Contactless Attendance Management System using Artificial Intelligence

M Rajamanogaran¹, S Subha², S Baghavathi Priya³ and Jeevitha Sivasamy⁴

¹ Data Science Consultant, Chennai, Tamil Nadu, India.
² Associate Professor, Department of Computer Science and Engineering, Rajalakshmi Institute of Technology, Chennai, Tamil Nadu, India.
³ Professor, Department of Information Technology, Rajalakshmi Engineering College, Chennai, Tamil Nadu, India.
⁴Research Scholar, Department of Computer and Information Science, Annamalai University, Chidambaram, Tamil Nadu, India.
manogaran248@gmail.com, subha.s@ritchenai.edu.in, baghavathipriya.s@rajalakshmi.edu.in, jeevithamca06@gmail.com

Abstract. Attendance monitoring is one of the vital administrative processes in all educational institutions and organizations. A well-structured system will enable the institutions to have an increasing growth. It helps the students and teachers in all ways to have a good progress in the attendance, thereby reducing the teachers’ time and effort. In physical classrooms, traditional method of calling the students names and marking their presence/absence is the routine process followed regularly. Attendance monitoring system is proposed using artificial intelligence. Firstly, a database containing the facial images of the students in a particular class is constructed. Knowledge gained using Convolutional Neural Network (CNN) is reused in a perfect manner using transfer learning. This system is designed to improve the students’ engagement time inside the classroom, to communicate to the parents frequently, to avoid proxy attendance and to generate detailed reports for future reference.

1. Introduction
In recent days, attendance management plays a crucial role in the educational institutions and organizations. The outcome of an educational institution is based mainly on the students’ attendance in the class room. In a traditional teaching system, it is required for the faculty to take the attendance manually before starting the class. Based on the percentage of attendance scored by a particular student, marks will be allotted. Nowadays, faculty face major issues such as increase in the student strength in a class, proxy attendance, handling late comers, shortage of time for syllabus coverage. In an automated system, efforts for taking the attendance will be greatly reduced and there is a possibility of preventing the proxy attendance using biometric methods. In the biometric method, students can fix their fingerprints in a device before entering the class. It is considered as the major factor for their presence in class. But in the recent days, another threatening fact is the spread of pandemic disease...
(COVID’19) very rapidly. After the reopening of schools and colleges, a precautionary measure of using AI powered contactless system must be made to avoid the usage of biometric attendance. Students will get infected if they use the biometric way. To overcome the above challenges, a Contactless Attendance Management System (CAMS) is proposed in an efficient manner. This system will record the students’ attendance automatically while entering the class, by recognizing their faces. The in-time and out-time of the students are also recorded frequently. Based on this calculation, the total time of presence of the students inside the class can be easily deliberated. There is no chance of giving fake attendance as each student has to record his or her facial identity. The proposed system aims to achieve reliability, accessibility and security in an efficient way.

2. Related works

One of the attendance management systems used biometric fingerprints and passwords. It has been developed as a desktop application for monitoring the attendance [1]. Attendance monitoring system was developed using RFID data logger to verify the attendance within a short duration. The system uses ASP.net for data analysis [2]. Another system used techniques to handle spoofing. But it recognized face up to 30 degree angle only [3]. A methodology was used to avoid fake attendance and proxies, thereby reducing the light intensity problem and head pose problem [4]. A portable device has been developed using face recognition technology to monitor the students’ attendance [5]. Bluetooth Smart based system is designed to track the attendance of students. This is aimed to avoid human errors and to reduce time [6]. A device has been developed to monitor the students’ attendance by recording their finger prints [7]. Through face detection, attendance is registered and matched with the face database using Principle Component Analysis (PCA) and Linear Discriminant Analysis algorithms [8]. A RFID based attendance system was designed to operate as a standalone system by sending SMS notification to the users [9]. Face recognition system was established for marking the attendance of the students. PCA is used for clustering the facial images of the students. But the new comers cannot be detected in this system [10]. Another system uses RFID tag and RFID reader to track the attendance and it focused on privacy and security related issues [11]. The proposed system is used to record the students’ attendance through their ID cards. Faculty members have to make use of their mobile phones to track the attendance [12]. An intelligent based real time system was implemented using RFID hardware to maintain students’ attendance during the class hours [13]. Biometric features were selected by applying Minutiae based algorithm and they were encrypted using Advanced Encryption Standard Algorithm [14]. Biometrics based Staff Attendance Monitoring System was proposed in the paper, in which the employees’ attendance was monitored and tracked by an administrator [15].

3. Proposed system

The main aim of Artificial Intelligence (AI) is to develop technology which makes the machines to mimic the human beings. Learning algorithms work on the basis of AI. In particular, machine learning plays a vital role through which the algorithms can be improvised based on their experience. Neural networks are a set of algorithms which is composed of artificial neurons. These artificial neurons will mimic the biological neurons. Real time problems can be solved using Artificial Neural Networks (ANN). A simple neuron N receives input from other neurons, and then it activates itself, adjust its weights using training samples. Deep learning, which is a subset of machine learning is based on ANN. CNN is a part of deep neural networks and it is widely used in many applications. In the proposed system, CNN is applied to monitor the contactless attendance of the students. There are many pre-trained models available in CNN for different use cases. In transfer learning, pre-trained models (Inception V3) are used as a basis for computer vision. Feature extraction is done for all the faces and is stored separately. In the real-time, if a student enters the class room, his/her face has been detected using the camera. The entire process is depicted in Figure 1.
4. Results and discussions

4.1. System results

Features of the detected facial image have been extracted and are compared with the features present in the database. A sample image of a student is shown in Figure 2. If there is a valid match, attendance will be marked as present and the time of presence will be recorded. From that moment, the in time has been recorded. The same process is used for recording the out time and based on these inputs, the total hours of the students present inside the class room have been calculated.

A sample attendance database is given in table 1. Thus, the attendance tracking of students is done efficiently using artificial intelligence.

Table 1. Sample attendance details
4.2. Performance analysis of the proposed work

By applying the InceptionV3 model, the classification report of seven different class labels of students has been generated. Based on the in time and out time, various measures such as precision, recall, f1-score and support values are depicted in Table 2. 

Precision is calculated as the number of positive class predictions that actually belong to the positive class and it is given by

\[
\text{Precision} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Positive}}
\]

The resulting value lies between 0.0 and 1.0, where 0.0 is used for denoting no precision and 1.0 for full or perfect precision. Similarly, recall is measured as the number of positive class predictions made out of all positive examples and it is calculated as follows.

\[
\text{Recall} = \frac{\text{True Positive}}{\text{True Positive} + \text{False Negative}}
\]

The resulting value lies between 0.0 and 1.0, where 0.0 is used for denoting no recall and 1.0 for full or perfect recall. Both precision and recall can be combined into a single measure called F-Measure or f1-score and it is calculated using the formula

\[
\text{F-Measure (f1-score)} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}
\]

Support is computed by calculating the total number of samples of the true response that is present in the given class.

| S.No. | Class label | In time (hh:mm:ss) | Out time (hh:mm:ss) | Total time (hh:mm:ss) | Present or Absent |
|-------|-------------|--------------------|---------------------|-----------------------|-------------------|
| 1     | Class1      | 18:22:30           | 18:25:41            | 3:11                  | Present           |
| 2     | Class2      | 18:25:13           | 18:25:42            | 0:28                  | Present           |
| 3     | Class3      | 10:10:15           | 12:25:45            | 2:15:30               | Present           |
| 4     | Class4      | 11:00:10           | 12:45:30            | 1:45:20               | Present           |
| 5     | Class5      | 09:15:20           | 12:15:35            | 03:00:15              | Present           |
| 6     | Class6      | -                  | -                   | -                     | -                 |
| 7     | Class7      | -                  | -                   | -                     | -                 |

Table 2. Classification Report for InceptionV3

|                | Precision | Recall | F1-score | Support |
|----------------|-----------|--------|----------|---------|
| Class1         | 0.97      | 0.97   | 0.97     | 40      |
| Class2         | 0.97      | 0.95   | 0.96     | 40      |
| Class3         | 0.95      | 0.90   | 0.92     | 40      |
| Class4         | 0.90      | 0.88   | 0.89     | 40      |
| Class5         | 0.89      | 0.97   | 0.93     | 40      |
| Accuracy       |           | 0.94   |          | 200     |

4.3. Confusion matrix for Inception V3 face recognition model
Confusion matrix is a measure for evaluating the performance of the face recognition model using the values of True Positive, True Negative, False Positive and False Negative. For generating confusion matrix, 40 test samples have been taken for each class. Diagonal values in the matrix give the true positive values for each class and the rest of values are interpreted as the misclassified classes. The confusion matrix for the proposed work is depicted in Figure 3.

**Figure 3. Confusion matrix for the proposed work**

### 4.4. Comparative analysis of various methodologies

The accuracy produced by various methodologies is compared with the proposed methodology Inception V3. Existing approaches such as LDA, RFID, SVM, PCA and usage of portable device are taken for comparison and their accuracy results are expressed in terms of percentage. In Figure 4, it is observed that the proposed system produces a better accuracy result of 95% when compared to the existing methodologies.
Figure 4. Comparison of various methodologies in face recognition

To achieve better accuracy, learning rate is taken as the measuring parameter. The learning rate controls how quickly the model is adapted to the problem. The learning rate for the model has been computed by measuring the loss and accuracy of Inception V3. Based on the number of epochs, loss and accuracy have been calculated and is represented in Figure 5.

Figure 5. Calculation of loss and accuracy in Inception V3 methodology

5. Conclusion and Future enhancements
An effective contactless attendance management system is developed using artificial intelligence. The work has been developed as a touch-free system to prevent the students getting affected from contagious diseases, especially COVID'19. The traditional way of taking attendance has been substituted by this system, thereby reducing the efforts taken by the faculty during each class hour. It
also avoids the proxy attendance given by the students, sometimes. The overall attendance for a class can be easily obtained by calculating the in-time and out-time of the students entering the class. A customized attendance report has been generated automatically and thus the system enables the faculty to save time for taking attendance in the class room. In future, this work can be converted into web services, applicable for all domains. Also, the 3-D images can be incorporated in future for producing better accuracy.

References

[1] Sarker D K, Hossain N I and Jamil I A 2016 Design and implementation of smart attendance management system using multiple step authentication 2016 International Workshop on Computational Intelligence (IWCI) pp 91-95
[2] Abas M A, Tuck T B and Dahlui M 2014 Attendance Management System (AMS) with fast track analysis 2014 International Conference on Computer, Control, Informatics and Its Applications (IC3INA) pp 35-40
[3] Chintalapati S and Raghunadh M V 2013 Automated attendance management system based on face recognition algorithms 2013 IEEE International Conference on Computational Intelligence and Computing Research
[4] Wagh P, Thakare R, Chaudhari J and Patil S 2015 Attendance system based on face recognition using eigen face and PCA algorithms 2015 International Conference on Green Computing and Internet of Things
[5] Bhattacharya S, Nainala G S, Das P and Routray A 2018 Smart Attendance Monitoring System (SAMS): A Face Recognition Based Attendance System for Classroom Environment 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT) pp 358-360
[6] Lodha R, Gupta S, Jain H and Narula H 2015 Bluetooth Smart Based Attendance Management System Procedia Computer Science 45 pp 524–527
[7] Mohamed, B. K. P and Raghu C V 2012 Fingerprint attendance system for classroom needs 2012 Annual IEEE India Conference (INDICON) pp 433-438
[8] Raghuwanshi A and Swami P D 2017 An automated classroom attendance system using video based face recognition 2017 2nd IEEE International Conference on Recent Trends in Electronics, Information & Communication Technology (RTEICT) pp 719-724
[9] Chen H 2014 Intelligent Classroom Attendance Checking System Based on RFID and GSM Advanced Materials Research 989–994 pp 5532–5535
[10] Poornima S, Sriprity N, Vijayalakshmi B and Vishnupriya P 2017 Attendance monitoring system using facial recognition with audio output and gender classification 2017 International Conference on Computer, Communication and Signal Processing (ICCCSP)
[11] Pireva K. R, Sique J and Berisha S 2013 RFID: Management System for students’ attendance IFAC Proceedings Volumes 46(8) pp 137–140
[12] Alghamdi S 2019 Monitoring Student Attendance Using A Smart System at Taif University SSRN Electronic Journal pp 107-115
[13] Rajan Patel, Nimisha Patel, Mona Gajjar 2012 Online Students’ Attendance Monitoring System in Classroom Using Radio Frequency Identification Technology: A Proposed System Framework International Journal of Emerging Technology and Advanced Engineering 2, Issue 2 pp 61-66.
[14] O.K. Oyetola, A.A. Okubanjo, O.O Olaluwoye 2017 A Secure Students’ Attendance Monitoring System Journal of Engineering Technology 2, Issue 1, pp 14-25
[15] M. Olagunju, A. E. Adeniyi, T. O. Oladele 2018 Staff Attendance Monitoring System using Fingerprint Biometrics International Journal of Computer Applications 179, Issue No.21