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SMART ATTENDANCE BASED ON FACE RECOGNITION USING RASPBERRY PI AND GSM MODULE FOR HOME INTIMATION

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Abstract: The Smart Attendance System based on face recognition using the Raspberry Pi 4 and GSM module is an automated solution for attendance management. The system captures real-time facial images of students and identifies them using face detection and recognition algorithms. Attendance is recorded automatically with date and time, reducing manual effort and preventing proxy attendance. The system also integrates a SIM900A GSM Module to send SMS notifications to parents, improving communication and transparency. All data is stored in a database and managed through a web application, allowing administrators to monitor and control attendance efficiently. The system is cost-effective, reliable, and suitable for educational institutions.

Keywords: Face Recognition, Smart Attendance System, Raspberry Pi, GSM Module, Automated Attendance, Computer Vision, Deep Learning, YOLOv8, FaceNet, DeepFace, Embedded Systems, Real-Time Monitoring

I. INTRODUCTION

Attendance tracking is a key part of management within educational institutions. Historically, manual attendance tracking involved the use of registers by instructors to record the attendance status of students. The conventional approach is time-consuming and inefficient since it takes too much time in the classroom and increases the burden on the instructor.

Manual systems also involve human error through mistakes during registration. Lastly, manual attendance systems are unable to handle proxy attendances since they do not have mechanisms for preventing them. Therefore, there is a need for a more efficient and effective automated system for managing attendance.

The incorporation of the SIM900L GSM module is aimed at increasing communication by sending SMS alerts to the parent whenever their child is recorded attending classes. This helps ensure that parents get instant feedback on whether the child attends classes. The project also features a web portal designed using Flask which helps the teachers keep attendance records and database management.

A. Motivation of the Research

The motivation for this research arises from the growing need to replace inefficient and error-prone traditional attendance systems with intelligent, automated solutions in educational institutions. Manual methods consume valuable classroom time, increase administrative workload, and fail to prevent issues such as proxy attendance, highlighting a clear gap in reliability and efficiency.

However, many existing systems either lack real-time communication features or depend on expensive infrastructure, limiting their usability in resource-constrained settings. This research is therefore motivated by the need to develop a cost-effective, embedded solution using platforms like the Raspberry Pi 4, integrated with GSM communication to provide instant attendance notifications. By combining automation, accuracy, and real-time communication, the proposed system aims to bridge the gap between traditional practices and modern technological capabilities, creating a more efficient, transparent, and scalable attendance management solution.

B. Objectives of the Work

The objective of this project is to develop an automated attendance management system using face recognition technology to accurately identify students and record attendance in real time. The system aims to implement efficient face detection and recognition techniques to ensure reliable identification while minimizing manual effort. It utilizes the Raspberry Pi

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4 as a cost-effective embedded platform for processing and system control. Another key objective is to prevent proxy attendance by verifying student identity through unique facial features. Additionally, the system integrates a SIM900A GSM Module to send SMS notifications to parents, improving communication and transparency.

II. LITERATURE SURVEY

These studies provide insights into face recognition, automated attendance systems, and IoT-based monitoring technologies, including system design, implementation methods, challenges, and future research directions. These works help in understanding existing solutions and provide guidance for developing the proposed smart attendance system.

[1] Anusha, S., et al. (2020). Face Recognition Based Attendance System Using Deep Learning. International Journal of Engineering Research & Technology.[2] Sathyanarayana, K., et al. (2019). Smart Attendance System Using Raspberry Pi. International Conference on Embedded Systems and Applications.[3] Patel, P., et al. (2018). RFID-Based Attendance Monitoring System. International Journal of Computer Applications.[4] Redmon, J., et al. (2016). You Only Look Once: Unified, Real-Time Object Detection. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR).[5] Taigman, Y., et al. (2014).

DeepFace: Closing the Gap to Human-Level Performance in Face Verification. IEEE Conference on Computer Vision and Pattern Recognition (CVPR).

The research demonstrates that deep learning-based face recognition systems significantly outperform traditional facial recognition methods. The DeepFace framework has influenced many modern face recognition systems and has become a widely used approach in applications such as security systems, authentication systems, and automated attendance management systems.

III. METHODOLOGY

A. System Design & Architecture

The Smart Attendance System employs the client-server architecture implemented in Raspberry Pi 4. The smart system consists of:

- •Web Application Interface (HTML/CSS/JavaScript)
- •Server-side Processing Engine (Python Flask REST API)
- •Artificial Intelligence (YOLOv8 + Deepface)
- •SQL database for attendance and user information
- •Hardware layer (dual USB cameras and SIM900L GSM Module)

B. Student Registration

1.Teacher registers the students using the dashboard.
2.The live camera feed detects several face images using YOLOv8 object detection.
3.The DeepFace algorithm computes 128-D vectors (FaceNet embeddings) for all detected face images.
4.The average of these embeddings is then stored in the database.

C. Face Recognition Pipeline

Table1: Techniques Used for Face Recognition

Step	Technique	Purpose
Detection	YOLOv8 (ONNX)	Locate face bounding boxes in frame
Encoding	DeepFace (FaceNet)	Extract 128-d face
Matching	Cosine Similarity	Compare against stored embeddings
Threshold	≥ 0.6 similarity	Accept or reject identity

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- Multi-face detection works on more than one student at once.
- Adaptive illumination normalization makes it work well in very dark/bright situations.

D. Procedure for Checking Attendance

1.The teacher initiates an attendance procedure in a particular class/subject.
2.Frames from a live video feed are analyzed one by one.
3.The detected faces are compared with those of the registered students.
4.The attendance is recorded along with the timestamp in SQLite.
5.Attendance procedure is stopped; non-attendees are determined.
6.A GSM module (SIM900L) automatically sends SMS messages to the non-attendees' guardians.

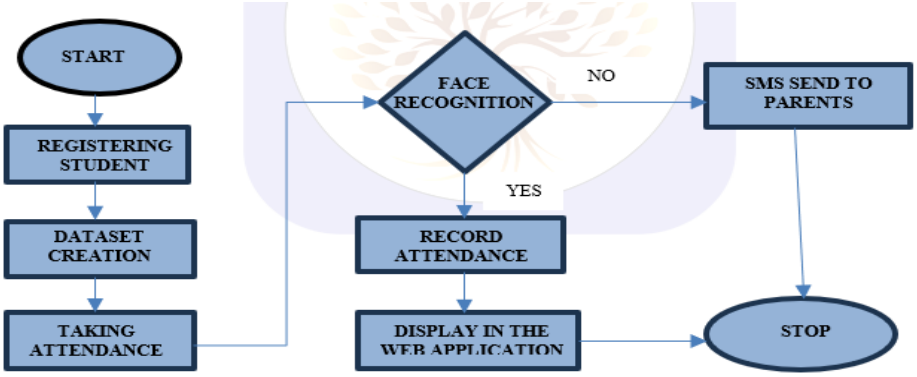

Fig1.Flow chart of Proposed System

E. Notification Mechanism

1.Serial UART communication with the SIM900L GSM module is used.
2.Python PySerial library sends AT commands to create and send SMS messages.
3.Automatic process after the attendance procedure for the non-attendees.

F. Project Environment Setup

1.Hardware: Raspberry Pi 4 (1GB RAM), dual USB webcams, SIM900L GSM module
2.Operating System: Raspberry Pi OS (based on Debian)
3.Remote Connection: Ngrok tunnel for remote web dashboard access
4.Server Process: Flask development server / Gunicorn

IV. HARDWARE COMPONENTS

A. Raspberry pi4

The Raspberry Pi 4 is a compact and powerful embedded system used as the main processing unit in the project. It performs tasks such as image processing, face recognition, database management, and system control. It also interfaces with peripherals like the camera and GSM module to enable real-time attendance and communication.

B. GSM Module

The SIM900A GSM Module enables wireless communication by sending SMS notifications to parents regarding student attendance. It is connected to the Raspberry Pi 4 using UART and operates using AT commands.

C. GSM Antenna

The GSM antenna is used to transmit and receive cellular signals for the SIM900A GSM Module. It enables the module to connect to the mobile network for sending and receiving SMS messages. A properly connected antenna ensures strong signal strength and reliable communication.

D. Web Cam

The webcam is used to capture real-time video or images of students for face detection and recognition. It is connected to the Raspberry Pi 4 via USB and acts as the primary input device.The captured frames are processed by the system to identify students and mark attendance automatically.

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E. SIM Card

The SIM card is inserted into the SIM900A GSM Module to enable cellular network connectivity. It allows the system to send SMS notifications to parents regarding student attendance. An active SIM with sufficient balance is required for proper communication.

F. SD Card

The 32GB SD card is used as the primary storage device for the Raspberry Pi 4.It stores the operating system, application code, database, and face recognition models. It provides sufficient space for system files, student data, and attendance records.

G. Power Supply Unit

The power supply provides stable electrical power to the Raspberry Pi 4 and other connected components. A regulated 5V, 2.5A (or higher) supply is required to ensure proper and uninterrupted operation.It maintains system stability and prevents issues like crashes or hardware malfunction.

V. PYTHON PACKAGES USED

TABLE 2. Python Packages Used in Application Development

Package	Purpose
Flask	Web framework for application development
Flask-SQLAlchemy	ORM for SQLite database management
Flask-Login	User session management
Flask-JWT-Extended	JWT-based authentication support
OpenCV-Python	Face detection and camera interfacing
NumPy	Numerical operations and embedding processing
Pillow (PIL)	Image processing and decoding
Ultralytics	Implementation of YOLOv8 model
DeepFace	FaceNet-based facial embedding generattion
PySerial	Serial communication with GSM module
TensorFlow/Keras	Deep learning backend for FaceNet
Bcrypt	Password hashing and security

VI. SOFTWARE IMPLEMENTATION

A. Face Detection Module

The system uses the YOLOv8 model to detect faces from live video frames captured through the webcam. It identifies facial regions and extracts them for further processing.

B. Feature Extraction Module

Facial features are extracted using FaceNet implemented via DeepFace. The model converts each face into a numerical embedding representing unique facial characteristics.

C. Face Recognition Module

The generated embeddings are compared with stored embeddings in the database using similarity measures. If the match exceeds a threshold, the system identifies the student and confirms attendance.

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D. Database Management Module

A SQLite database is used to store student details, facial embeddings, and attendance records. It is managed using Flask-SQLAlchemy for efficient data storage and retrieval.

E. Web Application Module

A web interface is developed using Flask to allow administrators to register students, capture images, and monitor attendance records in real time.

F. Image Processing Module

Libraries like OpenCV and Pillow are used for image capture, preprocessing, and handling camera input. These ensure proper image quality for accurate recognition.

G. Authentication and Security Module

User authentication is managed using Flask-Login and JWT, while Bcrypt is used for password hashing. This ensures secure access to the system.

H. GSM Communication Module

The system uses the SIM900A GSM Module with PySerial for communication. SMS alerts are sent to parents using AT commands when attendance is marked.

VII. RESULTS AND DISCUSSION

A. System Testing Environment

The operational flow of the proposed system is shown in Fig. 3. The system collects water quality parameters using pH, turbidity, temperature (DS18B20), and TDS sensors. The Arduino UNO processes the data, displays values on the 16×2 LCD, and transmits data to ThingSpeak via the ESP8266 module. If any parameter exceeds the threshold, a buzzer alert activates and the L298N motor driver triggers the water pump to initiate automated filtration.

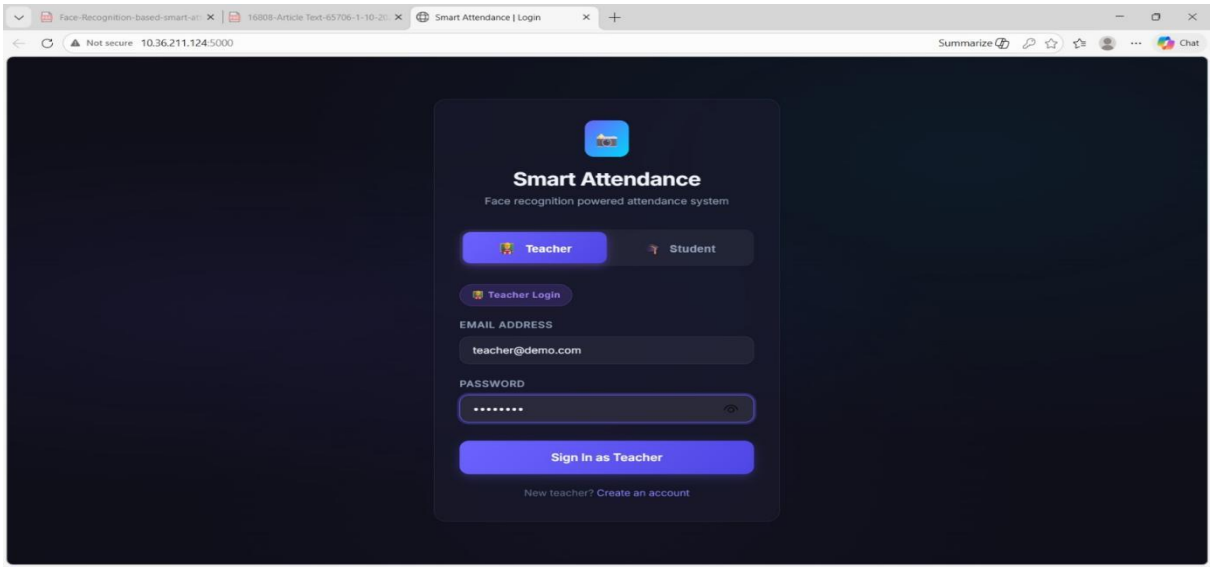

Fig. 2. Web Application Login Page

B. Face Detection Performance

The face detection component used the YOLOv8 model to detect faces from the live video stream. The model demonstrated efficient detection performance by accurately identifying facial regions in real time. Even when multiple faces appeared in the camera frame, the system was able to detect each face and process them individually.

The detection algorithm worked effectively under normal lighting conditions. However, detection performance slightly decreased in cases of poor lighting or when faces were partially obstructed. Despite these conditions, the system maintained acceptable performance for typical classroom environments.

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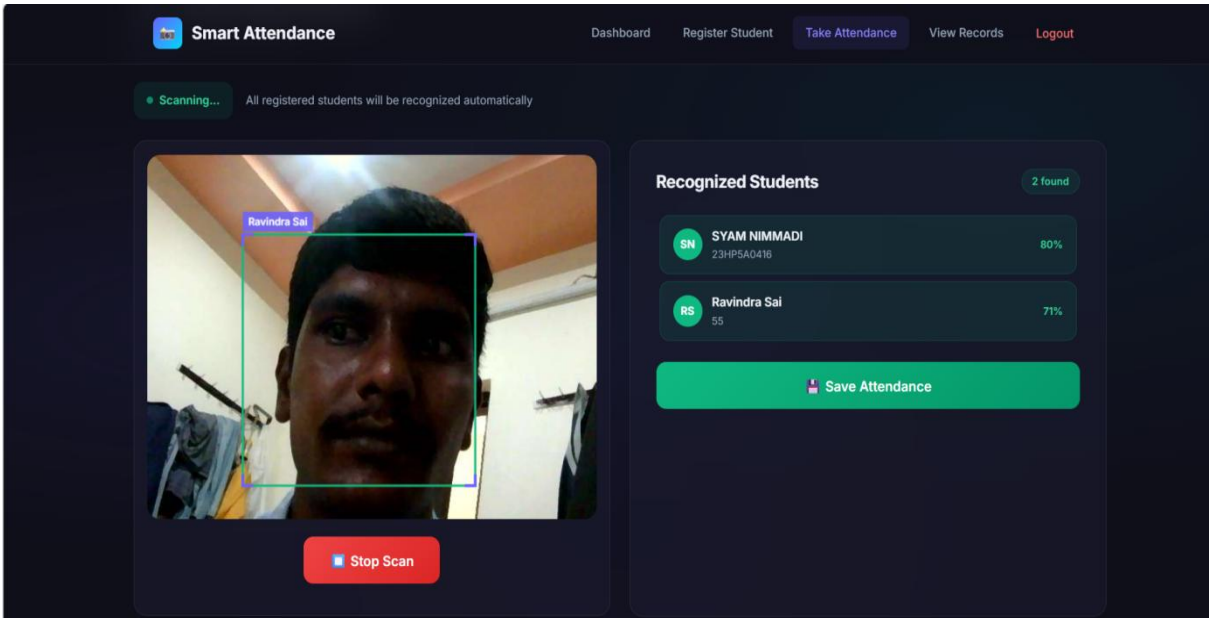

Fig. 3. Face detection While Taking Attendance

C Face Recognition Accuracy

The FaceNet model, implemented through the DeepFace framework, was responsible for extracting facial embeddings and performing identity verification. The recognition process involved comparing the embedding of the detected face with stored embeddings in the student database.

The system achieved a high recognition accuracy when the registered images were captured under appropriate lighting conditions and when students maintained a reasonable distance from the camera. The use of multiple training images during the registration phase improved recognition reliability by capturing variations in facial expressions and angles.

D. Attendance Recording Efficiency

Once a student's identity was successfully verified, the system automatically recorded the attendance in the SQLite database. The recorded data included the student's name, identification number, and timestamp. The automated recording process ensured that attendance was stored instantly without manual intervention.

The use of SQLite as the database management system proved effective for handling attendance data in an embedded environment. It provided fast data retrieval and storage while requiring minimal system resources. The integration with SQLAlchemy simplified database interactions and improved code maintainability.

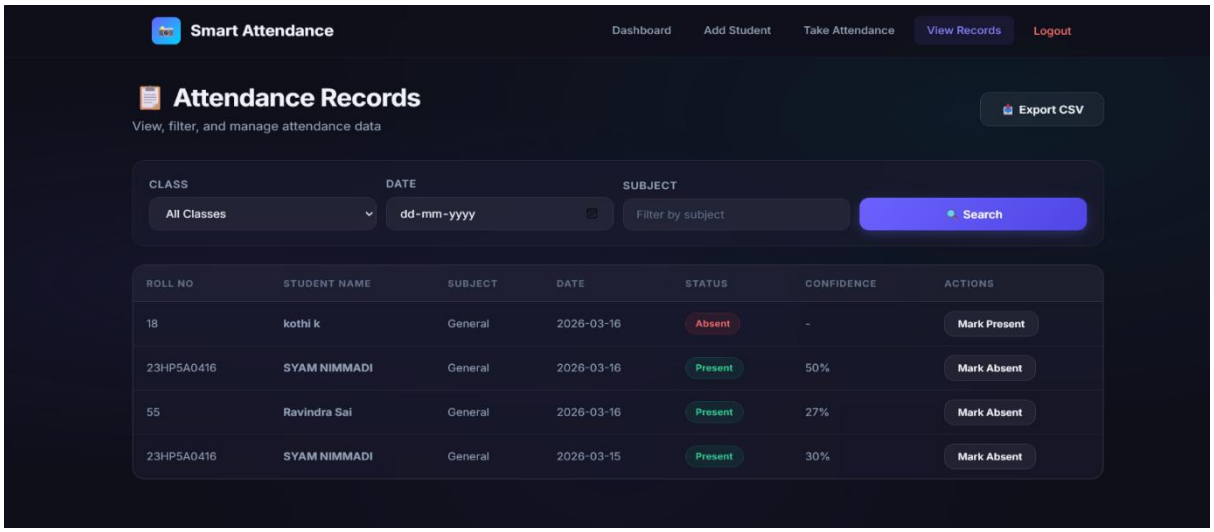

Fig. 4. Attendance Records

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E. Assembled Prototype

The hardware implementation of the system is based on the Raspberry Pi 4, which acts as the central processing unit for executing all operations. A USB webcam is connected to capture real-time images for face detection and recognition. The SIM900A GSM Module is interfaced with the Raspberry Pi using UART communication to send SMS notifications to parents. All components are powered using a regulated 5V power supply, ensuring stable and reliable system performance.

Fig. 5. Assembled Prototype Pictorial Representation.

F. System Advantages

The implemented system offers several advantages over traditional attendance systems. It eliminates manual attendance recording, reduces the risk of proxy attendance, and provides real-time monitoring capabilities. The integration of facial recognition ensures that attendance is verified using biometric identification, which improves accuracy and reliability.
Additionally, the SMS notification feature enhances communication between educational institutions and parents by providing instant updates about student attendance.

G, Discussion

The results indicate that the Smart Attendance System successfully achieves its objective of automating the attendance process using facial recognition technology. The system integrates computer vision techniques with embedded hardware to create an efficient and reliable attendance monitoring solution. The combination of real-time face detection, accurate recognition, automated database recording, and GSM-based notifications makes the system suitable for deployment in educational institutions.

Future improvements could include optimizing the facial recognition models for faster processing, integrating cloud-based databases for larger deployments, and adding additional communication methods such as mobile applications or email notifications. These enhancements would further improve system scalability, performance, and usability in real-world scenarios.

VIII. CONCLUSION

The Smart Attendance System developed in this project demonstrates an efficient and automated approach to managing student attendance using facial recognition technology. The system integrates computer vision techniques with embedded hardware to create a reliable solution that reduces the need for traditional manual attendance methods. By utilizing a Raspberry Pi as the central processing unit, a webcam for capturing facial images, and advanced deep learning models such as YOLOv8 and FaceNet, the system is capable of detecting and recognizing student faces in real time.

One of the major achievements of this project is the successful integration of hardware and software components to create a fully functional attendance system. The webcam captures live images which are processed by the facial recognition algorithms to identify registered students. Once a student is recognized, the system automatically records the attendance in the database without requiring manual input. This automation significantly reduces the time required for attendance recording and eliminates the possibility of human errors or proxy attendance.

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However, the system also has certain limitations that can be improved in future developments. Factors such as poor lighting, camera positioning, and facial occlusions may affect recognition accuracy. Additionally, the processing capability of the Raspberry Pi may limit the system's ability to handle large numbers of students simultaneously. Despite these challenges, the proposed system provides a strong foundation for developing more advanced and scalable smart attendance solutions.
In conclusion, the Smart Attendance System successfully achieves its objective of automating attendance monitoring using facial recognition technology. The combination of computer vision, embedded systems, database management, and wireless communication creates an efficient and reliable system that can be implemented in educational institutions. With further improvements and enhancements, the system has the potential to become a widely adopted solution for modern attendance management.

IX. FUTURE WORK

The proposed system can be further enhanced by incorporating advanced features to improve performance, scalability, and security. Future improvements may include the integration of cloud-based storage for centralized data management and access across multiple classrooms or institutions. The system can also be extended to support multi-camera setups for better coverage and accuracy in larger environments.

Additionally, implementing liveness detection and anti-spoofing techniques can improve security by preventing unauthorized access using photos or videos. Further optimization of deep learning models can enhance recognition accuracy under challenging conditions such as low lighting or occlusions. Integration with mobile applications and institutional ERP systems can also be explored to provide better accessibility, analytics, and real-time monitoring capabilities.

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REFERENCES

[1]. Charles A. Walton, electronic identification & recognition system Filed: Dec. 27, 1971 Appl. No.: 212,281.
[2]. Michael Dobson, Douglas Ahlers, Bernie DiDario, "Attendance Tracking System", United States Patent Application Publication, Pub. No.: US 2006/0035205 A1, Feb.16, 2006.
[3]. O. Shoewu and O.A. Idowu, "Development of Attendance Management System using Biometrics ", The Pacific Journal of Science and Technology, Vol. 13, Number1, pp.300-307, May 2012 (Spring).
[4]. L. Sirovich and M. Kirby (1987). "Low-dimensional procedure for the characterization of human faces". Journal of the Optical Society of America A 4: 519–524.
[5]. M.Turk and A. Pentland, "Eigenfaces for Recognition", Journal of Cognitive Neuroscience, March 1991.
[6]. Viola, P., & Jones, M. (2001). Rapid object detection using a boosted cascade of simple features. In Computer Vision and Pattern Recognition, 2001. CVPR 2001. Proceedings of the 2001 IEEE Computer Society Conference on (Vol. 1, pp. I-511).
[7]. C. Papageorgiou, M. Oren, and T. Poggio. A general framework for object detection. In International Conference on Computer Vision, 1998.
[8]. Automated attendance management system based on face recognition algorithms Computational Intelligence and Computing Research (ICCIC), 2013 IEEE International Conference.
[9]. Robust 3D Face Recognition. International Journal of Computer Sciences and Engineering (IJCSE), 2015 Volume 3, Issue-5 E-ISSN: 2347-2693

