

13/05/2025

FINGERPRINT RECOGNITION

Pattern Recognition Final Project

Lecturer

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Introduction

Biometrics uses physical or behavioral traits like fingerprints, face, iris, or voice recognition to identify or verify individuals, enhancing security and convenience in modern systems.

Fingerprint A unique and permanent ridge pattern on the fingertip, commonly used for personal identification.

Fingerprint Recognition uses fingerprints for identification or verification. **1:1** matches one fingerprint, while **1:N** searches a database. It's used in smartphones, security, and law enforcement.

Problem Statement

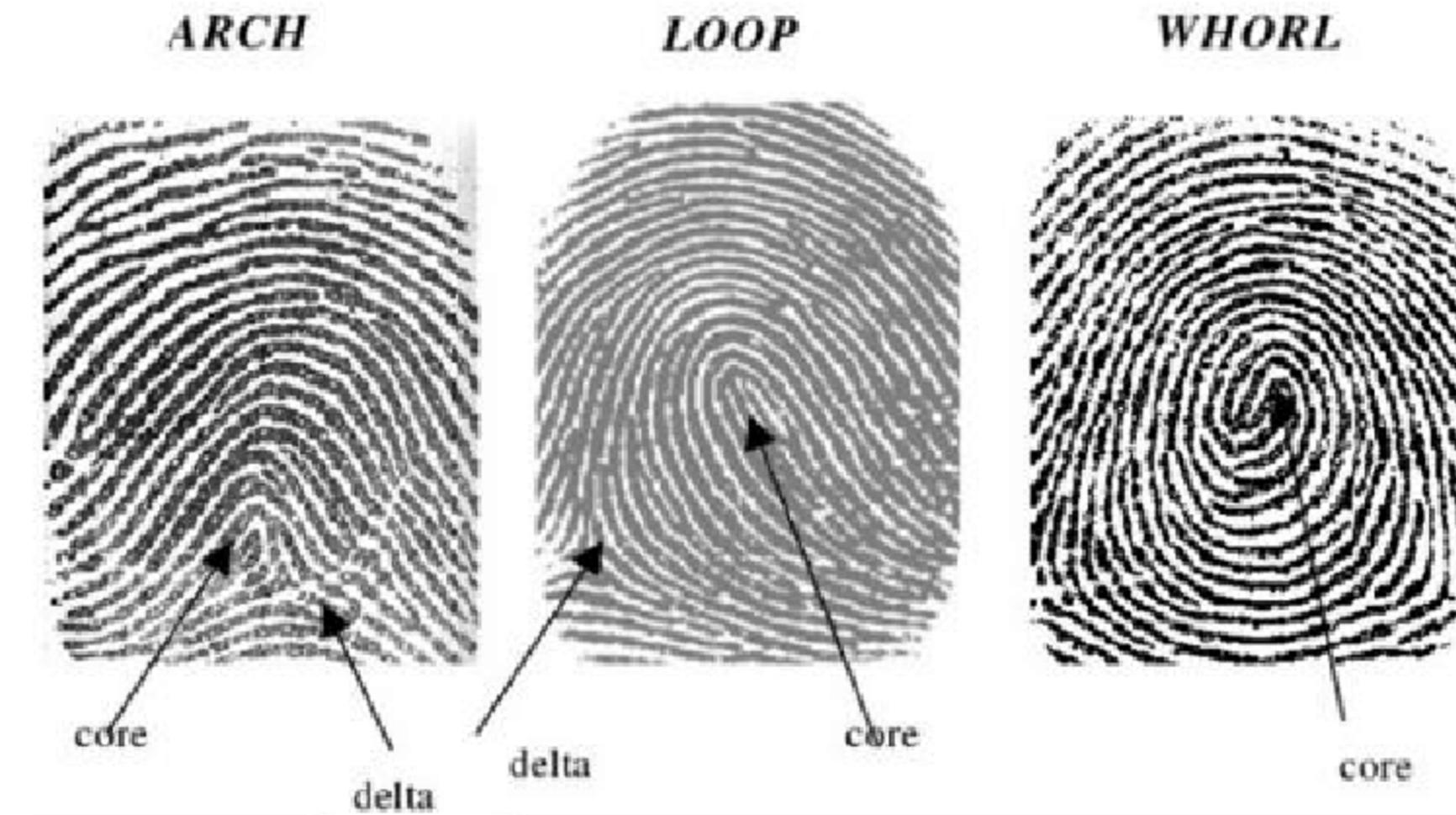
Core challenge Accurate fingerprint recognition is challenged by:

- Skin condition changes (e.g., dryness, cuts, moisture)
- Variations in pressure and rotation during scanning
- Partial or low-quality prints
- Sensor noise and distortions

Objective Design a robust and reliable fingerprint matching system to enhance biometric authentication performance across diverse real-world conditions.

Fingerprint Structure

Fingerprints consist of **ridges** (dark lines) and **valleys** (bright areas), forming three main patterns:



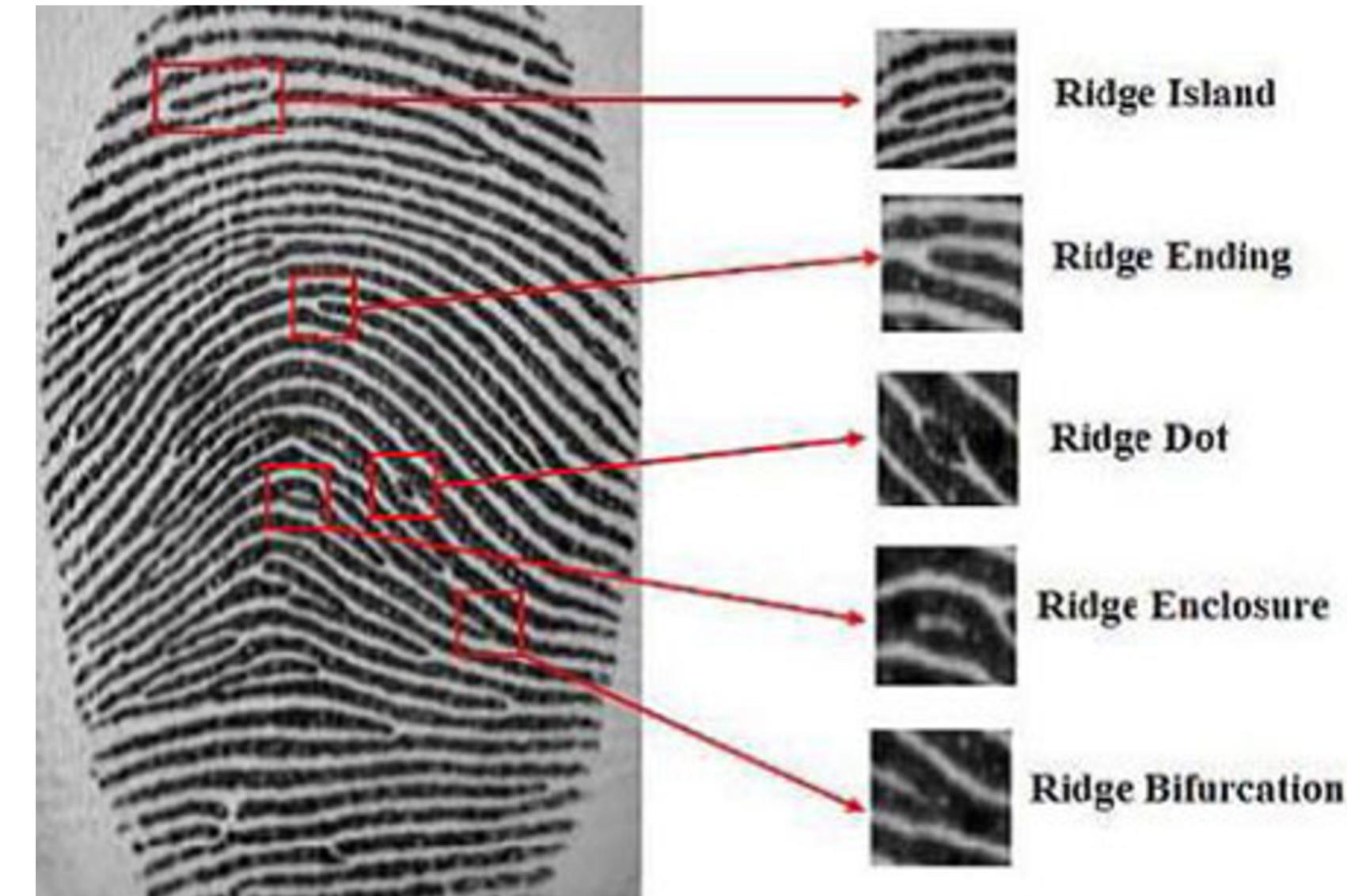
The core point is at the center of the **uppermost loop** and **aids** in alignment.

Fingerprint Structure

Minutiae are local discontinuities in fingerprint ridge patterns.

The two most common types

- **Ridge ending** (termination) where a ridge ends.
- **Bifurcation** where a ridge splits into two.



These features are unique, persistent, and critical for fingerprint matching and identification.

Dataset

Source Kaggle - FVC2000_DB4_B

Description

- Fingerprint images from various individuals
- Multiple impressions per finger
- Includes variations {rotation, partial prints, noise}

Format

- Grayscale .bmp images, 160x160 pixels

Dataset



- Standardized for academic comparison
- Represents real-world challenges: distortion, alignment issues
- Ideal for testing robustness of preprocessing and matching algorithms

Models used VGG16 and VGG19

Inversion method

- Splits each image into two halves and inverts each part.
- Extracts features from both halves in parallel.
- Enhances feature representation and diversity.

Multi-Augmentation method

- Generates 8 distinct augmented versions of each image.
- Increases training data variability.
- Reduces overfitting and improves classification accuracy.

Benefits

- Expands the feature space.
- Improves model robustness and overall performance.

Models

Model	Accuracy
VGG16 (Normal)	0.93
VGG16 (Inversion)	0.86
VGG16 (Augmentation)	0.92

Models

Model	Accuracy
VGG19 (Normal)	0.93
VGG19 (Inversion)	0.88
VGG19 (Augmentation)	0.93

Models

- **MobileNet** Uses depthwise separable convolutions to reduce computation.
- **EfficientNet-BO** Balances depth, width, and resolution for better performance with fewer parameters.
- **SE Attention** Uses global pooling and two dense layers to adjust channel importance.
- **Self-Attention** Captures long-range features using parallel conv layers, softmax, and ReLU.
- **CBAM** Adds attention on both channels and spatial features to improve learning.
- **Dual Attention** Combines position and channel attention for stronger features.

Models

Model	Accuracy
MobileNet+ (CBAM)	0.3580
MobileNet+ (Dual)	0.2901
MobileNet+ (Self-Attention)	0.8148
MobileNet+ (Squeeze and Excitation)	0.4383

Models

Model	Accuracy
EfficientNet-BO+CBAM)	0.9383
EfficientNet-BO+ (Dual)	0.8704
EfficientNet-BO+ (Self-Attention)	0.6975
EfficientNet-BO+ (Squeeze and Excitation)	0.9444

Fingerprint Identification Application

Select Model

EfficientNetB0+SelfAttention

Using model: EfficientNetB0+SelfAttention

Upload Fingerprint Image to Identify

Drag and drop file here
Limit 200MB per file • BMP, PNG, JPG, JPEG

00008.bmp 26.1KB X

Upload Dataset Fingerprint Images

Drag and drop files here
Limit 200MB per file • BMP, PNG, JPG, JPEG

Clear Dataset

Instructions

1. Select a model from the dropdown menu.
2. Upload a single fingerprint image to identify (.bmp, .png, .jpg, or .jpeg).
3. Upload multiple fingerprint images as the dataset (named as `person_name_imageX.ext` or `person_name.ext`).
4. Click "Clear Dataset" to remove all uploaded dataset images.

Demo

Identification Results

Model: VGG16+MultiAugmentation

Similarity Score: 1.0000

Matched Image(s):



1__M_Left_index_fi
nger.BMP
(Similarity: 1.0000)

All Dataset Images with Similarity Scores:



1__M_Left_index_fi
nger.BMP
(Similarity: 1.0000)

1__M_Left_little_fi
nger.BMP (Similarity:
0.9802)

1__M_Left_middle_
finger.BMP
(Similarity: 0.9808)

1__M_Left_ring_fi
nger.BMP (Similarity:
0.9799)

1__M_Left_thumb_
finger.BMP
(Similarity: 0.9540)



Conclusion

- We built a fingerprint recognition system using deep learning models like VGG, MobileNet, and EfficientNet-BO.
- Techniques such as image inversion, augmentation, and attention mechanisms improved performance.
- EfficientNet-BO + SENet achieved the best accuracy (0.9444).
- Our system is accurate, robust, and ready for real-world biometric applications.

**THANK YOU
FOR LISTENING**

