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Face Recognition Based on Real-time Attendance Management System

Dr. Sweety G. Jachak *1, Ruchita R. Raut*2, Tejaswini A. Rathod*3, Pooja A. Nemade*4, Udayan S. Jondhale*5

*1Assistant Professor, Department of Computer Engineering, Guru Gobind Singh College of Engineering and Research Centre, Nashik, Maharashtra, India,

*2,3,4,5 Student, Department of Computer Engineering, Guru Gobind Singh College of Engineering And Research Centre, Nashik, Maharashtra, India

ABSTRACT

In this digital era, face recognition system plays a important role in almost every sector. Face recognition is one of the used for biometric. This project can identify many students simultaneously and taking attendance without having to make direct contact. We proposed attend face, an independent system to analyze, track and grant attendance in real time using face recognition. In that system using snapshot of class from live camera feed, the system identifies student and marks them as present in the class based on their presence in multiple snapshots taken throughout the class duration. This system consists of four phases, database creation, face detection, face recognition, attendance up-dation, Database is created by image of the student in class. Face detection and recognition is performed using CNN, DCNN, MTCNN algorithm respectively. Faces are detected and recognized from live streaming video of the classroom. The system is fully automatic and requires no professor interfere or any form of manual attendance, since the backend directly interface with in class cameras.

Keywords - CNN, DCNN, Face Detection, Face Recognition, Real-Time Attendance.

INTRODUCTION

In recent years, technological advancements have revolutionized various facets of our daily lives, and one area witnessing significant transformation is attendance management systems. Traditional methods of attendance tracking, often prone to inefficiencies and errors, are gradually being replaced by innovative solutions, and among them, facial recognition-based systems have emerged as a powerful and reliable tool. This research paper explores the implementation and benefits of a Face Recognition-Based Real-time Attendance Management System, a sophisticated approach designed to revolutionize attendance tracking in various organizational settings. Unlike conventional methods that rely on manual data entry or card-based systems, this cutting-edge technology utilizes facial recognition algorithms to automatically and seamlessly record attendance in real-time.

The fundamental principle behind this system lies in its ability to capture and analyse unique facial features of individuals entering a designated area. A network of cameras captures facial images, and advanced algorithms process these images to identify and verify individuals with a high degree of accuracy. This not only eliminates the need for manual attendance marking but also enhances security measures through non-intrusive yet robust identification. In addition to the inherent accuracy of facial recognition technology, this system offers several advantages. It ensures efficiency by swiftly and accurately recording attendance as individuals move through the designated checkpoint. The real-time nature of the system provides instant updates, enabling administrators to monitor attendance promptly and make informed decisions. As organizations increasingly recognize the significance of time management, accuracy, and security, this research delves into the practical implementation and impact of Facial Recognition-Based Real-time Attendance Management Systems. By providing a detailed examination of its functionalities, benefits, and potential challenges, this paper aims to contribute to the evolving landscape of attendance management methodologies.

SYSTEM ARCHITECTURE

Requirements:

1) **Functional requirements**

System Feature 1 (Face Detection and Recognition)

a. Functional Requirement 1: Real-time Face Detection

1. The system must be able to detect faces in real-time from live camera feeds.
2. The detection should work under various lighting conditions and angles.

b. Functional Requirement 2: Face Recognition Accuracy

1. The system must accurately recognize registered individuals based on their facial features.
2. The recognition accuracy should be above 95 per under normal lighting conditions.

C. Functional Requirement 3: Multi-face Detection

1. The system should be capable of detecting and recognizing multiple faces simultaneously within the camera's field of view.
2. It should be able to handle a minimum of 3-4 faces in a single frame.

System Feature 2 (Attendance Tracking and Record Management)

a. Functional Requirement 1: Automated Attendance Marking

1. The system must automatically mark the attendance of recognized individuals once their faces are detected and matched.
2. Attendance should be marked in real-time.

b. Functional Requirement 2: Attendance Record Storage

1. The system must store attendance records securely in a centralized database.
2. Attendance records should include date, time, and the identity of the recognized individual.

c. Functional Requirement 3: Attendance Reporting

1. The system should generate customizable attendance reports for administrators.
2. Reports can be filtered by date, class, department, or individual.

System Feature 3 (User Management and Administration)

a. Functional Requirement 1: User Registration

1. The system must allow administrators to register individuals by capturing their facial data and linking it to their user profiles.
2. Registration should include personal information and unique identifiers.

b. Functional Requirement 2: Access Control

1. The system should have role-based access control, allowing administrators to manage user privileges.
2. Access control should restrict certain features to authorized personnel only.

c. Functional Requirement 3: System Configuration

1. The system must allow administrators to configure settings such as camera sensitivity, recognition thresholds, and attendance notification preferences.
2. Changes made to the system configuration should be applied in real-time. The system should have role-based access control, allowing administrators to man.

2) Non-Functional requirements

- Availability
- Scalability
- Security
- Privacy
- Functionality

Hardware Resources Required : Windows 11, 8GB RAM, Mobile Camera.3.9 . **Software Resources**

Required : C-sharp, Dot Net, Google Collab.

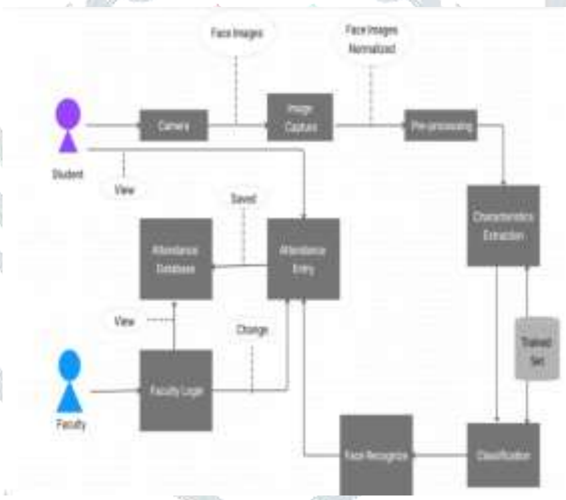


Fig.1 System Architecture

In the system the camera captured the student faces at a time then the image going for the pre-processing. After that pre-processing the image processing the image of face going for the characteristic extraction. In dataset the face image is processed. After the characteristic extraction module going for the classification of image with trained face dataset. In classification module will check which face is matched to the image face. After the classification module recognize the face.

Then the recognize face going for marked attendance. i.e., after recognition the module will mark the attendance in database. The faculty and the student will see the attendance. But only faculty or admin can change or edit the attendance in attendance database. This is the DFD (Data Flow Diagram) of our system:

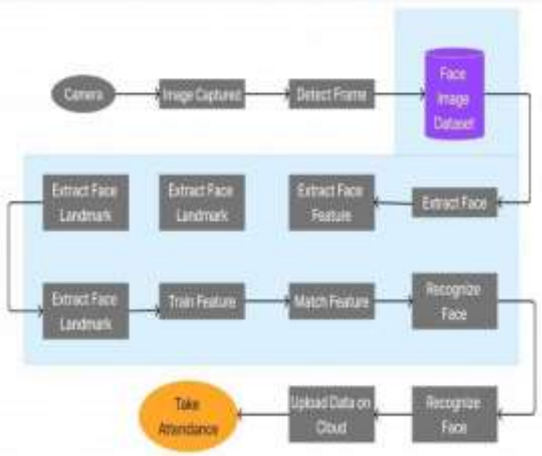


Fig.2.DFD Diagram

SYSTEM ALGORITHMS

CNN:

Convolutional Neural Networks (CNNs) are a class of deep learning models designed for image processing and pattern recognition. Inspired by the human visual system, CNNs consist of layers that automatically learn hierarchical features from input images. The key components include convolutional layers, which extract local features, and pooling layers, which down sample and retain important information. These layers, along with fully connected layers, enable CNNs to recognize complex patterns and objects in images. CNNs have proven highly effective in tasks such as image classification, object detection, and facial recognition due to their ability to capture spatial hierarchies and learn intricate features. CNNs are used for face detection, where they analyze images to identify regions containing faces. They're trained to recognize facial features and distinguish faces from other objects in the image.

MTCNN:

MTCNN, or Multi-task Cascaded Convolutional Networks, is a face detection algorithm designed for real-time applications. It consists of three stages: Proposal Network (P-Net), Refine Network (R-Net), and Output Network (O-Net). Each stage progressively refines facial region proposals, generating accurate bounding boxes and confidence scores. MTCNN is effective in detecting faces at different scales and orientations, making it widely used in applications like facial recognition and video surveillance. MTCNN is a more advanced face detection model that consists of multiple stages. It detects faces at different scales and refines the detection results, making it more accurate and robust for real-time applications.

DCNN:

A Deep Convolutional Neural Network (DCNN) is an advanced version of a Convolutional Neural Network (CNN) designed for complex image recognition tasks. DCNNs use multiple layers of convolution and pooling to automatically learn hierarchical features from input images. Deeper layers capture intricate patterns, enabling the network to recognize complex visual representations. DCNNs have proven effective in various applications, such as image classification and object detection, due to their ability to understand and represent hierarchical features in large datasets. DCNNs are employed for face recognition, where they learn to extract features from faces and map them to unique representations. These representations are then compared to a database of known faces to identify individuals in real-time.

MATHEMATICAL MODEL

Suppose we have the following known faces represented by vectors of facial features:

Y1 = [0.8,0.6,0.9,0.7]

Y2 = [0.7.0.5.0.8.0.6]
Y3 = [0.9,0.7,0.8,0.6]
And we have an unknown face represented by the vector : X = [0.85,0.65,0.88,0.67]
Now, let's calculate the Euclidean and Manhattan distances between the unknown face (X) and each known face (Y):

1. **Euclidean Distance:**

DE(X,Y1) = √(0.85 -0.8)2 + (0.65 - 0.6)2 + (0.88 – 0.9)2 + (0.67 -0.7)2 = √0.0025 +0.0025+0.0004+0.0009 = 0.0063 ≈ 0.0794
DE(X,Y2)=√(0.85-0.7)2+(0.65 0.5)2+(0.88-0.8)2 + (0.67 0.6)2 = 0.0225 +0.025 +0.0196 +0.0144 = 0.0815 ≈ 0.2856
DE(X, Y3) = √(0.85 - 0.9)2 + (0.65 -0.7)2 + (0.88 - 0.8)2 + (0.67 – 0.6)2 = √0.0025 +0.0025 +0.0196 +0.0144 = 0.039 ≈ 0.1975

2. **Manhattan Distance:**

DM(X,Y1)=|0.85-0.8|+|0.65-0.6|+|0.88-0.9|+|0.67-0.7| =0.05+0.05+0.02+0.03=0.13
DM(X,Y2)=|0.85-0.7|+|0.65-0.5|+|0.88-0.8|+|0.67-0.6| =0.15+0.15+0.08+0.07=0.45

DM(X,Y3)=|0.85-0.9|+|0.65-0.7|+|0.88-0.8|+|0.67-0.6| =0.05+0.05+0.08+0.07=0.25

Based on the calculated distances, the unknown face (X) is most similar to Y1 according to both the Euclidean and Manhattan distance metrics. Therefore, we can conclude that the unknown face likely belongs to the individual represented by Y1.

FRONT-END INTERFACE

We are creating a user-friendly front-end interface using Visual Studio's Windows Forms Application in C#. Integrate face recognition functionality using OpenCV libraries for real- time attendance management. Implement user authentication for access control and securely manage attendance records in a database. Ensure robust error handling and conduct thorough testing to guarantee reliability. Lastly, deploy the application with comprehensive documentation to facilitate user training and adoption.

Fig.3. Login Page

Fig.4. Student Registration Form

Fig.5. Face detected on camera and mark the attendance

Fig.6.List of Registration Student

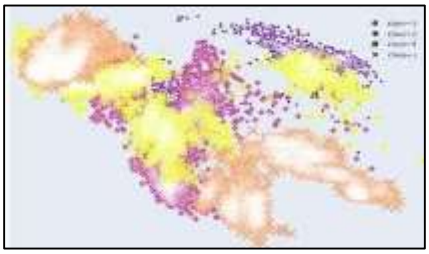


Fig.7. List of Present and Absent students

Data Collection:
The face data of the students is collected using an automated system, which accesses the system camera to take the video frames and transforms as a dataset by performing the following sequence of operations:

- Identify the location of face in the video frame.
- Extract the face image and convert into Grayscale image.

Fig.7. 3-Dimensional View of the Face Dataset

RESULT ANALYSIS

(Expected Outcome)

TABLE I: Details of Train and Test Data

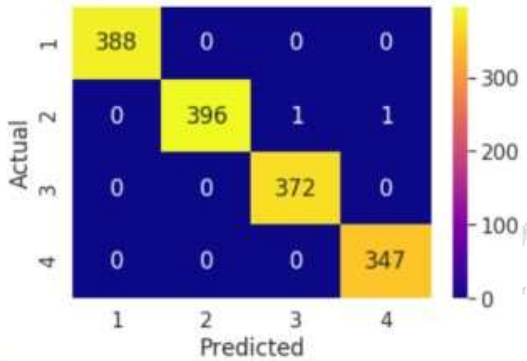
	Percentage	#Samples
Train	85	8525
Test	15	1505

TABLE II: Architecture of the proposed CNN

Layers	**Output Shape**	**#Parametes**
Conv2D	(None,98,98,64)	640
Batch Normalization	(None,98,98,64)	256

Conv2D_1	(None,96,96,64)	36928
Batch Normalization_1	(None,96,96,64)	256
Conv2D_2	(None,96,96,64)	102464
Batch Normalization_2	(None,96,96,64)	256
Max Pooling2D	(None,48,48,64)	0
Dropout	(None,48,48,64)	0
Conv2D 3	(None,46,46,128)	73856
Batch Normalization 3	(None,46,46,128)	512

TABLE III: Class-wise Accuracy:



lass Label	Accuracy
1	100.0%
2	99.49%
3	100.0%
4	100.0%

TABLE IV: Summary of Classification Accuracy:

Overall Accuracy	99.8671%
Average Accuracy	99.874%
Kappa Score	99.8226%
F1-Score	99.8674%
Precision	99.8611%
Recall	99.8743%

CONCLUSION

In conclusion, our project, represents a significant leap in modern attendance management. we have created an independent system capable of identifying and recording students' attendance in real time, all without the need for direct contact or manual intervention. System offers a seamless solution for various sectors, from education institutions to corporate settings and beyond. With its capabilities in face recognition and attendance tracking, our project represents a valuable tool for enhancing efficiency and security in attendance management processes.

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