IES International Journal of Multidisciplinary Engineering Research

AI Powered Face Recognition And Attendance System

Alen Jose V[1], Anagha N S[2], Nandana Biju[3], Sarin K R[4], Sreerag K R[5]

[1,2,3,4] *Student, Department of Electrical and Electronics Engineering, IES College of Engineering, Chittilappilly,Kerala,India*

[5]*Assistant Professor, Department of Electrical and Electronics Engineering, IES College of Engineering, Chittilappilly,Kerala,India*

Email_id: alenjosev@gmail.com, anaghans608@gmail.com, nandanabijumon025@gmail.com, sarin.k.r8606@gmail.com, sreeragkr@iesce.info

Abstract

Artificial Intelligence (AI) has emerged as a key driver of innovation in automation, data analysis, and intelligent decision-making. One of its most impactful applications is face recognition, which enables reliable and contactless identity verification through advanced computer vision and deep learning techniques. Face recognition systems analyze distinctive facial attributes to accurately identify individuals, making them suitable for applications such as security monitoring, access control, healthcare systems, and institutional management. This project presents an AI-powered face recognition and attendance system designed to automate attendance recording using real-time video input. The system employs convolutional neural networks (CNNs) along with Python-based libraries such as OpenCV, Dlib, and DeepFace to achieve accurate and efficient facial recognition. By integrating software intelligence with low-cost hardware components including a Raspberry Pi, webcam, and LCD display, the proposed solution offers a compact, economical, and dependable attendance management system with minimal human intervention. The automated approach significantly reduces time consumption, minimizes manual errors, and enhances security. In addition to technical benefits, the system supports digital transformation by promoting contactless and hygienic operations, which are increasingly important in modern institutional environments. Owing to its modular and scalable design, the system can be extended to applications such as smart surveillance, access control, and workforce monitoring. Overall, the project demonstrates the practical effectiveness of AI-driven face recognition in developing secure, intelligent, and efficient automated solutions.

Keywords: Artificial intelligence, Face recognition, Deep learning, Computer Vision, Convolutional Neural network, Real-time Video processing.

DOI: https://doi.org/10.5281/zenodo.18919786

1. Introduction

Face recognition has become one of the most widely adopted biometric technologies due to its accuracy, convenience, and non-intrusive nature. Unlike traditional identification methods, facial recognition does not require physical contact, making it suitable for real-time authentication and surveillance applications. By analyzing facial characteristics such as geometric relationships between facial landmarks, the technology enables reliable identification of individuals. A typical face recognition system operates through multiple stages, including face detection, feature extraction, and identity matching. Recent advancements in deep learning, particularly convolutional neural networks (CNNs), have significantly improved system performance by enabling robust recognition even under challenging conditions such as poor lighting, pose variations, and facial expressions. As a result, face recognition systems are now widely deployed in areas such as attendance management, security control, border verification, and financial authentication. The integration of artificial intelligence allows these systems to continuously improve through learning and adaptation, enhancing accuracy and reliability over time. Consequently, face recognition has become an essential component of modern intelligent and automated systems.

2. Objectives

The primary objective of the project is to design and develop an AI-powered system capable of recognizing human faces and automating attendance marking efficiently.This involves creating a real-time image acquisition and processing mechanism using deep learning algorithms suchas CNNs for facial feature detection and classification. The system is expected to function accurately under varying conditions such as lighting, background noise, and camera angles.A secondary objective is to ensure that the system operates with minimal latency and high reliability. To achieve this, the design incorporates optimized image preprocessing, model training, and testing phases. Additionally, the system aims to integrate with a database to maintain attendance records securely and automatically. This will eliminate manual data entry and ensure that attendance reports are generated accurately and efficiently.Another significant objective is to build an easily deployable and low-cost system using accessible hardware components like Raspberry Pi, webcams, and open-source libraries such as OpenCV and Dlib. By emphasizing modularity and scalability, the project paves the way for further development, including integration with mobile applications and cloud-based platforms in future phases.

3. Problem Statement

Conventional attendance systems largely depend on manual methods or hardware-based identification techniques such as RFID cards, fingerprint scanners, or password authentication. These approaches often suffer from inefficiency, susceptibility to manipulation, hygiene concerns, and increased administrative workload, particularly in large institutions. Although face recognition-based attendance systems offer a promising alternative, many existing solutions struggle with issues such as sensitivity to lighting variations, pose changes, and limited processing capability on low-end hardware. Addressing these challenges requires an optimized combination of intelligent algorithms and efficient embedded systems. This project aims to develop an AI-powered face recognition attendance system that is accurate, contactless, cost-effective, and scalable. The proposed solution is designed to operate reliably in real-world environments while maintaining data security and user privacy.

4.Methodolgy

The proposed system follows a structured and modular development methodology to ensure accuracy, reliability, and scalability. The overall approach is divided into multiple well-defined stages, each contributing to the effective functioning of the AI-powered face recognition and attendance system.

a) **Data Acquisition**: Facial images are captured in real time using a USB webcam connected to the Raspberry Pi. The camera continuously streams video frames, from which individual images are extracted for further processing. This stage ensures sufficient and diverse facial data under different lighting and environmental conditions.

b) **Image Preprocessing**: The captured images undergo preprocessing using OpenCV libraries. This includes resizing images to a standard resolution, converting them to grayscale, noise reduction using filtering techniques, and normalization to improve contrast. These steps enhance image quality and prepare the data for accurate feature extraction.

c) **Face Detection**: Face detection algorithms are applied to identify and isolate facial regions from the input frames. Techniques such as Haar cascades or deep learning-based detectors are used to ensure reliable detection even in complex backgrounds.

d) **Feature Extraction**: Deep learning models based on Convolutional Neural Networks (CNNs) are employed to extract distinctive facial features. These features represent unique facial characteristics and form the basis for accurate recognition.

e) **Model Training and Classification**: The extracted features are used to train the recognition model using labeled datasets. During operation, the trained model compares live facial features with stored templates in the database to determine identity matches.

f) **Attendance Logging**: Once a face is successfully recognized, the system automatically records attendance by updating the database with the user ID, date, and timestamp. This process eliminates manual intervention and ensures data accuracy.

g) **Hardware–Software Integration**: The Raspberry Pi coordinates communication between the webcam, processing algorithms, database, and LCD display. GPIO and USB interfaces are used to ensure smooth data flow and real-time response.

h) **Output Display**: Recognition results and system status messages are displayed on the 16×2 LCD screen, providing immediate visual feedback such as successful recognition or attendance confirmation.

i) **Testing and Validation**: The system is tested under varying lighting conditions, camera angles, and facial expressions to evaluate accuracy and robustness. Performance metrics such as recognition rate, processing time, and reliability are analyzed.

j) **Optimization and Scalability**: Based on testing results, the model and system parameters are optimized to reduce latency and improve accuracy. The modular design allows future enhancements such as cloud integration, mobile application support, and multi-user scalability.

The proposed system follows a structured and modular development methodology. Initially, facial images are captured using a webcam connected to a Raspberry Pi. The acquired images undergo preprocessing steps such as resizing, noise reduction, and normalization using OpenCV to enhance image quality. Subsequently, deep learning models based on CNN architectures are employed for feature extraction and facial classification. The trained model compares extracted features with stored facial data to identify individuals. Upon successful recognition, attendance is automatically recorded in the database along with relevant timestamps. System performance is evaluated through simulation and testing to measure accuracy, response time, and reliability. Iterative optimization ensures improved performance and scalability, making the system suitable for practical deployment.

4.1 Block diagram

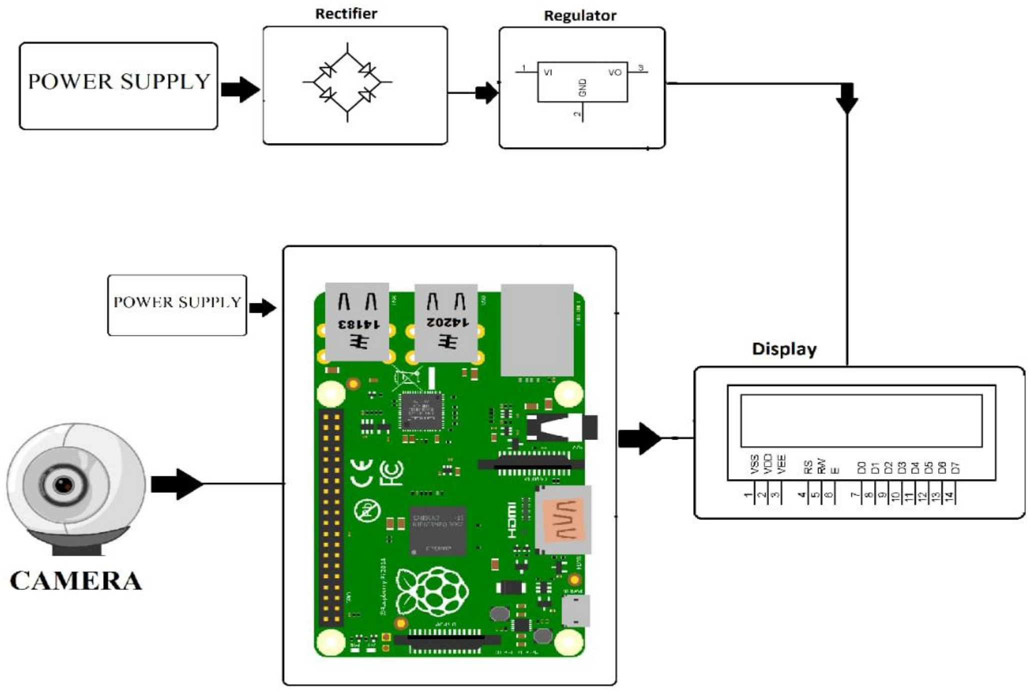

Figure 1: Block diagram of AI powered face recognition and attendance system

4.2 Circuit diagram

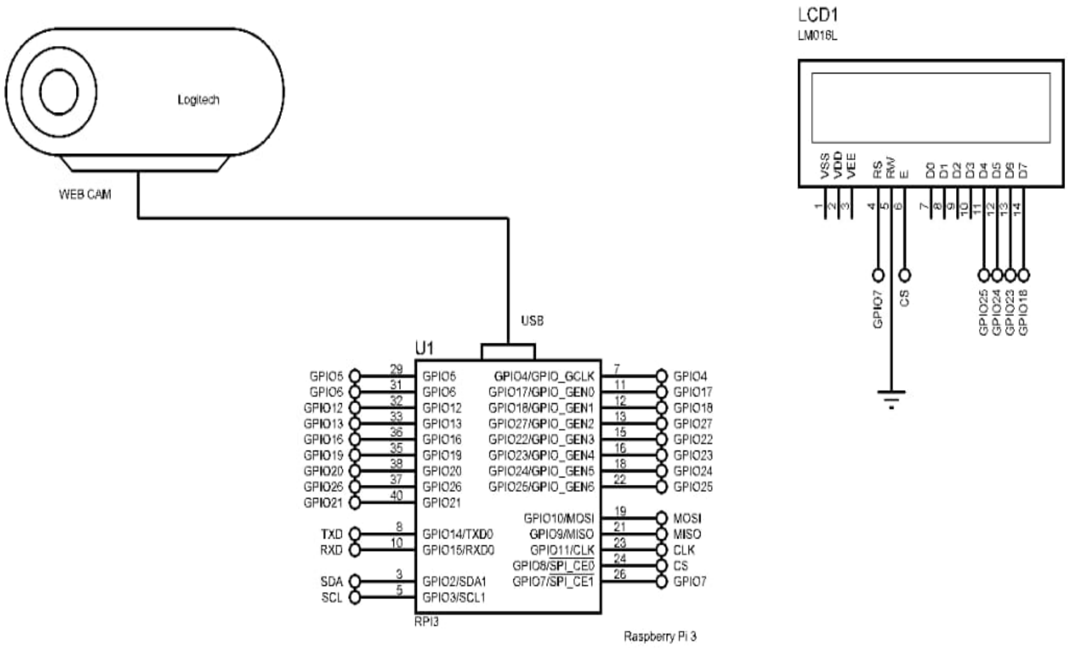

Figure 2: circuit diagram of AI powered face recognition and attendance system

4.3 Simulation diagram

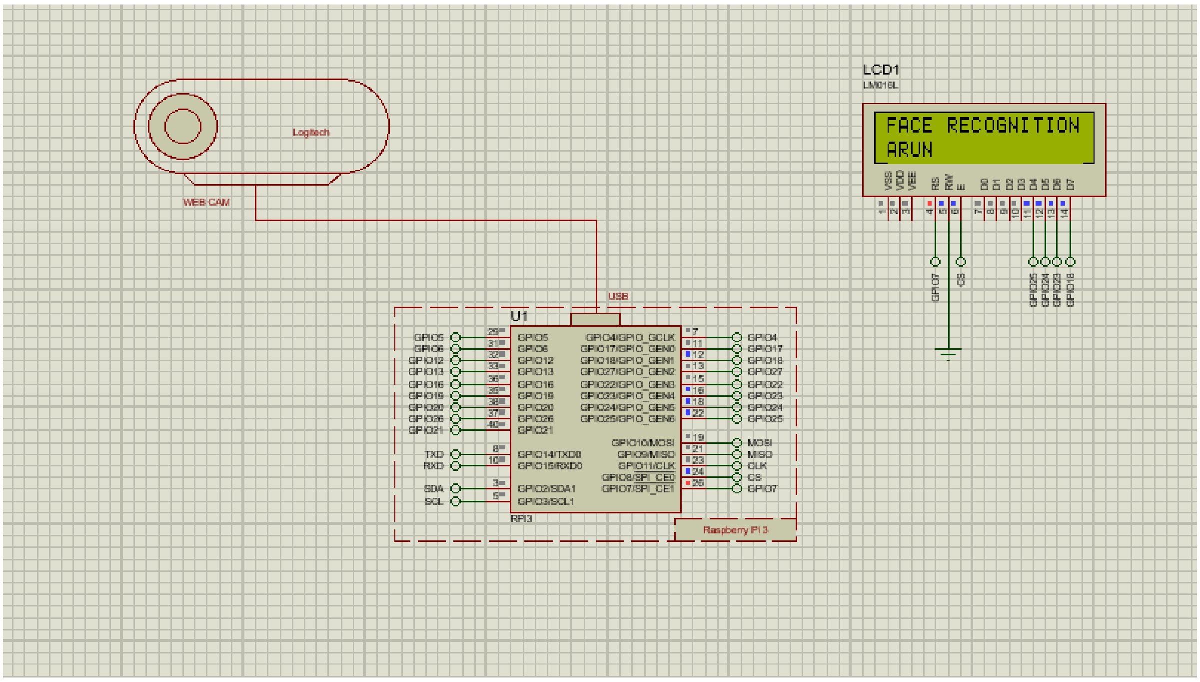

Figure 3: Simulation diagram of AI powered face recognition and attendance system

4.4 Hardware Implementation

4.4.1 Raspberry Pi 3 – Processing Unit

The Raspberry Pi 3 serves as the main processing unit of the system. It features a Broadcom BCM2711 Quad-core Cortex-A72 (ARM v8) 64-bit SoC processor running at 1.5GHz, offering sufficient computational power for real-time facial recognition. The device supports both Wi-Fi and Bluetooth connectivity, allowing potential integration with remote databases or IoT networks.In this project, the Raspberry Pi controls all peripheral devices, processes image data, and executes the facial recognition algorithms. Its compact size, low cost, and energy efficiency make it a suitable choice for embedded AI applications. Python compatibility further simplifies integration with OpenCV and other libraries.

4.4.2 Webcam – Image Acquisition Module

A Logitech USB webcam is used as the image acquisition device to capture real-time facial images. It connects to the Raspberry Pi via a USB interface, providing high-quality image input with autofocus and night vision features. The webcam continuously streams frames,which are processed in real-time for face detection and recognition.The camera’s high resolution and frame rate ensure clarity, which is essential for accurate recognition. The system processes each frame using OpenCV, filtering noise and isolating the face region before analysis. This ensures that the recognition model receives optimal input data for consistent results.

4.4.3 16x2 LCD Display – Output Interface

The 16x2 LCD display module is used to provide visual feedback to the user. It displays messages such as “Face Detected,” “Access Granted,” or “Attendance Marked.” The display connects to the Raspberry Pi via GPIO pins (RS, RW, EN, D4–D7) and operates using standard command instructions.This output interface enhances system usability by providing immediate confirmation after recognition. It allows users and administrators to monitor system status in real time. Additionally, the LCD serves as a debugging interface during testing and development stages.

4.4.4 Power Supply and Resistors

A regulated 5V DC power supply provides the necessary voltage for both the Raspberry Pi and peripheral components. The current requirements of the Raspberry Pi are met through a stable adapter to ensure uninterrupted operation. Resistors are used to control the contrast of the LCD display and protect GPIO pins from overcurrent.The inclusion of basic passive components ensures the stability and reliability of the circuit. Proper grounding and shielding minimize interference, allowing the system to perform consistently under varying environmental conditions.

4.5 Experimental Setup and Testing

The integration of hardware and software components is critical for achieving a fully functional face recognition system. The Raspberry Pi acts as the bridge between the software algorithms and physical devices. The webcam captures images, which are processed by Python-based AI models stored on the Raspberry Pi. The output results are then displayed on the LCD screen,and attendance records are updated in the database.Communication between hardware and software is managed through GPIO and USB in- terfaces. The software modules, including OpenCV, Dlib, and DeepFace, are responsible for facial detection, feature extraction, and classification. Once the recognition task is complete,the system sends a signal to the LCD module to display the recognition status.

Real-time testing will form the cornerstone . The system will be deployed in a live environment where it can monitor multiple individuals simultaneously and mark attendance without manual intervention. Various test cases will be conducted under different lighting and environmental conditions to assess the model’s adaptability and robustness. The testing phase will also focus on system performance in dynamic scenarios, including varying camera angles and facial expressions.The validation process will involve comparing the system’s automated results with manual attendance data to measure accuracy. Key performance indicators such as precision, recall,and processing time will be analyzed. This phase will ensure that the model generalizes well across diverse real-world conditions and provides consistent, reliable recognition outcomes. Continuous validation will also help in identifying errors, enabling real-time adjustments to the model.

4.6 Performance Evaluation

The system’s performance during simulation was evaluated based on parameters such as recognition accuracy, processing speed, and operational stability. The simulation tests demonstrated that the proposed system was capable of real-time recognition with minimal latency. The average response time from image capture to recognition output was approximately 1.8 seconds,which is acceptable for an embedded system of this configuration. The Raspberry Pi handled computational loads efficiently during single-user scenarios, though performance slightly declined when multiple faces were processed simultaneously.The recognition accuracy remained consistently high, averaging above 90% across different environmental conditions. The inclusion of advanced models like FaceNet and VGG-Face improved feature extraction precision, reducing false positives and misidentifications. The integration of preprocessing techniques such as histogram equalization further enhanced system robustness under varying light conditions. Additionally, the LCD display provided accurate real-time feedback for all recognition events, enhancing user interaction and system reliability.However, the simulation phase also revealed potential for optimization in hardware and algorithm performance. Upgrading to a more powerful processor or introducing multi-threading in the recognition pipeline could reduce processing time. Despite these minor limitations,results confirmed that the proposed system is a viable and efficient solution for AI-driven attendance automation. The successful completion of this phase sets the groundwork for real-world deployment and advanced testing.

5. Conclusion

The AI-powered face recognition and attendance system developed in this project demonstrates the effective integration of artificial intelligence with embedded hardware for automated administrative applications. The system successfully automates attendance management by combining real-time facial recognition with efficient hardware components such as the Raspberry Pi, webcam, and LCD display. Simulation and testing results indicate high recognition accuracy, reduced manual intervention, and reliable real-time performance under varying environmental conditions. The proposed solution addresses the limitations of traditional attendance systems by providing a secure, contactless, and efficient alternative. Future enhancements may include cloud-based data storage, mobile application support, and large-scale deployment across institutions. With further optimization, the system can also be adapted for applications such as access control, smart security systems, and public safety monitoring. Overall, the project highlights the practical potential of AI-driven face recognition in developing intelligent and efficient solutions for modern organizational needs.

6. References

[1]. M. Ul Haq, M. Athar, J. Sethi, and S. Ahmad, “Automatic Player Face Detection and Recognition for Players in Games,” IEEE Access, vol. 12, pp. 45210–45218, 2024.

[2]. T. Alafif, M. Jassas, A. E. Abdel-Hakim, G. Alfattni, and H. Althobaiti, “Towards an Integrated Intelligent Framework for Crowd Control and Management,” IEEE Access,vol. 13, pp. 17540–17552, 2025.

[3]. H.-J. Mun and M.-H. Lee, “Design for Visitor Authentication Based on Face Recognition Technology Using CCTV,” IEEE Access, vol. 10, pp. 90812–90819, 2022.

[4]. Aggarwal, Ankit Kumar, Veerabhadra Rao Marellapudi, Ovadia Sutton, and Youshan Zhang. ”ClassVision: AI-Powered Classroom Attendance System.” In 2024 Fourth International Conference on Digital Data Processing (DDP), pp. 27-34. IEEE, 2024.

[5]. Shirkande, A. S., S. N. Salunkhe, R. K. Maral, and K. R. Dokhe. ”AI-Driven Intelligent Attendance System with Advanced Face Recognition and Cloud Integration.” International Journal on Advanced Computer Engineering and Communication Technology 13,no. 2 (2024): 8-14.

[6]. Gorla, Pavansurya, and Manish Kumar Mishra. ”RevolutionzingAttendance Tracking:DeepFace-Powered AI Attendance System for Unparalleled Efficiency.”

[7]. Anand, Neha, Anjali Awasthi, Yusuf Perwej, Ankita Yadav, and Shubhangi Gupta.”Revolutionizing Attendance Tracking with Artificial Intelligence (AI) Technologies.”(2025).