

Image Processing Report

Fingerprint Recognition

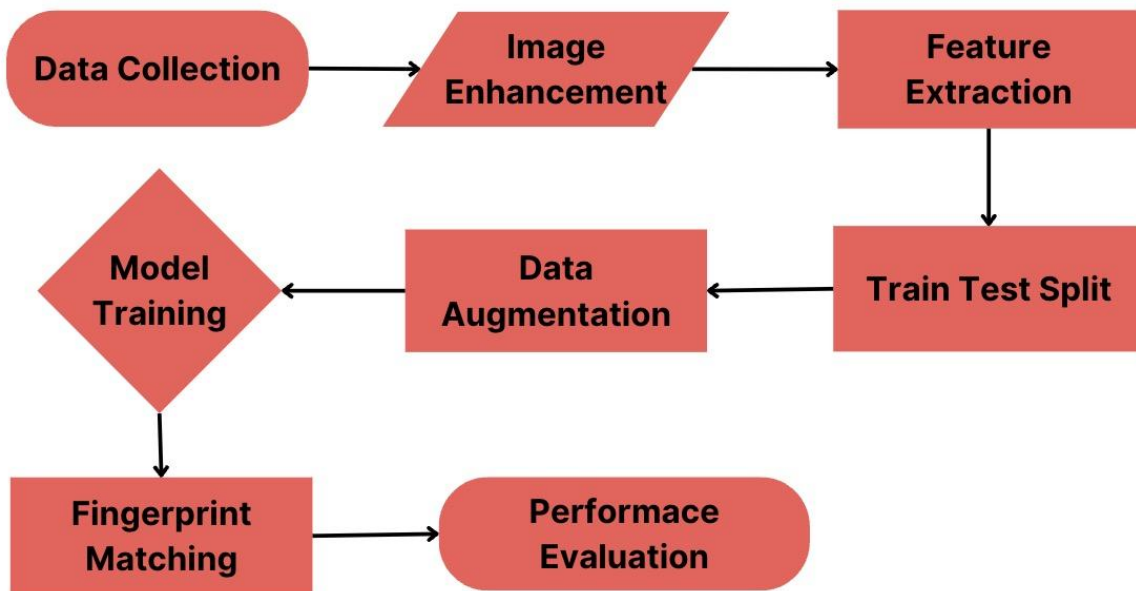
Team Details:

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2. Raghav Khullar - 106120091
3. Swati Parida - 106120131

Problem Statement:

The objective of the project is to develop a fingerprint recognition system utilizing convolutional neural networks (CNN) and Random Forest models. Given a test fingerprint image, the system aims to identify and return the most closely matched fingerprint image from a database, achieving robust and accurate biometric identification.

Design:



- Dataset:
 - Train data: 80 images (8 people - 10 fingerprints per person)
 - Test data: 80 images (8 people - 10 fingerprints per person)
- Image Enhancement:
 - Histogram Equalisation
 - Gabor Filtering
- Feature Extraction:
 - Convert fingerprint images into pixel information, extracting relevant features for model training
- Data Augmentation:
 - Rotation: Randomly rotates images up to 30 degrees.
 - Width Shift: Randomly shifts images horizontally by up to 10% of the width.
 - Height Shift: Randomly shifts images vertically by up to 10% of the height.
 - Zoom: Randomly zooms into images by up to 20%.
 - Horizontal Flip: Randomly flips images horizontally.
 - Vertical Flip: Randomly flips images vertically.
- Model Training:
 - Random Forest
 - CNN
- Fingerprint Matching:
 - Evaluate the trained model on test data.
 - Test its ability to match a given fingerprint image with the most closely resembling fingerprint from the dataset.
- Performance Evaluation (accuracy metrics):
 - Precision
 - Recall
 - F1 score

Tools Used:

- Google Colab
- Open CV
- Numpy
- Pandas
- Keras
- Tensorflow

Code Link:

<https://github.com/swati1504/Fingerprint-Recognition>

Sample Test Cases:



Demo Video:

https://drive.google.com/file/d/19iO_FXkshrLkhoWT29fq1NNDW71n4Vgy/view?usp=drive_link

How is it different from the existing solutions?

Our approach distinguishes itself from existing solutions through the strategic combination of a CNN model with advanced image enhancement techniques. While many fingerprint recognition systems rely solely on CNNs for feature extraction and pattern recognition, our methodology incorporates additional preprocessing steps. Specifically, we employ histogram equalization to improve the contrast and overall quality of fingerprint images, ensuring that key details are accentuated. Furthermore, Gabor filtering is applied to capture intricate ridge patterns, enhancing the model's ability to discern unique fingerprint characteristics. This synergistic integration of CNNs with image enhancement methodologies enhances the robustness of our solution, allowing for improved accuracy and performance in fingerprint recognition tasks. In addition to the CNN model, we have also implemented Random Forest Classifier for fingerprint recognition. The innovative combination of these elements addresses limitations observed in traditional CNN-based approaches, positioning our methodology as a more refined and effective solution for fingerprint recognition.

Contribution of each team member:

- **106120065: Image Preprocessing, Enhancement and Feature Extraction**
 - Implemented image preprocessing techniques for preparing fingerprint images for model input.

- Applied image enhancement methods, such as histogram equalization and Gabor filtering, to improve the quality of fingerprint images.
 - Ensured that the input data for the CNN model was optimized for accurate feature extraction.
- **106120091: Frontend Development, Random Forest Model and Research**
 - Designed and implemented the frontend part for a live demo of the fingerprint recognition system.
 - Conducted research on various fingerprint recognition techniques.
 - Designed and developed the Random Forest Model for fingerprint recognition.
 - Integrated the frontend with the backend components for a cohesive user experience.
- **106120131: Data Augmentation, CNN Model and Performance Evaluation**
 - Implemented data augmentation techniques to diversify the training dataset.
 - Developed and trained the CNN model for fingerprint recognition.
 - Conducted model training, hyperparameter tuning, and performance evaluation.