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Project Based Learning

Face Recognition

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1 Introduction

1.1 Objective

The objective of this project is to develop a Python-based solution for comparing two celebrity photos to determine if they depict the same person or different individuals. This involves facial recognition techniques using a deep learning approach to extract and compare facial features.

1.2 Background

Facial recognition technology has gained significant attention due to its applications in security systems, social media, and identity verification. This project leverages deep learning models to perform face verification tasks, contributing to the broader field of computer vision and machine learning.

2 Methodology

2.1 Dataset

The dataset used consists of celebrity photos sourced from an available dataset, containing multiple samples per individual. This variety makes it suitable for training and testing facial recognition models.

2.2 Preprocessing

The preprocessing steps include:

- Loading and converting images to RGB.
- Detecting faces within the images.
- Extracting and resizing the detected faces to a standard size (160x160 pixels).

2.3 Feature Extraction

Facial features are extracted using a pre-trained FaceNet model, which is known for its accuracy in generating embeddings representing the unique characteristics of a face.

2.4 Model

The model architecture used is based on the Siamese Neural Network principle, which is effective for tasks involving comparisons. However, for this implementation, a Support Vector Machine (SVM) classifier is used for the final classification, utilizing the face embeddings generated by the FaceNet model.

3 Implementation

3.1 Environment Setup

Tools and libraries used include:

- Python 3.12

- Google Colab for execution
- Libraries: OpenCV, TensorFlow, Keras, MTCNN, and others

3.2 Code Explanation

3.2.1 Dataset Loading and Preprocessing

The dataset is loaded from Google Drive, and necessary libraries are installed.

```
1 from google.colab import drive
2 drive.mount('/content/drive')
3
4 !pip install keras-facenet
5 !pip install tensorflow
6 !pip install keras
7 !pip install preprocessing
8 !pip install image
9 !pip install mtcnn
```

3.2.2 Face Detection

The MTCNN library is used for face detection, extracting faces from images for further processing.

```
1 from mtcnn.mtcnn import MTCNN
2 from keras_facenet import FaceNet
3 import numpy as np
4 import matplotlib.pyplot as plt
5 from PIL import Image
6
7 detector = MTCNN()
8 embedder = FaceNet()
9
10 # Load and preprocess an image
11 image = Image.open('./img_dataset/AL-Limby/El-Lemby004.jpg')
12 image = image.convert('RGB')
13 pixels = np.asarray(image)
14
15 # Detect faces
16 results = detector.detect_faces(pixels)
17 x1, y1, width, height = results[0]['box']
18 x1, y1 = abs(x1), abs(y1)
19 x2, y2 = x1 + width, y1 + height
20 face = pixels[y1:y2, x1:x2]
21 image = Image.fromarray(face).resize((160, 160))
22 face_array = np.asarray(image)
```

3.2.3 Model Training

The dataset is split into training and testing sets. The faces are converted into embeddings using the FaceNet model.

```
1 from sklearn.model_selection import train_test_split
2
3 trainX, testX, trainy, testy = train_test_split(X, y, test_size=0.2,
4         shuffle=True, random_state=42)
5 embedder = FaceNet()
6
7 def get_embedding(model, face):
8     face = face.astype('float32')
9     mean, std = face.mean(), face.std()
10    face = (face - mean) / std
11    sample = np.expand_dims(face, axis=0)
12    yhat = model.predict(sample)
13    return yhat[0]
14
15 emdTrainX = [get_embedding(embedder.model, face) for face in trainX]
16 emdTestX = [get_embedding(embedder.model, face) for face in testX]
17
18 emdTrainX = np.asarray(emdTrainX)
19 emdTestX = np.asarray(emdTestX)
```

3.2.4 Classification

An SVM classifier is trained on the embeddings to classify the faces.

```
1 from sklearn.preprocessing import Normalizer, LabelEncoder
2 from sklearn.svm import SVC
3 from sklearn.metrics import accuracy_score
4
5 in_encoder = Normalizer()
6 emdTrainX_norm = in_encoder.transform(emdTrainX)
7 emdTestX_norm = in_encoder.transform(emdTestX)
8
9 out_encoder = LabelEncoder()
10 out_encoder.fit(trainy)
11 trainy_enc = out_encoder.transform(trainy)
12 testy_enc = out_encoder.transform(testy)
13
14 model = SVC(kernel='linear', probability=True)
15 model.fit(emdTrainX_norm, trainy_enc)
16 yhat_train = model.predict(emdTrainX_norm)
17 yhat_test = model.predict(emdTestX_norm)
18
19 score_train = accuracy_score(trainy_enc, yhat_train)
20 score_test = accuracy_score(testy_enc, yhat_test)
21 print('Accuracy: train=%.3f, test=%.3f' % (score_train*100, score_test*100))
```

3.2.5 Face Verification

Face verification is performed by comparing embeddings of two faces and computing the distance.

```
1 ii = "./img_dataset/AL-Limby/El-Lemby007.jpg"
2 jj = "./img_dataset/AL-Limby/El-Lemby001.jpg"
3
4 detect_ii = embedder.extract(ii, threshold=0.95)
5 detect_jj = embedder.extract(jj, threshold=0.95)
6 dd = embedder.compute_distance(detect_ii[0]['embedding'],
7                               detect_jj[0]['embedding'])
8
9 if dd < 0.5:
10     print('Same Person')
11 else:
12     print('Not Same Person')
13 print(dd)
```

4 Results

4.1 Evaluation Metrics

The model's performance is evaluated using accuracy on the training and testing datasets. The classifier achieves an accuracy of `train=xx.x%`, `test=xx.x%`, indicating its ability to correctly classify faces.

4.2 Performance

The face verification task correctly identifies if two images depict the same person based on a threshold distance between their embeddings.

5 Conclusion

5.1 Summary

This project successfully demonstrates the use of deep learning techniques for facial recognition and verification. The combination of MTCNN for face detection and FaceNet for embedding generation provides an effective solution for comparing celebrity photos.

5.2 Future Work

Future improvements could include using a larger and more diverse dataset, exploring different neural network architectures, and implementing real-time face recognition systems. Further optimization and fine-tuning could also enhance the model's accuracy and robustness.

6 References

1. StoicStatic. (n.d.). Face recognition dataset [Data set]. Kaggle. Retrieved June 7, 2024, from <https://www.kaggle.com/datasets/stoicstatic/face-recognition-dataset/data>
2. Patel, V. (n.d.). Face recognition dataset [Data set]. Kaggle. Retrieved June 7, 2024, from <https://www.kaggle.com/datasets/vasukipatel/face-recognition-dataset>