IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

Impact Factor 8.311 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 13, Issue 2, February 2026

DOI: 10.17148/IARJSET.2026.13239

FACE ATTENDANCE SYSTEM USING MACHINE LEARNING

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Abstract: Attendance management is an essential requirement in educational institutions and organizations, as it plays a significant role in tracking discipline, participation, and performance. The traditional attendance system, such as manual registers, signature sheets, and roll calls, is time-consuming, prone to errors, and susceptible to proxy attendance. To overcome these drawbacks, this research work proposes a Face Attendance System based on Machine Learning and Computer Vision concepts. The proposed system uses live image acquisition through a camera, face detection through the Haar Cascade algorithm, and face recognition to identify registered users for automatic attendance marking with precise date and time stamping. The proposed system is developed using Python, OpenCV, Flask, and SQLite with a modular approach to distinguish application logic and database management. The experimental results demonstrate that the proposed system greatly minimizes manual labor, increases accuracy, and improves reliability compared to the traditional attendance system. The proposed system can be efficiently employed in educational institutions and organizations as a cost-effective, user-friendly, and scalable solution for automated attendance management.

Keywords: Face Recognition, Attendance System, Machine Learning, Computer Vision, OpenCV, Haar Cascade, Flask, SQLite.

I. INTRODUCTION

The human face is one of the most distinctive and natural ways of identifying a person. Humans tend to identify each other through facial features, and this has led to the development of face recognition systems in the computer vision field. In recent years, face recognition systems have been widely accepted in various applications, including security surveillance systems, access control systems, authentication systems, and attendance management systems. Among these applications, the attendance management system has great importance in educational institutions and organizations, as it is directly linked to discipline and efficiency.

Conventionally, the attendance is marked by the use of manual systems such as name-calling, register signing, or the use of paper-based attendance cards. Although these systems are easy to implement, they have a number of serious flaws. The system is timeconsuming, especially when dealing with a large number of students in class or employees in an organization. The system is also prone to human errors such as mistakes, loss of records, and fraud. Another serious problem with the current system is proxy attendance, where one person marks the attendance of another.

To address these issues, different automated attendance systems have been developed, such as RFID-based systems, barcode-based systems, and fingerprint-based biometric systems. Although these systems have improved efficiency to a certain extent, they still have limitations. For example, RFID cards can be lost or borrowed, fingerprint systems involve contact, which may lead to hygiene issues and wear and tear of the device, and some biometric systems require costly hardware. On the other hand, face recognition is a contactless, convenient, and natural way of identification that does not require any additional device to be carried by the user.

However, with the advancements in machine learning and computer vision, face recognition technology has become more accurate, faster, and reliable. Methods such as Haar Cascade Classifiers, Deep Learning-based Convolutional Neural Networks, and Feature-based Matching Algorithms have made it possible to detect and recognize faces in real-time. By combining face recognition technology with an attendance management system, it is possible to automate the entire attendance process and make it more accurate and transparent.

This project deals with the design and development of a Face Attendance System based on Machine Learning. The system takes live images from a camera, identifies faces using the Haar Cascade Classifier, identifies registered faces, and marks their attendance automatically in a database with the current date and time. The system is built using Python,

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OpenCV, Flask, and SQLite, making it simple, flexible, and easy to implement. The proposed system will serve as an efficient, secure, and economical alternative to the existing attendance systems.

1.1 PROBLEM STATEMENT

However, despite the fast evolution of digital technology, many learning institutions and organizations are still using the traditional or semiautomatic approach to manage attendance.

The traditional approach is inefficient, time-wasting, and error-prone. In a large classroom or organization, a lot of productive time is wasted during the process of taking attendance, which could have been used for other productive purposes. Additionally, the traditional approach supports proxy attendance and record manipulation, which compromises the integrity of the attendance records.

Although some automated systems like RFID and fingerprint recognition systems exist, they are associated with hardware costs and potential hygiene concerns, among other issues. Hence, there is a need for a trustworthy, contactless, and automated attendance system that can detect individuals and mark their attendance without human involvement.

1.2 OBJECTIVES

The main aim of this project is to design and develop an automated face recognition attendance system using machine learning and computer vision techniques in order to overcome the limitations of the existing manual attendance systems. The system will be able to identify and track people accurately based on their facial characteristics and mark their attendance automatically with the correct date and time details. Another significant aim of this project is to design and develop the system using Python, OpenCV, and Flask with an SQLite database to store and manage the user and attendance data in an efficient manner.

This project also aims to minimize manual labor, reduce human errors, and eliminate proxy attendance issues using accurate identity verification. Furthermore, the project aims to design and develop a system with a simple and user-friendly interface for administrators and users, making it easy to implement in educational institutions and organizations. Finally, the aim of this project is to design and develop a cost-effective, efficient, and scalable attendance management system.

1.3 PROPOSED SYSTEM ARCHITECTURE

The proposed Face Attendance System is designed in a modular fashion, where every module is designed to perform a particular task in the entire process. The system is made up of a number of major components, which include the Image Capture Module, Image Preprocessing Module, Face Detection Module, Face Recognition Module, Attendance Management Module, and Database Management Module.

The Image Capture Module employs the use of a camera to capture live images of the users. The images form the input for the system. The Image Preprocessing Module is responsible for the conversion of the captured images to grayscale and the application of basic filters to remove noise from the images. The images are made suitable for analysis through this process.

The Face Detection Module employs the Haar Cascade classifier offered by OpenCV to detect the face region in the image. The classifier searches the image at various scales to detect regions that correspond to face features. After detecting a face, the face region is obtained and sent to the succeeding module.

The Face Recognition Module compares the detected face with the existing face information in the database. By examining face features and characteristics, the system verifies whether the face belongs to any registered user. Upon successful detection, the identity of the user is verified.

The Attendance Management Module records the attendance of the identified user along with the current date and time. The data is then stored in the database by the Database Management Module, which utilizes SQLite for storing and managing data. The modular structure of the system enables each component of the system to be developed and modified separately in the future.

II. METHODOLOGY

The methodology of the proposed Face Attendance System follows a systematic and structured approach that includes data collection, image preprocessing, face detection, face recognition, and attendance recording. Each stage plays a crucial role in ensuring the accuracy and reliability of the system.

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2.1 DATASET COLLECTION

Data gathering is the first process involved in the creation of the face attendance system. In this project, data gathering entails the registration of users and the taking of their facial images using a camera. The administrator is required to enter the basic details of the users, including their names and identification numbers, and take various images of each user under different circumstances. Taking various images helps the system understand the variations in facial expressions, lighting, and minute changes in the users' images.

The images are stored in the system and associated with the relevant user data in the database. Care is taken to ensure that the images are clear, well-lit, and well-aligned. The quality of the data gathered has a great impact on the functionality of the face recognition system, as poor-quality images may result in false detection and recognition.

2.2 IMAGE PREPROCESSING

Image preprocessing is a significant step that is used to prepare the images captured for face detection and recognition. At this level, the images are converted to grayscale. This significantly reduces the complexity of the images and increases the speed of processing. Grayscale images are adequate for face detection and recognition, as the color component is not necessary in this process.Apart from the conversion to grayscale, basic noise removal processes can be carried out at this level to enhance the quality of the images. Image preprocessing ensures that all the images are in a standard format and ready for analysis.

2.3 FACE DETECTION

The face detection process is carried out by the Haar Cascade classifier provided in OpenCV. The Haar Cascade classifier is a machine learning-based technique that has been trained on a large number of positive and negative images to detect faces. The classifier searches the preprocessed image at various scales to detect regions that contain facial characteristics.

After the face is detected, the region is extracted from the image and sent to the face recognition system. This is done to ensure that only the necessary part of the image is used for recognition, thus improving the accuracy and minimizing the impact of background information.

2.4 FACE RECOGNITION AND MATCHING

In the face recognition process, the identified face is matched with the stored face information in the database. The system evaluates key facial information and patterns to match with the registered users. If a match is obtained, the system verifies the identity of the user. If there is no match, the system does not record attendance and can display a corresponding message.

The above process is very important for avoiding unauthorized access and proxy attendance. By ensuring that only registered faces can be recognized, the system ensures the authenticity of the recorded attendance.

2.5 ATTENDANCE RECORDING

Once the recognition is successful, the system marks the attendance of the user along with the date and time. This data is stored in the SQLite database. The data stored can be viewed, updated, or exported by the administrator through the web interface. This reduces the chances of errors that could have occurred while manually entering the data.

III. IMPLEMENTATION DETAILS

The Face Attendance System is developed using the Python programming language because of its simplicity, flexibility, and powerful support for machine learning and computer vision libraries.

OpenCV is used for image processing and face detection, Flask is used for developing the web interface, and SQLite is used as the database for storing user and attendance data. Other libraries such as NumPy are used for numerical computations and data manipulation.

The system is divided into several files to ensure a clean separation of concerns. The application code is written in main.py, which is responsible for image acquisition, face detection, face recognition, and web routing. The database code is written in db.py, which is responsible for the insertion and retrieval of user and attendance data. The file database.db holds all the data, and haarcascade_frontalface_default.xml is used as the pre-trained model for face detection.

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3.1 FLOW CHART

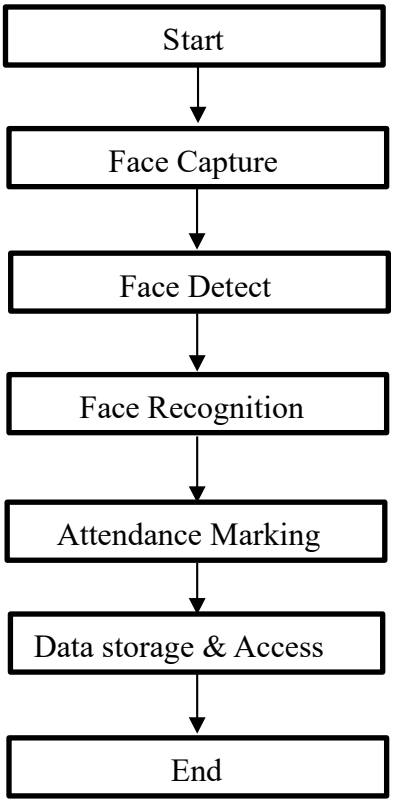

Fig: 3.1 Face Attendance System Workflow

3.2ETHICAL CONSIDERATION

The system deals with personal and biometric information, it is important to consider the ethical aspects involved in the development and implementation of the system. All user information needs to be stored in a safe and secure manner and should not be accessible to anyone who is not authorized to view it. The information should only be collected after proper consent has been sought and should only be used for the purpose of attendance management. The system should not be used for tracking purposes without consent.

IV. LIMITATION OF THE SYSTEM

Although the proposed Face Attendance System is capable of performing well, it also has some drawbacks. The system is largely dependent on lighting and camera quality. If the lighting is poor or the camera resolution is low, it may affect the accuracy of face detection and recognition. The system may also encounter problems if the users wear masks, glasses, or other accessories that cover their faces partially. Moreover, the system is currently designed for small to medium-scale applications and may need optimization for largescale applications.

V. RESULTS AND DISCUSSION

The system was tested with a number of registered users in a controlled environment. From the observations made during the experiment, it is evident that the system is capable of detecting and recognizing faces successfully and marking attendance accordingly. The system is also capable of reducing the time taken to conduct attendance and eliminating errors associated with manual attendance systems. The web-based interface is also useful for administrators to manage users and check attendance records. Although there are some challenges associated with the system when the environment is unfavourable, the performance of the system is satisfactory.

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VI. FUTURE ENHANCEMENTS

In the future, the system can be improved by adding deep learning-based face recognition models. Techniques for liveness detection can also be added to the system to prevent spoofing attacks using images and videos. The system can also be improved by adding cloud storage, mobile applications, and analytics capabilities to enable better reporting and monitoring. All these improvements will make the system more scalable and secure.

VII. CONCLUSION

This paper has demonstrated a Face Attendance System based on Machine Learning and Computer Vision that can automate the attendance management process. The system, which utilizes OpenCV and Haar Cascade for face detection, Python and Flask for application development, and SQLite for database storage, can efficiently and effectively manage attendance. The system can minimize the occurrence of proxy attendance and can increase the accuracy of attendance records. Further improvements can be made to the system to make it widely applicable in institutions and organizations for efficient attendance management.

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