A survey on Intelligent attendance tracking system using convolution neural networks and face recognition

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Abstract

The proposed Intelligent Tracking System combines the advances of face recognition and the power of Convolution Neural Networks (CNNs) to simply the task of making attendance to education in any setting. Roll-call, biometric systems, and RFID-based attendance and check-in systems have always been a slow, tedious event which always had some level of inaccuracy and was subject of proxy attendance (In terms of the integrity/honesty) of their kids in school. The power of deep learning (especially CNNs) provides a way to eliminate problems through a highly accurate, precise and efficient means of marking attendance which is performed automatically, reduces chances of human error and proxy attendance and can work in a wide variety of conditions. The Intelligent Tracking System is designed to accept secured storage of data with easy access for Teachers to manage documentation while also providing analytics to monitor trends and generate reports. The Intelligent Tracking system is a smart, scalable solution for the modern education environment it supports a clear process of attendance and ultimately accountability of each student.

Keywords

Facial Recognition, Convolutional Neural Networks (CNNs), Deep Learning, Image Classification, Real-Time Processing, Automatic Attendance, Machine Learning, Data Analytics, Neural Networks, Feature Extraction, Computer Vision, Smart Campus, Real-Time Data Logger, Attendance Verification.

Introduction

Traditional attendance methods, especially manual roll call and biometric systems, are two examples of outdated and traditional attendance methods that are inefficient. The Intelligent Attendance Tracking system utilizes facial recognition technology, powered by Convolutional Neural Networks (CNNs), as a contactless, automated attendance solution. By discerning which students are present in real-time, students are identifiable, to ensure security, accuracy, and efficiency in attendance tracking. The benefits of this artificial intelligence-oriented system are laid out in the paper. It reduces the workload of administration, creates operational efficiencies, and provides educational institutions insights into data analytics. This system also provides an actionable level of scalability and convenience catering especially well to modern educational environments in addition to helping

politely update traditional attendance methods. The intelligent system is capable of adapting and executing effectively differently in both large lecture halls and classrooms with a handful of students.

Existing System

Facial Recognition for Automated Attendance Management: a solution Adapted to Senegalese Educational Apartheid system, research, provides a solution with automatic attendance taken through facial recognition for the Senegalese educational system. Traditional attendance taking in schools with overcrowded classrooms is often ineffective, as all educators will attest to. Our system of attendance management incorporates artificial intelligence, that includes all of its functionalities, and an advantages of OpenCV, DNN module, which strikes a balance between accuracy and the amount of available resources. The described architecture is an integrated attendance management system. The integrated attendance management system has a user-friendly interface, capable of processing live video, and automated reports. It entirely relies on a Flask server and a MySQL database. The attendance system includes local adaptions while considering local diversity as well as existing surveillance systems found in most of the schools in Senegal. Testing demonstrated highly accurate facial detection capabilities while also protecting from performing unethical research, as well as complying with Senegalese laws on protection of personal data for expediting the education system.[1]

Revolutionizing Attendance Tracking: A Holistic Automated Facial Recognition System aims to overcome the limitations of current systems, especially in large courses where proxy attendance is common, by developing an automated facial recognition system to monitor student attendance in classrooms. The system attempts to provide a modern, effective, and scalable method of tracking attendance. Key features of this system are interaction with security cameras that reduces proxy attendance; continuous observation which enhances accuracy; and facial recognition provides accurate tracking. Automated attendance tracking demonstrates efficiency, reliability compared to the manual approach, and less human effort. It also uses a holistic approach to include many activities such as taking photographs using a camera, recognizing people, as well as matching and recognizing them.[2]

The Internet has advanced rapidly, face recognition technology is used in abundance, with issues of face database security in general. A multi-face image compression encryption (MFICE) process is proposed, which utilizes the electromagnetic radiation Ktz neuron (ERKN) for the protection of recognized (or recognized) faces. The MFICE process includes first extracting only the faces. Then the resulting face images are compressed upon the semi-tensor product compressed sensing (STP-CS) algorithm and compressed images are combined in to one single large cube; here a 3D cube. Following this the interface confusion algorithm, the 3D shuffling algorithm, and 3D diffusion algorithm are subsequently performed employing the chaotic sequences generated from the ERKN iteration, and finally the ciphertext image cube image is obtained. The proposed scheme is analyzed and evaluated for results that show satisfactory feasibility and security properties.[3]

Managing attendance in an educational context is clearly important, however tracking attendance manually can involve significant problems, including being time consuming and having an opportunity for proxy attendance. The solution we devised is a new face recognition system. Our face recognition system is in a different technological platform than the previous face recognition and other biometric methods (such as iris recognition). We will use a Haar Cascade Classifier to identify where the face is in the image, then use K-Nearest Neighbors

(KNN) to identify the face. The face recognition system is able to maintain a dynamic database to keep up with changes in the student roster. This allows the classes to involve new students or drop old students. After the face is recognized, the attendance of the student is then recorded digitally, usually in a spreadsheet, thus eliminating handwriting attendance and making classroom management more efficient. This automated attendance recognition and record keeping saves instructional time and reduces the likelihood of attendance errors and discrepancies. This face recognition attendance system is a most valuable tool for educational entities.[4]

A cloud-based electronic attendance management system utilizing a distinctive facial recognition algorithm was developed to increase effectiveness and accuracy in an educational setting. A cloud-based electronic attendance management system was also developed using the CASIA WebFace dataset and a collection of different images of facial images to apply deep learning methods to locate facial features and identify people. The process began by capturing images, then performing preprocessing that removes noise content using the webcam or mobile device, followed by classifying the image with facial detection using Haar Cascades, a fast approach to finding faces when someone is facing the camera in real-time), extracting facial features with Convolutional Neural Networks (CNN) learning and classifying facial behaviour in convoluted data, reviewing extracted facial features and comparing them to individuals in the database, and then attendance can be updated in real-time. The cloud-based structure was able to process large data with speed and accuracy in real-time attendance records. The architecture allows for scale to support a variety of classroom environments and class sizes. The outcomes underscore significant improvements in accuracy and in speed to monitor attendance, affirming the unique opportunity for automated facial recognition / address attendance in current educational environments. This research fills a void for a new and ongoing evolution on intelligent solutions to attendance, to implement an automatic attendance management solutions.[5]

The primary objective is to communicate an upgrade to attendance management process mean line through a technically enhanced smart attendance mechanism with face recognition technology. This article proposes the creation and implementation of a face detection and recognition mechanism to automatically detect, identify, and keep a record of students through facial recognition purpose on attendance in their recorded classroom attendance. The previous format of recordings was based on time and attendance records, while the previous system had issues of accuracy and efficiency. We have developed an attendance system with the use of the LBPH algorithm, which is an upgrade to the one that previously existed for use. The attendance system will allow for face recognition, as we will create a face to face database for each student, the face will be compared at attendance, and attendance will be maintained in an Excel format. Where face records tracked each day, we will send that data via email address through the college's faculty. An attendance management system that uses facial recognition technology combines the concepts of student identification based on facial biometrics and face recognition technology, with the latest technologies in monitoring and computing.[6]

Human resource management in an organization is a very important factor. The same is done by the management of Mbak Dwi's restaurant. However, until 2022, the management of employee attendance still uses a manual system. Manual attendance systems often cause attendance data to be at risk of being manipulated so that the data is invalid. The purpose of this study is to create a presence system with face detection using the HAAR Cascade Classifier method. The methods used in this study include the literature method, an observation method and a

prototyping method. This research produced a presence system using face detection. The test results show that the system was able to detect and identify faces well with the use of 5W (261 Lux) LED lights at a distance of 20 to 40 centimeters. It has a good accuracy value in dry face conditions, at 20 to 40cm. The recording of the employee's face was done at a distance of 20 to 40cm using a lighting of about 261 Lux under dry face condition. This is done so that the image of the face can be captured by the attendance system perfectly. There are several drawbacks of the HAAR Method which are position of the face, image shooting condition, direction of light source, and characteristics of the sensor and camera lens.[7]

Face recognition is becoming an increasingly popular area of computer vision and image processing. With multiple discipline areas of applications, it is mostly related to law enforcement, surveillance and biometric identification. The proposed system will create a suspect identification system using face recognition technology with OpenCV, Haar cascade classifier, LBPH and AdaBoost. The question this project is trying to answer is how to identify and track criminals, which falls on law enforcement agencies. We are suggesting a technology that might have the capability to achieve real time detection and identification of criminals using face detection and recognition methods using machine learning. We will be able to generate a collection of criminals as records and follow all future reports as a continual database to help identify criminals and track identified criminals based on both live footage from closed circuit TV or saved images from pictures we manually upload. The proposed system will be faster, more accurate, robust, reliable and easier to use than current systems. The positive impact of using machine learning based approaches to identify and/or recognize faces will result in a more efficient and accurate criminal identification system, which is more important than ever in today's world.[8]

Face recognition-based attendance systems with real-time capabilities that utilize deep learning methods aim to provide faultless and real-time attendance control for multiple institutions. The system proposed boasts that it has identified relevant objectives in relation to face detecting, model type, Real-time, gathering information, and bettering and maximizing the accuracy and reliability of face recognition using dlib, cvzone and YOLO algorithms for face detecting and blur detection. The authors of the study intend for this system to provide possible opportunities for increasing efficiency since it utilizes known parameters to improve as well as contribute to real-time systems in attendance. The proposed system provides a commitment to very high accuracy and real-time processing with some value to attendance control in situations where reliability is a difficult task, which will pave the way for future opportunities to develop new methodologies for leveraging the proposed and improved techniques in parallel, clearly combining the strengths of high accuracy and efficiency. [9]

Leveraging existing CCTV infrastructure, their project offers a cost-effective and technologically advanced attendance monitoring system. The core involves integrating deep learning algorithms, employing ResNet for face detection and FaceNet for recognition. These models are chosen after rigorous comparisons with alternatives like VGGNet and Dlib. The study develops a highly accurate face recognition system using a curated dataset of over 3000 student images. Their system, detailed in architecture, seamlessly integrates ResNet and FaceNet into an efficient backend. The resulting application empowers educators to monitor and manage attendance, updating records in an Excel sheet for administrative convenience. Emphasizing successful student attendance by face recognition, their innovation aims to streamline tracking to reduce administrative workload. By optimizing classroom management, our system contributes to the ongoing evolution of modern educational practices.[10]

It becomes exceedingly difficult to keep an eye on every student's whereabouts in huge classes. Although biometric technologies, like fingerprint scanning, provide a means of managing attendance, they also present certain practical challenges. There are often long wait times for students as they wait their turn to undertake the process of scanning, thereby exacerbating inefficiencies. An inventive method that makes use of deep learning's capabilities-more especially, Convolutional Neural Networks (CNNs)-has been developed to overcome these innate difficulties. The procedure of identifying students in a classroom setting is made easier by this advanced technology. To further this technical progress, a Python programming framework-based Graphical User Interface (GUI) with a focus on user needs has been created. This tasteful fusion of cutting-edge technology with an approachable design philosophy aims to improve the effectiveness and efficiency of attendance tracking.[11]

Monitoring and updating attendance records of students is an integral part of activities in schools and colleges. To mitigate the laborious work of keeping attendance records, an automated method of attendance monitoring using face as a biometrics is proposed. In this paper, face detection and recognition for maintaining student attendance using deep learning methodology is presented. Face detection in low-resolution CCTV footage is achieved using the Haar Cascade algorithm with 88.59% detection accuracy. The detection is not limited to frontal face detection. It also has side face selection along with varied illumination situations. These detected faces are then used to create a student face database. The Convolutional Neural Network (CNN) is trained on this face database for student recognition to mark attendance. A total of 60 students' face data is used in this for recognition and updating attendance for 5 subjects. The proposed CNN provided 76% face recognition accuracy for the implemented network.[12]

Deep learning and transfer learning are extremely important in the internet sector and the health care industry. Face recognition technology is essential in practically every industry in our digital age. Several improvements have been made to automatic facial recognition (AFR) technology in an ever-changing world. Managing the daily student attendance system is made simple with Smart attendance with Real-Time Face Recognition. In the proposed method, Images of the students in class are used to construct a dataset. Both Face detection and recognition are performed using the Multitask Convolution Neural Network algorithm. The data will be uploaded after the face is recognition. The proposed method compared with Haar Cascade Convolution Neural Network Classification method and other few methods. The proposed method produced better result compared to other methods.[13]

The integration of advanced security technologies, particularly the widespread deployment of mobile cameras equipped with real-time face recognition capabilities, heralds a new era of surveillance capabilities. This paper presents a comprehensive overview of a cutting-edge surveillance system designed to enhance security measures in public and private spaces. Unlike traditional CCTV setups, this system leverages strategically positioned mobile cameras equipped with sophisticated face recognition algorithms such as YOLO, Haar feature based cascade classifiers, OpenCV, and LBPH (Local Binary Pattern Histograms).Upon detection of a person of interest, the system swiftly matches the face against a pre-existing database, providing instantaneous identification. Moreover, the system concurrently displays the associated location information in real-time, facilitating swift and targeted response measures.Key features of this system include its ability to send immediate notifications containing the individual's name and precise location details to specified recipients, typically via text messages to predetermined numbers. This functionality ensures that relevant authorities are promptly informed, enabling them to address potential concerns or threats efficiently.By amalgamating cutting-edge face recognition

technology with mobile surveillance cameras, this system not only strengthens security efforts but also streamlines response mechanisms.[14]

Facial recognition technology plays a crucial role in various applications, from enhancing security at banks and organizations to streamlining attendance tracking in public gatherings and educational institutions. Traditional methods of attendance marking, such as signatures, names, and biometrics, can be time-consuming and error-prone. To address these challenges, a smart attendance system is proposed, leveraging Deep Learning, Convolutional Neural Networks (CNN), and the OpenCV library in Python for efficient face detection and recognition. The system utilizes advanced algorithms, including Eigen faces and fisher faces, to recognize faces accurately. While deep learning models excel with large datasets, they may not perform optimally with few samples. By comparing input faces with images in the dataset, the system automatically updates recognized names and timestamps into a CSV file, which is then sent to the respective organization's head. Additionally, the system allows users to upload a single photo or a group photo, and it returns matched photos as output using a CNN. This feature enhances the system's flexibility and usability, providing users with a convenient way.[15]

Monitoring attendance is a crucial component in identifying a person's presence in a corporate or educational setting. The modern method of recording attendance without the possibility of proxies can be accomplished simply by recognizing a person's face. Hence, face recognition of an individual can make the laborious work of manually recording attendance easier. Convolutional neural network is a deep learning-based ok method, which is used to run the integrated attendance system. The real-time capture of the image allows for the recognition of a person's face. After the dataset has been collected, the features are retrieved as NumPy arrays. The model's primary goal is to identify various faces and log the desired attendance. A file with the extension of '*.txt' contains a record of every person's attendance. Since it makes it simpler to categorize the attendance daily, the file name is preserved as the date on which the attendance was recorded. At one moment, it is possible to recognize the faces of several people and store the names in a specific text file. In the work, authors discussed the above strategies to implement the model.[16]

The integrated automated smart attendance system utilizes RFID, Wi-Fi, and visual recognition technologies to elevate classroom security and ensure precise monitoring of attendance records. It consolidates cutting-edge components such as RFID tags, ESP8266 Wi-Fi modules, ESP-32 CAM modules, solenoid locks, servo motors, and PIR sensors to devise a strong remedy. RFID technology enables accurate attendance tracking by assigning tags to students and faculty members. The Wi-Fi and visual recognition components enhance the system's functionalities, facilitating wireless connectivity, instantaneous data transfer, and validation of identities. Solenoid locks and servo motors ensure controlled access, responding to validated attendance records. PIR sensors detect motion, contrasting between genuine presence and proximity. The paper's methodology delineates the necessary hardware and software requirements, procedures for system initialization, testing phases, establishment of server connectivity, implementation of access control mechanisms, and formulation of end-of-session protocols. It highlights the successful integration and validation of hardware components, backend connectivity, identity confirmation, attendance recording, data encryption, and session termination procedures. The research aims to modernize attendance tracking in educational settings, improving efficiency, accuracy, and

security while appreciating the need for further adaptation to suit diverse educational environments for broader adoption and sustained advancement.[17]

In recent years, technological advancements have brought about transformative changes in various educational domains, notably in attendance management. Conventional methods for tracking student attendance are often cumbersome and susceptible to proxy interventions. Face recognition technology has emerged as a promising solution to enhance this system within educational institutions. The investigational study presented in this paper aims at designing and implementing a face recognition-based system to automate the manual attendance taking process of educational institutions. This study is encompassed with two phases. The Phase I is for an analytical study to identify a best face recognition model. The Phase 2 is to design and implement an attendance tracking system incorporated with the best model identified in Phase I. A comparative study with five state-of-the-art face detection models, in the Phase I, revealed that the Caffe (Convolutional Architecture for Fast Feature Embedding) model as a best suited one for further experiments in this study. The Phase II proposes a system, named as AAIRAA (Amrita's AI-based Recognition and Analytical Application), integrating the Caffe model. The proposed AAIRA system is equipped with the features of facial recognition, emotion detection and fall detection. This study also incorporates user level testing of the AAIRA system, in an educational institution, which have proved its potential in streamlining the administrative tasks, diminishing the potential for fraudulent attendance and tracking of attendance.[18]

From the very beginning of the twenty-first century, every task has started to be digitalized and computerized. In this modern age, education, being the most powerful tool for transforming the world into a better place, has led to a high demand for smart classrooms. This paper introduces an automated system designed to transform traditional classrooms into intelligent learning environments. A smart switching system for regulating electrical load is proposed here. A gesture-based interface to ensure exact control over the sound system has been proposed, adding a layer of intuitive interaction. Additionally, this system simplifies attendance tracking by integrating real-time face recognition of students, facilitated by a camera positioned above the classroom. Promoting easy access and interaction, users can operate a variety of classroom electrical devices using natural language voice commands. The system has been tested under different environments, including variable lighting configurations, distance between person and camera, moving subjects, and a diversity of persons. The suggested system responds to electrical loads in 0.68 seconds after commanding. The automatic sound system has an accuracy of 94.12%. The facial recognition technology has a 98 % recognition accuracy. Experimental findings reveal the system's convenient operation, good safety, and strong practicability.[19]

In the COVID-19 epidemic, almost everyone wears a mask to limit the spread of the virus. This creates a problem for the traditional face recognition model that essentially fails in the scene of identity verification that relies on the face itself (e.g., security check, community visiting check-in, etc.). Therefore, improving the performance of recognition of masked faces is urgent. Most of the recent state-of-the-art methods of face recognition are based on deep learning, where large amounts of training data are needed.[20]

In educational institutions, monitoring student at- tendance is often considered cumbersome and time-consuming. While several systems have been proposed to tackle this issue, such as Radio Frequency Identification (RFID) and Near Field Communication (NFC) for hardware-based solutions, and algorithms like deep facial recognition, Haar Cascading, Local Binary Pattern Histogram (LBPH) Algorithm, and Convolution Neural Network (CNN) for facial recognition, but practical implementations are still limited. This paper presents a novel approach that combines facial recognition algorithms with IoT integration to provide a practical and real-time attendance monitoring solution. The hardware setup consists of a Raspberry Pi 3b paired with a Pi Camera sensor, providing a cost-effective and efficient solution for capturing facial images. On the software side, a web-based user interface hosted on a web server manages data storage on a dedicated database server. This interface provides administrators with real-time access to attendance data, allowing for efficient monitoring and analysis. Compared to existing solutions, our system offers several advantages, including improved accuracy, real-time monitoring capabilities, and seamless integration with existing infrastructure. The system's scalability and ease of use make it suitable for educational institutions of all sizes.[21]

Finally, the system includes a model updates and training phase, allowing for on-going relevance. New images of students can be added at various intervals, allowing the model to update it's recognition if students change their appearance (e.g. hair style, aging, glasses, etc). A retrained model ensures that the system will continue to work, as the student facial recognition will continue to improve as students face changes over time. This continual learning also helps with system robustness over time, ensuring it doesn't diminish in it's accuracy and effectiveness.[22]

Intelligent Monitoring System that combines Internet of Things (IoT) and Artificial Intelligence (AI) technology to automate the class attendance process in a way that is reliable and efficient. Traditional methods for taking attendance are labor intensive and very time-consuming with many being subject to error, or inconsistencies. The Intelligent Monitoring system, in contrast, brings together object detection & recognition AI models, wireless communication, and cloud monitoring to generate attendance data that can be taken as reliable, with the ability to track student-by-student attendance data, and overall attendance statistics. The system is made up of an ID reader with radio frequency tags, facial recognition system with a camera and AI algorithms, and a cloud monitoring system that tracks overall attendance statistics. The proposed system looks to address the burdens of traditional attendance and provide an answer to inaccurate, unreliable, and inefficient methods.[23]

The system represents a modern way of managing student attendance through the use of face recognition and innovative techniques using both Convolutional Neural Network (CNN) and Haar Cascade frontalface default algorithm. This system utilizes OpenCV and newly developed face recognition techniques to provide a resourceful and effective attendance solution for educational institutions. Some of the properties of the system include face detection and recognition in real time, support for multiple face recognition, and the ability to interact with current attendance management systems. The project uses deep-learning algorithms that provide confidence while recognising students' faces. As effectively demonstrated through implementation, the OpenCV and deep-learning processes can serve as an automated means of managing student attendance. Thus, this innovative face recognition solution can measure accuracy and efficiency, while enhancing operational efficiency in educational

contexts. Overall, the system provides a solution that aims to improve the attendance management processes in the 21st century. [24]

Face recognition is one of the most prevalent applications of image processing, playing a critical role in various industries, particularly in authentication tasks such as school attendance. The "face recognition" attendance system enables high-definition monitoring and advanced computer technologies to identify students based on their facial biostatistics. This system aims to digitize the traditional and labor-intensive method of recording attendance by calling names and maintaining paper records, which are prone to manipulation and proxies. Current biometric and conventional methods also suffer from similar vulnerabilities. This research work proposes a robust solution utilizing the Python OpenCV library to automate the attendance process. The system generates and saves attendance reports in Excel format post face recognition, and it has been tested in diverse conditions, including varying lighting, head movements, and changes in student-camera distance. The proposed approach demonstrates high accuracy and efficiency, significantly reducing manual effort and time commitment. Furthermore, the system is cost-effective and requires minimal installation effort, presenting a reliable and efficient tool for classroom attendance management.[25]

Conventional classroom attendance systems often demand considerable amounts of time, are historically error-prone and do not provide timely data. This study provides a framework for an Alternative Attendance System employing face recognition technology through the RetinaFace algorithm. The RetinaFace algorithm is deemed an excellent system for the task of taking attendance because its performance is quite good across the range of outdoor, indoor, and variable lighting. The system employs a camera to take photographs of people's faces, the RetinaFace algorithm to blue620 recognize and identify people, and a record keeping system to input their information into a computerized database. We explain the system architecture, how the system is deployed, and how we evaluated the system with an emphasis on how the system improved overall data insights, efficiency, and accuracy of attendance. The system was shown to perform well, and effectively on the forward-facing camera, with an identification rate of 91% from our experimental testing. The proposed Approach removes human error, and greatly reduces the total administrative tasking in relation to traditional methods of attendance taking. It provides a useful application which provides new capabilities for attendance management using advanced face recognition technology. The system provides tangible improvement in outcomes of accuracy, efficiency, and changes in data driven capabilities when compared to the current methods of taking attendance, while providing a more reliable method of attendance input..[26]

The distributed work model, which allows people to work from multiple physical places, has gained significant popularity in recent years, particularly since the outbreak of the COVID-19 epidemic. Despite the potential advantages of cost reductions associated with office space and flexible working environments, this model presents difficulties in effectively controlling and monitoring employee work activities. Applying advanced technologies in human resources can enable organizations to address these challenges effectively. However, SMEs face challenges in adopting advanced technologies such as AI and facial recognition due to financial constraints, lack of technical expertise, and concerns about cost-effectiveness. The paper focuses on developing a low-cost attendance monitoring mobile application that utilizes real-time facial recognition and location analysis for SMEs. We try to enhance the real-time registration and identification flow with the camera of employees' mobiles by handling large data streams and integrating the system with a cloud-based solution. First, the AI facial detection module uses the camera on mobile devices as input devices to ensure the flexibility of face recognition data input. The AI Engine layer is built by applying a deep learning-based facial recognition model that was

trained using a large dataset of collected employee faces. Employees' facial identities using the Resnet34 model integrated Additive Angular Margin Loss function to identify employees' facial identities. The facial recognition model is designed to operate in real-time, with the ability to detect and identify employees as they check in and out of the workplace. Finally, we demonstrate an experimental prototype on a mobile phone application using React Native, NodeJS, and Python. The mobile application is designed to operate on both iOS and Android platforms, ensuring widespread accessibility for SMEs. The experimental findings provide empirical evidence that our system exhibits accuracy and efficiency in the tasks of facial identification and personnel matching. This research will serve as a valuable reference for executing strategies that are appropriate for SMEs.[27]

The Facial Recognition research explores advancements in facial recognition technology for identity verification using CNNs, PCA, and sequential neural networks. Unlike identification, verification ensures an individual's claimed identity, which is crucial for security applications. The study enhances face verification across multiple imaging modalities—thermal, infrared, visible light, and combined visible-infrared—by leveraging the pre-trained VGG16 model for feature extraction and PCA for dimensionality reduction. Introducing the VGG16-PCA-NN method, validated on the Sejong Face Database with a 70% training, 15% testing, and 15% validation split, the approach achieves near-perfect accuracy across various visual modalities. While results demonstrate promise, comparisons with existing methods require careful interpretation due to dataset variations. This research significantly advances biometrics and security by improving reliability and performance, overcoming environmental challenges, and enabling robust multi-modal facial authentication.[28]

With the extraordinary growth in images and video data sets, there is a mind-boggling want for programmed understanding and evaluation of data with the assistance of smart frameworks, since physically it is a long way off. Individuals, unlike robots, have a limited capacity to distinguish unexpected expressions. As a result, the programmed face proximity frame- work is important in face identification, appearance recognition, head-present evaluation, human-PC cooperation, and other applications. Software that uses facial recognition for face detection and identification is regarded as biometric. This study converts the mathematical aspects of a person's face into a face print, which is then stored in a database to verify an individual's identification. A deep learning system compares a digital image or an image taken quickly to a previously stored image(which is saved in the database). The face has a significant function in interpersonal communication for identifying oneself. Face recognition technology determines the size and placement of a human face in a digital picture. Facial recognition software has a wide range of uses in the consumer market and in the security and surveillance sectors. The COVID pandemic has brought facial recognition into greater focus lately than ever before. Face detection and recognition play a vital part in security systems that people need to interact with without making physical contact. The pattern of online exam proctoring is employing face detection and recognition. Facial recognition is used in the airline sector to enable rapid, accurate identification and verification at every stage of the passenger trip. In this research, we focused on image quality because it is the major drawback in existing algorithms and used OPEN CV, Face Recognition, and designed algorithms using libraries in python. This study discusses a method for facial recognition along with its implementation and applications.[29]

The development of deep learning-based biometric models that can be deployed on devices with constrained memory and computational resources has proven to be a significant challenge. Previous approaches to this

problem have not prioritized the reduction of feature map redundancy, but the introduction of Ghost modules represents a major innovation in this area. Ghost modules use a series of inexpensive linear transformations to extract additional feature maps from a set of intrinsic features, allowing for a more comprehensive representation of the underlying information. GhostNetV1 and GhostNetV2, both of which are based on Ghost modules, serve as the foundation for a group of lightweight face recognition models called GhostFaceNets. GhostNetV2 expands upon the original GhostNetV1 by adding an attention mechanism to capture long-range dependencies. Evaluation of GhostFaceNets using various benchmarks reveals that these models offer superior performance while requiring a computational complexity of approximately 60–275 MFLOPs. This is significantly lower than that of State-Of-The-Art (SOTA) big convolutional neural network (CNN) models, which can require hundreds of millions of FLOPs. GhostFaceNets trained with the ArcFace loss on the refined MS-Celeb-1M dataset demonstrate SOTA performance on all benchmarks.[30]

Methodology

The Intelligent Attendance Tracking System's evolution is designed around a single methodical development workflow, which includes many phases and is built from data collection to model deployment.

The first stage begins with data collection, and in this instance, numerous different images will be collected for the facial recognition (FR) accumulator. Students will undergo a face enrolment stage at the start of the project. Students will need to present themselves many different photos of themselves in various conditions (e.g., different angles, shifts in lighting, different facial expressions, etc.), so there are many ways of accurately portraying themselves to use for modelling in subsequent stages. This is important so that the face recognition model needs to recognize students in multiple classroom settings and so it can provide the model with as many different images as possible. The students' faces will also be collected as live images through the camera in the classroom and processed in real time during the class in order to store data for attendance purposes. This is also important to ensure that the system has done this portion of fulfillment during all attendance events.

Next is face detection and pre-processing. Again, at the time of writing this class, the camera will be taking video frames, and we will use the OpenCV library to detect the student's face in real-time. There are numerous viable methods in OpenCV by which to detect faces, typically as part of the algorithm itself, Haar Cascades or Single Shot MultiBox Detector (SSD) with some reasonable accuracy, the results do vary, from when a face is detected the image will get cropped and re-sized back to the input of the model, typically 224x224 pixels. The image will then go through pre-processing and pixel values are normalized, the normalization is helpful for standardizing our data and for performance, not just for performance oh and for reliability and accuracy too.

Once an image has been preprocessed, the next stage of facial recognition is Convolutional Neural Networks (CNN). The reason CNN is good for facial recognition is that they learn hierarchical representations, which is useful for our recognition, as the lower levels will learn simple features like "edges," while the higher levels will learn more complex features like "eyes," "nose," and "mouth." For face identification, we can use pre-trained models, such as VGG-Face, FaceNet or even models made explicitly in CNN form, like a self-built CNN that will detect the distinctive features of each student's face and create a feature vector for the student's face. The image's feature vector is created, and then the feature vector is compared to all the relevant and unique feature vectors associated with individuals for recognition.

Once a student's identity is confirmed, the system is ready to begin logging attendance. Student attendance will be logged to an attendance log showing in real-time time of students entering the class. The attendance log is stored in a database and may be accessed by the teacher or administrator at any time usually via a web interface. The use of face recognition technology to automate attendance logging process means that the user does not have to take roll or tick-off students names on a sheet of paper since it is the fully automated process.

After taking and managing attendance, attendance data is recorded for every class, and automatically uploaded to a central location. This central location can be used by the user to display and manage that data, using a simple, easy to navigate web or mobile application. After logging the attendance, the system will notify the user if there was an issue, for example, there will be no face detected, or there was more than one face taken to represent that student. These elements of the system not only ensure the accuracy of the attendance manager, but also the validity of the overall attendance tracking.

Finally, the system includes a model updates and training phase, allowing for on-going relevance. New images of students can be added at various intervals, allowing the model to update it's recognition if students change their appearance (e.g. hair style, aging, glasses, etc). A retrained model ensures that the system will continue to work, as the student facial recognition will continue to improve as students face changes over time. This continual learning also helps with system robustness over time, ensuring it doesn't diminish in it's accuracy and effectiveness.

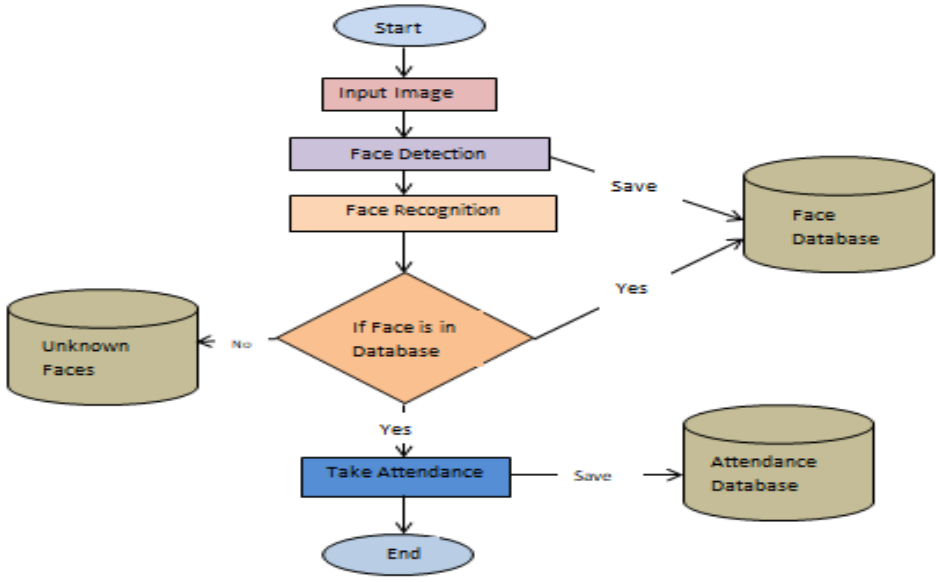


Fig1.1 : The flow chart helps us to understand the steps involved in Tracking the Student's Attendance using Face Detection and Face Recognition Algorithms.

Analysis

MODELS	ACCURACY
MTCNN	99.0%
CNN	90.0%
ResNet-50	93.0%
FaceNet	96.5%
VGG16	91.5%
InceptionV3	94.5%
MobileNetV2	90.0%

TABLE1: Comparison of Existing Models [5]

The table1 conveys MTCNN achieved the highest accuracy, followed by FaceNet, which also performed very well. InceptionV3 demonstrated strong performance, slightly ahead of ResNet-50. VGG16 showed moderate accuracy, while both CNN and MobileNetV2 delivered similar but comparatively lower results.

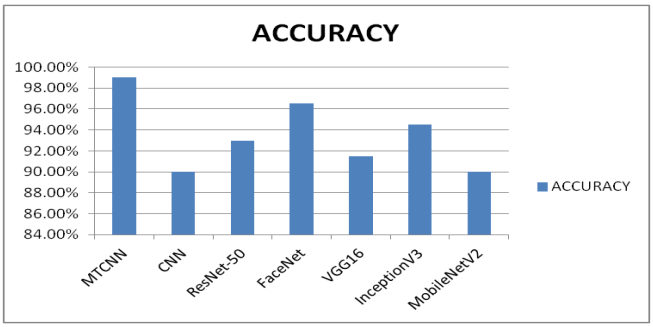


Fig2: Graphical Representation of accuracy of different algorithms

Approach	Dataset	Highlights
DeepFace (3D modeling + deep learning)	LFW	Achieved 97.35% accuracy
Center loss function	LFW	Precision of 99.28%
CNNs with VGG Face dataset	VGG Face	Achieved 98.95% accuracy
Angular Softmax loss	CASIA-WebFace	99.42% accuracy
DOG, PLS, and HOG for thermal-visible FR	WSRI, UND-X1, NVESD	Used DOG filtering and contrast enhancement
Subspace learning (CCA, PLS)	PCSO, CARL	75.61% Rank-1 accuracy
Deep perceptual mapping	UND-X1	83.73% accuracy with full gallery
Deep autoencoder	CARL, UND-X1, EUROCOM	85% Rank-1 on CARL (full gallery)
Cross-domain ID for thermal-visible	SCFace	Accuracy up to 96%
GAN-based (Pix2Pix, GANVFS, SAGAN, Raw)	Custom Dataset	Up to 96% with Fondje's method
Triple triplet CNN approach	Not specified	90.61% recognition accuracy

TABLE2: Highlights from Approach and Datasets[28]

Conclusion

The Intelligent Attendance Tracking System represents a significant advancement in automating and enhancing the efficiency of attendance management in educational institutions. By leveraging the power of face recognition and deep learning through Convolutional Neural Networks (CNNs), the system offers a highly accurate, contactless, and secure method for recording student presence. This innovation addresses key challenges associated with traditional attendance methods, such as time consumption, human error, and the risk of proxy attendance.

The system's ability to operate in real time, adapt to changing student appearances, and scale across different classroom sizes ensures its relevance and practicality in diverse educational settings. Moreover, its seamless integration with existing institutional infrastructures allows for easy implementation and accessibility through user-friendly web and mobile interfaces.

Overall, this intelligent solution not only streamlines administrative workflows but also aligns with modern educational goals of digitization and smart campus development. It provides a future-ready platform that improves data integrity, saves valuable instructional time, and enhances the overall learning environment.

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Conflict of Interest Statement

The authors have no conflict of interest to disclose.

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