

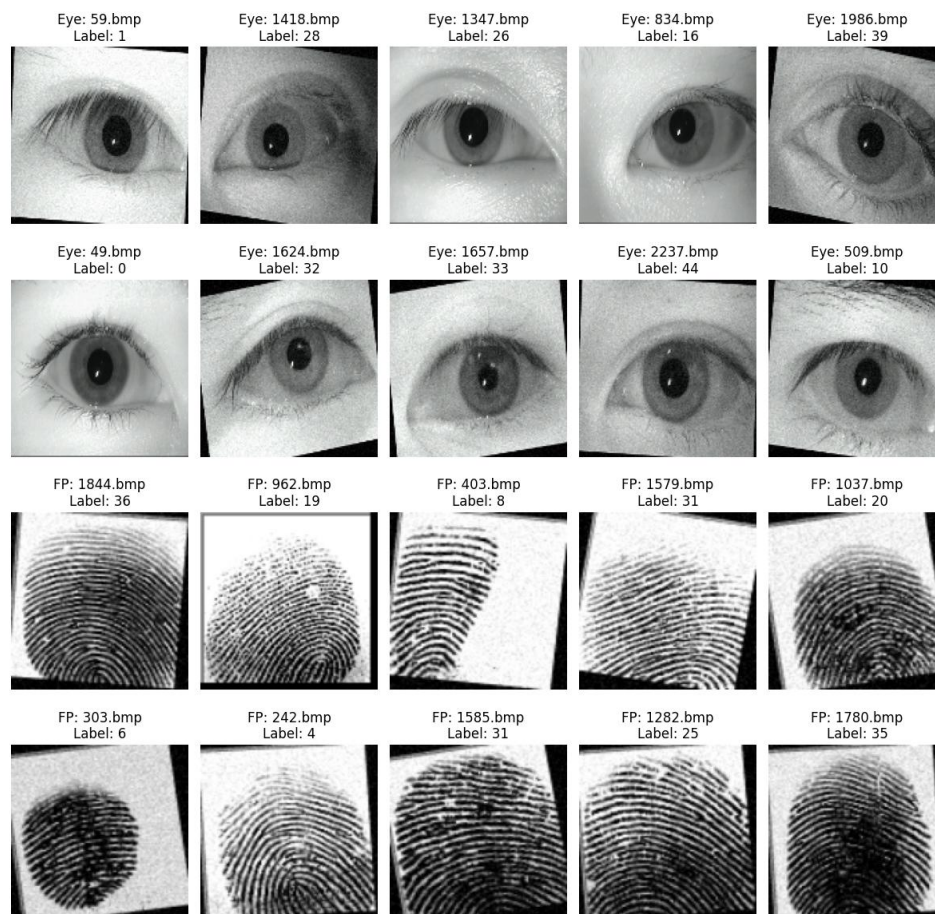
Multi-Modal Biometric Authentication using Iris and Fingerprint Images

Objective:

The goal of this project is to build a robust biometric recognition system by combining **iris** and **fingerprint** data. The system uses **Deep Learning-based Model** that authenticates users by simultaneously analyzing their **iris** and **fingerprint** images, improving identity verification accuracy through multi-modal fusion.

Dataset:

- The dataset originally had **10 images per class** for both iris and fingerprint.
- To improve model training, we applied **data augmentation** (rotation, flipping, noise, zoom) to generate up to **50 images per class** total 45 classes of each iris & fingerprint .
- 50 iris and 50 fingerprint images per user (total: 4,500 images for each modality)
- .bmp images resized to 128x128



Model Architecture:

- **Inputs:** Dual input model (one for iris, one for fingerprint)
 - **Feature Extractor:** CNN with 3 convolutional layers per input branch
 - **Fusion:** Concatenation of iris and fingerprint feature maps
 - **Output:** Dense layers leading to a softmax layer for classification into 45 classes
 - **Training:** 50 epochs, batch size of 64, optimizer = Adam, loss = categorical crossentropy
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Results:

- **Initial Accuracy (Epoch 1):** (2.4%)
- **Final Accuracy (Epoch 50):** (99.5%) (training), (97.8%) (validation)
- **Loss Decreased:** From 5.61 \rightarrow 0.06
- **Classification Report:** Shows strong class-wise precision, recall, and F1-score
- **Visualizations:** Random samples and predictions show high prediction accuracy

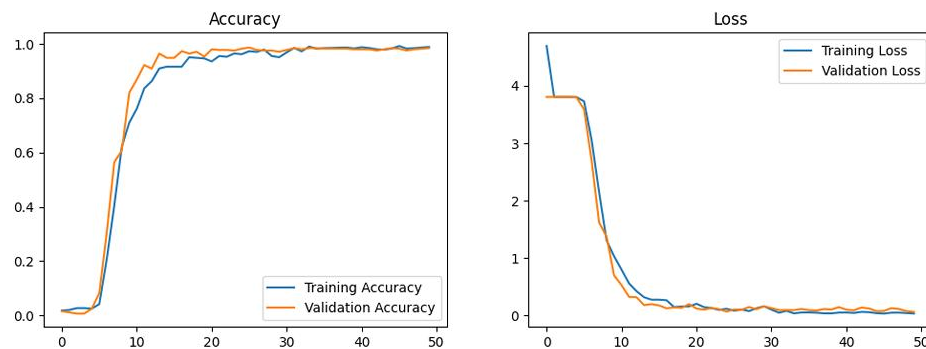


Figure 4: 6 Fingerprint and Iris Accuracy and Loss

Key Features:

- **Multi-modal fusion:** Combines two biometric traits for robust authentication
 - **End-to-end deep learning pipeline** with image preprocessing, model training, evaluation, and visualization
 - **Accurate predictions** with very low validation loss
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Conclusion:

This project demonstrates the effectiveness of **multi-modal biometric systems** by leveraging CNNs for combined fingerprint and iris-based identity verification. The model achieved high accuracy, making it suitable for secure authentication applications.