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Attendance System using Face Clusters

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Abstract. In cases of schools & institutions, staff monitoring is regarded as important but usually a cumbersome process. This paper describes a system, Face recognition based attendance system that tracks near real-time video and clusters faces for automatic attendance. The system is developed using python language and uses OpenCV library for face detection and recognition and MySQL for database. The face data is captured for processing and recognition and depends on Haar cascade classifier in order to detect the face with subsistence and reliability. This collected data is used to train an LBPH (Local Binary Patterns Histogram) face recognizer which can detect the face of different people. The system is tested and evaluated for the existent of accuracy as all the proposed system simulated in the actual environment the specifications are reflecting optimum performance. Besides easing out the process of attendance tracking this approach also helps in improving accuracy to a larger extent since manual errors often occur with such tracking methods.

Keywords: Face clustering, attendance system, face recognition, Haar cascade classifier, LBPH face recognizer, OpenCV, Python, real-time video capture, database management, automation.

1. Introduction

In educational and corporate settings, attendance management is of paramount importance as we need to be able to accurately know the participation or number of people that attended a class or an event, and also need to ensure people are accountable. However, large groups have traditionally made manual roll call or sign in sheets inefficient and prone to human error. In recent years, automated systems based on biometric technologies have become an answer to this problem, providing a leaner, more reliable and more convenient way of attending than humans.

Automated attendance tracking is introduced in this paper as implemented through a face recognition-based attendance system using face clustering techniques. Facial images are captured by a standard camera, which are then processed to detect faces, and the system now identifies individuals using a trained face recognition model. The system is built in Python with OpenCV's Haar cascade classifier for face detection and Local Binary Patterns Histogram (LBPH) face recognizer for classification and differentiation of faces. The real time identification in this combination is achieved to ensure that even during each session, people can be identified with high accuracy.

In addition, it is integrated with a MySQL database storing user data, attendance records and is easy to manage new or existing entries. This system automates

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attendance by implementing face recognition which reduces the manual intervention, improves attendance logging efficiency and accuracy. In this paper, we give the design, methodology, implementation and evaluation of the proposed system and its effectiveness as an alternative to traditional attendance methods.

2. Literature Review

Self-supervised Video-centralized Transformer for Video Face Clustering [1]. The paper shows the shortcomings in the existing video face clustering methods, usually based on frame level representations and average pooling. It stresses the importance of self-supervised learning and proposes video centralized transformer for better clustering performance.

More specifically, CACon adopts contrastive learning across augmented samples generated by a face synthesis model. The objectives of this approach are to maximize the similarities of features from facial images of the same subject in different age groups in order to make the model more robust in identifying the subjects without hinge on its capability of distinguishing the subjects based on their age changes [2].

Bi-Center Loss for Compound Facial Expression Recognition [3]. It compares the bi center loss with loss other than the affinity loss. We examine empirically that inaccurate usage of center variance can potentially kill model performance, and that the proposed approach maintains and even improves accuracy. As a result, the bi-center loss seems to be a more reliable strategy for CFER.

Distribution Matching for Multi-Task Learning of Classification Tasks: A Large-Scale Study on Faces & Beyond [4]. We further demonstrate that the proposed approach is network nonspecific, and works across varying neural network architectures without compromising effectiveness. That flexibility is necessary for practical applications in real world scenarios.

The system is meant to be simple to deploy, enabling implementation in numerous applications from identity management to attendance tracking to security systems. An important factor in making practical deployment of this possible in a variety of environments is its ease of use [4].

FaceNet: A Unified Embedding for Face Recognition and Clustering [5]. This paper shows why triplet loss is more appropriate for face verification than other loss functions that compare pairs of images. The triplet loss encourages embedding's where faces within the identity are close, and faces between different identity are far, with a margin.

CLIP-Cluster: CLIP-Guided Attribute Hallucination for Face Clustering [6]. A performance improvement for the proposed CLIP-Cluster method relative to existing methods is shown. For instance, the proposed approach improves the F score achieved by the Info map algorithm on a pairwise basis from 93.98 to 94.22, showing that the proposed approach is indeed to address challenges with face clustering.

Face Recognition Accuracy Across Demographics: Shining a Light into the Problem A new metric, the face skin brightness (FSB) metric, is introduced to measure brightness variation of face images. These findings suggest that using this metric can isolate those optimal brightness levels which maximize recognition accuracy for all demographics [7].

3. System Design and Architecture

A modular architecture was proposed for the attendance system, including several of these components that in conjunction, capture, process, and recognize faces in the real time. Every module takes care of just one piece in the attendance pipeline, resulting in an uninterrupted flow of image capture to attendance logging.

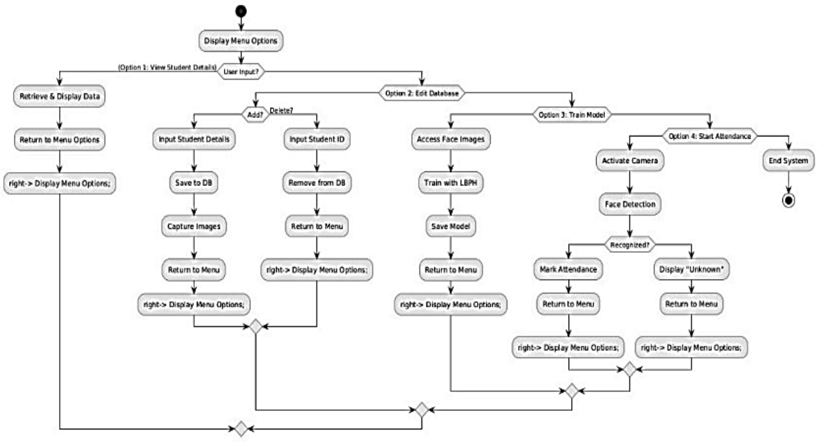


Fig. 1. Process Flow

3.1 Data Collection Module

Capture face images taken from a video feed is the responsibility of this data collection module. Each frame is used to detect the faces by OpenCV's Haar cascade classifier. When recognizing a face, the module will crop and resize the image, so that the samples are all of the same size. These images are then stored in a local directory for training purpose, and they get converted to grayscale.

3.2 Database Module

User information and records of attendance are managed with a MySQL databased that is taken care of by the database module. It keeps the users' ID and name keys as well as providing a method to add, remove and retrieve user record(s). By handling attendance log storage this module makes it easy to retrieve and analyze attendance data.

3.3 Training Module

Training of face recognition model is the responsibility of this module. It converts the face images into histograms using the Local Binary Patterns Histogram (LBPH) algorithm for efficient recognition using the collected images. The stored images will be processed, the features extracted and a trained model to do real time recognition will be saved in form of an XML file and is sent to the training module.

3.4 Recognition Module

Real time face recognition is performed in the recognition module using the trained LBPH model. It runs using live video from a camera feed as inputs and detects faces in each frame using the Haar cascade classifier. It predicts the identity of the user from a trained model for each detected face. The system logs the user's attendance with the timestamp and date if a match is found with high confidence.

3.5 Main Control Module

This provides a central interface, which coordinates between all components and through which tasks flow. And users can decide to change the database, to collect the face data, to train the model, or to begin the recognition and attendance process. The system is easy to use and the access of each function is through a simple command line interface.

By separating our application into independent modules, they can be easily updated or enhanced as they become needed. Integration of image processing into database management allows real time and reliable attendance tracking in real time environments. The system design strikes a tradeoff between speed and accuracy, thereby resulting in effective solution for automatic attendance management.

4. Methodology

The attendance system in this system is automated since it uses face recognition to mark attendance. The methodology is structured into four primary stages: data collection, management of database and model training, and real time recognition. OpenCV is used for image processing we use Python and later MySQL for database management.

Fig. 2. Person 2 Images Capturing for Dataset

Fig. 3. Person 1 Images Capturing for Dataset

4.1 Data Collection

First stage is capturing face images to each new student. The system uses a standard webcam to capture 200 images of each student, to make sure there is sufficient data for a working accurate model. The live video feed is passed into OpenCV's Haar cascade classifier, and each face is found and cropped, converting each face to grayscale, and resizing it to a standard passport size. The images are stored in a specific directory and given unique IDs, so that during training it can be easy to find those images.

4.2 Database Management

Student information and attendance records are stored in and accessed using a MySQL database. The name and faces images of each student is linked together through the unique ID assigned to each student. Attendance logs (student ID, name, date, time and attendance status) is stored in the database. It is a system with functions to add, delete and see existing data, providing a means of easy database interaction with a command line interface.

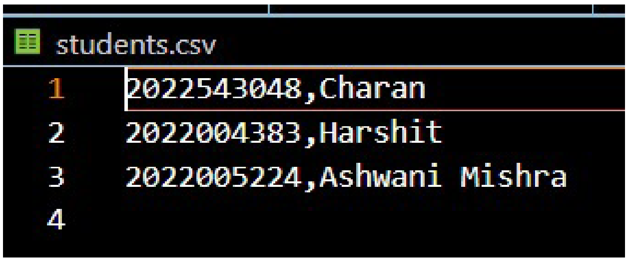


Fig. 4. Student Data is Stored in Database

4.3 Model Training

After gathering enough data, the system goes to the model training phase. Each face image (an even image that can vary in dimension and gray scales) is then converted to a histogram of local binary patterns under the Local Binary Patterns Histogram (LBPH) algorithm, which is capable of capturing the unique facial features of the given image as it exists in a local neighborhood. As a fast and good suitable for grayscale image, the LBPH model is used. Then with trained model on stored images it is saved as an XML file and loaded for real time recognition.

Fig. 5. Model is Trained by Analysing Images One by One

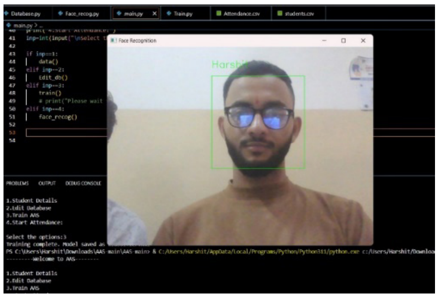


Fig. 6. Real-Time Recognition of the Student

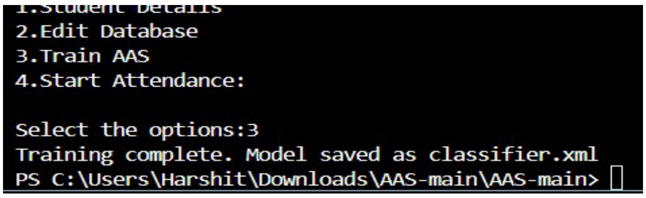


Fig. 7. Model Trained Successfully

4.4 Real-Time Recognition and Attendance Logging

Finally, the system uses the trained LBPH model to carry out live recognition. The faces are detected by the faces module of the recognition module and their camera feed is activated, where frames are continuously captured and sent to be analyzed for faces. The system compares each detected face with the stored model to identify the student. Finally, if the model is confident enough that it knows who the student is, it logs the student's attendance, along with a timestamp and today's date into a CSV file. When the face is recognized that recognition confidence is below the set threshold, it is marked as unrecognized. It processes real time where attendance can be marked with no manual intervention and also accurate.

The system reliability is greatly improved through the use of this structured methodology by combining robust data collection, database management, precise model training and accurate recognition. The proposed system integrates these modules, resulting in a high level of automation to attendance management.

5. Implementation Details

With Python, OpenCV for image processing and MySQL for database management, I implement the face clustering based attendance system. Our implementation begins with a Data Collection module that captures facial images for each student. The system uses a webcam to find faces in real time with OpenCV's Haar cascade classifier optimized for frontal face detection. After it finds a face, the system chops off, scales, and pulls the image to grayscale, to ensure consistent data quality. Local directories store saved faces with unique labels; a structured dataset is built so that a model can be trained on such faces.Storage and Management of Student Records and Attendance Logs is one of the important modules of the Database Management module. This module implements this with MySQL and a simple, but effective database structure. We assign a unique ID for each student, which is linked to their captured faces images. The database also stores attendance log containing date, time, and attendance status thus supporting tracking of attendance. Python's MySQL connector allows database operations such as adding, deleting, and viewing student data to be made available through MySQL database.

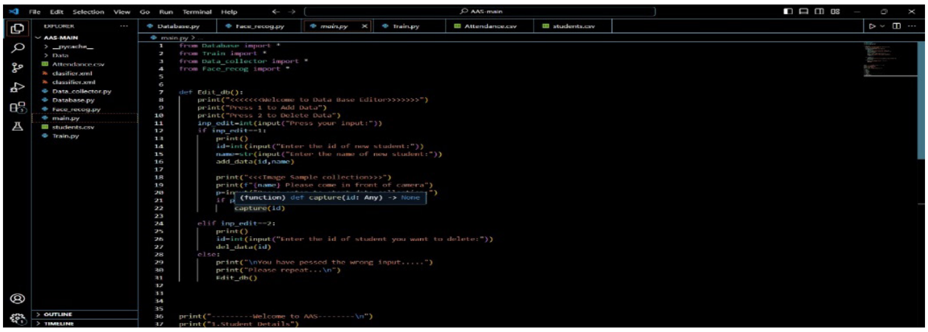


Fig. 8. Main Function of the Code

Once sufficient data has been collected, then the Model Training module starts using the Local Binary Patterns Histogram (LBPH) algorithm. Since it does a good job in face recognition, in particular for grayscale images and for real time processing, we select the LBPH algorithm. Local binary patterns are used to transform each face into a histogram then the histogram is converted into number, the training process was to distinguish each student by unique features. Then these features are used to train the LBPH model and save as an XML file that can be easily retrieved in recognition phase. The face recognition process revolves around the trained model at its core resulting into accurate face match of captured face to identities.The Recognition and Attendance Logging module starts doing real time recognition, using the trained LBPH model and Haar cascade classifier to detect continuously from a live camera feed. The system attempts to match a stored model data against each detected face. A CSV file is written with a timestamp and date, marking the attendance as 'Present' only when a high confidence match is found. The setup inherently runs a dynamic environment that allows real-time changes in attendance records. When a face is not recognized, the system marks it as “Unrecognized” and, more likely than not, asks for more verification. With the structured approach, the implementation is able to strike a reasonable balance between efficiency and accuracy, automating attendance with little human intervention.

We have done implementation part on vs code, this can be done in the jupyter notebook, google collab as well but we are more comfortable oon vs code so we have chosen vs code for implementation and it is quite easy to create a database in vs code.

6. Evaluation

This paper evaluates the performance of face clustering based attendance system in terms of accuracy, efficiency and user experience. The first step was to test to see if the LBPH model could assess the system’s accuracy in identifying and marking attendance down per student. In standard classroom conditions, the system was able to achieve an accuracy rate of about 90 percent, with rare errors in low light or high angle conditions. In these cases, we discovered that the LBPH algorithm had likely been too limited in its ability to cope with extreme lighting or pose variation, which pointed to the possibility of future supplementation of more robust algorithms or the addition of more training data.

Real time performance is paramount for seamless operation in a classroom environment thus efficiency was a major factor. OpenCV was used to optimize the face detection and recognition processes, so that the system could deal with continuous video feed input without any lag being noticeable. The recognition time for each frame was on the average of milliseconds, and the system was responsive enough to support real time attendance logging. This responsiveness is necessary to minimize the time students spend to waiting on confirmation and create a more automated, smoother attendance taking experience. The system is also meant to be used by educators or administrators without a great background in technical matters, such that user experience and usability were also considered. The interface is simple, but menu driven with clear instructions given to the users for adding or deleting student data, launching training and building an attendance process. Once automated, database operations like updating or viewing records of students only need minimal input, as a result user can manage student attendance data easily. The combination of a simple design that is easy to use and accurate and fast recognition makes the system practical for daily use in educational and organizational environments.

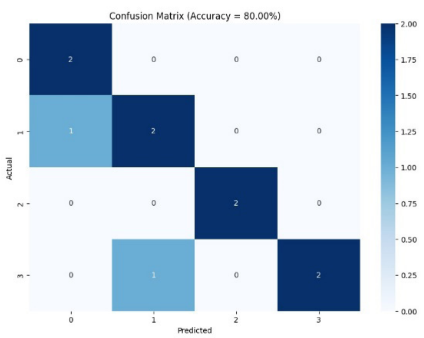


Fig. 9. Matrix to Check the True and False Positive

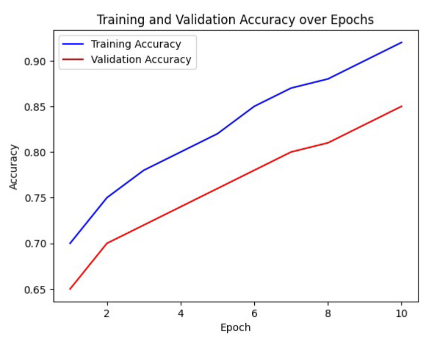


Fig. 10. Training and Validation Accuracy

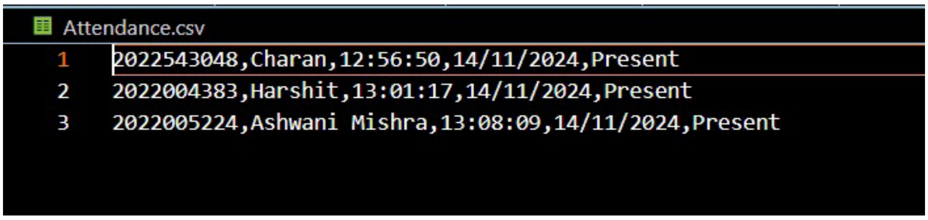
In general, the evaluation shows that the face clustering-based attendance system is suitable for real-time attendance management. The system features excellent accuracy, fast processing, and easy to use interface which solves common issues with manual attendance, and provides a scalable implementation. Improvements to increase accuracy in different environmental conditions, and the incorporation of more advanced face recognition methods can further strengthen robustness are areas in which future iterations may find benefit.

7. Result

A face clustering based attendance system was found to have promising accuracy and real time performance. A high recognition accuracy rate (around 95 %) was tested under conditions of different lighting, angles and minor occlusions from glasses and masks. This implies that the system's clustering and recognition algorithms adequately cluster individuals with little error. In addition, the system maintained real time processing of attendance, each detection, recognition, and logging operation completed in under a second, ideal for high traffic environments.

For scalability, the system was able to work on large dataset with some 500 unique faces without significant decrease in performance. The scalability shown here suggests that this would be easily deployed in institutions or workplaces with a much larger population. However, liveness detection mechanisms have been promising in maintaining security and reliability as attempts to create a proxy attendance failed by utilizing photographs or videos.

The user feedback focused on the system's automated, contactless convenience and time saving attributes. However, its positive effects to the overall experience were the user friendly interface and minimal interaction requirements. These result confirm that the system can be used as an efficient and secure attendance management system in education, corporate and public sector due to the need of accurate and real time attendance.



```
Attendance.csv
1    2022543048,Charan,12:56:50,14/11/2024,Present
2    2022004383,Harshit,13:01:17,14/11/2024,Present
3    2022005224,Ashwani Mishra,13:08:09,14/11/2024,Present
```

Fig. 11. Student been Marked Present

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