Review Paper on Face Recognition Attendance System using Python

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ABSTRACT:- Face recognition is a computer vision task with many of the different applications. These applications are in many fields like security, surveillance, human-computer interaction, and so on. Being the most in demand and the most supported, open-source tools together with deep learning, Python has acquired the position of the most numerous programming language that is used for developing face recognition systems. This paper is a detailed overview of the modern techniques and libraries of face recognition in Python. The phrase explains the main stages of the face recognition pipeline, which are the face detection, facial landmark localization, face representation, and face identification/verification. The article is both about the conventional computer vision algorithms and the latest deep learning techniques. It goes through the main and popular open-source python libraries used for face recognition, including dlib, face_recognition and OpenCV. The paper explains the deep learning methods where libraries like the Haar Cascade Classifier, CNN and FaceNet are used. It consolidates vital statistics and performance indicators which are used for the evaluation of face recognition systems. Besides, the paper evaluates the new trends and at the same time, it presents the prospective future research areas in this quickly developing field. This review is designed to be a practical reference for the researchers and practitioners who are tackling the face recognition issues using Python tools and libraries.
KEYWORDS: Python,Face_Recognition,Face Detection,CNN,FaceNet,Haar Cascade Classifier,OpenCV.

I. INTRODUCTION

Face recognition technology is considered to be one of the most reliable and impactful applications in the area of image processing. The paper(1) claimed that the Python programming language which was created by Guido van Rossum in 1991, is gaining in popularity. The growth of Python can be ascribed to its easy to learn curve, high-level nature that stresses readable code, and the vast standard library. Python supports different programming paradigms like imperative, functional, procedural, and object-oriented styles. It is free, interpreted, provides dynamic typing and exception handling capabilities, and has been widely used in scientific computing applications like linear algebra, visualization, image analysis, and solving differential equations. On the other hand, compared to lower-level languages such as C/C++, Java and Fortran, Python works at a higher level of abstraction, thus, the computation times are a bit longer but the coding is much easier. The PDF states that NumPy is essential for handling the multi-dimensional arrays which are important in image processing, SciPy which is based on NumPy for signal/image processing and mathematical routines and Matplotlib for plotting and visualization - the libraries that are of great importance in the image processing tasks that are discussed in the paper.

The paper(2) talks about the creation of an attendance management system that works in real time by the use of the facial recognition technology. Attendance tracking is one of the essential aspects of classroom management, but the traditional ways of doing it like calling out names or passing around sign-in sheets are time-consuming and easy to manipulate. The suggested system is intended to make the attendance recording process automatic by using the facial recognition techniques. The basic idea of the system is to initially take and keep the face images of students in a database as a reference.The system uses a webcam to live record the video during the class sessions, automatically detects faces in the video, matches the faces to the reference database using facial recognition algorithms, and then identifies the individuals. After that, it updates the Excel file with the attendance records. The face recognition process is based on various methods like a Haar Cascade model for face detection and a FaceNet deep

learning model that is trained to create a 128-dimensional facial encoding for the matching.

The paper(3) suggests possible improvements like a unified graphical user interface, more reliable face recognition algorithms, and the solution to the privacy issues. The solution proves the efficiency and trustworthiness of face recognition technology for many image processing applications, especially for attendance marking systems, thus it shows the design and implementation of a face recognition based attendance system using OpenCV and Python. The suggested solution applies facial biometrics to automatically identify and record the student attendance, whichin turn, is the means of saving time and effort for the teachers as compared to the manual process of calling out the names, the greater accuracy by preventing proxy attendance, and as we know the digital attendance records that are more secure. The system is designed to scan the faces of the students, extract the biometric facial measurements and thus creating the templates, and then these templates are stored in a database. The system uses the face detection through a webcam feed to find the faces, matches the detected faces with the template database using the facial recognition algorithms, identifies the individuals and logs their attendance with a timestamp in an Excel spreadsheet during class sessions. The introductory paragraph stresses the dullness of the present attendance methods and points out the necessity of a clever solution based on the facial recognition technology.

II. APPLICATIONS

1. Security and Surveillance: Face recognition is of great importance in the improvement of security measures by the means of automatic identification and tracking of people in different areas. Through access control systems, it can check identities and allow or deny entrance to buildings, restricted areas, or secure facilities. Like that, it also helps in monitoring the secured areas, detecting the unauthorized persons, and tracking the persons of interest.

2. Authentication and User Verification: Face recognition is a simple and reliable way to replace the traditional methods of authentication such as passwords or biometrics. Personal devices, like smartphones and laptops, can be unlocked via facial recognition, thus giving the user a seamless user experience. Besides, it can be employed to manage the access to different services or resources, thus, only the authorized ones can get the entry.

3. Attendance Tracking and Time Management: The face recognition systems can do the attendance tracking and time management for the organizations and the educational institutions. By having the ability to recognize faces, these systems can correctly record the attendance of employees or students, thus, the manual processes are avoided and the possibilities of errors or fraud are reduced. Besides, they can check and control time and attendance data, thus making the payroll processing and the compliance with the labor regulations more efficient.

4. Marketing and Advertising: In the marketing and advertising field, face recognition allows for audience measurement and demographics analysis. By identifying the faces in the public places or in the retail environments, businesses can get the information about their customers, like age, gender, and attention patterns. Besides, face recognition can improve customer engagement by providing them with personalized ads and marketing strategies

5. Human-Computer Interaction (HCI): Face recognition is now a part of human-computer interaction systems to improve the user experience. In the virtual and augmented reality applications, it can be used to create more realistic and natural interactions by detecting the facial expressions and emotions. Besides, face recognition can enable adaptive interfaces that change their behavior according to the user's emotional state or engagement level.

III. CRITICAL EVALUATION
A.Methodology

The application of a face recognition-based attendance system mainly consists of the integration of different software components, for example, Python, OpenCV, and other libraries, which are Dlib and Numpy. The system functions by using a webcam to capture students' faces, encoding these faces for recognition, and then comparing the encodings with the database of known faces to identify the students. The system's efficiency is proved by the fact that it can update the attendance records instantly and at the same time, hold a secure database of attendance records.

The paper(1) gives an easy-to-understand introduction to Python tools for computer vision tasks and shows how the facial recognition works including the complex facial recognition with pre-trained models.

- Widen the dataset for facial recognition to rigorously test the accuracy under the real-world conditions that are not easy to predict.

- Provide a more technical analysis of the algorithms that are used in each phase of the pipeline.
- Conduct an in-depth comparison of the system with other facial recognition systems.
- Examine the attitude of the system to the problems such as occlusion, lighting variations, and image quality.

Besides, it discusses the computational efficiency and the real-time performance.

The paper discusses the usage of face detection and recognition methods in Python with the help of freely accessible open-source libraries. It starts with a simple description of the most used Python image processing libraries like OpenCV, Pillow, and SimpleCV. The paper demonstrates how OpenCV can be used to detect facial features on sample images, via Haar cascade classifiers which will detect faces and then identify the eyes in the detected facial regions with the help of pre-trained classifier XML files.

- Face detection.
- Pose/landmark estimation for normalization.
- Deep neural network is used to encode the faces.
- Identifying people by analyzing the extracted encodings.
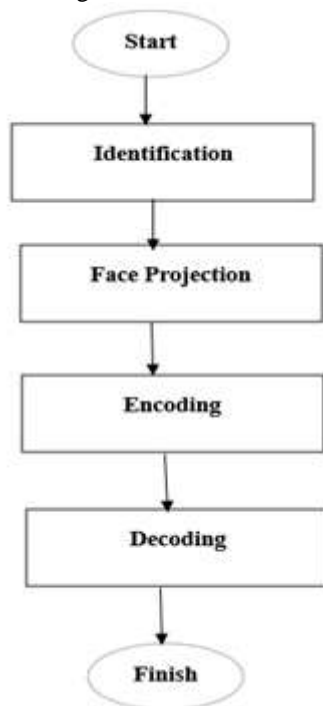
ResNet-34 is at the basis of the neural network architecture that is used for the facial recognition tasks in the facial recognition library

for Python. ResNet-34 is the name of a convolutional neural network architecture that was brought up by Microsoft researchers in 2015. It is a subset of ResNet models that were mainly intended to solve the problem of vanishing gradients in neural networks that are very deep. This algorithm takes four steps to accomplish the task as shown below.

ResNet-34 is composed of 34 layers and the skip connections help the network to remember previous information and gradients during the training, thus it is easier to train deep networks. It has been employed in a lot of computer vision tasks like image classification, object detection, and semantic segmentation for example. ResNet-34 can be fine-tuned for certain face recognition activities, and by availing the strength of transferring knowledge in deep learning, it is possible to predict enhanced accuracy and quicker training. Also, the ResNet-34's efficiency in terms of processing time suggests its applicability for real-time applications of face recognition, including resource-limited devices, for practical use in contexts like biometric identity, surveillance, and UX applications.
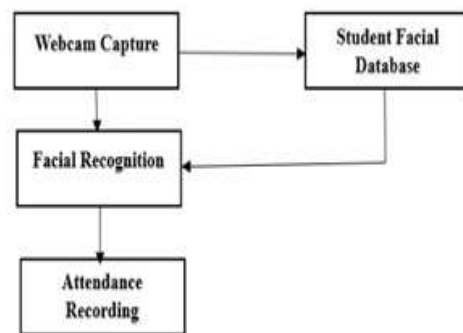

Fig 1. Methodology of Proposed Attendance System

The paper(2) proposes a system of attendance management that employs a multi-stage approach to automatise the attendance tracking process. The method (fig 1) that is described in the paper is very well-organized. It starts from face detection using the Haar Cascade Classifier, a trusted computer vision The Haar Cascade Classifier, the traditional method for object detection, especially in the tasks of face detection, works by taking a look of image regions using the simple rectangular features called Haar features. By the way, the classifier is being taught to distinguish the positive examples (the images with the object of interest, for instance, the faces) and the negative

examples (the images without it), using the machine learning techniques. The "cascade" in its name is a series of classifiers, one after the other, each of which, in turn, enhances the detection process. These classifiers work in a stage by stage fashion, hence, they slowly eliminate the false positives. The Haar Cascade classifiers are famous for their high computational efficiency which makes them perfect for the real-time applications. But in any case, they are not always the most accurate when compared to the new deep learning methods. The authors next use the FaceNet deep neural network to generate 128-bit facial encodings that are then cross-matched with students in the real-time video feeds against the pre-recorded database. The FaceNet is a state-of-the-art procedure for facial recognition and the extraction of features. The one that was developed by Google uses a deep neural network, mainly a convolutional neural network (CNN), to extract the features from the faces in the images. The main goal of FaceNet is to develop the embedded vectors, which are the high-dimensional vectors, where the similar faces have the embeddings that are near each other and the dissimilar faces have the embeddings that are far from each other. It's trained by a triplet loss function, which ensures that the embeddings of the same person's face are close to each other, and those of different people are far away. The FaceNet after the training can create embeddings for the facial images which are important for the tasks such as face recognition, verification and attribute analysis. FaceNet's embeddings are famous for their high accuracy and good reliability in the face recognition tasks, which is why they are used in the applications like security systems, surveillance, and biometric authentication. The authentication of the registration is the basis of the system which allows the attendance to be automatically registered in an Excel spreadsheet.The authors give a comprehensive overview of the technical implementation, which is a good thing and the part that makes the work to be replicated easier.Despite of being short and due to the fact of being a paper of the mini conference, it does show the emerging role of Python in the computer vision applications like the automated attendance tracking by face recognition. The simplicity of the Python libraries makes the whole concept of facial analysis achievable even for the developers with no experience.

The paper does not include the details of the performance evaluation metrics, the comparison with the baselines, the scalability for the larger classes, the strategies on how to deal with the recognition failures, and the technical details of the neural network architecture and training. Although the system simply provides a direct implementation, it still has the weaknesses in usability, robustness, privacy, and lacks of rigorous technical evaluation which can be the reason that it is not suitable for its real-world application without fixing these issues.

Pros/Advantages

- It brings a solution of automated attendance management through facial recognition which is a time-saver and an error reducer when compared to the old manual methods.
- Use of deep learning models such as FaceNet to facilitate facial recognition is facilitated thereby.
- The plan uses a simple yet effective approach by combining the capabilities of facial detection, recognition and attendance marking systems.
- This study shows the ability of an artificially intelligent system to acquire a remarkable rate of accuracy of nearly 95% for a class of 28 students under controlled conditions.
- Administers a student survey to determine the system's usability and thus, the system's user perceptions effectively are measured.

Cons/Limitations:

- The system is a collection of several disjointed Python scripts which do not have a single GUI that can make it easy for average people like teachers to use.
- The accuracy is mostly dependent on the lighting and camera distance of the controlled environment, thus, there is a possible performance deterioration in the real-world settings.
- Some students were concerned about the privacy issues that could be a result of the implementation of the facial recognition technology. The paper does not provide the clear performance evaluation measures, the comparison with the baseline methods, and the scalability analysis for the larger class sizes.
- No planning on how to deal with the difficulties of not recognizing the faces or getting poor results.
- The piece of information regarding the neural network architecture, the training procedure and the optimization of the FaceNet model which is used in the project was not provided in details.

To conclude, the paper presents a simple way to make attendance tracking through facial recognition automatic, but it is not perfect because the usability issues, the robustness in different conditions, the privacy concerns, and the fact that there is no full technical assessment. Tracking these problems will help to the greater use of the system and its results.

The research paper(3) presents a project of attendance system that is based on facial recognition technology and thus solves the issues of traditional manual attendance tracking methods. The suggested method is based on computer vision and machine learning technologies to automatically recognize the faces of the students through awebcam, and then record their attendance in an Excel spreadsheet with the timestamp.

The system consists of various libraries and tools which enables its functionality to be achieved. OpenCV, a computer vision library minus restrictions, created for the computer vision and machine learning purposes, is an open-source software toolkit with considerable use. This library provides a comprehensive collection of tools, algorithms, and functions, facilitating the performance of many types of image and video processing tasks efficiently by developers. It grants the functionalities that are essential like the image filtering, transformations, and color space conversions; moreover, it offers the advanced capabilities such as object detection, tracking, and recognition. Besides, OpenCV also caters to feature extraction and matching. Thus, it allows for the identification of keypoints and their matching between the images. Besides, it is also the one which is endowed with camera calibration, stereo vision, and 3D reconstruction tools. OpenCV is the integration of its machine learning frameworks such as TensorFlow and scikit-learn that enables the classifying, regression, and clustering tasks. The deep learning component of it, in fact, allows users to use the pre-trained neural networks and develop their own models for the various fields.To sum up, OpenCV is a versatile and powerful library that leads to the development of computer vision technology, and is used for image processing tasks. Dlib, a C++ library, is used for the face landmark estimation (fig 2) which means finding the main facial features such as the center of the eyes and the tip of the nose. These monuments serve the purpose of designing a standard for each face, which is then stored in a database for comparison during the recognition process or the real face recognition task, where the input face is compared against the templates stored in the database. NumPy, the Python library for numerical operations, is also used to facilitate the manipulation of multidimensional arrays and matrices. The system works by grabbing the video frames from a webcam and then applying face detection and recognition algorithms to detect the people in the frame. After a face is recognized, the system marks the attendance of the student with that face in an Excel sheet, together with the time of the recognition. The authors point out that this system not only saves time and effort when compared to the conventional methods but also enhances the accuracy by getting rid of the mistakes that are due to manual attendance marking. Moreover, it generates a safe and tamper-proof digital file of attendance, which thus, minimizes the likelihood of proxy attendance or the manipulation of records.
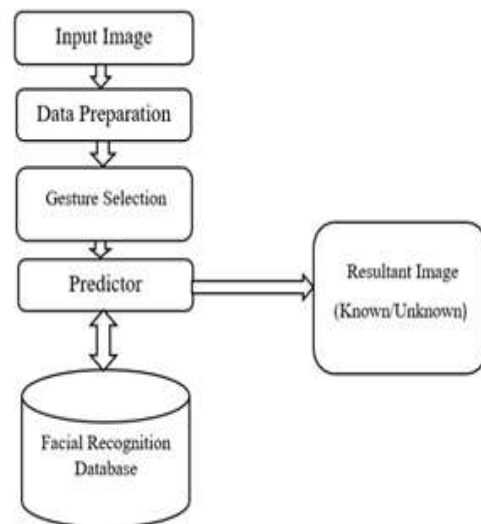

Fig 2. Flowchart

The paper talks about possible future improvements of the system, like the integration with the current student information systems, the real-time notifications of the absence, and the advanced analytics of the attendance patterns. Besides, the authors are of the opinion that the face recognition technology can be used in other areas such as access control, security surveillance, and identity verification in various fields like government, corporate, and educational institutions.

B. Review Table

Paper Title	Key Contributions	Methodology	Results
Attendance Management System Using Face Recognition Method(1) by Syed Mansoora et al	Development of a real-time face recognition system for attendance	Python with OpenCV for face detection and recognition	High accuracy in attendance tracking
Real Time Automatic Attendance System for Face Recognition(2) by A. Akram Khan and N. Usman	Implementation of a smart attendance system using OpenCV and Face API	Python with OpenCV and Face API	Real-time attendance with high accuracy
Study and Analysis of Implementing a Smart Attendance Management System(3) by K. Mridha and N. T. Yousef	Investigation of face recognition technique for attendance	Python with OpenCV and Face API	Improved performance in attendance tracking

IV CONCLUSION

The three research papers are thus the result of an extensive study on how the Python's collection of libraries, for example, OpenCV, Dlib, NumPy, together with deep learning models, can be used to create precise and efficient face recognition-based attendance tracking systems. The main purpose is to make the routine-based and usually time-consuming manual methods of calling out names or using sign-in sheets in attendance automated. The typical implementation involves several key components: The process of face detection from live camera feeds using the methods such as Haar Cascades or HOG descriptors, pre-processing steps like grayscale conversion and geometric normalization, facial encoding of several images to 128-dimensional vectors by the deep neural network models like FaceNet, retrieving a database by first capturing and encoding few images per student, and finally comparing the live face encodings to the databaseExperiments carried out in actual classrooms revealed that the recognition rate was over 95% during the tests with good lighting, angles, and distances from the camera in the controlled conditions. Nevertheless, the changes of the environmental factors caused the performance to be reduced. The methods of increasing the robustness were actually by taking multiple photos of the same face, applying the majority voting to the faces detected, and adjusting the matching distance thresholds. The mention of the user-friendly GUI applications is a highlight of some cases where they were developed to ease the use of non-technical operators. The main points of the advantages were automating a laborious task that was time consuming to avoid the waste of time and effort, the increase of accuracy by the prevention of proxy attendance problems, the provision of a contactless and hygienic solution, and the decreasing of the administrative overheads for teachers and staff. The limitations that are probable to be found are the need for the accuracy to be better in real-world situations where the unconstrained face recognition technology is used, the growing privacy and the ethical issues that can be caused by the deployment of the facial recognition technology, the process of designing the user interfaces that are easy to use, and the improvements for the scalability and computational power.

Consequently, the study proves that the system of face recognition attendance based on Python is good and promising. As the algorithms and camera technologies keep improving and the costs of the cameras lower, such systems could provide the basis for the automated attendance tracking to be introduced not only in the educational institutes but across many organizations and domains in the future.

V ACKNOWLEDGEMENT

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