DR. VISHWANATH KARAD MIT WORLD PEACE UNIVERSITY, PUNE

Department of Computer Engineering & Technology
School of Computer Science & Engineering
Seminar
Third Year B. Tech, Semester 5

COMPARISON BETWEEN FACE RECOGNITION ALGORITHMS AND TECHNIQUES

SEMINAR REPORT

Under the Guidance of
Dr. Vinayak Musale

Prepared By

Krishnaraj Thadesar, PA10, 1032210888

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Abbreviations

1. **PCA** - Principal Component Analysis
2. **LDA** - Linear Discriminant Analysis
3. **SVM** - Support Vector Machine
4. **KNN** - K-Nearest Neighbors
5. **CNN** - Convolutional Neural Network
6. **DNN** - Deep Neural Network
7. **ANN** - Artificial Neural Network
8. **ML** - Machine Learning
9. **DL** - Deep Learning
10. **AI** - Artificial Intelligence

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Name of Student

1. Krishnaraj Thadesar, PA10, 1032210888

Contents

Abstract and Keywords

0.1 Abstract

Face Recognition is a biometric method of identifying an individual by comparing live capture or digital image data with the stored record for that person. It is a widely used technology in security systems and can be compared to other biometrics such as fingerprint or eye iris recognition systems. This report will discuss the various algorithms and techniques used in face recognition and compare them based on their performance and accuracy. The report will also discuss the implementation of these algorithms and techniques in real-world applications.

Methods used in Face Recognition by most commonly used python libraries like OpenCV, Dlib, etc. will be discussed in this report. The report will also discuss the various challenges faced in face recognition and how these challenges can be overcome. The report will also discuss the future of face recognition technology and how it can be used in various applications.

0.2 Keywords

Face Recognition, Biometric, Algorithms, Techniques, OpenCV, Dlib, Python, Machine Learning, Deep Learning, Artificial Intelligence, Security Systems, Applications, Attendance System, Surveillance System.

Chapter 1

Introduction

Face recognition is a biometric technology that utilizes distinctive features of the face to identify individuals. Widely employed in security systems, it serves various applications such as access control, attendance tracking, and surveillance. While face recognition has existed for decades, recent advancements in machine learning and computer vision have significantly enhanced its accuracy and reliability. Numerous algorithms and techniques are available, each with unique strengths and weaknesses. In this seminar, we aim to compare popular face recognition algorithms and assess their performance using a standardized dataset.

1.0.1 Problem Statement

We need to compare the various face recognition algorithms and techniques to determine which one is the most accurate and efficient. We also need to discuss the implementation of these algorithms in real-world applications.

1.0.2 Need of the Project

- The motivation for this topic came from impending research for a Project titled "Machine Learning Powered Automated Facial Attendance Tracking System".
- The project aims to develop a system that can automatically track attendance using facial recognition technology.
- To achieve this goal, it is essential to understand the different face recognition algorithms and techniques available and evaluate their performance to identify the most suitable approach for the project.
- By comparing the performance of different face recognition algorithms and techniques, we can gain insights into their strengths and weaknesses and make informed decisions about which approach to use for the project.
- This seminar will provide a comprehensive overview of the most popular face recognition algorithms and techniques and evaluate their performance on a common dataset to help guide the development of the attendance tracking system.

This project will help in understanding the various face recognition algorithms and techniques and how they can be implemented in real-world applications. It will also help in understanding the challenges faced in face recognition and how these challenges can be overcome.

To use the correct method and library in finding attendance, so as to reduce time and cost, while also maintaining high levels of accuracy, it was necessary to compare the various face recognition algorithms and techniques.

Chapter 2

Literature Review

2.1 Paper 1

Title: *"A Comparative Study of Facial Recognition Techniques: With focus on low computational power."* Author: *Schenkel, T., Ringhage, O. and Branding, N.* [7]

2.1.1 Positives and Learnings from this Paper

1. The publication compares five performance metrics, including recall and F-score, providing a comprehensive evaluation of facial recognition techniques.
2. It addresses the importance of balancing low computational time and prediction ability for security systems, offering practical guidelines for implementation.
3. The research questions are clearly defined, focusing on significant differences in performance, training time, and prediction time among different facial recognition techniques and classifiers.

2.1.2 Identified Research Gaps

1. The document lacks detailed information on the specific facial recognition techniques and classifiers used in the experiments.
2. It does not provide a detailed breakdown of the dataset used for training and testing the facial recognition models.
3. While the document mentions the comparison of results, it does not delve into the specific findings or implications of these comparisons.

2.2 Paper 2

Title: *"A Comparative Study on Facial Recognition Algorithms"* Author: *Sanmoy Paul and Sameer Acharya* [8]

2.2.1 Positives and Learnings from this Paper

1. Comparative Analysis: The study provides a comparative analysis of different facial recognition algorithms, allowing developers to make informed choices based on recognition accuracies.
2. Algorithm Selection: By studying the advantages and disadvantages of various algorithms, developers can select the best facial recognition algorithm for their specific implementation needs.
3. Future Improvements: The research suggests future efforts to test on a larger set of images to enhance the accuracy of CNN and explore combining multiple machine learning classification algorithms for increased recognition accuracy and handling large datasets.

2.2.2 Identified Research Gaps

1. The document lacks detailed discussion on the specific methodologies used for training and testing the algorithms, which could provide more clarity on the experimental setup.
2. There is no mention of the computational resources or hardware specifications used for running the experiments, which could impact the reproducibility and scalability of the results.
3. The publication does not delve into the potential biases or limitations in the dataset used for training and testing the facial recognition models, which could affect the generalizability of the findings.

2.3 Paper 3

Title: *"A comparison of facial recognition algorithms."* Author: *Delbiaggio, Nicolas.* [9]

2.3.1 Positives and Learnings from this Paper

1. Thesis covers a comprehensive comparison of facial recognition algorithms like Eigenfaces, Fisherfaces, LBPH, and OpenFace.
2. The study includes a detailed explanation of each algorithm, their strengths, weaknesses, and performance in a test case scenario.
3. The findings highlight OpenFace as the most accurate algorithm for facial recognition, providing valuable insights for further research in the field.

2.3.2 Identified Research Gaps

1. Lack of Exploration of Real-World Applications: The paper focuses on comparing facial recognition algorithms in a controlled setting. However, it does not delve into the practical applications of these algorithms in real-world scenarios.
2. Limited Discussion on Algorithm Limitations: While the strengths of the algorithms are discussed, there is a lack of emphasis on the limitations of each algorithm.
3. Absence of Future Research Directions: The paper concludes with the identification of the most accurate algorithm but fails to suggest potential future research directions in the field of facial recognition.

2.4 Paper 4

Title: *"Evaluating impact of race in facial recognition across machine learning and deep learning algorithms."* Author: *Coe, James, and Mustafa Atay.* [10]

2.4.1 Positives and Learnings from this Paper

1. The paper provides a detailed comparison of various facial recognition algorithms, including Eigenfaces, Fisherfaces, Local Binary Pattern Histogram, deep convolutional neural network algorithm, and OpenFace.
2. It highlights the efficiency and accuracy of these algorithms in real-life settings, with OpenFace being identified as the algorithm with the highest accuracy in identifying faces.
3. The study's findings offer valuable insights for practitioners in selecting the most suitable algorithm for facial recognition applications and suggest ways for academicians to enhance the current algorithms' accuracy further.

2.4.2 Identified Research Gaps

1. The paper focuses on a few specific facial recognition algorithms like Eigenfaces, Fisherfaces, and Local Binary Pattern Histograms. It lacks exploration of a wider range of algorithms available in the field, potentially missing out on newer, more accurate models.

2. While the study evaluates the algorithms' accuracy, it does not delve into their performance in real-life settings or practical applications. This gap could impact the algorithms' effectiveness when deployed in scenarios beyond controlled test environments.

3. The paper mentions the use of a custom dataset for testing the algorithms but does not elaborate on the dataset's diversity or size.

2.5 Paper 5

Title: *"A Comparative Study of Facial Recognition Techniques: With focus on low computational power."* Author: *Schenkel, T., Ringhage, O. and Branding, N.* [11]

2.5.1 Positives and Learnings from this Paper

1. Efficiency Evaluation: The paper provides a detailed comparison of popular open source facial recognition algorithms, highlighting the efficiency and accuracy of each in real-life settings.

2. Practical Implications: The findings of the study offer valuable insights for practitioners in selecting the most suitable algorithm for facial recognition applications, enhancing decision-making processes.

3. Academic Contribution: The research contributes to the academic field by emphasizing the importance of improving the accuracy of existing algorithms, paving the way for further advancements in facial recognition technology.

2.5.2 Identified Research Gaps

1. The paper focuses on comparing a few facial recognition algorithms like Eigenfaces, Fisherfaces, and Local Binary Pattern Histogram. However, it lacks a comparison with a wider range of algorithms to provide a more comprehensive analysis.

2. While the paper evaluates the algorithms' performance in a controlled environment using test datasets, it doesn't discuss the practical implementation challenges or results in real-life scenarios, which could be a crucial research gap.

3. The paper does not delve into the scalability and efficiency aspects of the facial recognition algorithms studied. Understanding how these algorithms perform with larger datasets or in real-time applications could be a significant research gap to address.

Chapter 3

Methodology and Implementations

3.1 Methodology

Libraries Tested
These are the libraries that were used to train and test a model.

1. OpenCV
2. face_recognition
    - face_recognition is a Python library that provides a simple interface for face recognition tasks.
    - It is built on top of the dlib library, which is a popular library for machine learning and computer vision tasks.
    - face_recognition provides a high-level API for face detection, face alignment, and face recognition, making it easy to use for developers.
    - The library uses deep learning models to detect and recognize faces in images and videos, achieving high accuracy and reliability.
    - face_recognition is widely used in research and industry for various face recognition applications, such as access control, surveillance, and attendance tracking.

3.2 Advantages

1. High Accuracy: Face recognition technology can achieve high accuracy rates, making it suitable for security applications.
2. Non-intrusive: Face recognition is a non-intrusive biometric technology that does not require physical contact with the individual being identified.
3. Fast and Efficient: Face recognition systems can process large amounts of data quickly and efficiently, making them suitable for real-time applications.
4. Scalable: Face recognition technology can be easily scaled to accommodate large numbers of users, making it suitable for applications with a large user base.
5. Versatile: Face recognition technology can be used for a wide range of applications, from access control to attendance tracking to surveillance.

3.3 Disadvantages

1. Privacy Concerns: Face recognition technology raises privacy concerns due to its potential for misuse and abuse.
2. Security Risks: Face recognition systems can be vulnerable to attacks, such as spoofing and impersonation, which can compromise security.
3. Bias and Discrimination: Face recognition systems can be biased and discriminatory, leading to inaccurate and unfair results.
4. Legal and Ethical Issues: Face recognition technology raises legal and ethical issues related to data privacy, consent, and surveillance.
5. Technical Limitations: Face recognition technology has technical limitations, such as sensitivity to variations in lighting, pose, and occlusions, which can affect accuracy and reliability.
6.

3.4 Evaluation Metrics

1. Accuracy: The percentage of correctly identified faces out of the total number of faces.
2. Precision: The percentage of correctly identified faces out of the total number of faces identified.
3. Recall: The percentage of correctly identified faces out of the total number of faces in the dataset.
4. F1 Score: The harmonic mean of precision and recall, which provides a balanced measure of accuracy.
5. Time taken: The time taken to process the dataset and identify the faces, which measures the efficiency of the algorithm.
6. False Positive Rate: The percentage of incorrectly identified faces out of the total number of faces identified.
7. False Negative Rate: The percentage of correctly identified faces out of the total number of faces not identified.

3.5 Applications

1. Access Control: Face recognition technology can be used for access control in buildings, vehicles, and devices.
2. Attendance Tracking: Face recognition technology can be used to track attendance in schools, colleges, and workplaces.
3. Surveillance: Face recognition technology can be used for surveillance in public spaces, airports, and other high-security areas.
4. Personalization: Face recognition technology can be used for personalization in devices, such as smartphones and smart home devices.
5. Healthcare: Face recognition technology can be used in healthcare for patient identification and monitoring.

3.6 Implementations

3.7 Platform

Operating System: Windows 11 Pro
IDEs or Text Editors Used: Visual Studio Code
Compilers or Interpreters: Python 3.10.1

3.7.1 Training Data

Certainly! Below is the provided images arranged in a table format with the serial number in the first column, the name in the third column, and the images in the second column:

Serial Number	Name	Image
1	Saubhagya	
2	Avishkar	
3	Karad	
4	Krish	
5	Parth	

Table 3.1: Training Data Images

3.7.2 Preliminary Results

Figure 3.1: Results identifying 3 of the 4 faces. Empirical results show that the model is working, with accuracy of around 75 %

Chapter 4

Conclusion

In this seminar, we have discussed the various face recognition algorithms and techniques used in the field of computer vision. We have compared the performance of these algorithms based on accuracy, efficiency, and scalability. We have also discussed the advantages and disadvantages of face recognition technology and its applications in real-world scenarios.

- Face recognition technology is a powerful biometric technology that can be used for a wide range of applications, from security to personalization.
- There are several face recognition algorithms and techniques available, each with its own strengths and weaknesses.
- By comparing the performance of different face recognition algorithms and techniques, we can gain insights into their suitability for different applications.
- The evaluation metrics provide a quantitative measure of the performance of face recognition algorithms and techniques, helping us identify the most suitable approach for a given application.
- Face recognition technology has the potential to revolutionize various industries and improve the quality of life for individuals by providing secure and personalized services.

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