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Student Information System with Face Recognition Attendance

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Abstract - This student information system is a platform that makes it possible for schools to efficiently and transparently manage student data. Currently, handwritten logs and paperwork are used to manage student records, which leads to various issues like data loss, data redundancy, data inconsistency, and other human errors in addition to being time-consuming and inaccurate. Our student information system can significantly reduce the majority of these issues. The system we have built is a student information system that holds a range of student data, such as academic, attendance, and personal data. This system makes use of deep learning and facial recognition to automate the attendance process. Facial recognition is chosen as the method of authentication and CNN algorithm is used for higher accuracy, robustness and in-variance. It uses the student entering time and leaving time to create a data log which is used to calculate the total time attended by the student. This system will also analyze the entry and exit times of students on a particular day and display the students that are present and absent in real time. The system will then use this information to display various charts about the student attendance and academics using a user-friendly interface with three different user modes: teacher, student and admin.

Index Terms - Authentication, Facial recognition, Deep-learning, Robustness, Data log, Real time, User modes

Introduction

Face recognition, a widely used image processing technology, has gained popularity due to its extensive applications. One such application is its utilization for identifying individuals within an organization for attendance purposes. Facial recognition uses machine learning algorithms to construct a facial template and compare it to a database to confirm or identify a person. Attendance systems based on facial recognition use the distinctive facial features of individuals to automatically indicate their attendance, negating the need for manual recording.

Student information systems, on the other hand, are extensive databases that house and handle a variety of student-related data, such as personal information, academic and attendance records. A traditional Student Information System is a comprehensive database-driven application used by schools to manage student data.

It typically includes functionalities such as student registration, enrollment, attendance tracking, grades management, course scheduling, and student performance analysis. The information system serves as a centralized platform for storing, managing, and retrieving student-related information efficiently.

A facial recognition attendance system that smoothly connects with a student information system is the main goal of the system. In addition to offering a secure and reliable way of attendance marking, the integration also improves security and fraud prevention by reducing the likelihood of proxy attendance. This project will help eliminate the traditional attendance system, minimize manipulation during attendance and record the arrival time as well as leaving time of the students. Overall, this initiative has tremendous potential to increase data accuracy, streamline attendance management procedures, and boost operational effectiveness in educational institutions. In this paper, we present our system, integrating Facial Recognition Attendance and a student information system. We showcase the design, implementation, and evaluation of our system, emphasizing its significance in addressing the contemporary challenges in student attendance systems.

Objective

This project was created with the intention of fulfilling the following objectives:

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A. Recognize the faces of the students and log their attendance automatically

The face recognition model is responsible for recognizing the faces of students as they enter the classroom and recording their entry time in the database. As the student leaves the classroom, the exit time is recorded and attendance is marked automatically based on this entry and exit times.

B. Implement a user-friendly student information system

A student information system including all the attendance and academic records is maintained. Student records are displayed to the user upon request with the help pf illustrative graphs and charts showcasing the academic mark sheet of student through the years and their attendance records.

In subsequent sections, we will elaborate on the methodology employed for system development, encompass- ing model selection, training, and evaluation processes. Furthermore, we will present experimental results and insights derived from the implementation of our integrated Student Information System with Face Recognition Attendance, highlighting its practical applications and implications within the realm of Convolution Neural Networks.

Literature Review

Face recognition using deep neural network has been trending nowadays as, with the aid of deep learning approach, the performance of the system has greatly improved. Millions of images are trained by using DNN because it used both CPU and GPU system parallel for achieving great performance of the model. Convolutional Neural Network is one of the special forms of deep neural network as it has multiple layers to obtain the better features of images through learning procedure [1].

The main advantage of CNN network is to classify images and object recognition which is made easier by the existence of ImageNet [2]. Deep neural network contains multiple hidden layers: each of which has its own specialty, enormous collection of data for training, and can learn more essential features, improving the accuracy of classification of objects and prediction of faces very well [3]. Deep Learning is more suitable for larger collections of data. In comparison with standard feed forward neural network with similarly sized layers, Convolutional Neural Network has less connections and parameters, which makes it easier to train the data [4]. Basically, there are three layers in the CNN architecture: convolutional layer, pooling layer and fully connected layer.

At present, face recognition has been used for many things, one of which is student attendance at universities [5]. Face recognition can improve and manage the attendance system, reduce errors in the manual recording process by providing an automatic and reliable attendance system which increases privacy and security, prevents fake attendance, and provides regular attendance reports [6]. The steps taken in facial recognition include recording student videos, converting them into frames, connecting them to a database to ensure their presence or absence, and marking the presence of students that are recognized, to maintain records. All the data will be stored and displayed using the display screen [7].

SIS is being used by schools to support a range of activities including attendance monitoring, assessment records, reporting etc. One of the notable emerging trends in SIS is the integration of biometric technologies, particularly facial recognition, for various purposes such as attendance tracking, identity verification, and access control. Another emerging trend is the use of personalized learning platforms and adaptive analytics within SIS to support individualized instruction, student engagement, and academic success. These systems leverage data analytics, machine learning algorithms, and educational data mining techniques to analyze student performance, identify learning patterns and provide tailored recommendations or interventions.

A. Limitations of Existing Systems

- Manual attendance systems: Manual attendance systems relying on paper-based records are prone to errors and inaccuracies due to human error, such as forgotten entries, illegible handwriting or recording incorrect information.
- Automated attendance systems: While generally more accurate, these systems may still encounter issues such as misreads or misinterpretations of RFID tags and also pose security risks if the cards are lost, stolen or duplicated, allowing unauthorized access to the system. This raises security concerns related to data privacy, identity theft and unauthorized access.
- Software focused systems: The software-focused systems frequently fail and have few administrative tools. The main issues that pose a serious difficulty in this industry are the lack of comprehensive programs and designers' neglect. The existing systems mostly use traditional algorithms, as opposed to deep-learning algorithms, so they are not highly accurate, and also

face a variety of issues like lighting issues, posing issues, scale variability, low image capture accuracy, and issues due to partially occluded faces

B. Solutions provided by our system

The automated system that is mentioned in this paper applies image processing with OpenCV as a library for face detection with MTCNN and CNN algorithm for face recognition. The shortcomings of existing systems are overcome by our system as follows:

- This system is a low capital alternative to the hardware based existing systems.
- It is a software that makes use of the existing camera infrastructure that most schools already have. It utilizes the footage from surveillance cameras to detect and recognize the faces of people which helps to determine the entry and exit time of students.
- Our System is a better alternative to currently existing facial recognition systems that use traditional algorithms which takes a long time to detect and recognize the faces of people.

Methodology

A. System Block Diagram

The figure above shows the block diagram of our system. The main UI is the dashboard of the SIS which will be used by the user to navigate through the student details such as their personal details, attendance records, etc. in the system which is backed by a face recognition module that is used to recognize the faces of students and store their data in the database which can be accessed through the middleware. The system is composed of:

1) *Face Recognition model:* To facilitate the fine-tuning of our model and subsequent testing, we meticulously curated datasets from the footage captured by the surveillance camera. The compilation and preparation of these datasets were crucial for ensuring the effectiveness and reliability of our machine learning models.
   - Input Image: A real-time image is given as input via a CCTV or a digital camera or a webcam which is then fed for pre-processing.
   - Pre-processing: The data obtained is processed in various steps, as detailed below:
     – Normalization: Normalization standardizes the pixel values of images, ensuring they fall within a consistent range ensuring that the face images are uniform across different samples, which is essential for accurate comparison and recognition.
     – Grayscale Conversion: Converting color images to grayscale can simplify the processing and reduce the computational complexity of face recognition models as they contain only intensity information, which is often sufficient for facial analysis tasks.
     – Data Augmentation: Data augmentation artificially increases the diversity of the training dataset by applying transformations to the images, such as rotation, shifting, flipping, and zooming. This helps the model generalize better to unseen data and reduces overfitting.

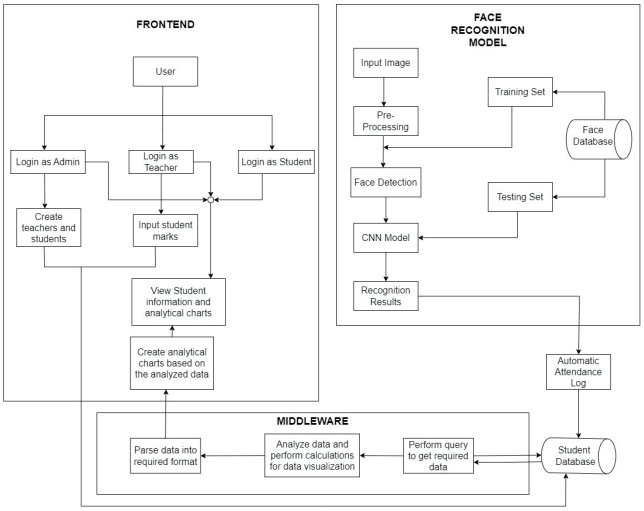

Fig. 1 System Block Diagram

     – Shuffling: Shuffling the data ensures that the model doesn't learn patterns based on the order of the data, which could lead to biased learning. Shuffling randomizes the order of samples in each batch, preventing the model from learning sequential patterns that may exist in the data.
   - Face Detection: It is the first step in the process of identification where the face has been detected for further processes. Face detector library such as OpenCV locate faces and draw bounding boxes around faces and keep the coordinates of bounding boxes.

- Face recognition using CNN model: The face is recognized by matching the detected face against one or more known faces in a prepared database. It involves the following steps:
  - Convolutional Layers: In a CNN, there are multiple layers containing convolutional filters (or kernels) responsible for detecting specific features within an image. These filters are applied across the entire image, extracting various features at different levels of abstraction.
  - Feature Extraction: The early layers in a CNN focus on extracting broad features from the input image, such as edges, textures, and patterns. As the data progresses through the network, subsequent layers detect increasingly complex and specific features, ultimately leading to high-level representations of objects or patterns within the image.
  - Filter Training: During the training process, the CNN learns the optimal values for the filters in each convolutional layer by analyzing a labelled training dataset. Through backpropagation and gradient descent, the network adjusts the filter values to minimize the difference between predicted and actual labels.
  - Prediction: Once trained, the CNN is used to make predictions on new images. The learned filter values are applied to the input image, allowing the network to identify and classify objects or patterns present in the image. In the context of face recognition, the CNN is trained to recognize specific facial features and match them against known faces in a database.
- Training set: The training set is a crucial component of the face recognition system, as it is used to train the CNN model to recognize faces accurately. In the context of face recognition, the training set consists of a collection of labelled images, where each image contains one or more faces along with corresponding labels indicating the identities of the individuals.
  - Face Database: The face database is prepared in such a way that it automatically detects and extracts faces from images, eliminating the need for manual cropping or preprocessing. This ensures that the training data only contains images of faces, simplifying the training process.
- Testing Set: Once the CNN model has been trained on the training dataset, it is evaluated using a separate testing dataset. The testing dataset serves to assess the performance of the trained model and determine its accuracy under various conditions.
  - Evaluation: The testing dataset consists of a separate collection of labelled images that the CNN has not seen during training. These images are used to evaluate the model's ability to generalize to new, unseen data and accurately recognize faces in real-world scenarios.
  - Performance Metrics: Various performance metrics, such as accuracy, precision, recall, and F1 score, can be used to quantify the performance of the face recognition system on the testing dataset. These metrics provide insights into the model's effectiveness and help identify areas for improvement.

2) *Middle-ware:* The middle-ware is an essential part of our system that is in charge of gathering and analyzing the student data that the face recognition model has saved in the database. The student's username and timestamp, which show their entry and departure times on a particular day, make up this information. The middle-ware examines this extracted data and extracts valuable insights by using various queries. For example, it calculates metrics like the overall number of absences for a given day or class and the distribution of gender among students. The context these computations offer is crucial for comprehending class attendance trends and demographic distributions of a particular class.

3) *Front-end:* Leveraging the capabilities of charts.js, the system generates a variety of analytical charts that provide valuable insights on a student's attendance and academic records. These charts are accessible to users upon logging in, with their access privileges determined by their assigned roles: Admin, Student

or Teacher. Upon logging in, the system verifies the user's credentials and assigns them to one of the designated roles. Each role is associated with specific access rights tailored to their responsibilities and needs with the system:

- Student Access: Students are granted access to view their personal details, including their academic records and attendance data in the form of illustrative charts and graphs that helps them to track their academic progress over time.
- Admin Access: Admins have the highest access rights with the system. They are empowered to create and manage user accounts, including accounts for both teacher and students. Additionally, admins also have access to view the attendance and academic records of each student of a classroom and analyze the records with the help of the generated graphs and charts.
- Teacher Access: Teachers are granted access to input and manage student marks, facilitating the assessment of performances through analysis of attendance and academic results in the form of charts and graphs. This access enables teachers to record and update student grades, providing valuable feedback to students and admins.

These meticulous approaches underscore the robustness and efficacy of our Student Information System with Face Recognition Attendance, ensuring accurate differentiation between different faces of students in a class- room. Subsequent sections will delve into experimental results, performance evaluations, and insights derived from the implementation of our system.**Algorithms Used**

A. CNN Algorithm

Convolutional neural networks are composed of multiple layers of artificial neurons. Artificial neurons, a rough imitation of their biological counterparts, are mathematical functions that calculate the weighted sum of multiple inputs and outputs an activation value. When you input an image in a ConvNet, each layer generates several activation functions that are passed on to the next layer.

The first layer usually extracts basic features such as horizontal or diagonal edges. This output is passed on to the next layer which detects more complex features such as corners or combinational edges. As we move deeper into the network it can identify even more complex features such as objects, faces, etc.

Based on the activation map of the final convolution layer, the classification layer outputs a set of confidence scores (values between 0 and 1) that specify how likely the image is to belong to a "class." For instance, if

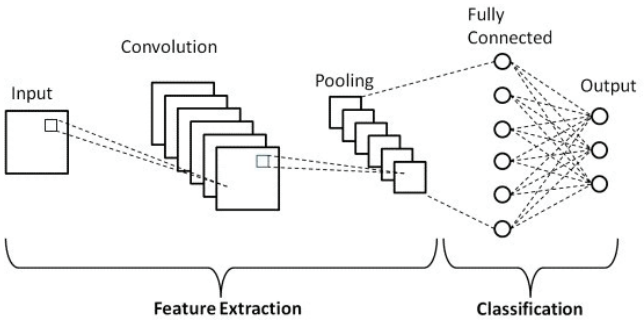

Fig. 2 Working of CNN

you have a ConvNet that detects cats, dogs, and horses, the output of the final layer is the possibility that the input image contains any of those animals.

A CNN typically has three layers: a convolutional layer, a pooling layer, and a fully connected layer. A typical architecture consists of repetitions of a stack of several convolution layers and a pooling layer, followed by one or more fully connected layer.

B. MTCNN Algorithm

Multi-Task Cascaded Convolutional Neural Network is a modern tool for face detection, leveraging a 3-stage neural network detector. MTCNN algorithm is a multi-task network structure, it can not only complete the face detection function, but also do the task of marking the key points of the face. The integration of the recognition system will be higher and the running speed will be faster, so the MTCNN algorithm is selected as the face detection algorithm in this system.

Verification and Validation

1) Epoch Accuracy: The epoch accuracy plot serves as a powerful visual aid for monitoring and evaluating the training process of machine learning models, providing insights into convergence, generalization, and overall performance.

In the context of our project, we trained a model to detect faces in images using a dataset. We conducted training for 20 epochs, meaning the model underwent 20 complete iterations over the training data. At the end of each epoch, we evaluated the model's performance on both the training

and validation sets and recorded the accuracy achieved.

- Results: Following fine-tuning and evaluation, the trained model demonstrated robust performance:
  - – Validation Accuracy: 0.97

The achieved validation accuracy underscores the effectiveness of the facial recognition system, validating its utility in distinguishing between various human faces.

Through this methodology, we have showcased the efficacy of leveraging CNN algorithms for face recognition, emphasizing its compactness, efficiency, and remarkable performance in real-world applications.

Result

Our project, a sophisticated student information system, boasts robust face recognition attendance capabilities, achieving a remarkable 97 percent accuracy rate. This success is attributed to our utilization of the VGG16

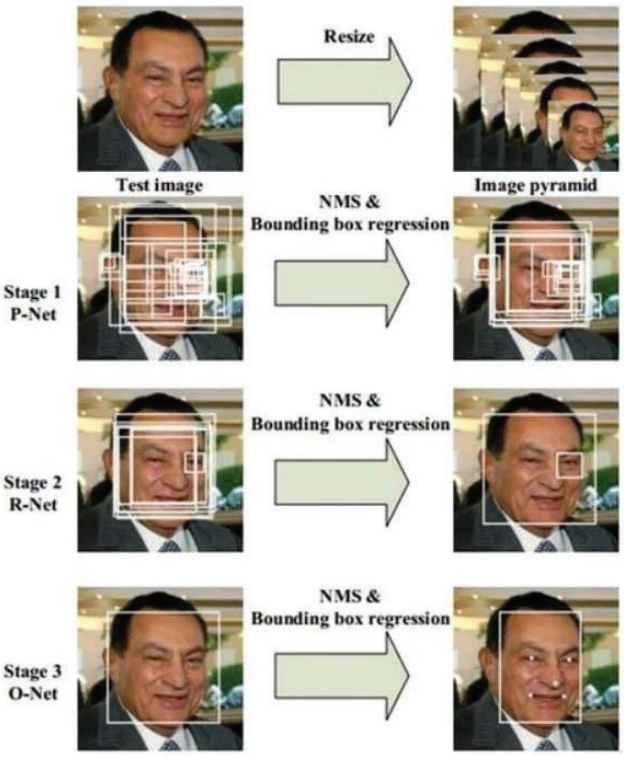

Fig. 3 MTCNN working visualization

deep learning model and MTCNN for face detection, trained meticulously on a diverse dataset. Seamlessly integrated with a PostgreSQL database, our system ensures reliable and secure data management, enabling efficient extraction of attendance records through SQL queries. The user-friendly frontend interface provides easy access to attendance statistics, individual student records, and administrative functionalities tailored for streamlined operations within educational institutions. Detailed student profiles offer comprehensive insights into attendance trends and academic performance, visually represented through charts and graphs generated using Charts.js, thereby enhancing decision-making processes and administrative efficiency.

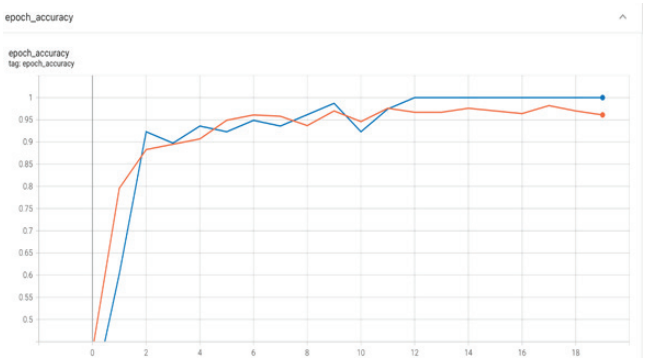

Fig. 4 Epoch Accuracy Plot

Conclusion

In conclusion, our student information system featuring face recognition attendance not only ensures precise and effective attendance tracking but also equips administrators and teachers with insightful tools for student management and analysis. Developed using VGG16 and MTCNN, our face recognition system represents a notable advancement in biometric technology, delivering high accuracy and efficiency in attendance management. With user modes for admin, student, and teacher, the system offers personalized access control, while the user- friendly front-end showcases analytical charts derived from student attendance records. Overall, the integration of face recognition technology holds immense potential for transforming attendance tracking systems across industries, leveraging AI and machine learning to optimize operations and enhance workforce management.

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