Journal of **N**onlinear **A**nalysis and **O**ptimization
Vol. 16, Issue. 1: 2025
ISSN : **1906-9685**

Leveraging Facial Recognition for Efficient Attendance tracking in Educational Institutes using Raspberry Pi and OpenCV

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ABSTRACT_ One of the important daily duties at schools, colleges, and businesses is keeping track of attendance. Usually, it is done manually using techniques like calling someone by name or roll number. This project intends primarily to create an automatic attendance tracking using face recognition technologies for student and staff.Designed with Raspberry Pi, this project offers a hardware-based and software as opencv of facial recognition system for automatic attendance monitoring in educational institutions. Using algorithms and the Haar Cascade classifier, the system combines a high-resolution camera, a dedicated processing unit, and a database to rapidly capture, process, and verify student and faculty faces.

The mechanism also sends suitable higher authorities an absentee list. Absent students trigger an absentee email report to their parents. Staff members are treated similarly; present and absent alerts go to their email. Salaries are also computed automatically and sent to staff members via email at month's end. It guarantee the system's measures such processing speed and recognition accuracy are assessed.

Keywords: Face Recognition, Attendance Tracking,OpenCV, High-Resolution Camera, Raspberry Pi, Haar Cascade.

1.INTRODUCTION

A basic duty in educational institutions, companies, and many other organisations is attendance tracking. Traditionally, attendance is recorded by calling out names or using roll numbers, a technique that is not only time-consuming but also prone to inaccuracies. Manual attendance techniques can result in errors such proxy attendance, record loss, and ineffective management of big data sets. Larger schools call for an automated and dependable attendance tracking solution that reduces human involvement while enhancing efficiency and accuracy.. A commonly used computer vision method, the Haar Cascade classifier, is employed by the project to detect faces quickly in real-time. Facial recognition also improves the system's accuracy and resilience. The. Its capacity to provide real-time attendance reports is among the main characteristics of this system. The system keeps a log of

present and absent people and automatically captures attendance data. An automated email notification to parents guarantees prompt communication in case of student absenteeism. Faculty attendance is likewise tracked; reports are sent to upper management by email. The system also calculates salaries automatically depending on attendance data, hence offering an effective payroll administration tool. Apart from attendance tracking, this system has uses in student monitoring, authentication, and access control. It guarantees that only registered people are allowed entrance and helps to prevent unauthorised access to institutions, hence improving security.

2.LITERATURE SURVEY EXISTING SYSTEM

[1]A.F. Abate, M. Nappi, D. Riccio, and G. Sabatino mentioned that Face recognition systems fall into two categories: verification and identification.Face verification is a 1:1 match that compares a face image against a template face images, whose identity is being claimed. On the contrary, face identification is a 1:N problem that compares a query face image against all image templates in a face database to determine the identity of the query face.Authors also mentioned the spreading of various biometric techniques that includes the human features like finger print,voice,iris,hands and database. Writers also noted the proliferation of other biometric methods comprising human characteristics such finger print, voice, iris, hands and face.

[2]Yang, Hao; Han, Xiaofeng created a unique real-time video-based attendance system using facial recognition technology. The device that automatically registers attendance by collecting photographs of students faces using a camera and comparing them with data recorded in a database saves time and effort on human labour. Writers also held a conversation about the accuracy rate of different attendance verification techniques and the accuracy rate of real-time vedio processing.

3.PROPOSED SYSTEM

Aiming at the limitations of conventional fingerprint recognition techniques, this proposal describes an automatic attendance system based on facial recognition. Specifically for the Indian setting, the system intends to offer a thorough solution for real-time attendance monitoring in educational institutions. Acknowledging the shortcomings of manual attendance systems, this initiative uses face recognition technology to allow staff and students to see their attendance records, obtain in-depth information, and simplify the attendance process using live video feeds. The system runs by creating individual facial encodings for every staff member and student, keeping these encodings next to their corresponding IDs. The Haar Cascade Classifier, a strong object detection technique, is used to carry out feature extraction.. The system updates attendance records in real time for students by means of image capture, facial detection, and matching against stored encodings. The technology shows the student's photograph, roll number, and section upon successful matching, therefore giving instant verification. The system notifies the student's parents if they are missing, automatically creating an absentee list for the class teacher or Head of Department (HOD).Staff attendance monitoring works in much the same way; the system takes pictures, identifies faces, and compares them to stored encodings to change attendance records. The system shows the staff member's photograph and ID upon successfulmatching. Especially, the system tracks staff members' in and exit timings and computes the time difference to properly track their presence. Staff absentee lists are supplied to upper management to guarantee responsibility and effective administration. The system also calculates salaries automatically

depending on attendance data, hence offering an effective payroll administration tool and sending the staff's monthly salary email report. Should the system not correlate a face with the kept data, it shows "UNKNOWN," meaning an unacknowledged person.

4. HARDWARE REQUIREMENTS

Hardware we used in this project are following

1.Raspberry pi3B+
2.Web Camera
3.HDMI – HDMI Cable

5. SOFTWARE REQUIREMENTS

Software we used here are

1.OpenCv
2.Raspbian OS

6.RESULTS AND DISCUSSION

6.1 Results

Leveraging Facial Recognition for Efficient Attendance Tracking in Educational Institutions using Raspberry Pi and OpenCV" successfully demonstrated an automated system for recording attendance using facial recognition technology.

Fig 6.1.1 Raspberry pi Connections

The fig 6.1.1 shows a Raspberry Pi 3B+ Raspberry pi connected with essential peripherals for a facial recognition-based attendance system. The board is powered through a USB-C cable, indicated by the glowing red power LED. Several USB ports are utilized, one of which is connected to a USB webcam that captures facial images.This webcam is a critical component of your project, as it is used for detecting and recognizing faces in real-time using OpenCV.

Fig 6.1.2 Overall Connections

The fig 6.1.2 captures a working setup of a Raspberry Pi 3B+ connected to a monitor.

6.2 STUDENT RESULTS

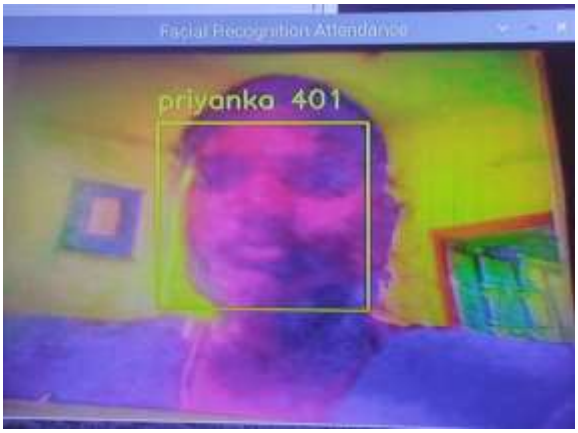


Fig 6.2.1 STUDENT 1

Fig 6.2.2 STUDENT 2

The image represents a real-time output generated by our Facial Recognition Attendance System.The fig 6.2.1 names "Priyanka" roll number “401” and fig 6.2.2 "Haritha Priya" roll number “402” are displayed in yellow above the bounding boxes, indicating successful identification.

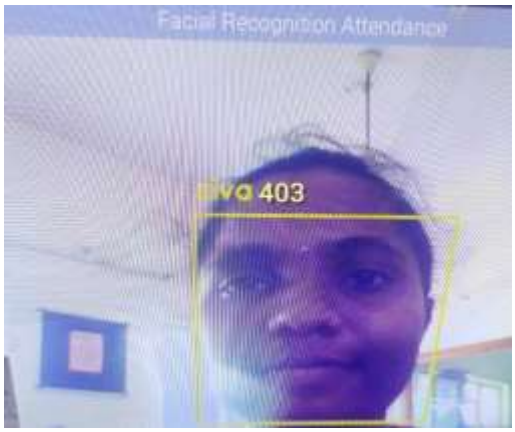


Fig 6.2.3 Student 3

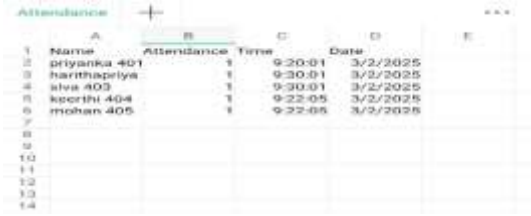
Fig 6.2.4 Student 4

The above image represents a real-time output generated by our Facial Recognition Attendance System. The fig 6.2.3 names "siva" roll number “403” and fig 6.2.3 "keerthi" roll number “404” are displayed in yellow above the bounding boxes, indicating successful identification.

Fig 6.2.5 STUDENT 5

The above image represents a real-time output generated by our Facial Recognition Attendance System.. In Fig 6.2.5, the name “Mohan” and roll number “405” is displayed in yellow above the bounding box, indicating successful identification.

CASE 1



	A	B	C	D	E
1	Name	Attendance	Time	Date	
2	priyanka 401	1	9:20:01	3/2/2025	
3	harithapriya	1	9:30:01	3/2/2025	
4	siva 403	1	9:30:01	3/2/2025	
5	keerthi 404	1	9:22:05	3/2/2025	
6	mohan 405	1	9:22:05	3/2/2025	
7					
8					
9					
10					
11					
12					
13					
14					

Fig 6.2.6 Attendance Sheet 1

The fig 6.2.6 attendacne sheet 1 displays a sample Excel attendance sheet generated by our Facial Recognition Attendance System. In this students Priyanka, Haritha Priya, Siva, Keerthi, and Mohan were recognized, and their attendance was recorded at 9:22:05 on 3/2/2025.

CASE 2

Attendance

	A	B	C	D	E
1	Name	Attendance	Time	Date	
2	priyanka 401	1	9:20:56	4/2/2025	
3	haritha priya	1	9:21:11	4/2/2025	
4	siva 403	1	9:21:31	4/2/2025	
5	keerthi 404	0	9:30:01	4/2/2025	
6	mohan 405	1	9:22:03	4/2/2025	

Fig 6.2.7 Attendance Sheet 2

The fig 6.2.7 attendacne sheet 1 shown represents the output of the Excel attendance sheet generated. The attendance is recorded automatically once a student's face is detected and recognized by the system. In this output, Priyanka, Haritha Priya, Siva, and Mohan are marked present on 4/2/2025 before 9:30:01, while Keerthi is marked absent.

CASE 3

Attendance

	A	B	C	D	E
1	Name	Attendance	Time	Date	
2	priyanka 401	1	9:20:01	5/2/2025	
3	harithapriya	0	9:30:01	5/2/2025	
4	siva 403	0	9:30:01	5/2/2025	
5	keerthi 404	1	9:22:05	5/2/2025	
6	mohan 405	1	9:22:05	5/2/2025	

Fig 6.2.8 Attendance Sheet 3

The fig 6.2.8 attendacne sheet 3 shown represents the output of the Excel atten+dance sheet generated.In this output, Priyanka, Keerthi, and Mohan are marked present on 5/2/2025 before 09:30:01, while Haritha Priya and Siva are marked absent.

Absentees list

	A	B	C	D	E
1	Name	Attendance	Time	Date	
2	keerthi 404	0	9:30:01	4/2/2025	

Fig 6.2.9 Absent excellist1

This fig 6.2.9 report was automatically generated by our facial recognition-based attendance system on 4/2/2025 absent list. The report was sent directly to the HOD via email.

Attendance

	A	B	C	D	E
1	Name	Attendance	Time	Date	
2	harithapriya	0	9:30:01	5/2/2025	
3	siva 404	0	9:30:01	5/2/2025	

Fig 6.2.10 Absent excellist2

This fig 6.2.10 report was automatically generated by our facial recognition-based attendance system on 4/2/2025absent list. The report was sent directly to the HOD via email.

EMAIL

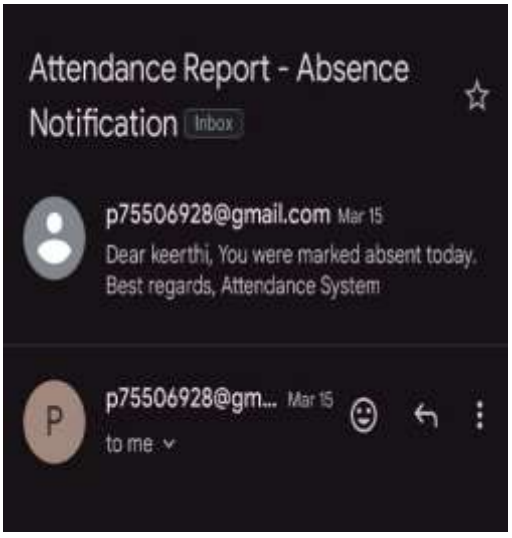


Fig 6.2.11 Absent Email1

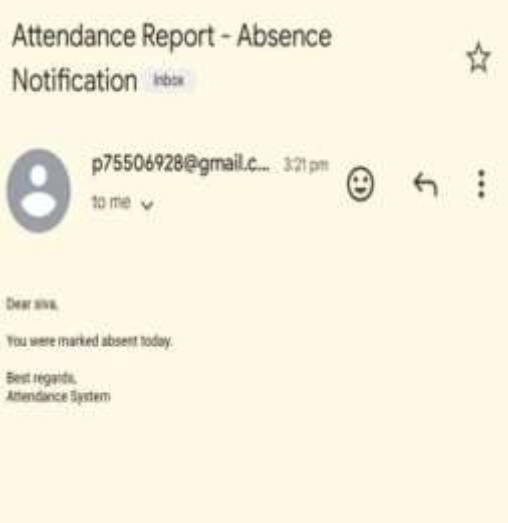


Fig 6.2.12Absent Email2

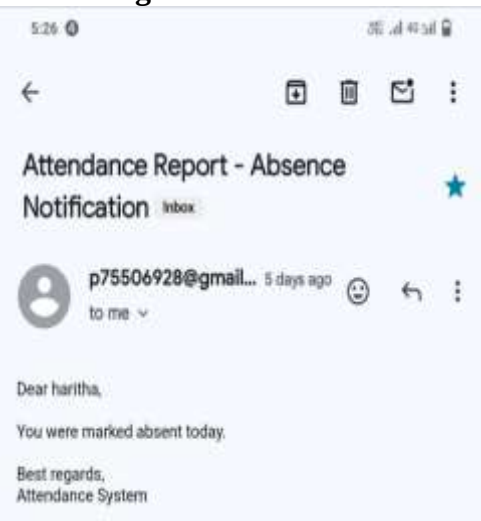


Fig 6.2.13 Absent Email3

Absence Notification Email – Output View
The figures 6.2.11,6.2.12,6.2.13 displays the automated absence notification email sent by the Facial Recognition Attendance System. Whenever a students is marked absent, the system instantly triggers an email notification to the concerned individual or their parent/guardian.

6.3 STAFF RESULTS

Fig 6.3.1 Staff 1

Fig 6.3.2 Staff 2

The image demonstrates the real-time facial recognition system successfully identifying staff members named fig 6.3.1 "Jaya Staff ECE" and fig 6.3.2 "Raju Staff ECE".

Fig 6.3.3 Staff 3

Fig 6.3.4 Staff 4

Fig 6.3.5 Staff 5

The figures 6.3.3,6.3.4,6.3.5 demonstrates the real-time facial

recognition system successfully identifying staff members named "Sandya Staff CSE," "Rekha Staff CSE," and "Yuvaraju Staff EEE."

CASE 1

	A	B	C	D
1	Name	Attendance	Time	Date
2	jaya staff ec	1	9:20:03	12/3/2025
3	raju staff ece	1	9:20:15	12/3/2025
4	sandhya staf	1	9:21:04	12/3/2025
5	rekha staff c	1	9:21:35	12/3/2025
6	yuvaraju staf	1	9:22:40	12/3/2025

Fig 6.3.6 Staff Attendance Sheet 1

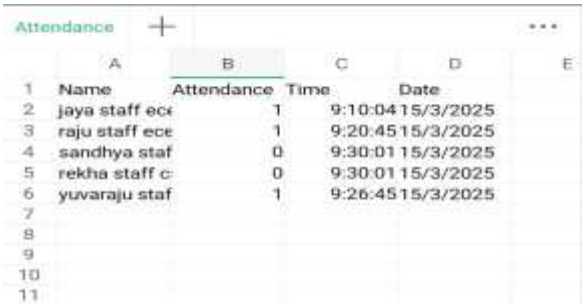
The above fig 6.3.6 Excel sheet displays the automatically generated attendance report for staff using the Facial Recognition Attendance System developed with Raspberry Pi and OpenCV. The exact timestamp of recognition, 9:30:01, and the date, 12/3/2025, are automatically recorded. In this report, Jaya Staff, Raju Staff, Sandhya Staff, Rekha Staff, and Yuvaraju have been successfully recognized and marked present.

CASE 2

Fig 6.3.7 Staff Attendance Sheet 2

The above 6.3.7 Excel sheet is generated by the Facial Recognition Attendance System designed using Raspberry Pi and OpenCV. The sheet records essential details such as the Name of the staff members (Jaya Staff, Raju Staff, Sandhya Staff, Rekha Staff, Yuvaraju), Attendance marked as '1' for present and '0' for absent, Time as the exact timestamp of recognition, and Date which is logged automatically. On 13/3/2025, the system successfully recognized Jaya Staff, Raju Staff, Rekha Staff, and Yuvaraju as present before 09:30:01. Sandhya Staff was marked absent (0), even though a timestamp exists—this could be due to a failure in facial recognition or the individual being present but not accurately detected by the system.

CASE 3

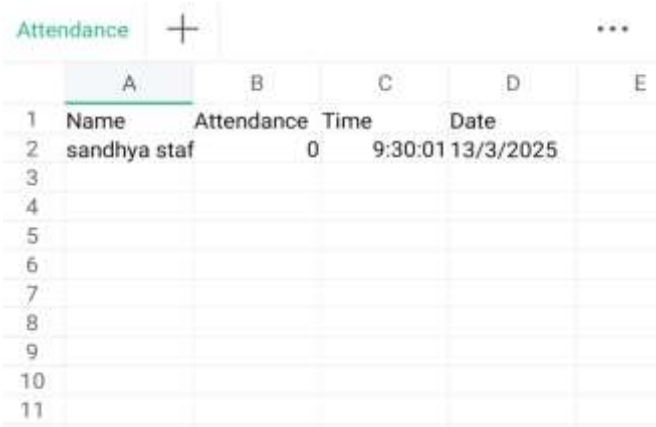


	A	B	C	D	E
1	Name	Attendance	Time	Date	
2	jaya staff ec	1	9:10:04	15/3/2025	
3	raju staff ece	1	9:20:45	15/3/2025	
4	sandhya staf	0	9:30:01	15/3/2025	
5	rekha staff c	0	9:30:01	15/3/2025	
6	yuvaraju staf	1	9:26:45	15/3/2025	

Fig 6.3.8 Staff Attendance Sheet 3

This fig 6.3.8 Excel sheet represents the automatically recorded attendance of staff members using a Facial Recognition-based Attendance System developed with Raspberry Pi and OpenCV. The sheet includes columns such as Name (staff member identified by the system), Attendance (1 for Present, 0 for Absent), Time (recognition timestamp), and Date (attendance date). On 15/3/2025, Rekha Staff and Sandhya Staff were marked absent (0) after 9:30:01.

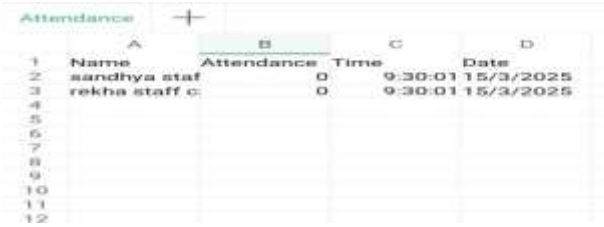
ABSENTEES LIST



	A	B	C	D	E
1	Name	Attendance	Time	Date	
2	sandhya staf	0	9:30:01	13/3/2025	

Fig 6.3.9 Staff Absentreport 1

This fig 6.3.9 report was automatically generated by our facial recognition-based attendance system on 13/3/2025. It provides a comprehensive list of staff who were absent, facilitating efficient communication. The report was sent directly to the principal via email.


Attendance

	A	B	C	D
1	Name	Attendance	Time	Date
2	sandhya staf	0	9:30:01	15/3/2025
3	rekha staff c	0	9:30:01	15/3/2025
4				
5				
6				
7				
8				
9				
10				
11				
12				

Fig 6.3.10 Staff Absentreport 2

This fig 6.3.10 report was automatically generated by our facial recognition-based attendance system on 15/3/2025. It provides a comprehensive list of staff who were absent, facilitating efficient communication. The report was sent directly to the principal via email.

EMAIL

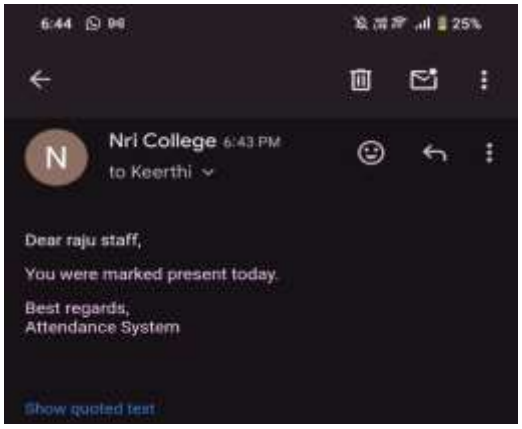


Fig 6.3.11 Staff Present Mail 1

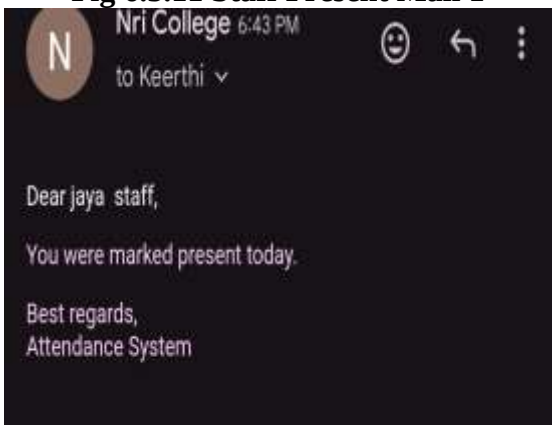


Fig 6.3.12 Staff Present Mail 2

Email Notification Feature of the Attendance System

The fig 6.3.11 and 6.3.12 displays an automated email notification sent to a raju staff and jaya staffregarding their attendance status for the day. This email is generated by the Attendance System, which is part of the Facial Recognition-Based Attendance Tracking System developed using Raspberry Pi and OpenCV.

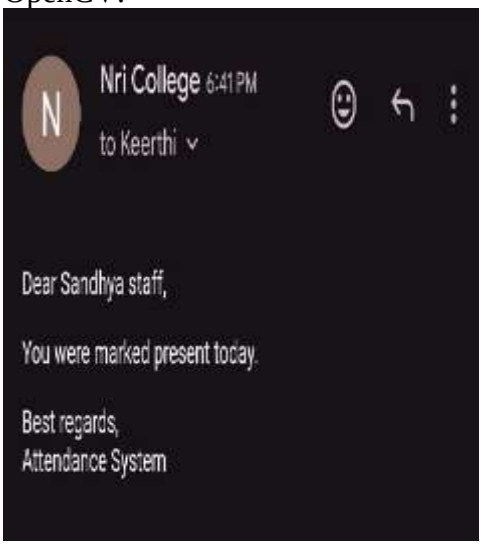


Fig 6.3.13 Staff Present Mail3

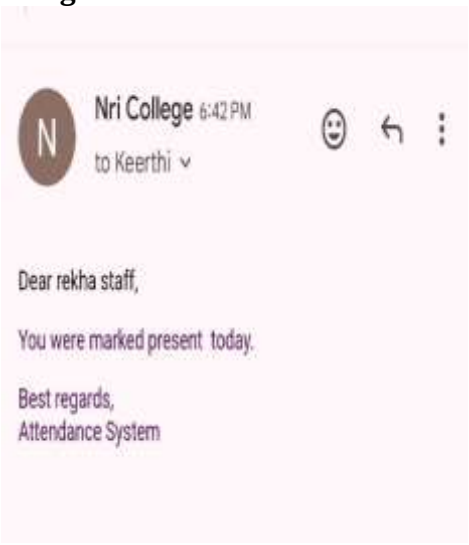


Fig 6.3.14 Staff Present Mail4

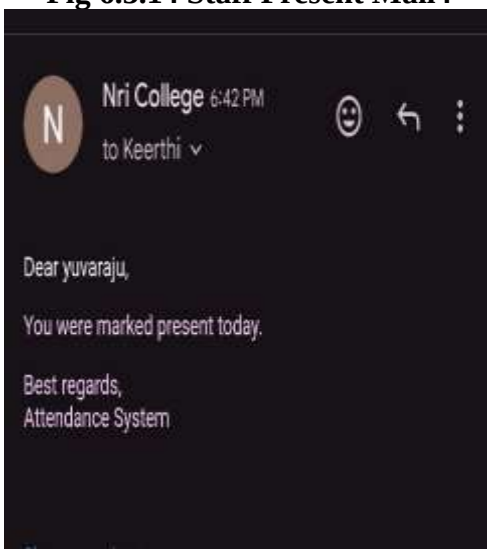


Fig 6.3.15 Staff Present Mail6

The fig 6.3.13,6.3.14,6.3.15 displays an automated email notification sent to a sandhya staff,rekha staff,yuvaraju staffregarding their attendance status for the day.

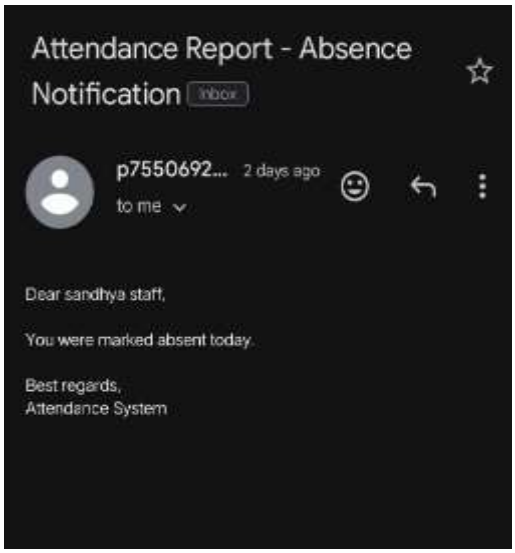


Fig 6.3.16 Staff Absent Mail 1

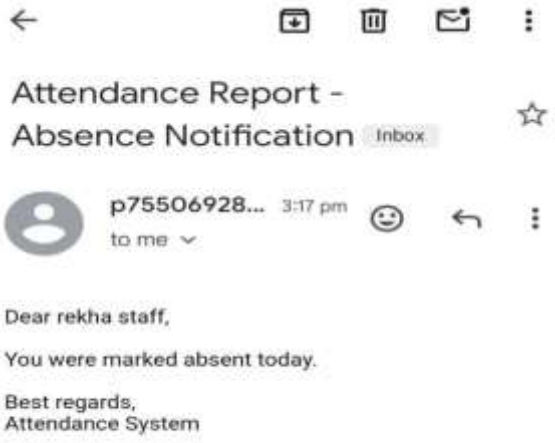


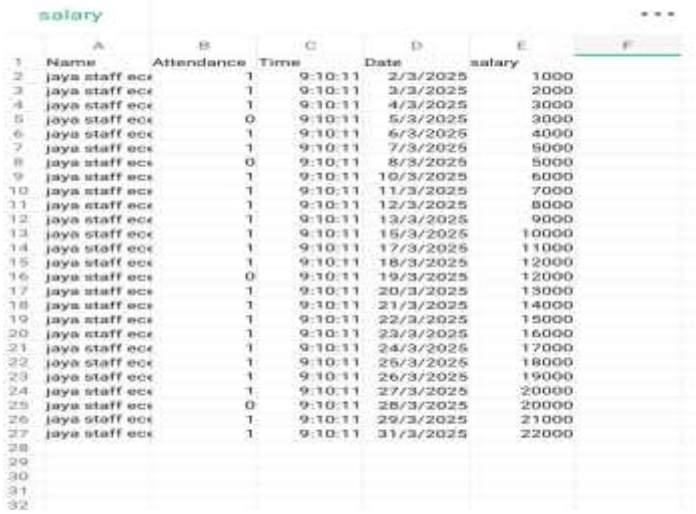
Fig 6.3.17 Staff Absent Mail 2

The fig 6.3.16,6.3.17 displays an automated absence notification email sent to Sandhya staff, rekha staff informing them that they have been marked absent for the day. This email is generated by the Facial Recognition-Based Attendance Tracking System, which utilizes Raspberry Pi and OpenCV for efficient attendance monitoring.

Fig 6.3.18 Unknown

The fig 6.3.18 showcases the Facial Recognition Attendance System in action. The system attempts to identify a person but has labeled them as "Unknown." This indicates that the detected face does not match any stored records in the attendance database.

Salary Calculation


salary

	A	B	C	D	E	F
1	Name	Attendance	Time	Date	salary	
2	jaya staff ec	1	9:10:11	2/3/2025	1000	
3	jaya staff ec	1	9:10:11	3/3/2025	2000	
4	jaya staff ec	1	9:10:11	4/3/2025	3000	
5	jaya staff ec	0	9:10:11	5/3/2025	3000	
6	jaya staff ec	1	9:10:11	6/3/2025	4000	
7	jaya staff ec	1	9:10:11	7/3/2025	5000	
8	jaya staff ec	0	9:10:11	8/3/2025	5000	
9	jaya staff ec	1	9:10:11	10/3/2025	6000	
10	jaya staff ec	1	9:10:11	11/3/2025	7000	
11	jaya staff ec	1	9:10:11	12/3/2025	8000	
12	jaya staff ec	1	9:10:11	13/3/2025	9000	
13	jaya staff ec	1	9:10:11	15/3/2025	10000	
14	jaya staff ec	1	9:10:11	17/3/2025	11000	
15	jaya staff ec	1	9:10:11	18/3/2025	12000	
16	jaya staff ec	0	9:10:11	19/3/2025	12000	
17	jaya staff ec	1	9:10:11	20/3/2025	13000	
18	jaya staff ec	1	9:10:11	21/3/2025	14000	
19	jaya staff ec	1	9:10:11	22/3/2025	15000	
20	jaya staff ec	1	9:10:11	23/3/2025	16000	
21	jaya staff ec	1	9:10:11	24/3/2025	17000	
22	jaya staff ec	1	9:10:11	25/3/2025	18000	
23	jaya staff ec	1	9:10:11	26/3/2025	19000	
24	jaya staff ec	1	9:10:11	27/3/2025	20000	
25	jaya staff ec	0	9:10:11	28/3/2025	20000	
26	jaya staff ec	1	9:10:11	29/3/2025	21000	
27	jaya staff ec	1	9:10:11	31/3/2025	22000	
28						
29						
30						
31						
32						

Fig 6.3.19 Salary Report 1

The system captures and recognizes faces in real time, accurately marking attendance and improving efficiency. Implemented on a Raspberry Pi with OpenCV, it enhances attendance management for staff in educational institutions by automating the process, reducing manual errors, and preventing proxy attendance.The above fig 6.3.19 displays the salary details for Jaya Staff ECE, including the staff attendance report.

Fig 6.3.20 Salary Report 2

The system captures and recognizes faces in real time, accurately marking attendance and improving efficiency. Implemented on a Raspberry Pi with OpenCV, it enhances attendance management for staff in educational institutions by automating the process, reducing manual errors, and preventing proxy attendance.The above fig 6.3.20 displays the salary details for sandhya staff cse,including the staff attendance report.

7.CONCLUSION

In conclusion, Raspberry Pi with OpenCV's facial recognition-based attendance system is an effective and automated option for educational institutions. Face detection using the Haar Cascade algorithm accurately recognises students and staff, minimising laborious attendance marking. Webcams take face data and match it with pre-stored records, making the procedure easy. Attendance is immediately logged and displayed on the connected PC after recognition. The system also emails attendance reports to improve communication. The Head of the Department (HOD) receives the attendance list automatically for easy record-keeping and monitoring. Student absences are reported to parents via automated email. Staff members receive a confirmation email and, optionally, a monthly salary summary when the system records their attendance. This automated procedure reduces errors, eliminates proxy attendance, and boosts attendance management efficiency.

FUTURE SCOPE

Liveness Detector Liveness detection can ensure that the observed face is real to prevent picture and video faking. Mobile App Integration A companion mobile app for real-time attendance viewing and notifications can improve accessibility for parents, students, and staff. Support for several cameras helps increase entry point coverage and scalability in large institutions. speech and RFID Integration Multi-factor authentication using facial recognition and speech or RFID improves security and dependability. Adding mask recognition to the model can ensure functionality during pandemics or in health-conscious environments.

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4.**https://github.com/Patelrahul4884/Attendance-Management-system-using-face-recognition**