FEATURE EXTRACTION EFFICIENT FOR FACE VERIFICATION BASED ON RESIDUAL NETWORK ARCHITECTURE

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Introduction

- Face verification is a sub-system of face recognition systems that can detect, extract features, and verify human identity from frontal faces.
- A face verification system generally follows a common approach, and different solutions have been proposed for each step of it.

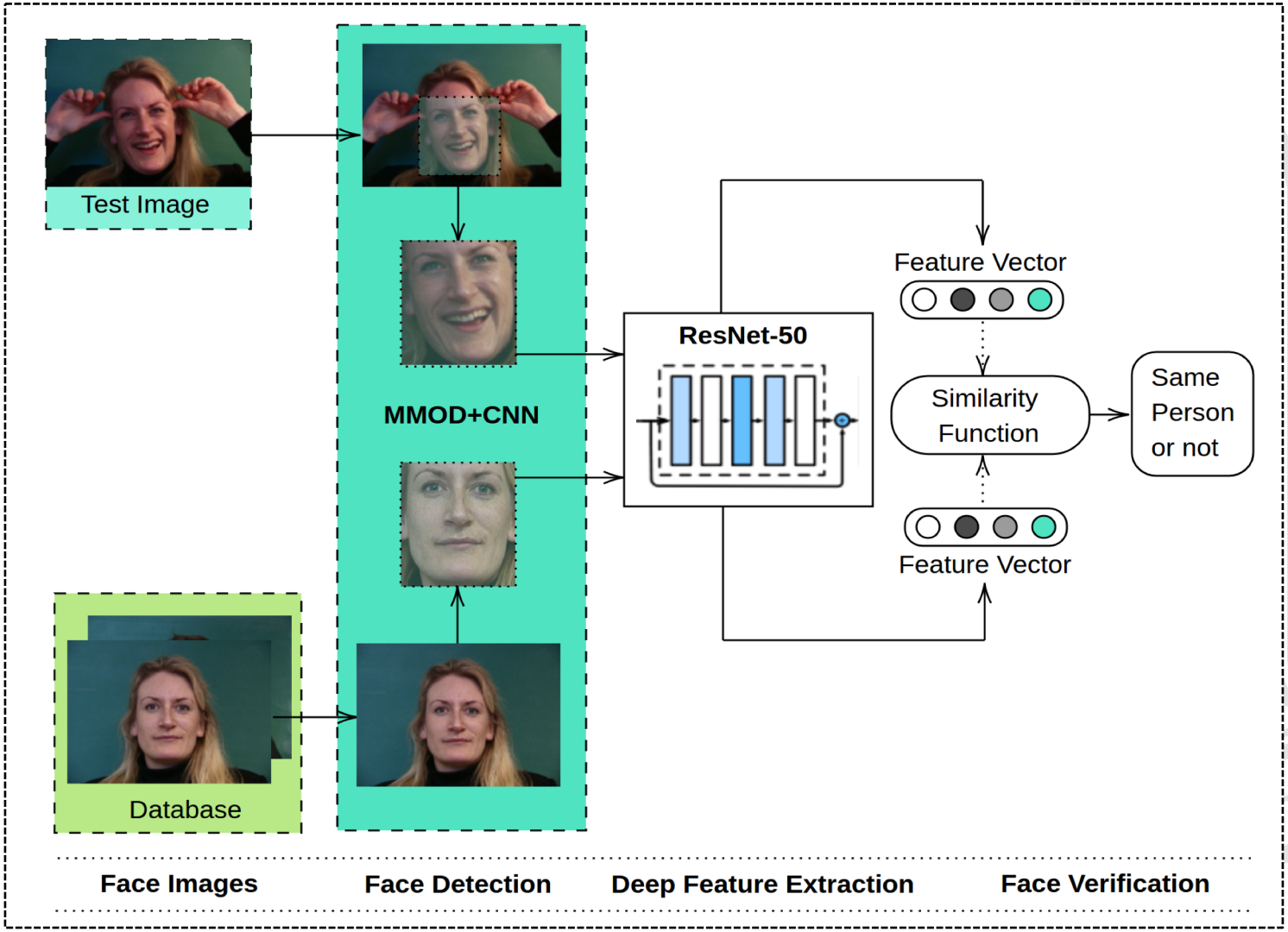
Introduction

- These steps can be summarized as:
  - **Face Detection**
    - Face detection and facial landmark localization are applied to find human faces from the various devise.
  - **Feature Extraction Techniques**
    - The local descriptors and CNN architectures are applied to extract the robust features.
  - **Similarity and Verification**
    - The similarity function is employed to find the similarity value between query faces and faces from the database and verify if two faces are similar or not.

Contributions

- In this paper, we focus on improving the face verification system, as follows.
- **Face detection:**
  - the max-margin object detection (MMOD) and CNN methods, called MMOD+CNN, were proposed.
- **Face verification:**
  - The ResNet50 model is proposed to extract the deep feature from faces.
  - The similarity function is employed to find the similarity value. The high value is considered.

The Proposed Face Verification System



Experiments

- We report some experiments to evaluate the effectiveness of our approach on several face image databases; LFW, BioID, and IMM.
- We applied the ***face detection accuracy value*** for face detection to evaluate the face detection algorithms as follows.

$$FDA = \frac{(p - n) * 100}{N}$$

Experiments

- We used the ***similarity function*** only the similarity value larger than **0.85**. The equation is shown as follows.

$$cos(\theta) = \frac{\sum_{i=1}^{n} a_i \, b_i}{\sqrt{\sum_{i=1}^{n} a_i^2} \sqrt{\sum_{i=1}^{n} b_i^2}}$$

- ***The Top-1 accuracy*** is proposed. In our study, the actual class matches with the highest similarity value.

Face Databases

- **Labeled Faces in the Wild (LFW)**
  - The LFW dataset consists of 13,233 images of 5,749 persons.
  - We used this dataset only to *evaluate the face detection algorithm*

Face Databases

- **BioID Face Database**
  - This dataset contains 1,521 grayscale images of 23 persons.
  - We performed both face detection and face verification on the BioID database.

Face Databases

- **IMM Face Database**
  - This dataset is divided into two datasets; IMM face (240 images of 40 different humans) and IMM frontal face (120 images of 12 persons).

IMM Faces and IMM Frontal Faces

Evaluation

- **Face Detection**
  - We made comparisons with three well-known face detection techniques: MMOD+CNN, Haar-Cascase, and HOG+SVM.

Face detection algorithms	Face detection accuracy (%) on face databases	
	LFW	BioID
Haar-Cascade	93.05	93.29
HOG+SVM	99.43	98.88
MMOD+CNN	**99.91**	**99.54**

Evaluation

- **Face Verification**
  - We experimented with the effect of feature extraction techniques. Three feature extraction techniques; SIFT, HOG, and ResNet-50, were performed.

Feature extraction methods	Number of features	IMM frontal face	IMM face
LL+SIFT	8,704	100	90.81 ± 0.17
LL+HOG	544	100	94.35 ± 0.11
DG+SIFT	14,080	96.2 ± 0.23	95.79 ± 0.21
DG+HOG	880	100	98.82 ± 0.15
ResNet-50	2,048	100	99.46 ± 0.51

Discussion

- **The MMOD+CNN face detection**
  - This method can detect a small face because the small sliding windows with 50x50 pixels were sliding through the pyramid of images. Then, we sent each window to a simple CNN architecture to create robust deep feature.
- **A ResNet-50 architecture**
  - The architecture can be performed to extract the robust deep feature even when applied to extract from the unconstrained face, such as the face in different orientations, emotions, and light conditions.

Conclusion

- We proposed a face verification system, including face detection and face verification.
- **Face detection**
  - We proposed the MMOD+CNN method to detect faces in unconstrained environments. It can detect a normal face, a small face, and even a part of a face.
  - The MMOD+CNN method provided a high detection accuracy of more than 99.5% on the LFW and BioID databases.

Conclusion

- **Face detection**
  - We assigned the detected faces to the ResNet-50 model, to extract the 2,048 deep features. Then, we compared the query face with faces from the database.
  - The experimental results showed that the ResNet-50 obtained 100% accuracy on the IMM frontal face and 99.46% on the IMM face database.

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