**A**

**SEMINAR REPORT**

**on**

**Class Attendance System in Education with Deep Learning**

**Submitted to the Faculty of Engineering and Technology**

**B.Tech - V Semester**

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**Warangal – Telangana**

**2024-2025**



**C E R T I F I C A T E**

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# ACKNOWLEDGEMENT

I extend my sincere thanks to our esteemed guide, **V. Prashanthi, Asst. Professor** for his exemplary guidance, monitoring, and constant encouragement throughout the course at crucial junctures and for showing us the right way.

I am grateful to respected coordinators **Dr. M. Rajesh, Asst. Professor** for guiding and permitting me to utilize all the necessary facilities of the Institute.

I sincerely thank to respected convener **Dr. S. Raghu, Asst. Professor** for supporting me and utilizing all the necessary facilities of the Institute.

I would like to extend thanks to our respected head of the department, **Dr.** **S.** **Narasimha Reddy, Professor** for allowing us to use the facilities available. I would like to thank other faculty members also.

I would like to thank all of the faculty members, friends, and family for their support and encouragement given to us during the seminar

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## ABSTRACT

Whereas these developing technologies lead to enhancement in hardware gain of computers and increase in the processing capacity of processors, processing instantaneous and real-time images is possible by computers. Studies are also included on face recognition processes in the field of image processing. Facial recognition processes are extensively used in security applications and commercial applications. Especially in the last 20 years, high-performance results of AI studies have caused such research activities to spread to many different fields. Education is one of them. The potential and advantages of using AI in education can be grouped under three headings: student, teacher, and institution. One of the institutional studies may be the security of educational environments and the contribution of automation to education and training processes. From this point of view, deep learning methods, one of the sub-branches of AI, were used in this study. To achieve object detection from images, a pioneering study was designed and successfully implemented for record keeping of students' entry into the educational institution and for performing class attendance with images taken from the camera through the implementation of image processing algorithms. The application of the study to real-life problems shall be carried out in a school that is determined in the 2022-2023 academic year.

Key words: Face recognition, deep learning, artificial intelligence in education, HOG

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**CHAPTER 1**

**Introduction**

**1.1 Introduction**

The advancement in technology has enabled the processing of instantaneous and real-time images through hardware gain of computers and the increment of processing capacity of processors. In this way, studies in this field of image processing have been grown at rocket speed. The images captured through the cameras are processed on hardware-powered computers and researchers have done many studies on topics such as:

•Recognition of the visible object

•Face detection and recognition

• Face tracking

• Human emotion recognition

• Determination of human gender and age

• Sign language detection

The face recognition technique has been used in two major applications. The first main application of the technique is in security applications, primarily used in crime photo albums and video surveillance systems in real-time matching with video footage sequences. Commercial applications range from the static matching of photos on credit cards, ATM cards, passports, driver's licenses, and photo IDs to real-time matching with still images or video image sequences for access control. Each application places different restrictions on the handling of information and results.

The systems in educational institutions keep safety in mind for students. Many technological methods such as Radio Frequency Identification (RFID), wireless communication, fingerprint, iris, and advanced face recognition based, etc. are testedand was implemented in security systems. Most of these methods have very high costs of installing the system and therefore have some advantages and disadvantages. The fact that school budgets are not too high, an automatic attendance system was developed, using the existing technological infrastructure without the cost of extra equipment.

Especially in the last 20 years, high performances of AI studies contribute to the spread of these studies in many different fields. One of them is education. The potentials and advantages of using AI in education can be grouped under three headings such as students, teachers, and institutions. The safety of learning environments and how automation contributes to educational and training processes could be one of the institutional studies. From this perspective, deep learning (DL) methods, which are one of the sub-branches of AI, were used in this study. In this research, image processing algorithms were used for object detection from images, student admission records were kept with images taken from the camera, and a pioneering study was designed to perform class attendance.

**CHAPTER 2**

**Literature Review**

**2.1 Eldem and Palalı (2017)**

Eldem and Palalı (2017) have used in his study, Open Source Computer Vision Library (OpenCV), and image processing libraries. In the study, the component used is the OpenCVSharp which was created for the C# programming language that works in harmony with OpenCV. In the system, the images of people were taken through the camera, and the facial regions were marked with the haarcascade structure. Compare faces registered in the database with those faces from the camera using the template matching method. For the pilot study, a success rate of 79% has been observed in face recognition.

**2.2 Kaplan (2018)**

Kaplan (2018) used the Haar-Cascades classifier to determine whether there is a face in any image. In the study, AForge.NET software library was used to speed up image processing. EmguCV software library, which uses timer logic, was used to prevent lag in the interface. As a result, in this thesis study, face detection in images has been successfully performed in real time to meet the needs of the system.

**2.3 UCAR (2019)**

In his thesis, Uçar (2019) ascertained the distraction rates of students in a classroom setting where their faces are recognized in real time, head directions followed and head direction movements interpreted. He used image processing and machine learning libraries OpenCV and Dlib in his system. In the developed application, he photographed and recorded various head directions and facial expressions of the students. Based on the Local Binary Patterns method, the students' face recognition model was proposed using the training dataset. The photos marked as "Careful" and "Careless" were detected by the algorithm for a support vector machine. According to the results of the tests, the success rate of the system was determined as 72.4%.

**2.4 Savas et al. (2017)**

In the study by Savaş et al. (2017), it was targeted to determine the number of human faces involved in photographs captured through a mobile device and calculate the occupancy capacity of the environment with this number. In the study, haarcascade\_frontalface\_alt and haarcascade\_mcs\_cyepair\_big algorithms were used to detect face and eyes in photographs taken with smart devices. As a result, the haarcascade\_frontalface\_alt algorithm works more efficiently in the study.

**CHAPTER 3**

**Method**

**3.1 Study Architecture**

The camera, at the entrance of the classroom, captures images of the students, and using the image processing algorithms, which are one of the DL methods, the face of the student is detected. The data obtained through the images are then compared with the corresponding class database and student's attendance information is recorded. The steps involved for this process are as follows:

* Creating dataset from student images (by class)
* Getting lecture attendance photo by camera
* Face detection by Convolutional Neural Network (CNN) and Histogram of Oriented Gradients (HOG)
* Face recognition

**•** Registration of attendance records by effect of face recognition

**3.2 Dataset**

Carrying out the design and development studies before applying the designed study to real-world problems, a dataset consisting of web photos of real users and different popular names has been created that are easy to access during the development phase and provides the opportunity to act according to the situation. In the study, the comparison of this data set, which was created with the image to be taken from the camera, was carried out.

The images posted in the data set are recorded as id and the name and surname of the person. In order to avoid one more than two people entering the camera angle in the study, the resolution is set at 150 x 150 pixels from the start.

**3.3 Face Detection Method**

Face detection defines this information by finding the coordinates and size of face objects in an image or video that is received by the system.

In the images obtained from processes of face detection, some problems are usually encountered in images obtained from uncontrolled environments. These problems can be listed as follows:

• Exposure variation: The best scenario for face detection is one that only consists of frontal images, but generally, in uncontrolled conditions this is not the case. Further, a drastic degradation in performance by the face detection algorithms occurs due to large pose variations. There can also be a change in pose because of movements of the person or angle of the camera.

• Occlusion of occlusion: high variability is provided by elements like a beard, glasses, or hat. Also, faces can be partially covered by objects or other faces.

• Facial expressions: facial features vary largely because facial movements are entirely different.

• Viewing conditions: The face may appear very badly because of the environmental conditions from which it was taken or due to the camera from which it was clicked.

To improve the accuracy of the face recognition system, the accuracy rate of the chosen face detection algorithm should also be the highest. It is true that if faces are not detected correctly in a system, problems may occur during the polling; malfunction and sometimes this system may have to be restarted.

Generally, the problems in the system we have designed for educational institutions to use in real-world problems will be taken under control since the student photos that are to be placed in the dataset will be taken by the institution. Other than the problems that were overcome to create the dataset, students will also be warned to ensure that the camera gets a good view during the polling process.

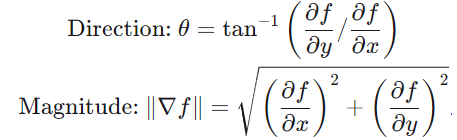
The essential information processing process in the real-time polling system was designed using the Python programming language and leveraging the face-recognition library. This library is built using the face recognition feature of the Dlib library and is built with DL. The model reached an accuracy of 99.38% in different studies. Dlib encompasses ML and DL algorithms (Recursive Least Squares, Support Vector Machine, K-Means, CNN, Deep Neural Network, Artificial Neural Network, Sequential Minimal Optimization) as well as tools (Speeded Up Robust Features, HOG, Fast HOG, Color Space Conversions) to implement a suite of complex software in C++ for real-world problems. It is an open-source library. It is applied in numerous fields, such as robotics, embedded devices, mobile phones, and large high-performance computing environments, and is used by both industry and academia.

It is the Open Source Computer Vision Library, or OpenCV, used in the designed architecture, an open source computer vision and ML software library. The library features more than 2500 optimized algorithms including a comprehensive set of computer vision and ML algorithms. These algorithms can be applied in face detection and recognition, object identification, human action classification of videos, camera movement tracking, moving objects tracking, 3D models extraction of objects, generation of 3D point cloud from stereo cameras, and image stitching in high resolutions.

In the Face-recognition library, there are two different face-detection models to be used in the designed architecture. These include HOG and CNN algorithm used for DL-based face detection. In this study, the face detection was performed using HOG, while CNN is widely used for most video processing applications with abundant video frames to be processed. CNN can be up to 3 x faster for batch processing if large numbers of images are to be processed and if a graphics processing unit (GPU) with Compute Unified Device Architecture (CUDA) is used. However, the HOG model, which is faster for both hardware costs and less processing in educational institutions, was preferred in this study.

**3.4 Face Detection with HOG**

Detection of face is one of the more challenging problems in ML. HOG used in the research: The feature descriptor in machine vision is a method used in processing digital images to detect objects. HOG is also widely used in detecting moving objects. Feature extraction in Figure 3 shows HOG and Gradient Direction and Gradient Magnitude.  
Formulas for finding direction and magnitude are provided in Equation (1) and Equation (2), respectively.



Based on Equations (1) and (2), the gradient direction and magnitude for each pixel are calculated, after which features are extracted as shown in Figure 4 for an example.

**CHAPTER 4**

**Face Recognition**

**4.1 Face Coding**

During the face recognition phase, all important measurements of the face area of all the photographs in the dataset were recorded using the face recognition algorithm. These measurements are actually a set of Red/Green/Blue (RGB) values that the algorithm learns only from the data samples provided to it. The algorithm for face recognition notes some important metrics on the face, such as the color, size and slope of eyes, the gap between eyebrows, etc. All this together defines the face coding (information from an image), which is used to identify a particular face. Face coding consists of 128 numbers. Each of these numbers represents an orthogonal component of face encoding. Figure 5 Sample values found from faces in the dataset.

**4.2 Face Comparison**

In the experiment, the differences found between the faces are used in the subsequent step. For every compared face, each component is checked and whether the component under consideration changes within the tolerance limits. The two sequences in Figure 6 show how close the given image (in the second parameter) is to each of the known face encodings in the given list (in the first parameter). The first sequence in the figure indicates much more similarity. It's clear that this sequence actually describes the person.

If multiple matches are provided for the same person, individuals in the data set will look very similar to each other in the photos. In such a case, a lower tolerance value is needed to enforce stricter face comparisons. Changing the value of the tolerance parameter can produce more accurate identifications. The default tolerance value is 0.6. Lower numbers enforce stricter face comparisons. From this comparison, login records are also saved to a .csv file for later use.

**CHAPTER 5**

**Results And Discussion**

**5.1 Performance Comparison**

Another difference between the two face detection models, HOG and CNN, was the performance of these two different face detection models used in the study in the Face-recognition library. In the experiments carried out, it was concluded that the HOG model captures the image on the camera faster and the FPS of the camera works better. The rates of capturing images and the FPS rates are shown in Table 1..

**Table 1. Image capture performance results**

| **Model Name** | **Image Capture Speed (Sec)** | **Fps Value** |
| --- | --- | --- |
| **HOG** | **0.0322** | **15** |
| **CNN** | **0.3262** | **5** |

**5.2 Attendance Recording**

Once the system found with the study encoded all the pictures in data set, and the features of the faces are kept in a list, when the camera compares the detected face and provides a match with the features of the faces in data set, the person's id and name-surname information appears on the screen. If the match is not achieved, the information that the face is not recognized is displayed on the screen. Figure 7 Examples of identified (matched) and unidentified (unmatched) faces.

The information obtained was matched against the list that was entered earlier into the database, and attendance-absence information was maintained. All student attendance information is stored in a .csv file in the study.

**CHAPTER 6**

**Implementation And Deployment**

6.1 Hardware and Software Requirements

The following are hardware and software requirements that must be met for the successful implementation of the class attendance system using deep learning methods:

Hardware Requirements:

• High-resolution camera for photo-taking of students' images.

• Suitable processing power (CPU/GPU) for real-time image processing.

• Legitimate storage to hold the dataset and attendance records.

• Networking infrastructure to transfer and store data.

Software Requirements:

• Python as the programming language.

• OpenCV library for image processing.

• Dlib library for machine learning and deep learning algorithms.

• Face-recognition library for face detection and recognition.

• Database management system for storing and retrieval of attendance records.

6.2 Deployment Strategy

Class Attendance system deployment strategy: The steps below have been taken during the class attendance system's deployment strategy,

1. Hardware and Software Installation:

• Digi cam with high resolution will be mounted at the entrance door

•  All software libraries and dependencies would be installed on the server

•  Suitable processing power and storage capacity would be available in a server**.**

2.Dataset Preparation:

• Compilation and preparation of the dataset of images of students.

• The dataset should be diverse, and representative of the student population.

3.System Configuration:

• Port the face recognition algorithm with the prepared dataset.

• Set up the database management system for storing attendance records.

4. Testing and Validation:

• Thoroughly test the system in a controlled environment.

• Validate the face recognition algorithm accuracy and reliability.

5. Deployment:

• Deploy the system within the education institution.

• Train the faculty and staff how to use the system.

6. Monitoring and Maintenance:

• Monitor the system day by day for any issues or errors.

• Periodically do maintenance and updates for the continuous optimal system running.

**CHAPTER 7**

**Ethical Considerations**

**7.1 Privacy and Data Security**

The introduction of a class attendance system involving deep learning methods poses significant ethical issues, such as privacy and data security. To this end,

• Informed Consent:

• Obtain informed consent from students and their parents or guardians prior to capturing and using their pictures to track attendance.

• Data Encryption:

• Ensure all data and information, including student photographs, attendance data, etc., are encrypted against unauthorized access.

• Access Control:

• Strict access control measures to limit the access to attendance records and images of students by qualified and authorized personnel only.

• Data Minimization

• Collect only that amount of data needed for attendance tracking purposes. Don't collect and preserve unnecessary personal information.

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**7.2 Ethical Use of AI in Education**

The use of AI in education should be ethical, meaning the technology should be used with reasonableness, fairness, and justice. The following principles should be followed:

• Transparency:

• Transparency in the use of AI in attendance systems - Students and their parents/guardians need to be educated about the system and how it will be using information from them.

• Fairness:

•.The AI algorithm with its applications in the system must be non- discriminatory and free from bias. Never discriminate against the students based on race, gender, or other characteristics that are protected.

• Accountability:

• Make the institution responsible for proper ethical usage of the AI attendance system. Set clear regulations and guidelines over its usage.

• Beneficence

• Apply the AI attendance system to benefit the students and better enhance their educational experiences; thus, making the system not cause any form of harm or inconvenience to the students.

**CHAPTER 8**

**Future Work**

**8.1 Enhancements and Optimizations**

Future research on the class attendance system employing deep learning methods should be in the form of optimizations and enrichments along the following directions:

• Better Accuracy:

• Enhance the accuracy of the face recognition algorithm to operate in various lighting conditions and different environments.

• Scalability:

• Enhance the scalability of the system to process large datasets and multiple classrooms.

• Real-time Processing:

• Design the system for real-time processing in order to complete attendance tracking instantly.

• User Interface:

• Make the system friendly and easy to use by the faculties and staff.

**8.2 Collaboration with Other Educational Technologies**

Further development could extend to integrating the class attendance system with other educational technologies, including:

• Learning Management Systems (LMS):

• Integrate the attendance system with LMS for an overall view of student attendance and academic performance.

• Student Information Systems (SIS):

• Implementing connection with SIS will integrate the attendance system to make the tracking process smooth and efficient.

• Versions of Attendance:

**CHAPTER 9**

**Conclusion**

A class attendance system based on deep learning techniques is a state-of-the-art advancement in educational technology. It could leverage face recognition and image processing algorithms to monitor student attendance efficiently and automatically. The application of advanced deep learning techniques such as Convolutional Neural Networks and Histogram of Oriented Gradients has significantly improved the accuracy and reliability of face detection and recognition, forming a robust system capable of real-world applications.

This would facilitate several advantages in implementing this system in educational institutions. For instance, it would make the afore-mentioned educational system track attendance, security, and even administrative burden. Since educators' focus would be more on teaching and student engagement, and administrators can ensure accurate and timely attendance records, automation will come out.

However, great challenges lie ahead-accuracy in different lighting conditions and the system's ability to handle large datasets. These shall improve in future research, like fine-tuning the algorithms further to perform better in diverse environments and to optimize the system for scalability. Ethical considerations do not hinge on security and data privacy.

Conclusion The class attendance system using deep learning methods has very great promises that will revolutionize the current mode of attendance management techniques in schools. Continued development of this technology and consideration for ethical implications could significantly enhance the efficiency and effectiveness of educational institutions.

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