1. M.A.P.Manimekalai[1], 2. Esther Daniel[1], 3.T.Mary Neebha[1],4. K.Muthulakshmi[2] ,5. Ryan Paul Jess.C[1], 6.Raguram.S[1]

Karunya Institute of Technology and Sciences (1), Sri Krishna College of Technology (2)
ORCID: 1.0000-0001-8854-4579; 2.0000-0003-1997-094X; 3.0000-0002-0981-3089

doi:10.15199/48.2024.05.46

Face Recognition Smart Attendance System using Convolutional Neural Networks

Abstract*. An automated face attendance system using Convolutional Neural Networks (CNN) is a promising technology for improving attendance management in educational institutions, workplaces, and other organizations. This system uses a deep learning model based on CNN to detect and recognize faces from images captured by a camera. The captured image is pre-processed by applying various techniques such as face detection, extraction, and normalization to extract facial features. The extracted features are then stored in a real-time database and used to train the CNN model to recognize the faces of individuals accurately. The system can efficiently handle various lighting conditions and pose variations to recognize individuals. The proposed method provides a fast and accurate approach to attendance management that can significantly reduce manual efforts and errors.*

Streszczenie. *Zautomatyzowany system obecności na zajęciach wykorzystujący konwolucyjne sieci neuronowe (CNN) to obiecująca technologia usprawniająca zarządzanie frekwencją w instytucjach edukacyjnych, miejscach pracy i innych organizacjach. System ten wykorzystuje model głębokiego uczenia się oparty na CNN do wykrywania i rozpoznawania twarzy na obrazach zarejestrowanych przez kamerę. Przechwycony obraz jest wstępnie przetwarzany przy użyciu różnych technik, takich jak wykrywanie twarzy, ekstrakcja i normalizacja w celu wyodrębnienia rysów twarzy. Wyodrębnione cechy są następnie przechowywane w bazie danych działającej w czasie rzeczywistym i wykorzystywane do uczenia modelu CNN w zakresie dokładnego rozpoznawania twarzy poszczególnych osób. System może skutecznie obsługiwać różne warunki oświetleniowe i stawiać różne pozycje w celu rozpoznawania osób. Proponowana metoda zapewnia szybkie i dokładne podejście do zarządzania frekwencją, które może znacznie zmniejszyć wysiłek i błędy wykonywane ręcznie.* (***Inteligentny system rozpoznawania twarzy wykorzystujący konwolucyjne sieci neuronowe***)
i dokładne podejście do zarządzania frekwencją, które może znacznie zmniejszyć wysiłek i błędy wykonywane ręcznie.

Keywords: Attendance, CNN (Convolutional Neural Networks), face images, extraction, IoT (Internet of Things).
Słowa kluczowe: frekwencja, CNN (konwolucyjne sieci neuronowe), obrazy twarzy, ekstrakcja, IoT (Internet rzeczy).

Introduction

The traditional attendance management methods involve manual processes that can be time-consuming and error-prone. With the advancement in computer vision and deep learning techniques, an automated face attendance system using Convolutional Neural Networks (CNN) has been developed, which has the potential to revolutionize attendance management in various organizations. This work captures images and uses a CNN-based deep learning model to recognize their faces. Moreover, the attendance data is stored in a real-time database, which can be accessed and managed remotely. We will also propose an additional method where the organizer can view the status of the presenters. The proposed work is fast, reliable, and cost-effective and can significantly reduce the workload of attendance management. This paper discusses implementing an automated face attendance system using CNN with a real-time database and highlights its advantages over traditional attendance management methods. The main purpose of this work is to produce an automated system where the users can able to provide attendance without any manpower with ease in real-time.

Literature Review

The implementation of Automatic attendance can be achieved by storing a person's ID and name and using a camera to take 60 images of their face[1]. A deep learning-based attendance system [2] that generates the list of students present using a group photo of a class was developed. The system employs a one-shot learning method for face recognition, ensuring robust and efficiency, even when dealing with new users with only a single image provided. An enhanced attendance system that uses Python and OpenCV to capture and detect the faces of students[3] was developed. The facial recognition algorithm extracts features like the forehead, mouth, eyes, nose, chin, and jaws to generate a facial signature. This [4] study proposes using a QR code reader system to automatically record users' faces. It can be modified to include a database to store and retrieve information from the QR code image. The proposed end-to-end face identification and attendance system that utilizes Convolutional Neural Networks (CNN)[5] operates on the CCTV footage or video of the class to mark attendance in a single shot. The proposed system is robust against challenges like occlusion, orientation, alignment, and luminescence of the classroom, and achieved a real-time accuracy of 96.02%, outperforming existing systems. A system uses a camera installed inside the classroom to capture photos, detect faces, and compare them with a database for attendance marking [6] is essential. Face detection and recognition are carried out using dlib[7], and the system compares the detected faces with a database of students' faces. This is an effective technique for managing attendance in the classroom. The system[8] uses algorithms to detect faces and recognizes registered students. It saves time and allows students to monitor their attendance status. To replace manual attendance with four steps such as database creation, face detection, recognition, and attendance updates [9] was developed to ease the burden of attendance marking by individual staff. Results are sent to faculty via email. The authors [10] stated this system ensures that people can only mark their attendance if they wear a mask, and an alert is given if they do not so the attendance can be monitored along with the check for mandatory rules imposed. However, a system that provides correct attendance without manpower, swiftly and with ease is crucial.

Proposed Smart Attendance Architecture

1. Architecture

This proposed architecture consists of a smartphone with a working selfie camera and a server-side database for storing the images and manipulating the data that is fetched from the user. Fig.1 shows the system architecture which uses the FaceNet CNN model to extract faces from the images and convert them to vector embeddings to differentiate images.

2. FaceNet CNN

FaceNet CNN is a specific type of Convolutional Neural Network (CNN) that is designed for face recognition tasks. Developed by Google, FaceNet CNN [11]-[13] is capable of automatically encoding facial features into numerical vectors, or embeddings, which can be used for face recognition and verification. Unlike traditional face recognition methods that rely on handcrafted features, FaceNet CNN uses deep learning to learn and extract facial features from raw images automatically. It employs a neural network architecture with multiple convolutional layers, pooling layers, and fully connected layers to learn and represent facial features hierarchically. One of the key innovations of FaceNet CNN is the use of a triplet loss function during training. This loss function ensures that the embeddings of the same person's face are closer in the embedding space compared to those of different people's faces. This helps in creating a compact and discriminative feature representation for each individual's face, making it easier to compare and match faces for recognition tasks. FaceNet CNN has achieved state-of-the-art performance in face recognition, surpassing human-level accuracy in many benchmark datasets. It has been widely used in various applications, such as identity verification, surveillance systems, and access control.

3. Flutter

Flutter, an open-source UI toolkit developed by Google enables the development of natively compiled applications for mobile, web, and desktop platforms from a unified codebase. This framework enables developers to create visually captivating and high-performance applications with a fast and smooth user experience. Flutter[14] uses a programming language called Dart, which is compiled into native code for different platforms, including iOS, Android, and the web. This enables Flutter apps to have a native look and feel and perform optimally on each platform. One of the key features of Flutter is its hot reload capability, which allows developers to see changes in the app's UI in real time without restarting the application. Flutter is widely adopted by developers and has a large and active community, which provides extensive documentation, tutorials, and plugins, making it a powerful and versatile toolkit for building modern and engaging user interfaces across multiple platforms.

4. Firebase Database

Firebase Database is a cloud-based NoSQL database developed by Google for building real-time, scalable, and serverless applications. It is part of the Firebase suite of tools for app development and provides a flexible and scalable backend solution for storing and synchronizing data in real-time across different devices and platforms. Firebase Database[15]-[17] uses a JSON data model, making it easy to store and retrieve structured data, such as user profiles, messages, and notifications. It provides real-time synchronization, allowing changes to data in the database to be automatically reflected in connected clients in real-time, making it ideal for building collaborative and interactive applications. Firebase Database also offers offline data access, authentication, and security features, making it a powerful and convenient choice for app developers to handle data storage and synchronization in their applications[18]-[20].

Proposed Smart Attendance Methodology

Our method is a cross-platform application developed in Flutter where users can able to register their face images and their respective details which will then be stored in the database which is inbuilt within the application. When the users register their identity, it will be stored in the Firebase database which will provide authentication and database features to our application. While registering for each subject in the registration portal, the Face Engine App automatically creates a unique QR code for each subject per user. They can provide attendance to their necessary subjects with the help of their unique QR code. This unique QR code should be shown in the Face Log App for marking attendance for each subject. To get their unique QR code for each subject, users need to show their registered face and verify their identity. Here the provided face image will be checked with the image present in the database, then it will generate the unique QR code. We use the FaceNet CNN for recognizing the images and classifying them by extracting the vector embeddings of each face image. Later it is stored in the Firebase database to compare the existing image with the image present in the database. These steps help in securing automated attendance. Teachers or organizers can also view who gave attendance in the Face Log App. When the users show their QR code in this App, it will automatically add the user's name and registration number to the database, which will later be reflected in the App.

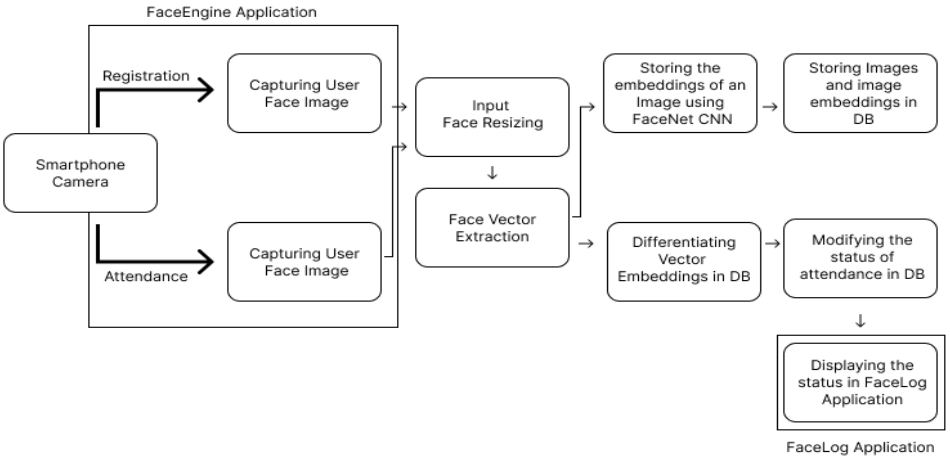

Fig. 1.Smart Attendance Proposed System Architecture

With the help of the Face Log App, teachers can later mark attendance or view the status of the students easily. Only the organizers or the teachers can able to access the Face Log App. Thus we help provide a secure way of providing attendance through automation via a cross-platform application.

Face engine App flow chart describes a system for making attendance using facial recognition which is shown in Fig.2.With the help of Flutter and Firebase along with Figma for UI, the FaceApp is built..Here we used the FaceNet CNN in the registration and login section where users can register and check whether their face image is present in the database.The software simulated results for registration, App log in and status view are created and illustrated in Fig.3.

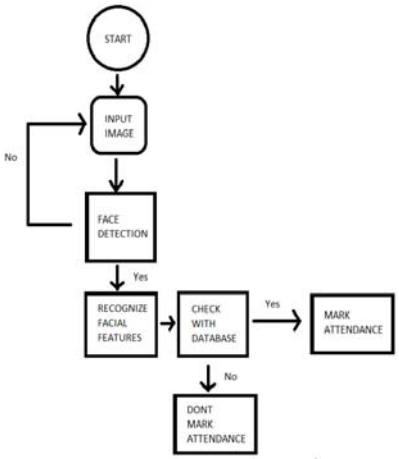

Fig 2.Face Engine App FlowChart

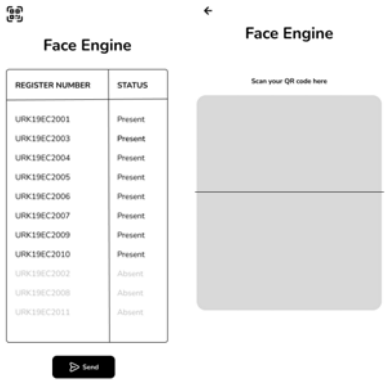

Fig. 3. FaceLog App UI for viewing status

Fig. 4. Face Registration and Recognition in the FaceEngine App

Results and Discussion

In this proposed method, we successfully got the face image from the user and extracted the vector embeddings of the image and stored them in the database. We were able to compare the images present in the database and were able to successfully update the candidates' attendance status in the Face Log App. The results obtained from Face Engine App are shown in Fig.4.The use of FaceNet CNN helped in easily differentiating the vector embeddings of an image.

The proposed smart attendance app automates attendance, making it easier and more accurate. The Smart Face attendance app is a user-friendly mobile app for students and instructors to access attendance records securely. This system is efficient, saves time and resources, and boosts transparency and accountability. It's simple for students to use in real time.

C0nclusion

Our proposed work helps in providing automation in attendance which helps in reducing the time and effort spent in marking attendance. The use of convolutional neural networks for face recognition enables accurate and efficient attendance tracking, while the user-friendly flutter-based mobile application provides a convenient platform for both students and instructors to access attendance records. The app provides a secure way to access attendance for each subject. It is simple to provide a unique identity for each user using unique QR codes. This proposed app not only saves time and resources but also enhances transparency and accountability in attendance management. With minimal effort, we provided a cost-efficient and stable method for the students to use with ease in real time.

Authors: *Dr.M.A.P.Manimekalai, Dr.Esther Daniel, Dr.T.Mary Neebha, Mr.Ryan Paul Jess, Mr. Raguram,Karunya Institute of Technology and Sciences, Coimbatore, India. Dr. K.Muthulakshmi, Sri Krishna College of Engineering and Technology, Coimbatore, India.*
Email:manisankar2008@gmail.com,estherdaniell@gmail.com,mary neebha@karunya.edu,kavi.neha@gmail.com

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