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Face Recognition Attendance System Using K-Nearest Neighbors Algorithm

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Abstract: This research paper presents the design and implementation of a real-time, contactless attendance monitoring system based on face recognition using the K-Nearest Neighbor (KNN) algorithm. With the growing need for secure, automated, and hygienic attendance systems—especially in educational institutions and workplaces—biometric solutions have become highly relevant. The proposed system utilizes a webcam to capture facial images of individuals, which are then pre-processed by converting them into grayscale and resizing them to a standard format. These images are used to train a KNN classifier that learns to distinguish between different individuals based on facial features.

The system employs Haar cascade classifiers for face detection, and during execution, it continuously scans and recognizes faces in real-time, logging attendance data with timestamps. All recognized faces are stored systematically in a text-based log file organized by individual and date. The solution was tested under various environmental conditions including well-lit indoor, low-light, and outdoor scenarios. The experimental results indicate a high level of accuracy, particularly in controlled lighting environments, with performance gracefully degrading in low-light scenarios.

The simplicity and efficiency of the KNN algorithm make it well-suited for small- to medium-scale applications, offering a cost-effective and scalable alternative to more complex deep learning models. This system serves as a practical demonstration of how traditional machine learning methods can still offer viable solutions for real-world biometric identification tasks.

Keywords: Face Recognition, Attendance System, KNN, OpenCV, Machine Learning, Pattern Recognition

I. INTRODUCTION

Attendance management is an essential administrative task in educational institutions, workplaces, and other formal environments. Traditional methods of attendance recording, such as paper-based registers or RFID cards, are not only time-consuming but also susceptible to human error and manipulation, including proxy attendance. These limitations highlight the need for a more robust, efficient, and secure solution. Biometric-based attendance systems, particularly those utilizing facial recognition technology, have emerged as a promising alternative. Unlike fingerprint or iris recognition, face recognition is non-intrusive and does not require physical contact, making it a safer and more hygienic solution—especially important in the post-pandemic world. It also offers the convenience of automatic identification without requiring users to carry cards or remember login credentials.

In this project, a real-time face recognition-based attendance system is proposed, using the K-Nearest Neighbors (KNN) algorithm. KNN is a simple yet effective machine learning algorithm known for its accuracy in classification tasks. The system captures face images using a webcam, processes them using OpenCV, and classifies them with a trained KNN model. Recognized individuals are logged into attendance records along with timestamps.

The system aims to provide a cost-effective, scalable, and user-friendly alternative to traditional methods. It is particularly suitable for educational institutions and small organizations seeking to adopt biometric solutions without investing in complex or expensive infrastructure. Through this project, we demonstrate the practical application of classic machine learning techniques in solving real-world problems related to security and identity verification.

II. LITERATURE SURVEY

A literature survey provides insight into existing face recognition systems and classification algorithms, helping to identify their strengths, limitations, and areas for improvement. The field has evolved from basic image processing methods to complex machine learning and deep learning models. This section highlights significant contributions in face recognition and justifies the use of the K-Nearest Neighbours (KNN) algorithm in the proposed system.

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A. Principal Component Analysis (PCA) – Eigenfaces

One of the earliest and most well-known approaches in face recognition was introduced by Matthew Turk and Alex Pentland (1991). They proposed the Eigenfaces method using PCA for dimensionality reduction and face representation. While PCA provides a simple and efficient method, it struggles with variations in lighting, facial expression, and pose.

B. Local Binary Pattern (LBP)

Ahonen et al. (2006) proposed the use of Local Binary Patterns for face recognition, which encodes local texture features into binary values. LBP is efficient in terms of computation and suitable for real-time applications but may not perform well under significant facial variation or lighting changes.

C. Support Vector Machine (SVM)

Osuna et al. (1997) demonstrated the effectiveness of Support Vector Machines in face detection and recognition. SVMs can classify high-dimensional data with good accuracy but may require extensive tuning and computational resources for large-scale systems

III. PROBLEM STATEMENT

Manual attendance processes are inefficient, non-scalable, and susceptible to proxy attendance. There is a need for an automated, real-time system that can accurately identify individuals and mark attendance without physical interaction.

IV. OBJECTIVES

1) To develop a real-time face recognition attendance system.
2) To implement the system using the KNN algorithm.
3) To automate attendance marking using webcam-based recognition.

V. PROPOSED METHODOLOGY

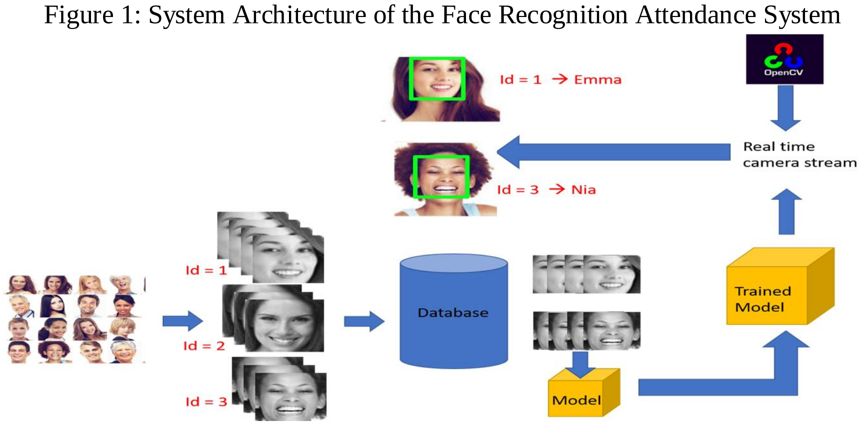
The methodology involves the following steps:

1) Face data collection using webcam.
2) Grayscale conversion and face detection using Haar cascades.
3) Feature extraction and dataset preparation.
4) Model training using KNN classifier.
5) Real-time face recognition and attendance logging.

The proposed system is a contactless, real-time, automated attendance system that uses facial recognition through a webcam. It detects and recognizes faces using Haar Cascade and the K-Nearest Neighbors (KNN) algorithm. Once a face is identified, the system logs the individual's name along with the date and time into a record. This approach eliminates manual intervention, improves hygiene, and ensures data accuracy.

The solution is implemented using Python and OpenCV, which are open-source and lightweight, making the system cost-effective and suitable for deployment in institutions and offices with limited infrastructure.

Figure 1: System Architecture of the Face Recognition Attendance System



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VI. IMPLEMENTATION

A. Data Collection

Using OpenCV, faces are detected via the webcam and saved after converting to grayscale and resizing to 100x100 pixels:

```
cv2.CascadeClassifier(cv2.data.haarcascades + "haarcascade_frontalface_default.xml")
cv2.VideoCapture(0)
cv2.imwrite("dataset/person_name/image.jpg", resized_face)
```

B. Feature Extraction & Training

All images are flattened and labeled. A KNN model with `k=3` is trained using scikit-learn:

```
knn = KNeighborsClassifier(n_neighbors=3)
knn.fit(X, y)
```

C. Recognition & Attendance Logging

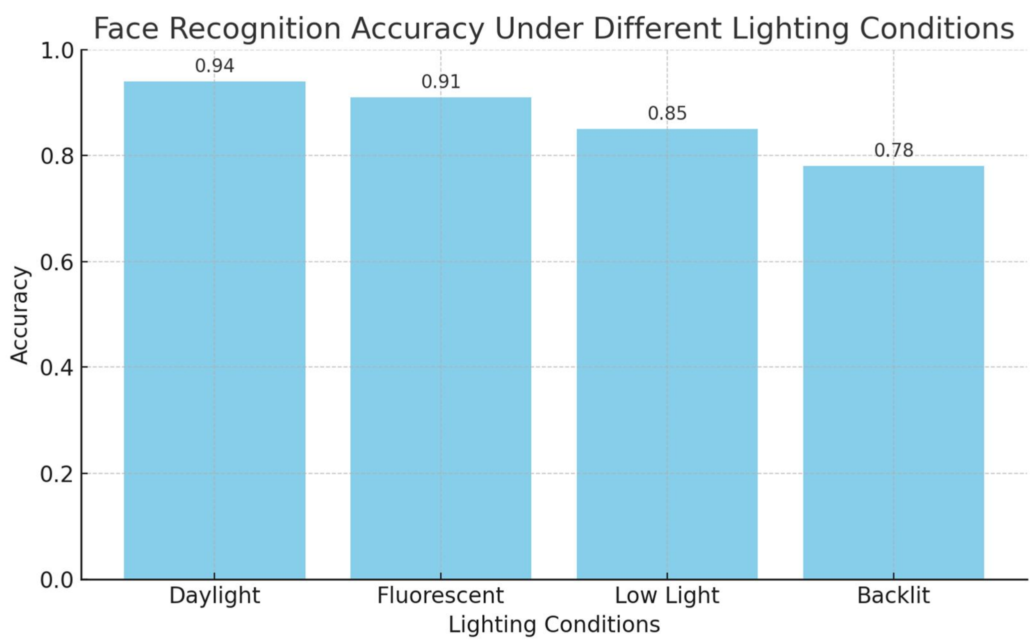
The trained model predicts face identities in real time and logs them into timestamped text files:

```
pred = knn.predict(face_flat)
with open("attendance/name/date.txt", "a") as f:
f.write(f"Recognized: {name} at {timestamp}\n")
```

VII. RESULTS

The system was tested using a dataset created by capturing face images of multiple users under varied lighting conditions. Recognition accuracy remained high under standard indoor environments, with some degradation observed under poor lighting.

Below is a graph illustrating the face recognition accuracy under different lighting conditions:



This demonstrates that while the model performs reliably in most scenarios, enhancements such as lighting normalization or deep learning techniques can further improve robustness.

Figure 2: Real-time Attendance Log Output in Terminal

This demonstrates that while the model performs reliably in most scenarios, enhancements such as lighting normalization or deep learning techniques can further improve robustness.

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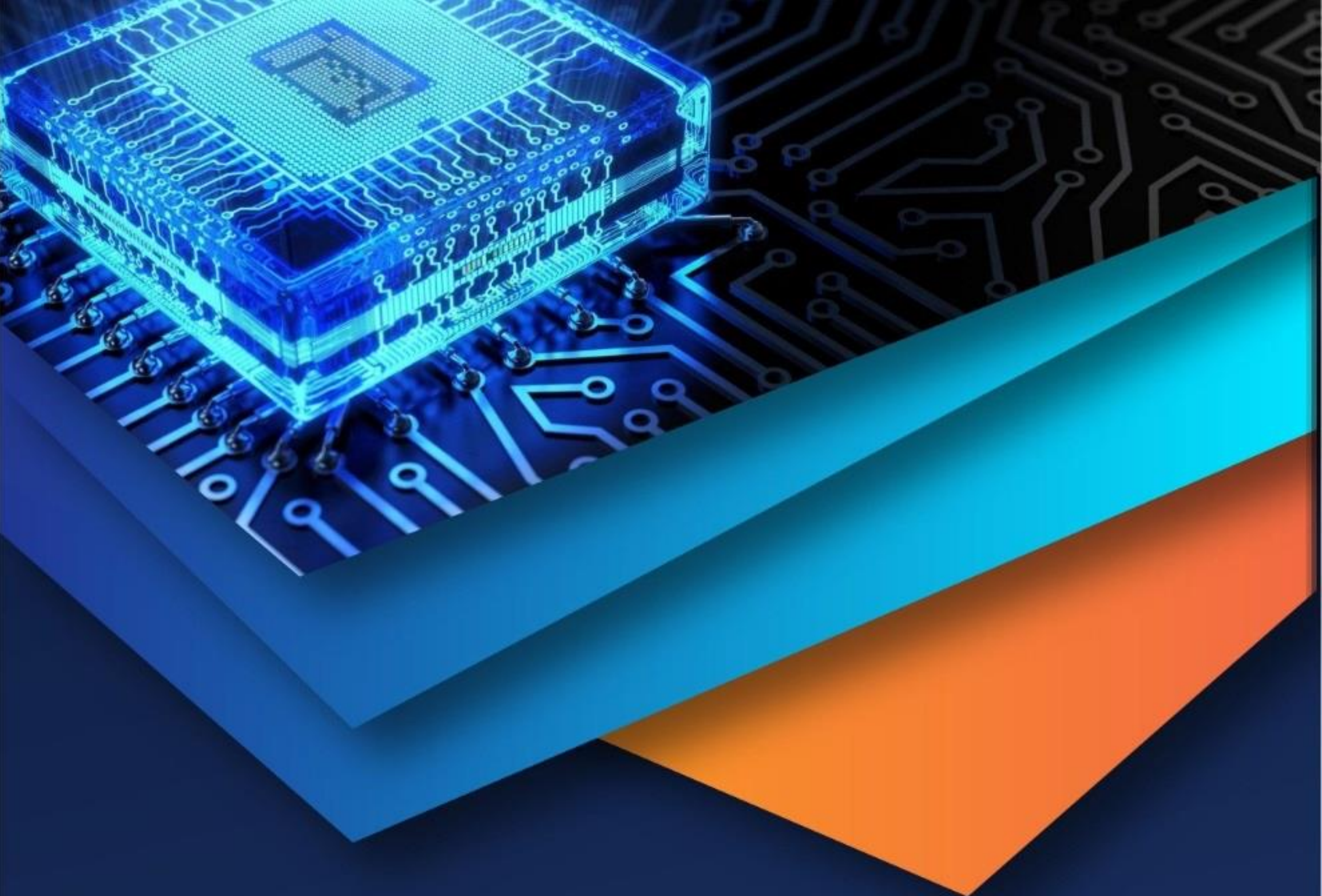

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