Exploratory Project Report

Attendance System Based on Computer Vision

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CERTIFICATE

This is to certify that this project report “Attendance System based on Computer Vision” is submitted by Anant Jain, Mamalesh Rajkumar Hake, Rajat Shukla and Shrirang Brajesh Gupta who carried out the project work under the supervision of Prof. Priya Ranjan Muduli. We approve this project for submission of the Exploratory Project, IIT(BHU) Varanasi.

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Acknowledgement

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Finally, we would like to acknowledge the contribution of the various research papers, articles, and online resources we referred to during the project. They gave us the necessary knowledge and insights to develop an effective and efficient attendance system.

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Abstract

Through our system, we aim to solve the problem of taking attendance in colleges by automating the process, which is currently a time-consuming and error-prone manual process. Our system employs face recognition technology to identify the students and mark their attendance while at the same time checking for proxies through liveness detection.

Introduction

In today's fast-paced educational environment, the traditional manual method of taking attendance is often tedious and time-consuming, leading to a waste of valuable time and resources. Since attendance is an important criterion which shows the punctuality and the dedication of a student towards his courses, it is essential to pay attention to it.

An attendance system built on computer vision is a technological solution that aims to automate the process of taking attendance. It utilises advanced computer vision algorithms and techniques to accurately and efficiently identify students and mark their attendance automatically. It solves these challenges, enabling educational institutions to manage their attendance system more effectively and efficiently. The system ensures that accurate and timely attendance data is available along with checking the liveness of the student present through its liveness detection. This can be useful for monitoring student attendance, identifying patterns, and taking necessary actions to improve attendance rates. Overall, implementing an attendance system is an important step towards improving the management of educational institutions and providing better outcomes for students.

Literature Survey

When it comes to attendance systems, there are many existing techniques and technologies available. In this literature survey, we will review some of the most common techniques used for temperature and humidity monitoring and their advantages and limitations :

1.) **Manual Attendance**

The traditional method of taking attendance involves manually marking the presence or absence of students. An instructor may employ several other methods to do the same depending on his/her convenience. These methods can be:

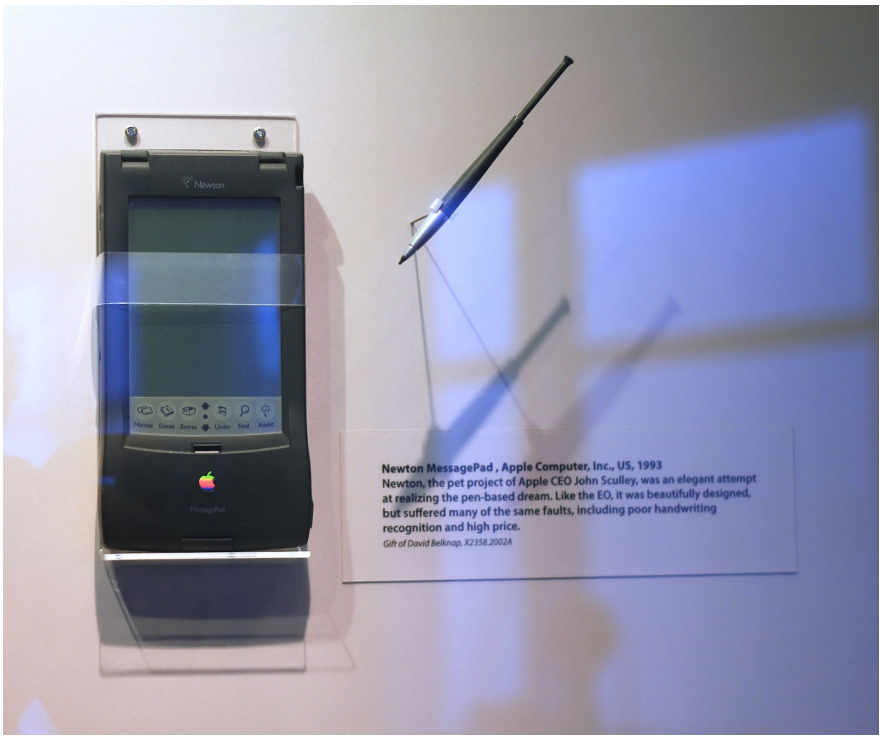
- Passing an attendance sheet for the students to sign - This is the general method in most of our classes. These involve many proxies since somebody else can forge one's signature. Hence the nature of the error is high. Along with these, the instructor must manually upload the attendance to some database to maintain his records.
- Having people raise their hands - this is a time-consuming process and a waste of the instructor's time, which can be used for teaching the course.

2.) Barcode/QR Code-based Attendance

In this method, each student is assigned a unique barcode or QR code. The code is scanned using a code reader, and the student's attendance is marked automatically. While this method is more efficient than manual attendance, it requires the student to carry their QR codes with them. Along with this, there is a greater risk of somebody else scanning someone else's QR code. Hence a chance of proxies.

3.) RFID-based Attendance

An RFID-based attendance system uses RFID (Radio Frequency IDentification) technology to mark students' attendance before every lecture in the institute. The students must use an RFID tag to mark their presence on the RFID reader. The data is stored in the attendance system with high accuracy and efficiency. Faculty members can use it for further operations. The cons are the high cost of printing these cards. Along with these their are chances of data leakages which threaten the privacy and security of RFID tags.



4.) Biometric-based Attendance

Biometric-based attendance system uses fingerprints, facial features like iris-scanning to identify students. While these methods are highly accurate and efficient, but they have high setup cost, are expensive to implement. There are also privacy concerns, since these information stored in the database are critical and their loss during cyber attacks and crimes are threat to the privacy of students.

5.) GPS-based Attendance

GPS based system uses location data to identify students. The system marks attendance based on the student's location within a predefined area. This method is efficient, but it requires the students to carry GPS-enabled devices at all times. Their is a breach of privacy in this case since an app will be constantly recording the data of student, their is also a fear of data leakage.

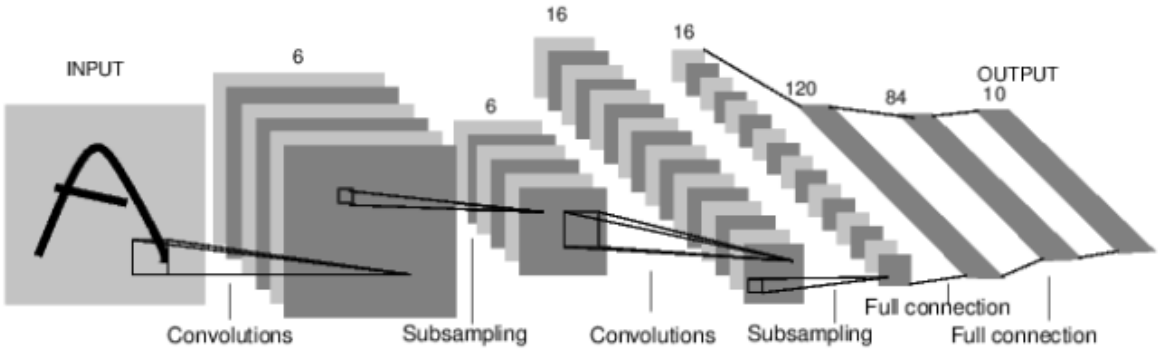
6.) Computer Vision based system

These systems use advanced image processing and machine learning algoriths to identify students based on their facial features. This method is highly efficient and doesn't require the students to carry any devices or tags.

Functioning of our Attendance System

The attendance system employs various algorithms for face detection along with checking the liveness of the student. The key algorithm for face detection are:

- **Dlib's Histogram of Oriented Gradients Technique**



Histogram of oriented gradients which is not only a face detection algorithm but also a complete object detection method. HOG is basically a feature descriptor that is performed both for image processing and computer vision techniques.

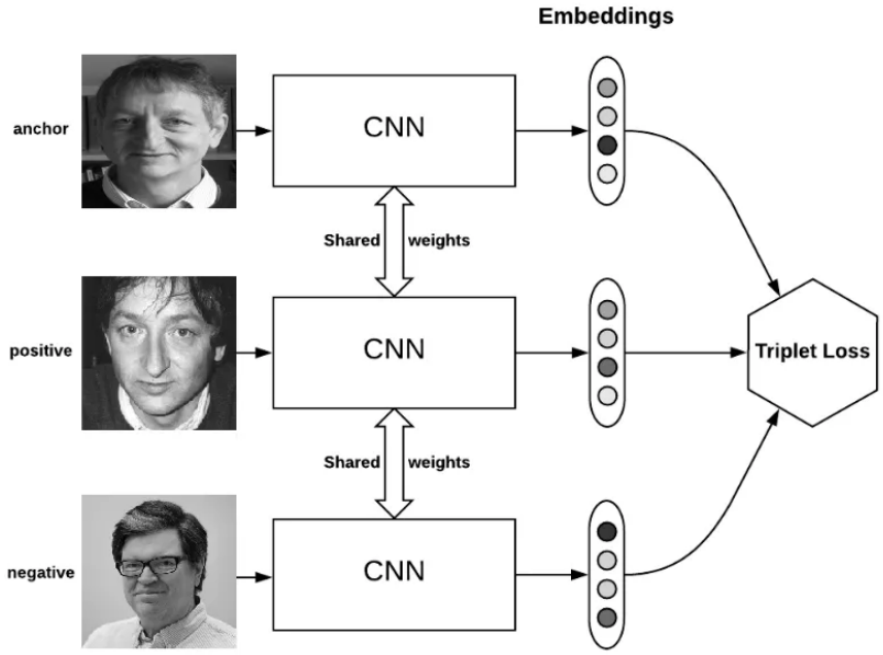
HOG uses mainly 5 filters during the preprocessing step they are as follows:

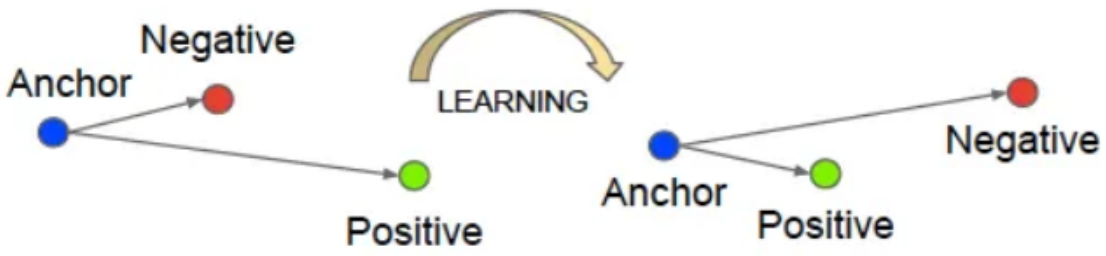
- Frontal face
- Right side turned face
- Left side turned face
- The frontal face but rotated right
- The frontal face but rotated left

- **FaceNet for Face Identification**

FaceNet provides a unified embedding for face recognition, verification and clustering tasks. It maps each face image into a euclidean space such that the distances in that space correspond to face similarity, i.e. an image of person A will be placed closer to all the other images of person A as compared to images of any other person present in the dataset

The main difference between FaceNet and other techniques is that it learns the mapping from the images and creates embeddings rather than using any bottleneck layer for recognition or verification tasks. FaceNet uses deep convolutional neural network (CNN). The network is trained such that the squared L2 distance between the embeddings correspond to face similarity. The images used for training are scaled, transformed and are tightly cropped around the face area. Another important aspect of FaceNet is its loss function . It uses triplet loss function (refer to Fig 1). In order to calculate the triplet loss, we need 3 images namely anchor, positive and negative. We will explore triplet loss in great detail in the next section.





The triple loss function can be defined as:

$$\sum_{i}^{N} \left[\|f(x_i^a) - f(x_i^p)\|_2^2 - \|f(x_i^a) - f(x_i^n)\|_2^2 + \alpha \right]_+$$

- **SVM Classifier:**

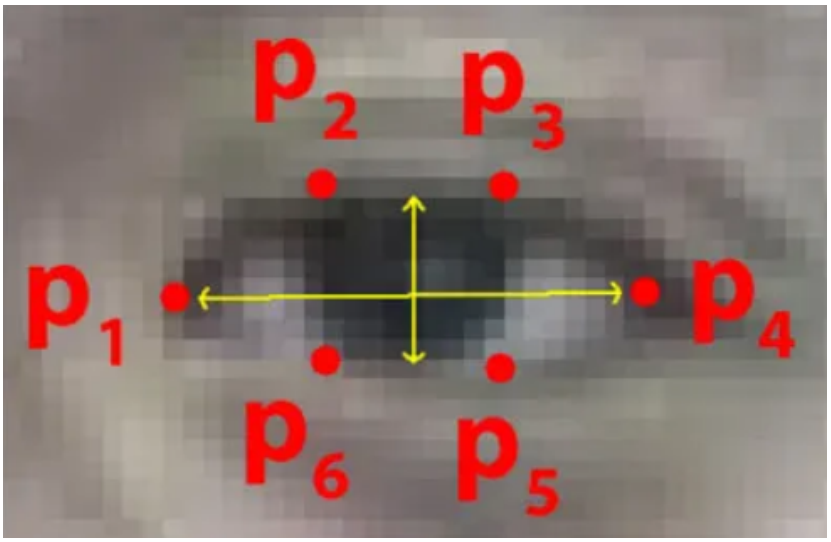
  It is used to query the database rapidly to improve the real-time speed of the system. In an SVM classifier, data is represented as points in a high-dimensional space, where each point corresponds to a feature vector representing the object. The algorithm finds the optimal hyperplane, which is a boundary that separates the points of one class from those of the other class. The optimal hyperplane is the one that maximizes the margin, which is the distance between the hyperplane and the closest data points of each class.

  During training, SVMs use a cost function to find the optimal hyperplane that maximizes the margin while minimizing the misclassification error. The cost function determines the penalty for misclassifying a data point and the tradeoff between maximizing the margin and minimizing the misclassification error.

Once trained, the SVM classifier can predict the class of new data points by evaluating which side of the hyperplane they fall on. The SVM classifier can work with both linear and non-linearly separable data by using techniques such as kernel trick, which maps the input data into a higher-dimensional space to make it separable.

- **Liveness detection using blinking of the eye:**

  To detect the presence of the candidate and not just a mere photo of him, liveness detection is employed through blinking of the eye. This is done by taking the Eye Aspect Ratio into account. Eyes are represented as 6 points the by face_recognition algorithm



  Through this we calculate the EAR using the formula:

$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

During normal circumstances, the Eye Aspect Ratio will be constant, but when there is a blink, it falls down to 0.

We add a threshold and compare it to the EAR, to determine if an eye blink has occurred. Only then will the attendance be marked

Inferences

The proposed attendance system built using computer vision technology has the potential to automate the process of taking attendance and make it more accurate and efficient. The model displays an accuracy of **99.4%**

In conclusion, the computer vision-based attendance system has emerged as a promising solution for educational institutions, offering accurate and efficient attendance tracking without requiring students to carry any devices or tags. With the advancements in image processing and machine learning, computer vision-based attendance systems have become more robust, reliable, and scalable, making them suitable for various applications.

The literature survey highlights that while other attendance systems such as manual, barcode/QR code-based, RFID-based, biometric-based, and GPS-based attendance systems have their advantages, they also have their limitations. Computer vision-based attendance systems offer a unique combination of accuracy, efficiency, and convenience, making them a popular and promising solution for attendance tracking.

The preliminary results and insights suggest that the computer vision-based attendance system can achieve high accuracy and efficiency in tracking attendance. However, the system's performance depends on lighting conditions, camera quality, and image resolution.

Inferences, discussions, and conclusions suggest that the computer vision-based attendance system can benefit educational institutions by reducing the workload of teachers and administrative staff, improving attendance accuracy, and providing real-time attendance tracking.

In summary, computer vision-based attendance systems offer a robust and efficient solution for attendance tracking, and they have the potential to revolutionise the way educational institutions manage attendance. With ongoing research and development, computer vision-based attendance systems can become even more reliable, accurate, and convenient, benefiting students, teachers, and educational institutions.

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