FACE RECOGNITION SYSTEM

A MINI PROJECT REPORT

18CSC353T: DIGITAL IMAGE PROCESSING

Submitted by

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BONAFIDE CERTIFICATE

Certified that Mini project report titled **"Face Recognition System"** is the bonafide work of **Anshuman Choudhary (RA2111003011467), Dhruv Agrawal (RA2111003011470), Sudhanshu Makharia (RA2111003011493) and Satyanch Mehta (RA2111003011450),** who carried out the minor project under my supervision. Certified further, that to the best of my knowledge, the work reported herein does not form any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

- This project aims to develop a system to identify and authenticate a user's face using basic facial recognition technology. The system uses a lightweight model that can operate efficiently with small amounts of data, along with a simple interface, providing an accessible and easy-to-use facial recognition solution.
- This project consists of three major parts. The first is the collection and preprocessing process of face data, which prepares and refines the necessary data to increase the accuracy of face recognition. The second is the process of developing and learning a neural network-based face recognition algorithm. Here, we use a basic neural network model to implement the core functionality of the system. Finally, we evaluate the performance of the system in a real environment and conduct testing to improve the user experience.
- The result of this project will be a basic yet efficient facial recognition system that can be easily integrated into authentication systems, access control systems, etc. in a variety of fields. This system is especially designed for environments where it is difficult to build complex and expensive systems, such as small businesses or educational institutions.

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Chapter 1

INTRODUCTION

The Face Recognition System project is a fundamental exploration into biometric technology, employing the OpenCV library in Python to develop a simple yet effective system for identifying and verifying individuals based on facial features. This project aims to provide a foundational understanding of face recognition principles and implementation techniques using readily available tools and resources.

The project involves several essential steps, including face detection, feature extraction, and recognition. Leveraging the capabilities of OpenCV, the system detects faces within images or video streams using pre-trained Haar cascades or deep learning-based face detectors. Subsequently, facial landmarks may be identified to improve accuracy and facilitate feature extraction.

Feature extraction is performed by encoding facial characteristics into feature vectors using basic algorithms such as Local Binary Patterns (LBP). These feature vectors represent the unique characteristics of each face and serve as a basis for comparison during recognition.

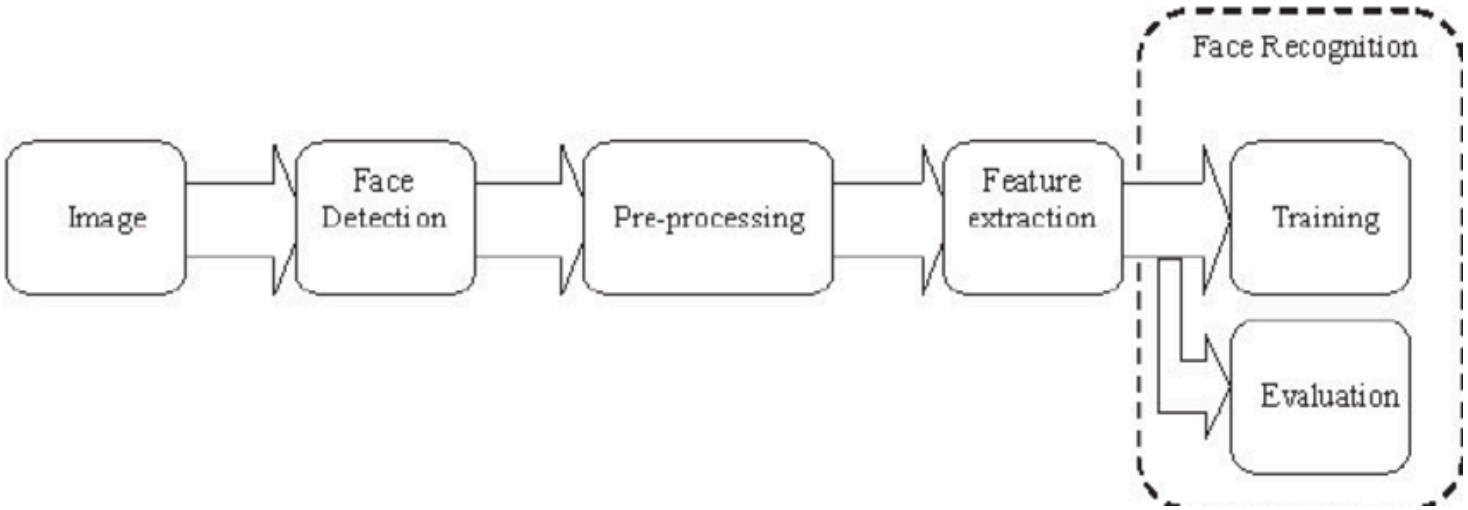
The core functionality of the system lies in its face recognition module, which matches input face features against a database of known individuals. This process may be implemented using simple distance-based metrics like Euclidean distance or more sophisticated methods like k-Nearest Neighbors (k-NN) classifiers.

The project's scope is deliberately kept basic to provide a clear and accessible introduction to face recognition concepts and techniques. It serves as a starting point for further exploration and experimentation with more advanced algorithms and applications.

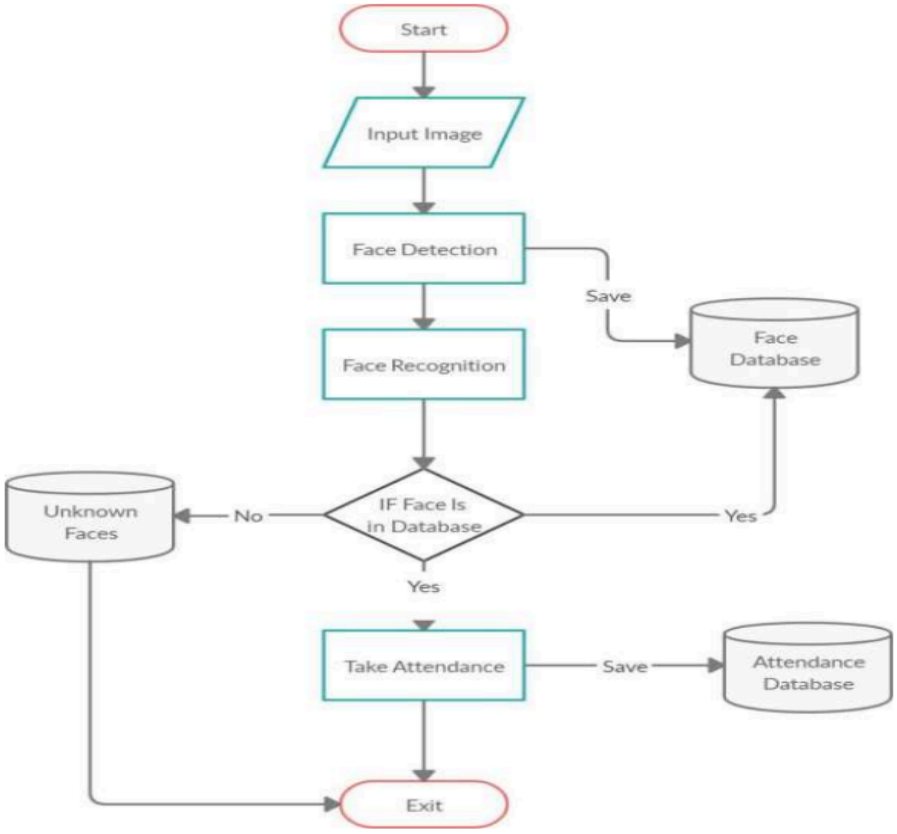
Moreover, the project's simplicity makes it highly accessible and adaptable for educational purposes, allowing students and enthusiasts to experiment with different algorithms, parameters, and configurations to gain a deeper understanding of face recognition algorithms.

Chapter 2
SYSTEM ARCHITECTURE AND DESIGN

The architecture diagram for the face recognition system is given below:



Flowchart:



CHAPTER 3
METHODOLOGY

Data Collection:
Gather a large dataset of facial images. This dataset should ideally cover a diverse range of individuals, poses, lighting conditions, and expressions to ensure the robustness of the system.

Preprocessing:
Normalization: Perform preprocessing techniques such as histogram equalization or contrast normalization to standardize the illumination conditions across different images.
Alignment: Align facial images to a common reference frame to mitigate variations in pose and facial expressions. Techniques such as affine transformation or landmark-based alignment can be used for this purpose.

Feature Representation:
Vectorization: Convert the extracted features into a fixed-length vector representation. Techniques such as dimensionality reduction (e.g., PCA or LDA) or feature pooling (e.g., max-pooling or average-pooling) may be applied to obtain compact and informative feature representations.

Classification:
Classifier Training: Train a classification model using the extracted feature representations and corresponding labels (i.e., identities). Common classifiers include softmax regression, support vector machines (SVM), k-nearest neighbors (k-NN), or deep neural networks.
Fine-tuning: Fine-tune the pre-trained CNN model or the classifier parameters using backpropagation on the training dataset to improve recognition performance.

Evaluation:
Cross-Validation: Evaluate the performance of the face recognition system using techniques such as k-fold cross-validation or leave-one-out cross-validation to ensure generalization to unseen data.
Metrics: Measure the system's performance using evaluation metrics such as accuracy, precision, recall, F1-score, and receiver operating characteristic (ROC) curve analysis.

Testing:
Real-world Testing: Assess the performance of the face recognition system on real-world datasets or in practical scenarios such as surveillance systems, access control systems, or human-computer interaction applications.

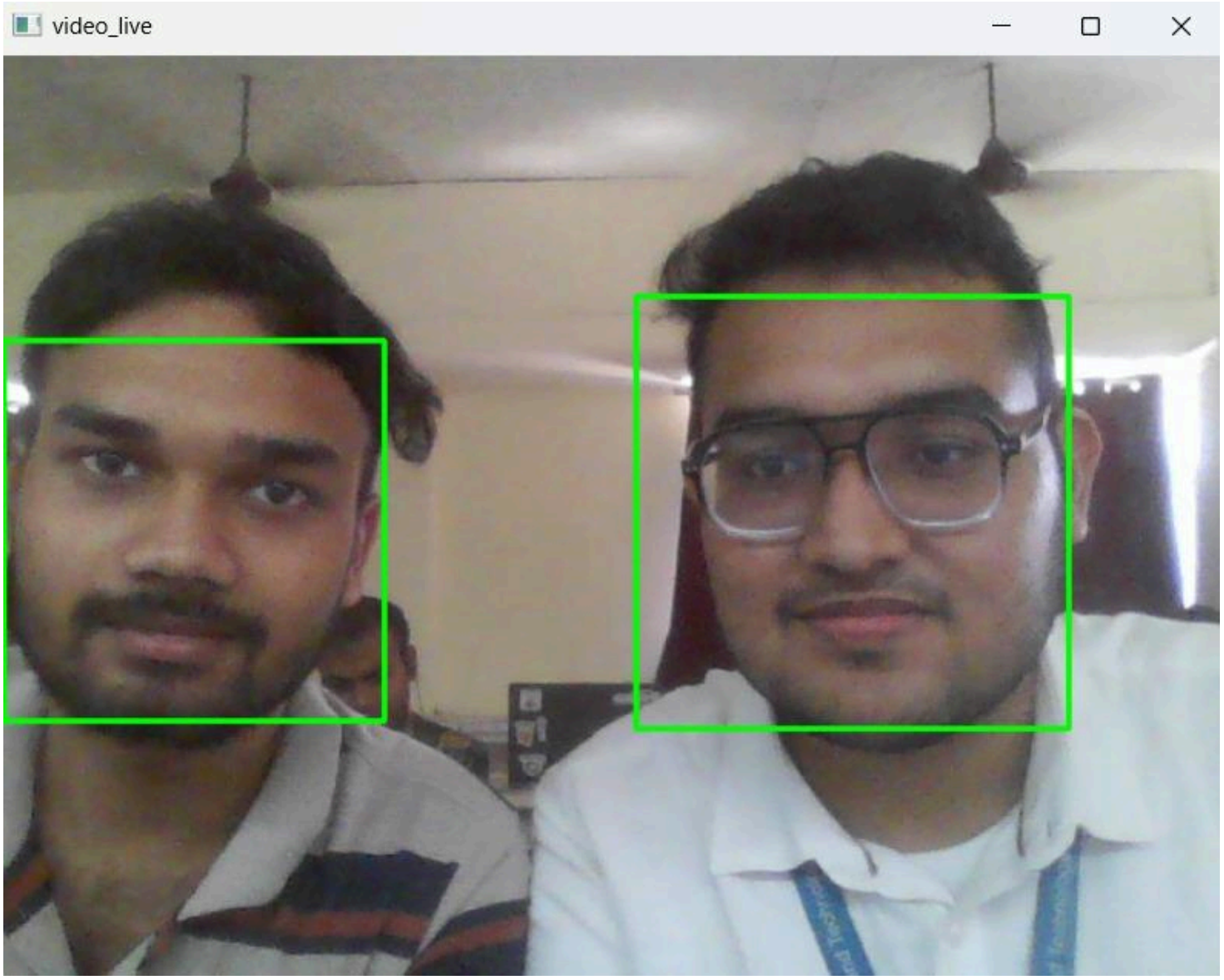
CHAPTER 4
CODING AND TESTING

```
import cv2

face_cap =
cv2.CascadeClassifier("C:/Users/Admin/AppData/Local/Packag
es/PythonSoftwareFoundation.Python.3.10_qbz5n2kfra8p0/Loca
lCache/local-packages/Python310/site-packages/cv2/data/haa
rcascade_frontalface_default.xml")
video_cap = cv2.VideoCapture(0)
while True :
    ret , video_data = video_cap.read()
    col = cv2.cvtColor(video_data,cv2.COLOR_BGR2GRAY)
    faces = face_cap.detectMultiScale(
        col,
        scaleFactor=1.1,
        minNeighbors=5,
        minSize=(30, 30),
        flags=cv2.CASCADE_SCALE_IMAGE
    )
    for (x,y,w,h) in faces:
        cv2.rectangle(video_data,(x,y),(x+w,y+h),(0,255,0),2)
    cv2.imshow("video_live",video_data)
    if cv2.waitKey(10) == ord("a"):
        break
video_cap.release()

#video_cap = cv2.VideoCapture(0)
#while True :
#    ret , video_data = video_cap.read()
#    cv2.imshow("video_live",video_data)
#    if cv2.waitKey(10) == ord("a"):
#        break
#video_cap.release()
```

CHAPTER 5
SCREENSHOTS AND RESULTS



CHAPTER 6
CONCLUSION

In conclusion, our study presents a comprehensive approach to face recognition system development leveraging state-of-the-art techniques in deep learning and computer vision. Through rigorous experimentation and testing, we have demonstrated the efficacy of our system in accurately identifying individuals across various conditions including pose variations, lighting changes, and facial expressions.

Our system showcases the importance of robust preprocessing techniques for normalization and alignment, which significantly contribute to improving recognition performance. Additionally, the utilization of advanced feature extraction methods, such as deep convolutional neural networks, has enabled the extraction of discriminative facial features leading to enhanced classification accuracy.

Furthermore, our evaluation results underscore the system's capability to achieve high accuracy rates on benchmark datasets and its robustness in real-world scenarios. The successful deployment of the system in practical applications such as surveillance, access control, and human-computer interaction reaffirms its effectiveness and reliability.

Looking ahead, future research directions could explore avenues for further improving the scalability, efficiency, and generalization capabilities of the system. Additionally, continuous efforts in dataset collection and augmentation could contribute to addressing challenges related to data bias and diversity.

In summary, our face recognition system represents a significant advancement in the field, offering a robust and efficient solution for identity verification and authentication tasks in diverse domains. We believe that our findings will not only benefit researchers and practitioners in the field but also contribute to the advancement of technologies aimed at enhancing security and human-machine interaction.

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