Computer Vision
MINI PROJECT
on
ATTENDANCE TRACKING SYSTEM USING FACE RECOGNITION

Submitted by

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C E R T I F I C A T E

This is to certify that,

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of TYBTech. (Computer Engineering and Technology) have completed their CV Mini Project report on Automated Attendance Tracking System Using Face Recognition and have submitted this end-term report towards fulfillment of the requirement for the Degree-Bachelor of Computer Science & Engineering (BTech-CSE-AIDS) for the academic year 2025-2026.

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MIT World Peace University, a distinguished institution renowned for its commitment to academic excellence and holistic development, has provided us with an environment that nurtures learning and fosters innovation. Professor Trupti Baraskar's profound academic expertise, highlighted by her Master's degree in Computer Science, has been instrumental in guiding our project. Her role as our CV instructor has profoundly impacted our academic journey at MIT-WPU, offering invaluable insights and mentorship that have greatly enriched our understanding and execution of the project.

In addition, MIT-WPU's strong emphasis on research and innovation aligns seamlessly with Professor's domain interests in Computer Vision and Machine Learning. Her scholarly work in these fields reflects the university's dedication to advancing knowledge in cutting-edge technologies and has inspired us to delve deeper into these exciting areas.

In conclusion, we are deeply grateful to Professor Trupti Baraskar and MIT World Peace University for their outstanding guidance, resources, and unwavering support, which have been pivotal in our academic pursuits and project achievements.

Sincerely,

Aastha Konde
Diya Parikh
Samar Patil
Anish Kodre

1. Introduction

In today's digital age, the rise of automated systems has transformed traditional processes, offering new levels of efficiency and accuracy. Attendance tracking, an essential activity in educational institutions and workplaces, has historically relied on manual entries, often resulting in inefficiencies, inaccuracies, and manipulation. For instance, teachers spend a significant amount of time recording attendance, while errors can lead to discrepancies in performance tracking and data management.

This project introduces an advanced **Facial Recognition-Based Attendance Management System** aimed at automating attendance tracking and providing data-driven insights through visualization tools. The system simplifies the attendance process, ensures real-time recognition, and enhances transparency while reducing manual effort.

Facial recognition technology, increasingly used in security and identification, provides a robust solution for accurate, quick, and verifiable attendance marking. Unlike traditional methods, this system enables institutions to streamline operations, improve data integrity, and make informed decisions using visual analytics. It is especially valuable in resource-constrained environments, where ease of use, minimal maintenance, and smart automation can have a significant impact.

1.1 Mini Project Statement

Manual attendance systems are time-consuming, error-prone, and vulnerable to manipulation. These limitations hinder effective performance tracking and administrative efficiency in educational institutions and workplaces.

To address these issues, the proposed project involves the development of a Facial Recognition-Based Attendance Management System. This Python and Computer Vision based application automates the attendance process using computer vision and integrates data visualization tools to present insights into attendance trends and anomalies. The solution focuses on improving accuracy, efficiency, and transparency, while being lightweight and accessible for deployment in diverse environments, including rural educational institutions.

1.2 Objective

The main objectives of the Facial Recognition Attendance Management System are:

- **Automated Attendance Tracking**: To eliminate manual efforts and inaccuracies by using facial recognition for real-time identification and record-keeping.

- **Data Visualization and Insights**: To provide dashboards and visual tools that help administrators analyze attendance patterns, trends, and discrepancies effectively.

- **Enhanced Accuracy and Security**: To ensure high precision and integrity of attendance data using face-matching algorithms and secured records.

- **User-Friendly Interface**: To offer an intuitive and easy-to-navigate interface that supports smooth operation by both staff and students.

- **Accessibility and Efficiency**: To develop a system that is lightweight, scalable, and deployable in resource-limited environments such as rural schools.

1.3 Motivation

The motivation behind this project stemmed from the inefficiencies observed in traditional attendance systems used in schools, colleges, and offices. Manual roll-calls are time-intensive and prone to human error. Biometric methods like fingerprint scanning, while better, still require physical contact and hardware maintenance.

Facial recognition offers a contactless, efficient, and accurate alternative. Furthermore, while several high-end systems are available, they are often expensive or overly complex. There is a gap in solutions that are:

- Affordable and open to customization

- Lightweight enough for low-resource environments

- Capable of turning attendance data into actionable insights

This led to the idea of developing an integrated, Python & CV based facial recognition attendance system, emphasizing automation, real-time performance, and visualization. The goal is to empower institutions—especially in under-resourced areas—with a reliable and intelligent system that supports better decision-making and improved educational outcomes.

2. Literature Review

The use of computer vision and machine learning techniques for Automated attendance management systems is gaining increasing attention due to their ability to streamline the attendance process and reduce manual errors. Recent work, such as[1] emphasizes integrating face detection algorithms within Learning Management Systems (LMS), offering a time-efficient solution while eliminating the need for manual work. Similarly, [2] explores the use of Personal Component Analysis (PCA) for biometric verification, enabling automatic logging of student attendance in classroom settings. Convolutional Neural Networks (CNNs) have also been implemented in real-time face recognition systems, as highlighted in [3]. Additionally, face recognition systems, such as the one presented in [4], employ Haar-Cascade and Local Binary Pattern Histogram (LBPH) algorithms to detect and recognize students from live video streams, making them more adaptable for a variety of applications. Solutions to overcome blind spots in single-camera setups have been proposed, as seen in [5] where a rail-mounted camera system provides complete coverage of classroom attendees. Moreover, the use of advanced techniques like the YOLO model for real-time face detection and recognition as demonstrated in [6], offers a robust, scalable solution that can be integrated seamlessly into existing workflows. These advancements demonstrate the growing trend toward automated attendance systems, driven by the need for efficiency and accuracy in both educational and professional environments.

The techniques implemented have progressed from traditional face recognition methods to advanced deep learning models. The first paper uses HAAR classifiers for face detection, combined with the eigenfaces algorithm for recognition, effectively managing false positives and incorporating an update mechanism to handle changes in appearance over time. Building on this, the second paper also employs the eigenface approach but integrates Principal Component Analysis (PCA), enabling the system to learn and recognize unknown faces over time with ease through OpenCV. Moving further, the third paper shifts to deep learning with a CNN architecture using Keras and TensorFlow, where the Viola-Jones algorithm detects faces, and a series of convolutional and pooling layers optimize performance for real-time recognition. Similarly, the fourth paper employs Haar-Cascade Classifiers for detection but adopts the Local Binary Pattern Histogram (LBPH) for recognition, focusing on histogram-based feature extraction for precision. The fifth paper introduces a rail-mounted camera system controlled by a microcontroller, which captures multiple angles of faces in large spaces, offering a hardware-centric solution for attendance systems and solving the blind spot drawbacks of the previous systems. Lastly, the sixth paper leverages the use of YOLO models (V5, V8, and V8 NAS) for person counting as well as face identification, with YOLO V8 NAS utilizing Neural Architecture Search (NAS) to optimize neural networks automatically. Together, these papers demonstrate the evolution of face recognition technology, from feature-based techniques to more sophisticated deep learning models.

The challenges and limitations observed across these studies mainly revolve around recognition accuracy and system efficiency. In the first paper, the system was deployed in three courses, involving 147 students, where it was found that only 70% of faces were successfully detected, and of these, just 30% were correctly identified. The primary challenge was outdated student images, leading to a higher recognition rate for first-year students (56%) compared to second and third-year students due to their changing appearances. The second paper highlighted that face recognition accuracy declines as the angle between the face and camera increases. While the system performed exceptionally well with frontal face detection (98.7% detection and 95% recognition), performance dropped significantly at higher face angles, reaching 0% for profile faces. The authors aim to improve this by leveraging mobile-based face recognition, which could expand its utility for everyday users. In the third paper, the performance of the face recognition system was optimized using convolution filters and pooling sizes. The system achieved a 98.75% recognition accuracy with a filter size of 3×3 and pooling window size of 2×2 and 4×4. However, it was noted that image capturing consumed the majority of the processing time (74%), indicating that further optimization could improve real-time performance. The fifth paper discussed challenges in stationary camera-based systems, where blind spots limit face detection. A sliding camera mounted on a rail system was proposed to mitigate this, ensuring full coverage of attendees in attendance systems. This design also reduces costs by allowing the use of multiple cameras connected wirelessly to a central face recognition system. Finally, the sixth paper emphasized performance evaluation using YOLO models, with YOLOv8 NAS outperforming YOLOv5 and YOLOv8 in mean average precision (mAP), precision, and recall. Despite achieving superior results (mAP of 92.6% and recall of 82.5%), however, the complexity and computational requirements of the models present potential challenges for real-time deployment.

3. Proposed System

The proposed system is a facial recognition-based attendance tracker. It starts with user registration, where individuals upload multiple photos. OpenCV encodes facial features, which are securely stored. The system scans faces in real time, automatically marking attendance by matching live data with stored records. Data integrity is ensured through cleaning and filtering, and visualized using Power BI to reveal attendance patterns. Statistical analysis further identifies relationships between attendance and demographic factors, supporting data-driven decisions to enhance engagement strategies.

3.1 System Design and Features

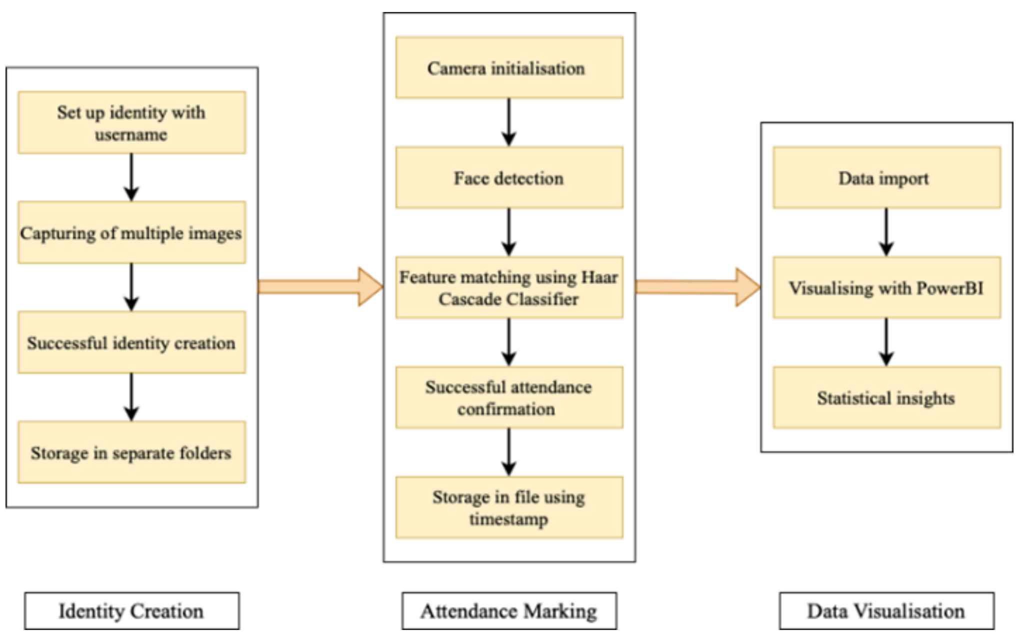

Figure 1. Modules of the System

3.2 Methodology

The methodology adopted for the development and deployment of the automated attendance management system is structured into several critical phases: data acquisition, real-time facial recognition-based attendance monitoring, data validation and integrity preservation, contextual data filtering and advanced data visualization.

a) Data Acquisition and Registration Process: The system initiates by acquiring biometric data during the user registration phase. Individuals upload multiple photographs, which are processed to generate facial signatures. Using OpenCV's feature encoding, the system detects and captures distinctive facial landmarks, encoding them into a vector space representation. These biometric signatures are then securely stored in a structured database using encryption methods to ensure data privacy and integrity. The robustness of this registration process is essential for minimizing false matches and ensuring the accuracy of future real-time recognition tasks.

b) Automated Real-time Attendance Monitoring and Recognition: Once the registration process is complete, the system moves into the real-time attendance tracking phase. This involves continuously scanning the environment using integrated camera systems (e.g., webcams or external IP cameras). The captured images are processed through a real-time facial recognition pipeline that compares live facial data with stored profiles. Using OpenCV’s Haar Cascade Classifier, the system performs efficient facial detection and matching. This classifier works by evaluating pixel intensities across multiple image regions, focusing on key facial features. Upon successful identification of a match, the system automatically marks attendance, updating the database with the corresponding timestamp and individual’s attendance record.

c) Redundancy Mitigation and Integrity Assurance: To maintain the reliability and integrity of the collected attendance data, a comprehensive data cleaning framework is implemented. This step involves identifying and eliminating redundant or incomplete records, addressing inconsistencies caused by false detections or multiple entries of the same individual. By ensuring that only accurate and verified data is retained, the system strengthens the foundation for further data analysis and visualization.

d) Contextual Data Filtering Mechanism: Following data cleaning, the system applies an advanced filtering mechanism to extract the most relevant attributes from the attendance records. Key attributes such as user ID, timestamps, and attendance dates are retained, while irrelevant data points are filtered out. The filtering process is crucial for optimizing data queries, focusing on variables that directly support analysis and reporting functions. This layer of data refinement ensures that subsequent processes operate on clean, structured data, thus improving system efficiency and report generation accuracy.

e) Advanced Data Visualization and Reporting*:* Once the data has been cleaned and filtered, the system integrates with Power BI to transform raw attendance data into actionable insights. Power BI's advanced data visualization capabilities allow for the creation of interactive dashboards and real-time reports, presenting attendance patterns, engagement levels, and absenteeism trends in a user-friendly format. These insights can be accessed by educators and administrators to monitor class participation, compare student attendance rates over time, and identify outliers. The integration with Power BI also supports ad-hoc query generation, enabling users to drill down into specific data points for in-depth analysis.

The face recognition framework of the system functions as described below,

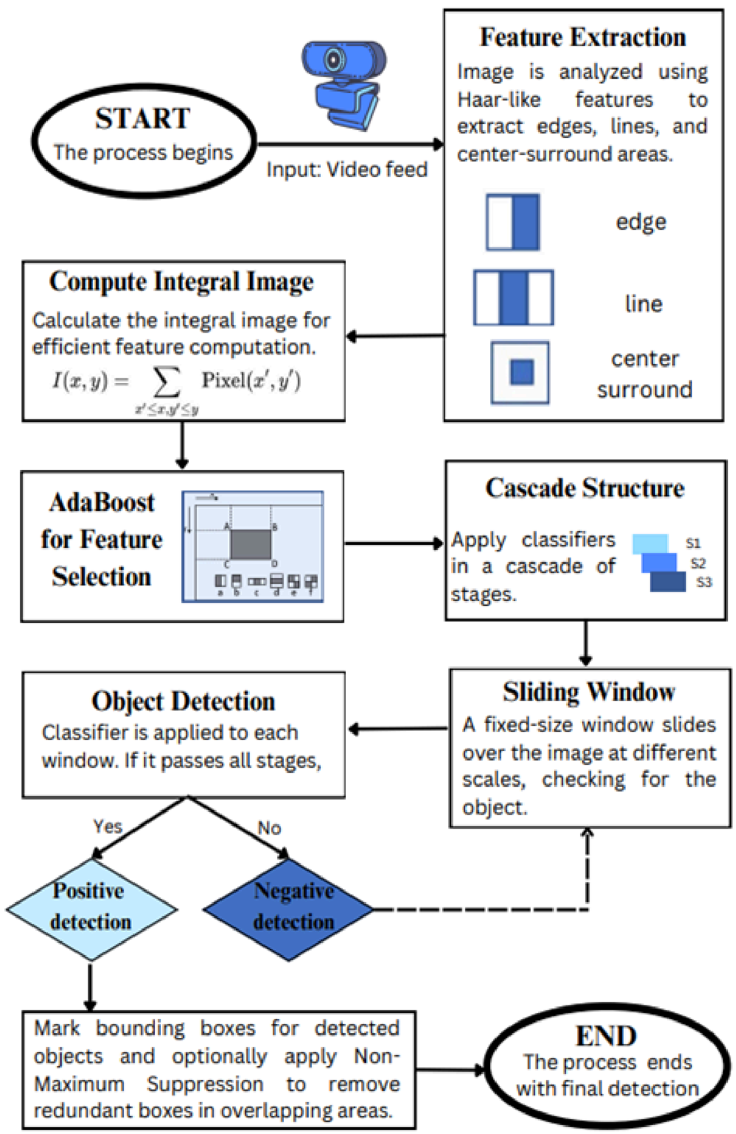

Figure 2. Face recognition process

4. Experimental Setup

4.1 System Setup

The system is structured to ensure seamless operation, starting with the precise identification of facial features in real time. During the registration phase, unique biometric profiles are generated from multiple image captures, creating a permanent identity that remains active for the entire duration of the student's enrolment in the university. Once created, the system ensures accurate matching through continuous monitoring and real-time data processing, enabling efficient and reliable attendance tracking for all courses.

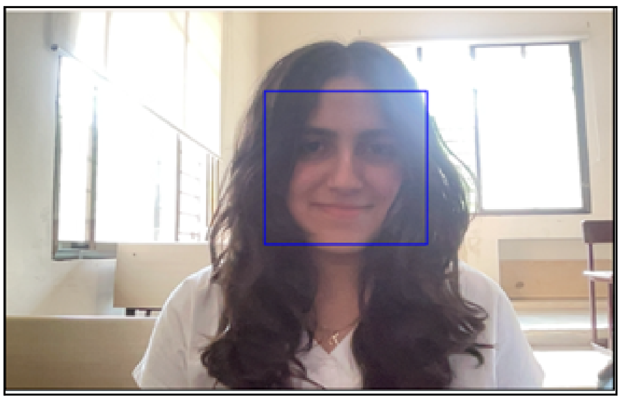

Figure 3. Face Detection

Figure 4. Identity Creation

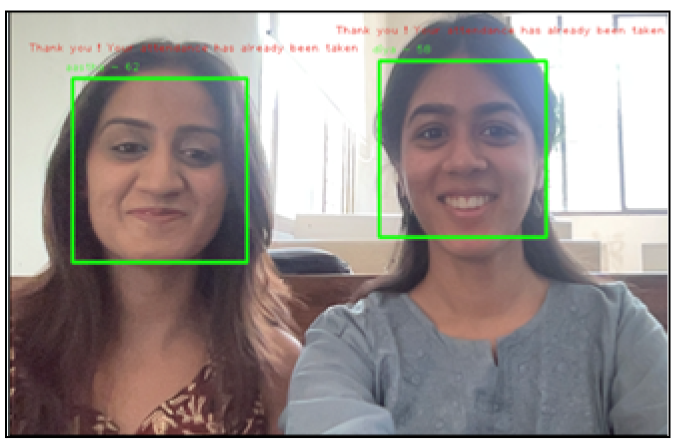

Figure 5. Face Recognition

4.2 Dataset and Pre-processing

The dataset utilized in our system integrates both student information and attendance records, with key attributes including Course, Specialisation, Panel, PRN, Roll Number, Name, and Attendance details such as Day, Date, and Time. A notable aspect is that the Time attribute contains certain null values, which are indicative of student absenteeism.

To facilitate granular analysis, we segmented the meta-dataset into multiple sub-datasets, each corresponding to an individual day. Each of these sub-datasets was augmented with an additional attribute—Subject—enabling subject-wise attendance tracking. For testing and evaluation purposes, we derived three distinct datasets, each representing a unique day. These datasets were then used for visualization and statistical analysis to derive insightful trends and patterns in attendance behavior.

From a Computer Vision perspective, our system integrates a comprehensive pipeline to enable accurate and real-time attendance tracking through face recognition. The following CV techniques were implemented:

a) **Face Detection Pipeline**: Detects faces from a live video feed using Haar cascade classifiers to identify human facial structures in real-time.
b) **Face Recognition (Prediction)**: Once a face is detected, it is identified and matched against the stored facial dataset using the LBPH (Local Binary Patterns Histograms) recognizer, enabling unique student identification.
c) **Grayscale Conversion**: Converts the captured color frame to grayscale, as face detection and recognition algorithms perform optimally on single-channel images.
d) **Contrast Enhancement**: Applies image enhancement techniques to improve contrast and visual clarity, aiding in better detection and recognition, especially under low-light conditions.
e) **Face Cropping and Resizing**: Extracts the face region from the detected bounding box and resizes it to a uniform shape for consistent recognition input.
f) **Object Detection (Bounding Box)**: Draws a bounding box around the detected face, providing a visual indicator and feedback in the live video feed.
g) **Processing Live Video Feed**: Continuously processes frames from the webcam to perform real-time detection and recognition, overlaying the video feed with bounding boxes and recognition labels.
h) **Face Data Collection, Saving, and Model Training**: For new students, multiple facial images are captured and saved into structured folders. The LBPH model is then trained using this collected data to enable accurate future recognition.

By integrating these techniques, the system ensures accurate attendance tracking based on facial identity while maintaining robustness and usability in live environments.

5. Results and Discussion

Our evaluation revealed that the automated system effectively processed attendance data, producing detailed statistical reports that highlighted key trends and correlations. The integration of advanced data visualization provided clear insights into attendance patterns, facilitating better decision-making. By uncovering factors influencing attendance rates, the system demonstrated its effectiveness in optimizing performance and reducing manual.

5.1 Testing Results

The system's testing involved a detailed evaluation of its workflow and performance. Initially, the identity creation phase captured 10 facial images per individual, which were stored in the database using a file-handling approach. This phase was completed with a 100% success rate, ensuring the system was ready for subsequent stages without any operational delays.

In the real-time face recognition phase, the system demonstrated robust performance. Camera initialization was achieved within 5 seconds, and pattern matching was executed with an accuracy rate of 96%. During tests, the system successfully recognized and matched 2-3 individuals simultaneously with a standard laptop webcam, which typically handles 640x480 resolution. Attendance was marked promptly with precise timestamps, demonstrating the system's capability to efficiently handle real-world scenarios and its effectiveness in simultaneous multi-person recognition. These results underscore the system's reliability and operational efficiency.

5.2 Statistical Results

In addition to effective testing results, our system also provides advanced statistical analysis for revealing key insights into attendance patterns and system performance. By leveraging various visualization tools such as pie charts, histograms, and tables, we uncovered important correlations between the attributes. These analyses enable data-driven decision-making, enhancing the system's ability to address and optimize attendance management effectively.

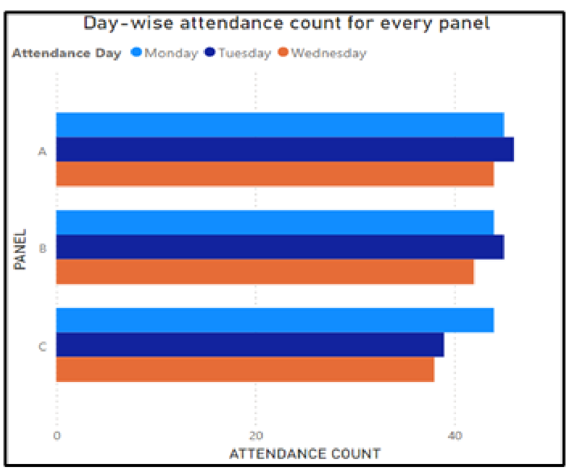

Figure 6. Stacked Bar Chart

Detailed report for day 1

Panel	S_prn	S_name	TOC	Peace	DEC	PS	AIES
A	1032221012	Aastha	08:26:20	09:25:17	10:44:17	13:36:15	14:28:15
B	1032220611	Ananya	08:29:23	09:31:06	10:41:34	13:30:37	14:36:18
C	1032224190	Anil	08:29:22	09:28:26	10:43:34	13:36:12	14:27:23
C	1032224171	Anish	08:29:23	09:29:34	10:44:30	13:36:45	14:27:34
B	1032223133	Atharva	08:31:53		10:37:50	13:36:58	14:33:14
B	1032220236	Ayush	08:27:09	09:28:44	10:50:53	13:33:05	14:28:44
C	1032224177	Dhananjay	08:28:17	09:26:14	10:48:05	13:32:49	14:34:57
A	1032221013	Diya	08:26:52	09:26:34	10:38:42	13:26:44	14:31:47
A	1032221016	Harshwardhan	08:28:44	09:30:25	10:40:57	13:35:39	14:29:32
C	1032224152	Kapil	08:29:12	09:28:15	10:43:12	13:35:45	14:27:12

Figure 7. Report Table

The stacked bar chart in Fig. 6 displays day-wise attendance counts for each panel, offering a clear summary of attendance trends over time. Each bar represents total attendance for a day, with different colors indicating attendance for individual panels. This visualization highlights patterns in attendance strength and consistency, making it easy to compare panel performance and identify days with attendance fluctuations. Fig. 7 provides a detailed breakdown of student attendance on Day 1, displayed in a tabular format, listing individual student attendance timings across subjects and panels. This breakdown enables precise tracking of student participation, allowing for analysis of punctuality, delays, and panel performance, and helps identify potential issues in attendance.

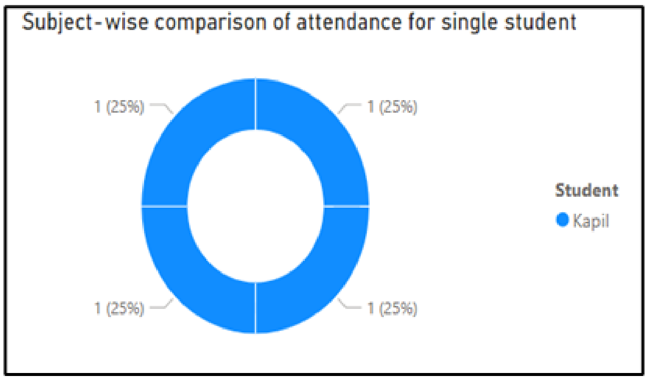

Figure 8. Donut Chart

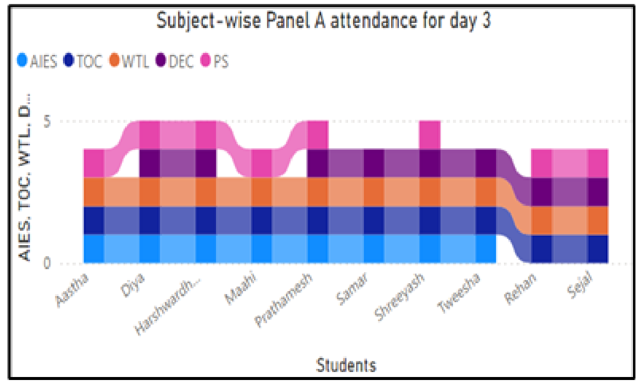

Figure 9. Ribbon Graph

Fig. 8 displays a subject-wise comparison of attendance for a single student using a donut chart. Each segment represents the proportion of classes attended in each subject, providing a clear view of the student's participation consistency. This visualisation helps identify any subjects with lower attendance, highlighting potential areas of concern regarding the student's engagement.The ribbon graph bar in Fig. 9 illustrates a subject-wise attendance comparison for students in Panel A on Day 3. The width of each ribbon represents the attendance level in each subject, offering a visual overview of participation patterns within the panel. This graph allows for the identification of subjects with varying attendance levels and helps evaluate overall student engagement within the panel. In conclusion, the statistical results provide a detailed analysis of key trends and patterns, offering a technical foundation for understanding the data and guiding further optimizations. These findings serve as a critical step in concluding the analysis of attendance and engagement, paving the way for actionable insights and future improvements.

6. Conclusion and Future Scope

This system introduces a face recognition-based attendance management system that effectively addresses the challenges of manual attendance tracking in a cost-efficient and accessible manner. By leveraging OpenCV's Haar Cascade Classifier for real-time facial detection and Power BI for attendance trend visualization, our system reduces manual effort while ensuring data accuracy. Targeted for resource-constrained environments, it eliminates the need for complex machine learning models, offering an affordable and reliable solution for educational institutions with limited computational resources.

In future work, we aim to address edge cases such as missed recognition for side profiles and students sitting behind others, ensuring full coverage in larger classrooms. Additionally, considerations like post-accident facial changes or surgeries will be tackled to maintain system accuracy. Further enhancements include improving recognition in varying lighting conditions and scaling the system to manage larger datasets and more complex environments.

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