School of Engineering and Applied Science (SEAS),
Ahmedabad University

ECE501: Digital Image Processing

Group Name: Humans.exe

Project 2: Person Retrieval

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I. Introduction

- **Goal:** Build a complete classical person retrieval system capable of detecting, extracting, and comparing facial features using non-deep learning methods.
- **Current Stage:** The major components of the system have been implemented — including preprocessing, face detection, feature extraction (LBP, DCT, PCA), normalization, and similarity measurement.
- **Focus of This Week:** Improving accuracy and reliability by integrating Haar Cascade-based face detection, resolving PCA dimension errors, normalizing feature vectors, and visualizing top retrieval results.
- **Outcome:** The retrieval system is now capable of producing consistent and interpretable results, with significantly improved matching accuracy across multiple faces in the dataset.

II. Objectives

The main objective for this stage was to refine and finalize the classical person retrieval pipeline by addressing earlier implementation issues and enhancing system performance. Specifically, the goals were:

- Achieve stable PCA transformation by ensuring consistent dimensions between training and query features.
- Normalize feature vectors before similarity computation to improve retrieval accuracy.
- Integrate Haar Cascade face detection to focus only on facial regions.
- Tune LBP and PCA parameters to capture better facial texture and global variance.
- Develop a basic visualization module to display top retrieved matches for a given query image.

III. What has been done so far (Progress)

The team has made significant progress toward a working classical person retrieval system. The following milestones were achieved this week:

- **Face Detection:** Implemented Haar Cascade-based face detection using OpenCV to automatically crop and process only facial regions, reducing background interference.
- **PCA Error Resolution:** Debugged PCA feature projection errors by ensuring consistent dimensionality across all feature vectors.
- **Feature Normalization:** Added normalization steps for LBP, DCT, and PCA feature vectors before similarity comparison, improving retrieval accuracy and stability.
- **Parameter Optimization:** Experimented with different LBP radii and PCA component counts to identify the best-performing configuration.
- **Similarity and Visualization:** Cosine similarity was finalized as the primary distance metric, and a visualization function was added to display the top 5 retrieved faces for each query.
- **Dataset Testing:** The system was tested on an expanded dataset of 32 images (8 persons $\times$ 4 images each), and results showed improved consistency in face retrieval.

Observations:

- Retrieval accuracy improved after applying normalization and restricting analysis to facial regions.

- PCA reduced redundancy in DCT and LBP features, making similarity computation faster and more efficient.
- Minor mismatches still occur for images with extreme lighting variations or partial occlusions.

IV. What is planned for next week

- Enhance robustness against illumination and expression changes using contrast normalization and histogram matching.
- Combine LBP, DCT, and PCA features through weighted fusion for higher discriminative power.
- Quantitatively evaluate retrieval performance using precision, recall, and accuracy metrics.

References

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