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Automated Attendance Management using Computer Vision: A Robust and Efficient Approach for Academic and Organizational Environments

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Abstract: At the beginning and end of each session, attendance is an important aspect of the daily classroom evaluation. When using traditional methods such as calling out roll calls or taking a student's signature, managing attendance can be a time-consuming task. The teacher normally checks it, although it is possible that a teacher will miss someone or some students' answers many times.

Face recognition-based attendance system is a solution to the problem of recognizing faces for the purpose of collecting attendance by utilizing face recognition technology based on high-definition monitor video and other information technology. Instead of depending on time-consuming approaches, we present a real-time Face Recognition System for tracking student attendance in class in this work.

After the recognition is completed, the attendance will be immediately updated in a Database with the relevant information. Many institutions will profit greatly from this endeavour. As a result, the amount of time it takes and the number of human errors it makes are minimized, making it more efficient.

Keywords: Face Detection, Face Recognition, Attendance, OpenCv.

I. INTRODUCTION

Many scientific discoveries and technologies have occurred in this modern period of automation to save manpower, improve accuracy, and improve our lives. The breakthrough in the field [1] of automation replacing conventional attendance marking activities is known as an Automated Attendance System. Biometric, smart-card, and web-based Automated Attendance Systems are the most common types. These systems are frequently employed in a variety of businesses.

When the strength is greater, the traditional method [2] of attendance marking becomes exceedingly time consuming and cumbersome. Automation of attendance systems has an advantage over traditional methods in that it saves time and can also be used for security [3]. This also aids in the prevention of bogus attendance. A facial recognition system is a computer programme that takes many images of a person and stores the data about that person's face so that when that person appears in front of the camera again, it can verify that person [4]. The face is the physical manifestation of one's individuality.

As a result, we've developed a face recognition-based automatic student attendance system. This technology has a lot of uses in everyday life, especially in security and surveillance systems. Facial recognition technology is a framework or programme that can authenticate an individual's identification by evaluating a photograph or video footage. The major goal of this research is to create an automatic attendance system based on face recognition [5]. To get better results, this project's test and training images are confined to frontal and upright facial photos [6], which only contain a single face. For humans, face recognition is an easy process.

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II. BACKGROUND

Hubel and Torsten Elie Wiesel demonstrated that we have specialized nerve cells for specific native features of a scene, such as lines and edges. Because humans don't perceive the earth as a collection of disparate objects, our vision should combine the different sources of input into a meaningful and helpful pattern [7]. Automatic face identification entails extracting important options from a photograph, golfing stroke them into a useful representation, and performing some quiet categorization on them.

Face recognition, three-dimensional reconstruction, and target recognition are all done with OpenCV, an open- source module. This could be used to avoid using a proxy. The problem with this method is that it only catches one image of a student at a time once he enters the classroom. The suggested system attempts to address the shortcomings of existing systems by including features such as face detection, feature extraction, feature detection, and analysis of student attendance. For feature detection, the system uses techniques such as image contrasts, integral pictures, colour features, and a cascading classifier. Due to the usage of a large number of face features (Shape, Colour, LBP, wavelet, Auto-Correlation), the method gives higher accuracy. Euclidean distance and k-nearest neighbour techniques are used to recognize faces [8]. Because the system considers the changes that occur in the face over time and utilizes appropriate learning algorithms, the findings are more accurate. The technology has been put through its paces in a variety of scenarios.

For the aim of testing the system's accuracy, we consider a specific area such as classroom attendance. The percentage of recognized faces per total number of tested faces of the same person is the parameter used. The system is put to the test in a variety of lighting conditions, with diverse facial expressions, partial faces (in crowded classes), and the presence or absence of a beard and spectacles. In the majority of the cases studied, improved accuracy (almost 100 percent) is reached.

III. LITERATURE REVIEW

There are a number of existing systems that are closely analogous to the proposed idea of using official recognition techniques and algorithms to indicate attendance in a class. A literature survey of the proposed systems was conducted to analyses these systems. The proposed case study was built around a few key sources in the field of facial recognition and image processing.

Using the other design methodologies, a descriptive framework was created [9]. This type of system makes use of the RFID technology [10] and the SURF algorithm [11] to create a student attendance control system. The SURF directly modifies the scale of box features to implement the scale space using box filter and integral image, similar to how SIFT produces a pyramid scale space and continually smooth's the image with Gaussian and then sub samples the image.

The authors presented a finger print-based attendance system in [12]. A portable fingerprint device has been developed that may be circulated among students to allow them to lay their finger on the sensor during lecture time without the intervention of the instructor. This technology ensures that attendance is recorded in an error-free manner.

The author of [13] is dealt with by the system. The issue with this type of attendance system is that students may lose their ID cards for various reasons, and there will be another opportunity to collect the students' information. It's a lengthy procedure. In addition, when compared to other types of facial recognition algorithms, the algorithm processing is quite slow.

The authors of [14] suggested an Iris recognition system based on Daugman's algorithm. This system employs an iris recognition management system that captures, extracts, stores, and matches iris recognition images. However, laying transmission lines in areas with poor topography is a challenge.

The authors of [15] proposed a system based on real- time facial recognition that is reliable, secure, and quick, although it still has to be improved in varied lighting circumstances. The initiative places a greater emphasis on fingerprint scanning than on face recognition systems.

The project will only recognise the student's face in one direction and record the student's attendance [16]. The author is experimenting with a new technology called fingerprint scanning, which comprises of a fingerprint scanner and a camera. The key benefit is that even if the camera does not recognise the student's face correctly after face registration, the student can be declared absent using this fingerprint scanner. CNN (Convolutional Neural Networks [17]) was used by the authors to detect and extract information from the collected photos that contained the students' faces.

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They also used CNN to train their model and an SVM (Support Vector Machine) [18] classifier to classify the images after they were trained. They were able to reach a 95 present accuracy rate [19]. The system implements the attendance system by employing the PCA (Principle Component Analysis) technique to recognise the faces of each and every student. It's method of minimising the number of variables in face recognition [20].

Every image in the training set is represented by Eigen faces, which are a linear combination of weighted eigenvectors. The covariance matrix of a training image set yields these eigenvectors. When compared to other methods, this algorithm has a significant computational advantage.

IV. EXISTING PROBLEM

This project is being carried out due to the concerns that have been highlighted on the methods which lectures use to take attendance during lectures.

The use of clickers, ID cards swiping and manually writing down names on a sheet of paper as a method to track student attendants has prompted this project to be carried out. This is not in any way to criticize the various methods used for student attendance, but to build a system that will detect the number of faces present in a classroom as well as recognizing them.

Also, a teacher will be able to tell if a student was honest as these methods mentioned can be used by anyone for attendance records [21], but with the face detection and recognition system in place, it will be easy to tell if a student is actually present in the classroom or not. This system will not only improve classroom control during lectures, it will also possibly detect faces for student attendance purposes.

V. METHODOLOGY

a. "Face Detection in Extreme Conditions: A Machine-learning Approach" - Sameer Aqib Hashmi

Analysis of the detection rates among these methods using various datasets in distinct methods. I have evaluated the difference in detection rate between the strategies in Table.

Algorithm	**Accuracy**
Viola-Jones	74.38%
HaarCascade	94%
MTCNN	99.95%

b. "Aggregate channel features for multi-view face detection" - B. Yang, J. Yan, Z. Lei, and S.Z. Li.

The face detection method used in this paper excels in detecting extreme poses and exhibits exceptional illumination invariance. Utilizing multi-view detection with separately trained subview detectors contributes to robust handling of pose variations.

The proposed detector achieves efficient detection speeds, running at 20 FPS for full yaw pose and 34 FPS for frontal faces using single-scale features, and slightly reduced but still impressive speeds with multi-scale features. With substantial performance gains and comparable speed, our method is a suitable replacement for the Viola-Jones detector in wild face detection scenarios.

c. "Investigation of IoT camera solutions in Smart Cities from a Technology, Information Security and Trust point of view" - Authors:
Andrea Lukacs, Lulea M

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This study has answered on the research gap identified according to which solution that is the most optimal and how the critical three components: technology, information security and trust can be included in a solution. However, as Critical Infrastructure is more important for society, the research within this field is considered to be additionally vital which is proposed as a possible research field for future researchers.

d. "Library Attendance System using YOLO v5 Face Recognition" - Authors: Mardiana, Meizanoardhi

Library Attendance System is able to integrate three-part of sub-system which include a face recognition system based on YOLOv5. YOLOv5 face recognition subsystem which can detect multiple objects in images and videos has an excellent level of performance in terms of the average object detection time standard per image.

A large number of face recognition systems with the YOLOv5 algorithm at the training stage took 3.736 hours for 1420 images with a total of 1000 epochs on a CUDA Nvidia Tesla T4 with 15079MB of memory.

VI. FUTURE WORK

Face recognition is the most biological features recognition technology, according to the cognitive rule of human beings, its algorithm is ten times more complex than a fingerprint algorithm. The system will do its work even if one is not in touch with it or forget about it.

Face recognition is featured by the following advantages compared to fingerprint: Using face recognition accurate and fast identification, industrial leading facial recognition algorithm matches more data than a fingerprint. High usability and security in this context failure to control and acquire rate is less than 0.0001%, fingerprint technology will have problems for enrolment with cold, wet, desquamation, elder, and around 5% people cannot get enrolled with a photo which is captured by the camera, there is no evidence with fingerprint technology to track the incident and user friendly design.

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