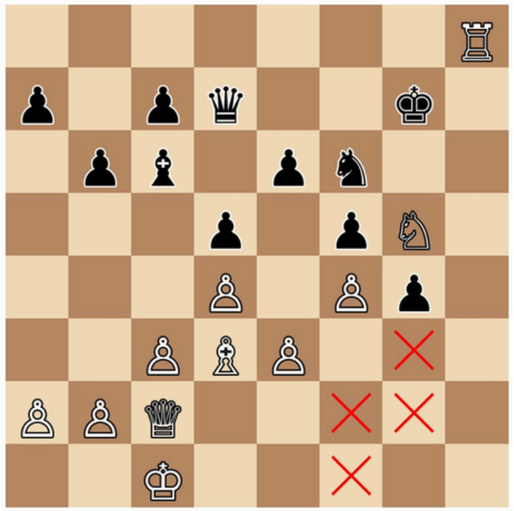
- Classify each square independently.











Model Architecture & Uniqueness

The Model:

- Architecture: ResNet18 (Transfer Learning).
- Training Data: Fine-tuned on >5,000 labeled square images.

Our Unique Approach:

- Geometric Heuristics: Handling occlusions by analyzing square corner visibility (missing corners → potential occlusion).
- Robust Data Augmentation: Applied heavy geometric and lighting transforms to ensure performance under varying real-world conditions.

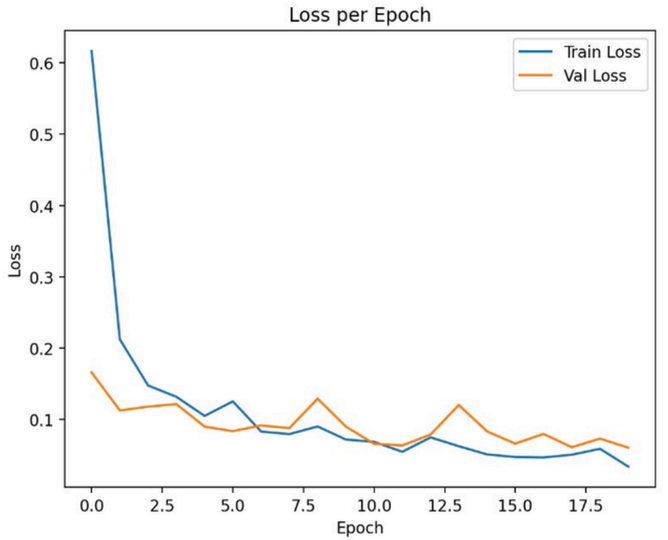
Results & Evaluation

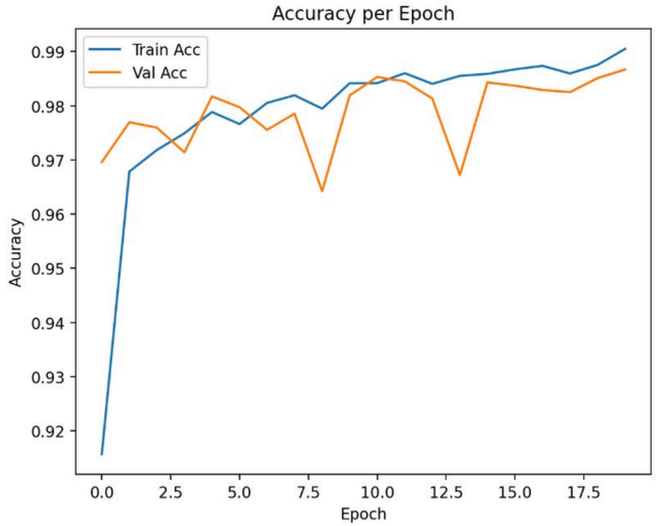
Performance:

- Test Accuracy: 98.4% (Square Classification).
- Board Reconstruction: High success rate on full boards.

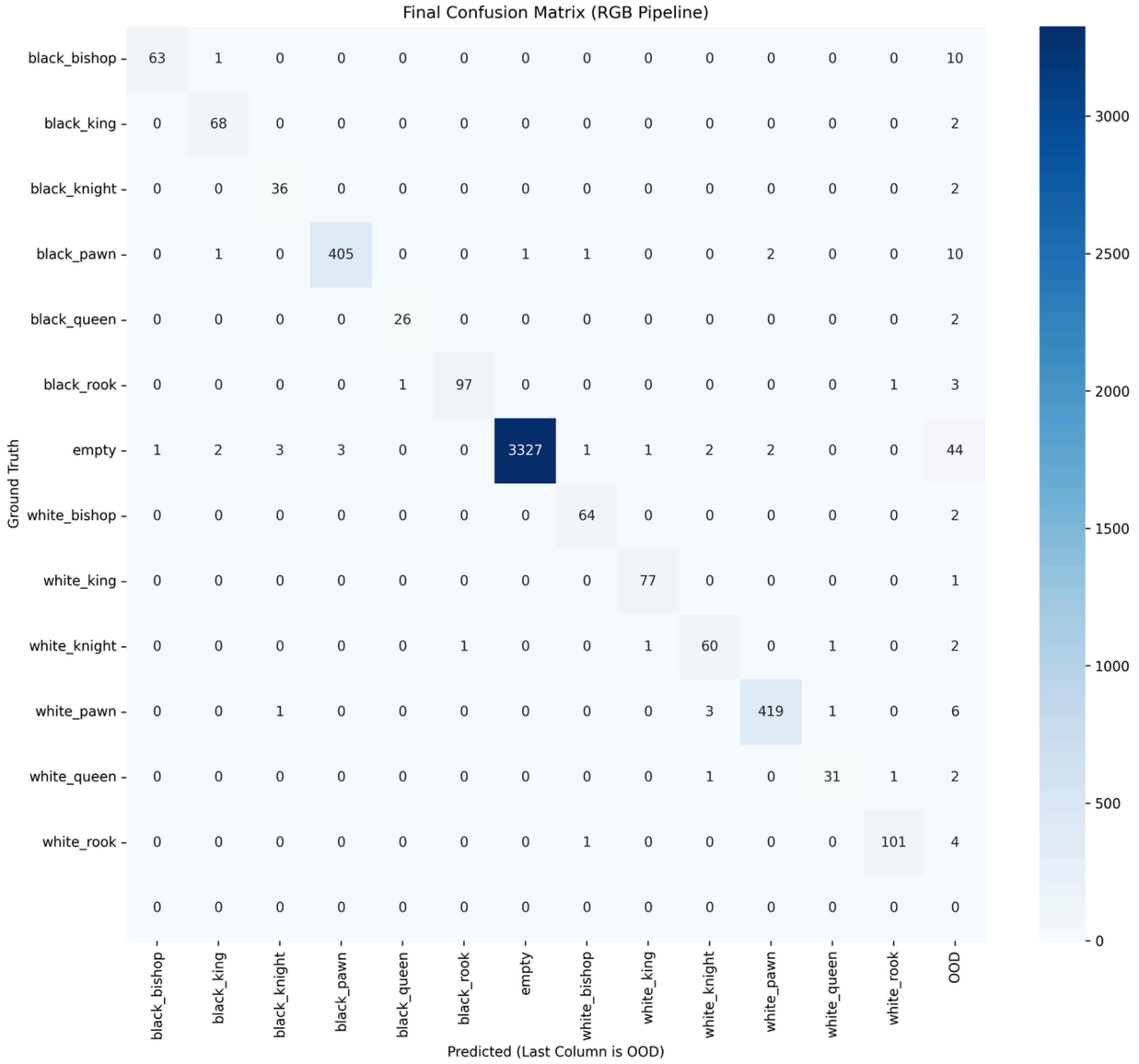
Analysis:

- High accuracy, minor confusion between visually similar pieces.
- The curves demonstrate fast convergence and strong generalization, with the validation loss.





Results & Evaluation



The strong diagonal confirms **high accuracy** across all classes. Minor misclassifications occur only between geometrically similar pieces, such as the Bishop and Pawn.

Failure Cases

Common Errors:

1. Geometric Ambiguity ("Top-Down"):
   - In 2D projection, distinct 3D features (height, cuts) are lost.
   - **Result:** High confusion rate between White Pawn and White Bishop due to identical circular bases.
2. Extreme Occlusions:
   - **Static:** Tall pieces (Queen/King) blocking the square behind them.
   - **Dynamic:** Player's hand moving across the board creates "unknown" artifacts that the model wasn't trained on.

Insights

Preprocessing Bottleneck:

- Model accuracy is strictly bounded by the board cropping quality.

Detection vs. Classification

Determining presence is robust. The real challenge is distinction between similar classes (King vs. Queen).

Detail Loss in Downscaling:

Resizing square crops to standard CNN inputs destroys fine-grained features. Small details often vanish, making distinct pieces look identical to the network.

Summary & Links

Conclusion:

- Developed a complete pipeline from raw image to digital FEN.
- Successfully handled real-world challenges like shadows and occlusions.

Project Site:

[Link to GitHub Pages]

Thank you!