Indian Institute of Information Technology, Vadodara (Gandhinagar Campus)

Design Project Report 2023

on

Face Recognition based attendance system

Submitted by

Jagruti Piprade
202151067@iiitvadodara.ac.in
Computer Science Engineering

Khushi Saxena
202151078@iiitvadodara.ac.in
Computer Science Engineering

Gargee Meshram
202151093@iiitvadodara.ac.in
Computer Science Engineering

under the supervision of

Dr. Bhupendra Kumar
Assistant Professor
Indian Institute of Information Technology, Vadodara (Gandhinagar Campus)
bhupendra_kumar@iiitvadodara.ac.in

BK Bhupendra Kumar

***Abstract*—In the digital age, face recognition systems have become integral across various sectors, serving purposes such as security, authentication, and identification. This paper introduces a face recognition-based attendance system utilizing a trained Convolutional Neural Network (ResNet model). The system prioritizes user-friendliness, providing an efficient solution for attendance tracking in educational and corporate settings. The research emphasizes its potential to revolutionize conventional practices, offering a dependable solution for modernized record-keeping methodologies and advancements in attendance monitoring systems.**

I. Introduction

Efficient attendance management constitutes a pivotal component in the realms of both education and corporate environments. Traditional methodologies grapple with inefficiencies, inaccuracies, and laborious procedures, leading to a pressing need for innovative solutions. [6] Addressing these challenges, the Face Recognition-Based Attendance System emerges as a cutting-edge and transformative approach. By harnessing the power of state-of-the-art technologies, including Convolutional Neural Networks (CNNs), facial landmark detection algorithms, and real-time image processing, this system represents a paradigm shift in attendance tracking methodologies.

In contrast to conventional means, where manual recording of attendance proves to be time-consuming and prone to errors, the Face Recognition-Based Attendance System introduces a seamless and automated process. This revolutionary system not only enhances accuracy but also significantly reduces the administrative burden on educators and corporate personnel. By leveraging facial recognition technology, it enables swift and contactless identification of individuals, fostering a more streamlined and technologically advanced approach to attendance tracking. This introduction encapsulates the transformative potential of the Face Recognition-Based Attendance System, poised to redefine the landscape of attendance management in the digital age.

As we delve deeper into the capabilities of the Face Recognition-Based Attendance System, it becomes evident that its transformative potential extends beyond the realms of accuracy and administrative efficiency. [5]This innovative approach not only revolutionizes attendance tracking methodologies but also addresses broader considerations shaping the educational and corporate landscapes.

II. LITERATURE SURVEY

The genesis of facial recognition technology can be attributed to the pioneering endeavors of Woody Bledsoe, Helen Chan Wolf, and Charles Bisson during the 1960s. Their early methodology involved manual annotation of facial landmarks, subsequently employing computer systems to statistically rectify pose variations. Despite the technological constraints of the era, their seminal work underscored the pragmatic feasibility of facial recognition as a viable biometric modality.

In the ensuing decade of the 1970s, Goldstein, Harmon, and Lesk expanded upon this foundational research, integrating 21 subjective markers, encompassing elements such as hair color and lip thickness, to facilitate the automation of the recognition process. Concurrently, the National Institute of Standards and Technology (NIST) initiated the Face Recognition Vendor Tests (FRVT) in the early 2000s, aimed at the comprehensive evaluation of commercial facial recognition systems. [3]

The year 2010 witnessed the incorporation of facial recognition features by Facebook, affording users the capability to discern individuals within photographs. Despite apprehensions regarding privacy implications, this feature garnered widespread acceptance, with an excess of 350 million images being tagged daily via facial recognition. Technological advancements continued, reaching a pivotal moment with the unveiling of the iPhone X by Apple in 2017, featuring Face ID functionality—a significant stride in the assimilation of facial recognition technology into everyday existence. [3]

[4] provides a comprehensive literature assessment of proven facial recognition methodologies, including both conventional and modern techniques. The machine learning-based Haar-cascade Classifier is notable for its effectiveness in real-time face detection—it even outperforms the deep learning era in this regard. Both facial traits and non-facial things are expertly recognized by it. But we moved on to a more sophisticated CNN ResNet model because of accuracy constraints.

Furthermore, we investigate face recognition with the adaptable K Nearest Neighbors (KNN) method. As an is non-parametric learner, KNN classifies incoming data according to how similar it is to preexisting datasets. Its application in both classification and regression tasks is noteworthy.

Most importantly, we actively develop and evaluate the KNN for face recognition and the Haar-cascade for face detection, going beyond theoretical exploration. The necessity for improved accuracy drove us to use an empirical technique and, as a backup, the CNN ResNet model. [1]

III. Present Investigation

In the current phase of our research, we delve into the exploration and enhancement of automated attendance systems, with a particular emphasis on the incorporation of state-of-the-art technologies. By synergistically employing OpenCV, Dlib, Tkinter, NumPy, and other relevant tools, our objective is to construct a resilient and effective attendance-tracking system based on facial recognition. This section elucidates the methodology and technological choices embraced in our research, providing insight into the rationale behind the selected tech stack and its pivotal role in realizing the overarching goals of the study.

A. *Tech stack*

- Python
  Chosen as the primary programming language due to its versatility, extensive libraries, and compatibility with the selected technologies. Python enables efficient integration and development across different components of the project.
- OpenCV
  Deployed for image processing and computer vision, specifically in facial recognition and landmark detection. OpenCV offers powerful capabilities for analyzing real-time video streams, a crucial component for accurately tracking attendance based on facial features.
- Tkinter
  Tkinter is employed for building the graphical user interface (GUI) of the application. It provides a user-friendly interaction platform, facilitating ease of use and navigation for both administrators and users.
- Dlib
  Chosen for its high-precision facial landmark detection capabilities, crucial in accurately identifying and tracking facial features. Dlib enhances the reliability of the facial recognition aspect of the attendance system.
- NumPy
  Selected for efficient numerical operations and data manipulation. NumPy optimizes the handling of arrays and matrices, streamlining the processing of facial recognition data within the application.
- Pandas
  Used for data manipulation and analysis. Pandas provide powerful tools for working with structured data, facilitating tasks such as organizing and processing attendee records efficiently.
- CSV
  The CSV format is employed for storing attendee records. It is a simple and widely supported format, ensuring compatibility and ease of data management within the project.
- HTML CSS
  HTML and CSS are employed to create a web-based interface for the attendance system. This allows for remote access and monitoring of attendance records through a user-friendly and visually appealing web interface.
- SQLite
  SQLite serves as the database management system for the project. It is lightweight, easy to implement, and well-suited for smaller-scale applications, making it an optimal choice for storing attendee data.
- Flask
  Used as the web framework for building the web application. Flask integrates seamlessly with Python and enables the creation of a dynamic web interface, providing a convenient platform for users to access attendance records remotely.

B. Shape predictor 68 face landmarks

"Shape predictor with 68 face landmarks" usually describes a particular kind of facial landmark detection model that recognizes 68 important points on a face. These points line up with different aspects of the face, like the mouth, nose, eyes, and facial contour. Applications involving computer vision and facial analysis frequently use this model.

The choice of 68 facial landmarks is a convention that stems from the specific model provided by the Dlib library for facial landmark detection. These 68 points are strategically placed to capture key features of the face, including the eyes, nose, mouth, and the contour of the face.

The distribution of these landmarks allows for a comprehensive representation of facial geometry, aiding in tasks such as face alignment, expression analysis, and pose estimation. The specific number of landmarks isn't fixed across all facial landmark detection models. Other models or datasets may use different numbers of points depending on their objectives and the level of detail required. For example, some applications might use a higher number of landmarks for more fine-grained analyses. [2]

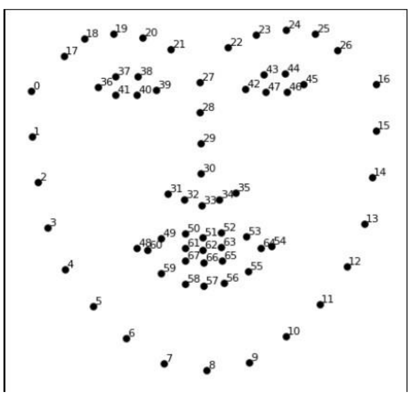

Fig. 1. Shape predictor 68 face landmarks

It's essential to note that the choice of landmarks is often a trade-off between capturing sufficient detail and maintaining computational efficiency. In real-time applications, having a moderate number of landmarks, such as 68, strikes a balance between accuracy and computational cost. Concluding machine learning and image processing C++ library is one of the most widely used tools for facial landmark detection. Dlib comes with a pre-trained shape predictor model that recognizes 68 landmarks on the face.

C. Workflow

1) Library Initialization:
   Initialize essential libraries like OpenCV, Tkinter, Numpy, Pandas, and Dlib. OpenCV enables image processing, Numpy handles numerical operations, Pandas manages data structures, Dlib for face detection and Tkinter for GUI development.

2) Video Feed Capture:
   OpenCV is employed to capture the video feed, extracting frames as the foundation for subsequent face identification. OpenCV provides robust functionalities for video processing, enabling efficient frame extraction and manipulation.

3) Face Identification:
   Dlib's face detection capabilities are employed to accurately identify faces within the frames obtained from the video feed captured by OpenCV.

4) GUI Interaction with Tkinter:
   Implement GUI interaction through Tkinter, which is a Python library for creating graphical user interfaces (GUIs). Tkinter is utilized to design and create the user interface where users can input their names for attendance in the face recognition project.

5) Database Feature Storage:
   SQLite, a lightweight relational database management system is used to interact with the database. The integration of SQLite with Python facilitates efficient storage of facial features in a structured manner for subsequent retrieval and analysis.

6) CSV File Feature Extraction:
   The facial features are extracted from images and systematically stored in a CSV file for record-keeping. The combination of Pandas and Numpy facilitates organized storage of facial features in a CSV format.

7) Face Detection Recognition:
   Utilize the recognition module for face detection, ensuring real-time updating of attendance records on the website. The flask functions as a web framework, creating a user interface for the face recognition system. It handles the communication between the back end (OpenCV and Dlib for face detection) and the front end (project website). This integration allows real-time updating of attendance records on the website when faces are recognized.

8) Website Access for Students:
   A user-friendly website interface is developed to provide students with convenient access to their attendance records. HTML structures website content, CSS styles its appearance, and Flask integrates with Python for back-end logic, interacting with the database (SQLite).

Our ongoing exploration represents a notable advancement in the domain of automated attendance systems, emphasizing

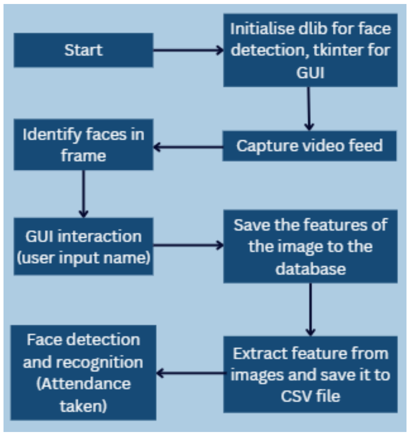

Fig. 2. Workflow

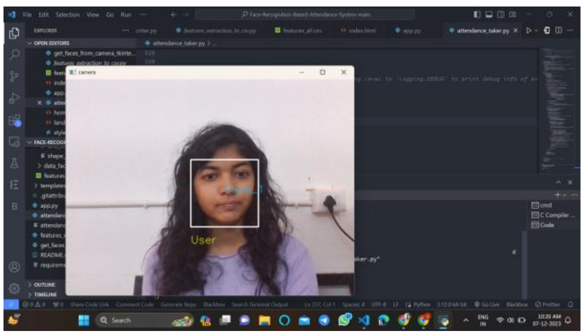

Fig. 3. Face Detection

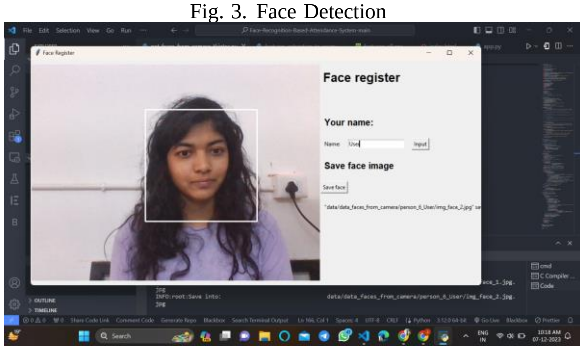

Fig. 4. Face Register

the integration of contemporary technologies. The thoughtful selection of tools aligns with our objective to construct an efficient attendance tracking system based on facial recognition. This section provides clarity on our chosen methodology and technological decisions, shedding light on the reasoning behind the selected tech stack and its crucial role in fulfilling the overarching goals of this study. Looking forward, the insights gleaned from this research are positioned not only to enhance attendance systems but also to contribute to broader discussions on the integration of cutting-edge technologies in educational and organizational contexts.

IV. Results and Discussions

Face recognition systems form an integral component of applications involving the processing of facial images. The conceptualization of a Face Recognition-Based Attendance System aims to address the inaccuracies inherent in conventional manual attendance processes. The objective is to create an automated system beneficial for organizations, particularly educational institutes.

The incorporation of a Graphical User Interface (GUI) facilitates seamless interaction between users and the system. Within this interface, users are presented with the option to write a student's name. Upon choosing a name and clicking the ”save face” button, the system initiates the webcam, capturing a series of photos and saving them. The utilization of a Convolutional Neural Network (CNN) algorithm enhances the system's face detection capabilities.

V. Conclusion and Future Work

The integration of a ResNet model, Dlib, NumPy, and OpenCV in the Face Recognition-Based Attendance System signifies a notable advancement in attendance tracking technology. The system's interface and real-time efficacy position it as a pragmatic tool for educational and corporate environments.

Future research focuses on enhancing system security through the integration of anti-spoofing measures and iris detection technology, aiming to fortify the system against potential instances of fraud and identity theft. Ongoing priorities include optimization and scalability, emphasizing algorithmic refinement, improved computational efficiency, and adaptability to diverse environments.

Anticipated developments include the introduction of automated notifications and reporting features, streamlining administrative tasks through real-time alerts, and comprehensive attendance reports. These enhancements underscore a commitment to technological excellence, ensuring sustained relevance and efficacy in addressing the intricate challenges of attendance management. The ongoing pursuit of refinement remains integral to providing institutions with a practical and reliable solution for attendance tracking.

In conclusion, the integrated system's advancements and planned developments signify a proactive approach to addressing the evolving landscape of attendance management. The incorporation of advanced security measures and features for streamlined administrative processes highlights a dedication to ensuring the system's continued effectiveness in meeting the complex challenges of attendance tracking in various organizational settings. The continuous refinement aligns with the pragmatic nature of the research, contributing to the system's practical utility.

Acknowledgment

This project was made possible through concerted efforts and support of our Professor Bhupendra Kumar whose guidance, expertise, and continuous support were invaluable throughout the project. His encouragement and insights significantly contributed to the project's success. We express our appreciation to IIIT-V for providing the necessary infrastructure, resources, and conducive environment that facilitated the successful completion of this project.

References

[1] James Philbin Florian Schroff, Dmitry Kalenichenko. Facenet: A unified embedding for face recognition and clustering. 06 2015.

[2] Palaniappan M, Sowmia K R, and Aravindkumar S. Real time fatigue detection using shape predictor 68 face landmarks algorithm. 2022.

[3] Saroj Mishra. A face recognition method using deep learning to identify mask and unmask objects. *Theses and Dissertations*, page 110, 01 2022.

[4] Jaiveek Baria Prof. Nileema Pathak Mitesh Chauhan, Mandar Dhakate. Attendance system using face recognition. *International Research Journal of Engineering and Technology (IRJET)*, 03 2022.

[5] S.P.Chokkalingam Nandhini R, Duraimurugan N. Attendance system. *International Journal of Engineering and Advanced Technology (IJEAT), Volume 8, Issue-3S*, 02 2019.

[6] Pavithra Smitha and Afshin. Face recognition based attendance. *International Journal of Engineering Research and V9(05)*, 06 2020.