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Smart Attendance System Using Face Recognition: A Machine Learning Approach

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ABSTRACT---

An attendance monitoring system using facial recognition uses a camera to capture images of individuals, which are then processed by a computer program to identify specific individuals based on their facial features. The system can then compare the identified individuals to a pre-existing database of known individuals and determine whether they are present or absent. This technology can be used in various settings, such as schools, offices, and factories, to streamline the attendance-taking process and reduce the potential for human error. Additionally, facial recognition can also be integrated with other technologies, such as time and attendance software, to provide a more comprehensive attendance management solution. It uses the latest technology and recognition of deep learning algorithms to make attendance smarter, creating a system that detects and recognizes the faces of students in the classroom or organization. "The human face is the most anterior portion of the human head. It refers to the area that extends from the superior margin of the forehead to the chin, and from one ear to another.". Facial identification is one of the biometric methods that must be made mandatory for this system. Based on this idea, it does it for an intelligent attendance system and takes less time than manual attendance system. This model will be a successful technology for attendance and student records.

Keywords--- Attendance, Face Identification, OpenCV, Local Binary Pattern Histogram (LBPH), Training and Recognition, Database

1. Introduction

Attendance monitoring is an essential process in any educational or corporate setting, as it helps to track the presence and punctuality of employees or students. Regular methods of attendance monitoring, such as manual sign-in sheets or ID card swipes, can be time-consuming and prone to errors. In recent years, technology has advanced to the point where facial recognition can be used for attendance monitoring. "Smart Face Recognition Attendance Monitoring System" uses technology to automatically record attendance by identifying people based on their facial features.

Every institution requires a robust and constant system to record the attendance of their students. And each institution has its own methodology, many institutions use attendance logs to manually record attendance, give names during lectures, and use biometric systems such as RFID card readers [1], fingerprint and iris systems, is almost non-existent and get involved every day. The usual method of manually calling students by name is time consuming. While RFID card systems give each student a proper identity, there is the potential for cards to be lost or mishandled by unauthorized persons for counterfeit attendance. It is not 100% accurate with other biometrics such as voice recognition, iris [2] or fingerprint [3].

Recognition or verification of a person's identity is done from the facial recognition technique either from a digital image or from a continuous image frame (video source). There are several ways that face recognition systems work, and they work by distinguishing between information provided as a person's face in a database and information selected about a person by face. It is the fastest and smartest time and attendance management system that uses face recognition [4] as its main purpose to guide the display of time and attendance. Face-recognition [5] is faster method among other approaches and reduces the possibility of proxies.

2. Literature Review

(1) Classroom Attendance Management System using Facial Recognition [1]: The traditional method of recording attendance can be unreliable since students may ask their friends to mark them present on their behalf. To overcome this issue, biometric attendance systems are often implemented. However, these systems can also suffer from reliability issues. As a result, face recognition technology has emerged as a more efficient and time-saving solution. The process involves four stages: image capture, face detection, face comparison, and updating attendance records in a database. (2) Attendance Recording System [2]: This research paper focuses on using face recognition technology to record attendance for entire classes in the increasingly digital world. The process involves capturing an image of a person and comparing it to an existing database, with the results being stored in MySQL. The accuracy of this method is reportedly 99%.

(3) Facial Recognition Algorithm for Biometric Attendance Management [3]: The process of face recognition begins by extracting facial features, such as the width of the pupil in the eyes or the breadth of the mouth. These features are then compared to an existing database. Numerous research papers have been published that explore facial feature extraction and the implementation of face recognition technology. The primary focus of these papers is to develop the most accurate face recognition methods, with some achieving similarity rates of up to 95%.

(4) Attendance Management System Based on Facial Recognition [4]: In order to make various tasks more efficient and effective for institutions and organizations, facial recognition technology can be utilized. This technology extracts facial features and converts them into numerical data. Once the data has been processed, an automatic email system can be used to send notifications to students or staff as needed. By using this method, institutions and organizations can streamline their processes and improve their productivity.

(5) Facial Recognition Automatic Attendance System [6]: The implementation of an Auto Attendance System can help to replace the manual attendance systems that can be labor-intensive and difficult to maintain. The focus of this particular study is on attendance-taking without requiring active participation from the students. The system works by using a camera placed in the classroom to capture an image, detect faces, compare them to a database, and record attendance accordingly. If a student's attendance is marked as absent, a notification is automatically sent to their parent or guardian to inform them of the absence. There are various ways to compare faces, and the process is highly personalized. One method is the use of Eigenfaces, which are a set of eigenvectors commonly used in computer vision to solve face recognition problems.

(6) Deep Learning Approaches for Face Recognition Using CNN and D-lib [7]: While significant progress has been made in the field of face recognition technology, it has only gained widespread attention in scientific and commercial circles in recent decades. In this study, a face recognition system is proposed that is based on deep learning and utilizes Convolutional Neural Networks (CNN) as well as D-lib face alignment. This approach represents a novel way to achieve more accurate and reliable facial recognition, with the potential to improve performance beyond what has been possible with previous methods.

(7) Facial Recognition-based Automatic Attendance System [8]: A face is a tangible and individual expression of a person's identity. Recognizing this, an automatic student attendance system has been developed that is based on facial recognition technology. This system has a broad range of potential applications in daily life, particularly in security and surveillance systems. One example of such applications is at airports, where facial recognition technology is used to detect potential threats and known criminals. In fact, the system has been successful in identifying and detecting over 4,444 individuals with criminal records.

(8) Attendance System Based On Facial Recognition [9]: The advancements in automatic facial recognition technology have brought about significant changes in the modern world. The use of real-time facial recognition for smart attendance tracking is an efficient and convenient way to monitor student attendance on a regular basis.

(9) Attendance Management System with Real-Time Facial Recognition [10]: The need for automation in modern academic systems has become increasingly important, especially for performance evaluation. Many of the traditional activities of academic organizations, such as calling out names or signing attendance sheets, are not only time-consuming but also prone to errors. With the advancement of technology, computer vision can be utilized to automate the manual approach to attendance tracking. Facial recognition using computer vision is the key to automating attendance without the need for paper and pen. This technology allows teachers, students, and parents to check attendance in real-time, anytime and anywhere. By implementing Deep Learning Image Processing techniques, the process of attendance prediction can be simplified, saving time and reducing costs.

(10) Each student's attendance rate is computed automatically by the system. The User List Graphical User Interface (GUI) provides a way to add and delete personal data of students [4]. When the system recognizes a student's face, their presence is confirmed, and their face information is updated in the MySQL database. The current data of each student is then sent to a server computer and securely stored for viewing by authorized personnel [7].

3. Proposed Method

The proposed system for automated attendance management is built upon a face recognition algorithm. When a person enters the classroom, the camera at the entrance captures their image. (Model 3.1) The face region is then extracted and pre-processed for further analysis. Since no more than two persons can enter the classroom at the same time, face detection becomes less complex. Compared to other systems, face recognition proves to be advantageous for analyzing faces and marking attendance.

Here is a proposed method for developing such a system in a research paper:

(1) Data collection: Gather a dataset of facial images of individuals who will be attending the event or class. The dataset should be diverse enough to include different races, genders, and ages to ensure that the system is accurate for a wide range of individuals. The images should also be taken in various lighting conditions and angles to improve the robustness of the system.

(2) Pre-processing: The images should be pre-processed to remove any noise, such as shadows or background clutter, that may affect the accuracy of the system. The pre-processing step can involve techniques such as normalization, equalization, and filtering.

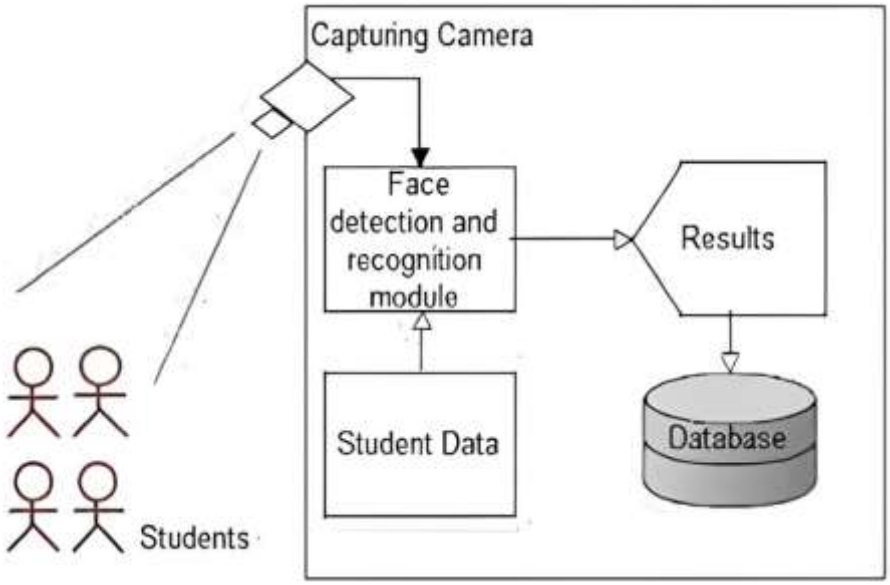
(3) Feature extraction: Extract facial features, such as eyes, nose, mouth, and eyebrows, from the pre-processed images. This step can involve using techniques such as Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), or Convolutional Neural Networks (CNN).

(4) Recognition: Use the extracted features to recognize individuals in real-time. The recognition step can involve various techniques, such as Support Vector Machines (SVM), K-Nearest Neighbors (KNN), or Neural Networks.

(5) Integration: Integrate the recognition system with an attendance management system, such as a database, to keep track of attendance records for each individual.

(6) Testing and evaluation: Test the system on a large dataset of facial images to evaluate its accuracy and efficiency. The evaluation can be done using metrics such as accuracy, precision, recall, and F1 score.

(7) Implementation: Deploy the system in the intended setting, such as a classroom or workplace, and monitor its performance in real-world conditions.



Model 3.1 Methodology

3.1 Face Detection

Face detection is a critical component of a smart attendance monitoring system using facial recognition. The detection process involves identifying and locating faces in an image or video frame, which is necessary to extract facial features and perform recognition accurately. To detect faces, we first need to detect them in an image. The Local Binary Pattern Histogram (LBPH) Face Detector [9] is unmatched in speed and provides relatively good accuracy. Python is strongly required to use ultra-lightweight models and requires specific models to perform actions. I need to use the LBPH model and resize the input image to 720x460. Some of the methods which are used for face detection in a smart attendance monitoring system are:

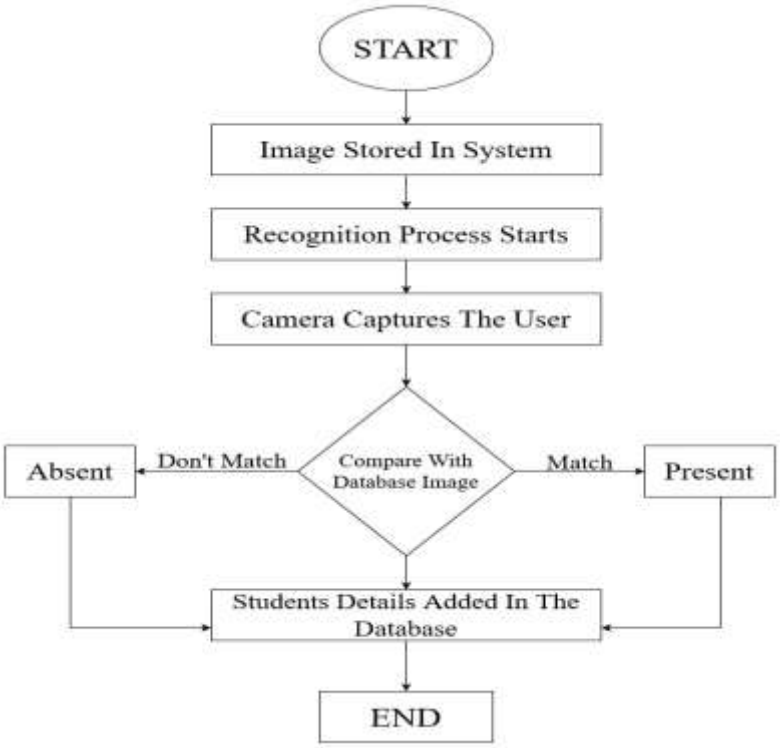
(1) Haar cascades: This is a popular method for face detection that uses Haar features to identify faces. It involves training a classifier on a large dataset of positive and negative images to detect patterns in the image that correspond to faces. The classifier then scans the image or video frame for these patterns to identify faces.

(2) CNN (Convolutional Neural Networks): CNNs have become popular for face detection in recent years due to their high accuracy. The network is trained on a large dataset of images to learn features that correspond to faces. The trained network can then be used to detect faces in real-time.

In a smart attendance monitoring system, the face detection method should be selected based on the requirements of the system, such as accuracy, speed, and computational resources available. The chosen method should also be robust to variations in lighting conditions, facial expressions, and poses to ensure accurate detection of faces.

3.2 Face Recognition

LBPH is a deep learning algorithm that achieves up to 80% accuracy for labeled facial information in a given dataset [10] and up to 90% of correctness in face recognition in a given dataset. The smart attendance monitoring system operates by grasping the person's facial image, then using facial recognition algorithms to compare the captured image in a saved database of known persons. If a equivalent dataset is discovered, the system records the individual's attendance. The system can be set up to automatically record attendance when a person enters a specific location, such as classroom or office, or it can be used in a more traditional manner where individuals must actively sign in or out. Please refer to Model 4.2 for enhanced comprehension.



Model 3.2 System Flowchart

4. Result and Discussion

Our proposed system operation involves three steps.

a) Creation of databases.

b) Model training.

c) Actual-time data recognition.

Prior to we start, drift all the libraries we need, in which the library includes

a) Opencv: for image/video processing.

b) Numpy: takes pixels as an array.

c) Dlib: for face matching (landmarks).

d) Os: switch/erect directories aa well as unfold files in directories.

e) Imutiles: for image manipulation (preprocessing).

f) Tensorflow: for creating layers and creating/loading models.

g) Xlsxwriter: for creating/reading/writing Excel sheets.

4.1 Database

In a smart attendance monitoring system using facial recognition, the first step is to generate a database of student photos. This database is used to train the facial recognition model to identify and recognize each student.

The database of student photos should be created using clear and varied images of each student. It is important to ensure that the photos are high quality and well-lit, with minimal background noise or distortion(Model 4.1). The photos should be in the .jpeg format, as this is a widely used format for images that can be easily processed by the facial recognition model.

Each student should have a corresponding folder in the database, containing multiple images of the student taken from different angles and under different lighting conditions. This variety of images is important to ensure that the model can recognize the student under different circumstances, such as when they are wearing glasses or a hat, or when the lighting is poor.

In addition, it is important to ensure that the database is kept up-to-date with any changes in the student population. This may include adding new students or updating the photos of existing students. Regular maintenance of the database can help to ensure the accuracy and effectiveness of the smart attendance monitoring system.

Once the database of student photos is generated, it can be used to train the facial recognition model. This involves extracting features from the photos and using them to create a unique profile for each student. The model can then use this profile to identify and recognize each student in real-time, allowing for accurate and efficient attendance monitoring.

Model. 4.1: Input Images

4.2 Training

After generating the database of student photos, the next step in developing a smart attendance monitoring system using facial recognition is to train and upskill the prototype.

The training process involves feeding the facial recognition model with a set of labeled images, which are used to create a model of the unique facial features of each student. This process is typically done using a machine learning algorithm such as Local Binary Patterns Histogram (LBPH) or Principal Component Analysis (PCA).

Prior to training, the images are preprocessed to extract the relevant features and to align them correctly. This preprocessing step involves using OpenCV functions such as face detection, alignment, and normalization. The resulting preprocessed images are then used to create transformations or alignments in the original image folder.

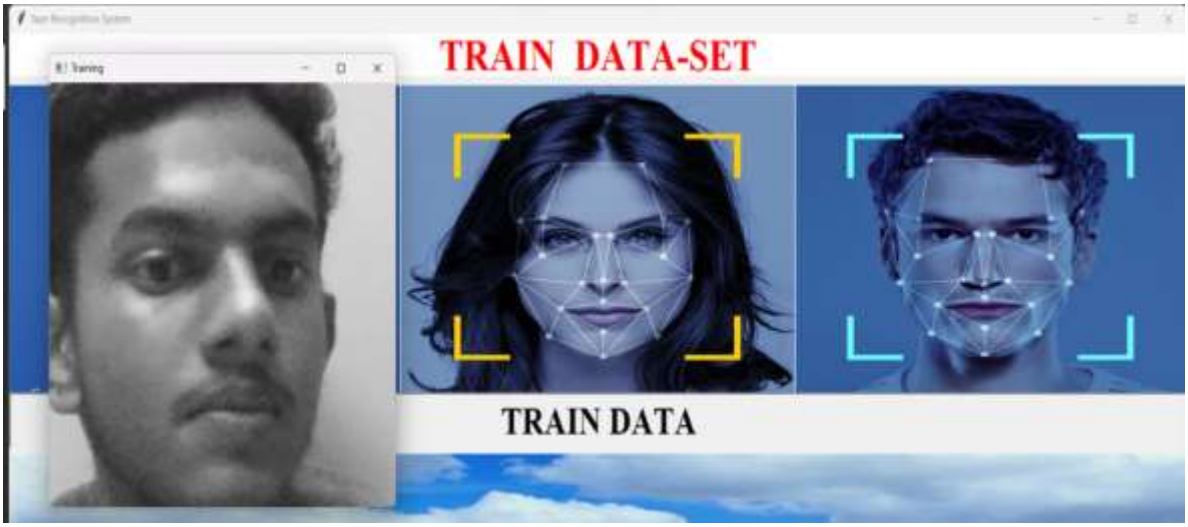
Once the images are preprocessed and aligned, the extracted features are dumped into the

haarcascade_frontalface_default.xml file, which is used to create a face detection model. The mapping of

the features to the appropriate student names and images is also done at this stage.

Finally, the facial recognition model is trained on the preprocessed images using LBPH, which is a popular algorithm for face recognition. The trained model is then tested to ensure that it can accurately recognize each student in the database. This testing process may involve using real-world scenarios or simulations to ensure that the model is robust and accurate under different lighting conditions, poses, and expressions.

Overall, the training and upskilling process is critical for the success of a smart attendance monitoring system using facial recognition. Model 4.2 presents a complete depiction of the enhanced knowledge of the training dataset, utilized for training the input images to ease the subsequent detection phase.



Model. 4.2: Training

4.3 Recognition

Face recognition requires face recognition. We have tried many face detectors like Yoloface, MTCNN, HOG, Ultralight Face Detector. And we chose the local binary histogram (LBPH) face detector because it enables accurate detection with less processing power. 70 to 80 faces can be detected in one frame. As well, the calculation duration is shortened as compared to other detectors.

Model 4.3: Recognition

Index	Method	No. Faces	Time (s)
a	face_recognition cnn	70	108.499
b	face_recognition hog	74	0.76
c	mtcnn	123	2.209
d	yoloface	129	1.063
e	ultra light	80	0.102

The following Python packages are required to use the LBPH model (Python version 3.6).opencvpython==4.1.1.26, tensorflow==1.13.1

Since we will be using a pre-trained model, we need to resize the input image to 640x480. If using the 320 model, size accordingly.

After pre-processing the images, we need to produce the LBPH structure and build an inference session.

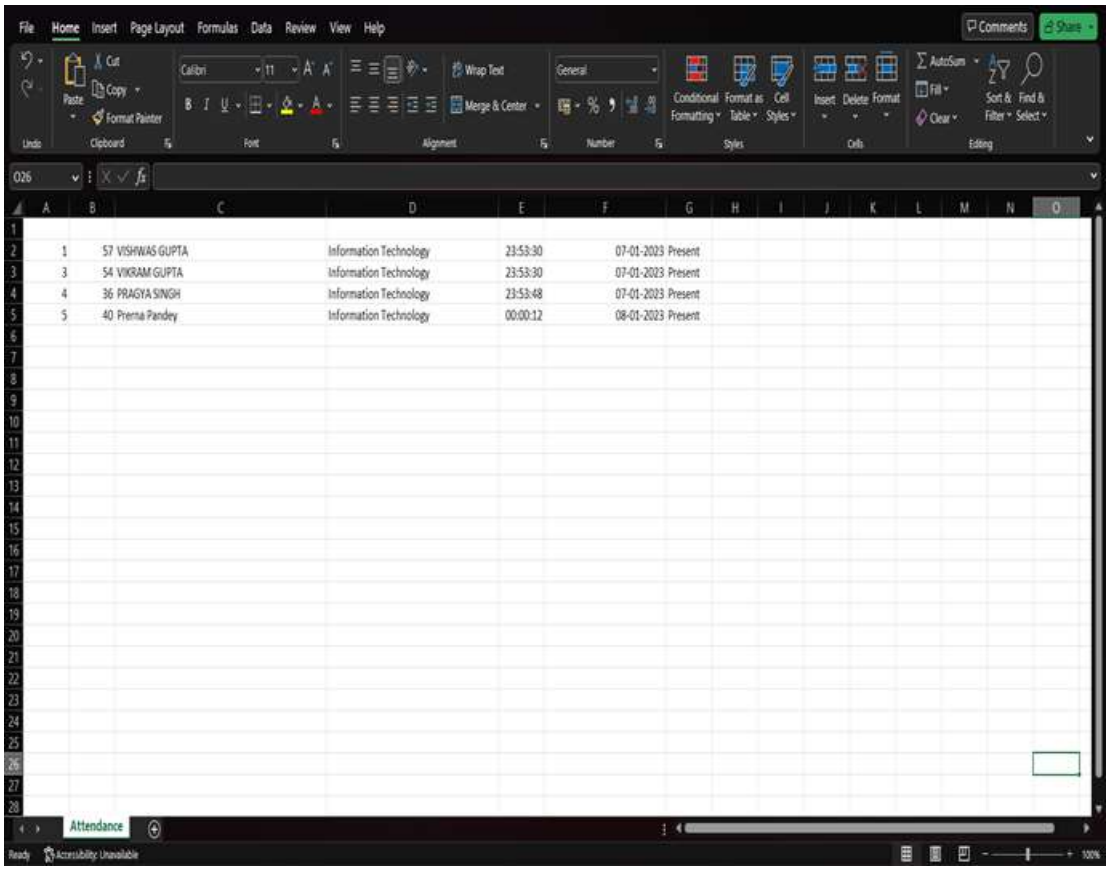
Once found, after that the major step is identification. Face recognition can be performed using various methods such as OpenCV, Resnet, FaceNet, VGGFaceNet, and MobileNetV2. Among them, OPENCV2 was selected because of highly accurate real-time face verification on mobile and embedded devices [14].

5. Result

To perform face recognition, one can simply download the dataset, which is named accordingly (CSV file). The system then uses the Euclidean distance and a threshold to measure the difference between the target face and the human faces in the database. If the difference between the two is greater than the threshold, the face is recognized as belonging to a celebrity. Conversely, if the difference is relatively large, the face is labeled as unknown. A real-time face recognition system was developed, which uses a CPU and can operate at 13 frames per second. Although it is not as fast as using complex CNNs, it is still comparatively quicker.

Yet, there is much that can be done to boost up the performance (i.e. accuracy and speed) of this structure. Potentially apply knowledge distillation to compress the current model and use low-bit computation to further lessen the bulk of the models. Additionally, other machine learning classification techniques [15] can be used for embedding to improve accuracy.

Model 5 is an output or result in the form of a report, which contains essential information about the students who have marked their attendance. The output includes the name of the student, the roll number assigned to them, their college identification number, and the department they are enrolled in. Additionally, the output provides the date and time when the attendance was taken, which can be used for further analysis and record-keeping purposes. By analyzing the information presented in Model 5, educators or administrators can keep track of student attendance, identify patterns, and make informed decisions regarding the learning environment.



Model. 5: Result

6. Conclusion

This project is built to handle attendance in a smarter way. LBPH is a deep learning algorithm that achieves up to 80% accuracy for tagged faces in a given data set and up to 90% accuracy for face recognition in a given data set. This helps administration by reducing the time it takes to manually record attendance and replacing the system of RFID cards assigned to each student with their own ID. The implementation of this model guarantees that lost cards or any similar issues do not affect the student's attendance record. The system can identify the students based on their biometric data, which is unique to each individual, and eliminate the need for traditional attendance methods that rely on physical identification cards or signatures. In doing so, the possibility of unauthorized access to the institution is also minimized, as only the registered students would be allowed to mark their attendance. This not only enhances the security of the institution but also helps in the efficient management of attendance records, enabling educators to maintain a more accurate account of student attendance. Therefore, the implementation of this model in real-life scenarios would be highly beneficial for educational institutions as it can improve their attendance management system, minimize the chances of forgery, and prevent strangers from entering the institution.

7. Future Scope

The automatic Time and Attendance (T&A) system based on facial recognition technology offers several benefits such as time savings and increased security. As the system operates automatically, it eliminates the need for manual attendance recording, which can be time-consuming and prone to errors. In addition, the facial recognition-based system offers greater security compared to traditional methods as it can accurately identify students based on their unique facial features.

In the future, the system can be further enhanced by automatically notifying parents when their child is absent from school. Moreover, the same system can be used to monitor attendance at the dormitory, providing greater security and accountability for students residing on campus. To inform parents about their child's attendance status, the system can be programmed to send a mail message containing absentee information and the student's attendance rate.

Unlike traditional attendance management systems, where attendance is recorded module-wise, the proposed system offers the convenience of updating attendance records with a single click or touch. This makes the attendance process more efficient, and educators can have accurate records at any time.

Parents can also access internal grades through their child's messages, providing them with regular updates on their child's academic progress. Overall, the automatic T&A system based on facial recognition technology is a comprehensive solution that offers numerous benefits, including time savings, increased security, and improved communication with parents.

References

[1] T.S. Lim, S.C. Sim, M.M. Mansor, ―RFID Based Attendance System‖, 2009 *IEEE Symposium on Industrial Electronics and Applications (ISIEA 2009), October 4-6, 2009, Kuala Lumpur, Malaysia.*

[2] S, Kadry; K. Smaili, ―A Design and Implementation of A Wireless Iris Recognition Attendance Management System‖, *ISSN 1392 – 124X Information Technology and Control*, 2007, Vol.36, No.3.

[3] M. K. P. Basheer, C. V. Raghu, ―Fingerprint attendance system for classroom needs,‖ *in Proc. India Conference (INDICON), 2012 Annual IEEE*, pp. 433-438, 7-9 Dec. 2012.

[4] S. Chintalapati; M.V. Raghunadh, "Automated attendance management system based on face recognition algorithms," Computational Intelligence and Computing Research (ICCIC), *2013 IEEE International Conference on*, vol., no., pp.1,5, 26-28 Dec. 2013, doi: 10.1109/ICCIC.2013.6724266.

[5] Nirmalya Kar and Ashim Saha; Study of implementing automated attendance system using face recognition technique unit", Computer Architecture (ISCA) 2017 *ACM/IEEE 44th Annual International Symposium on*, pp. 1-12, 2017.

[6] Dalal, N. and Triggs, B.: Histograms of oriented gradients for human detection. *In: IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR).* pp. 886–893. (2005).

[7] N. Rotem, J. Fix, S. Abdulrasool, S. Deng, R. Dzhabarov, J. Hegeman, et al., "Glow: Graph lowering compiler techniques for neural networks", *CoRR*, vol. abs/1805.00907, 2018.

[8] N. P. Jouppi, C. Young, N. Patil, D. Patterson, G. Agrawal, R. Bajwa, S. Bates, S. Bhatia, N. Boden, A. Borchers et al., "In-datacenter performance analysis of a tensor processing unit", *Computer Architecture (ISCA) 2017 ACM/IEEE 44th Annual International Symposium on*, pp. 1-12, 2017.

[9] T.-Y. Lin, P. Dollar, R. Girshick, K. He, B. Hariharan, and ´S. Belongie. Feature pyramid networks for object detection. *In CVPR*, 2017. 1, 2, 4.

[10] Howard, A. G., Zhu, M., Chen, B., Kalenichenko, D., Wang, W., Weyand, T., et al.: Mobilenets: Efficient convolutional neural networks for mobile vision applications. *CoRR, abs*/1704.04861 (2017).

[11] Schroff, F., Kalenichenko, D., Philbin, J.: Facenet: a unified embedding for face recognition and clustering.*In: CVPR* (2015).

[12] Han, S., Mao, H., Dally, W. J.: Deep compression: Compressing deep neural network with pruning, trained quantization and Huffman coding. *CoRR, abs*/1510.00149 (2015).

[13] T.-Y. Lin, P. Goyal, R. Girshick, K. He, and P. Dollar. Focal ´loss for dense object detection. *In ICCV*,2017. 1, 2, 4.

[14] G. B. Huang, M. Ramesh, T. Berg, and E. Learned-Miller. Labeled faces in the wild: A database for studying face recognition in unconstrained environments. *Technical report*, 2007. 6.

[15] Sun, Y., Wang, X., Tang, X.: Deeply learned face representations are sparse, selective, and robust. *In: Computer Vision and Pattern Recognition*, pp. 2892–2900 (2015)