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Attendance System in Third -Level Irish Institutions and Colleges Using Face Recognition Approach

MSc Data Analytics

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Attendance System in Third -Level Irish Institutions and Colleges Using Face Recognition Approach

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MSc in Data Analytics

Abstract

The generic system of taking attendance at universities by calling out the roll number of the students or calling out the name to mark as present or absent based on the responses from the students. This attendance system in third-level Irish institutions was an indirect way to encourage inaccuracy. Students often use the technique of proxy to help out their friends or copy the signatures of their classmates to mark the present. This being the general system of taking attendance of students has been the basis that leads to crop up of issues in the accuracy. This research presents a face detection-based automated attendance system that leverages the abilities of machine learning techniques. This research implements a system of attendance using convolutional neural networks (CNN) and Histogram of Oriented Gradients (HOG) with SVM to detect faces and identify the face present. The system developed in the research was found to achieve 90% accuracy obtained through visual verification. The models implemented in the study outperformed the models implemented in previous literature that mostly involved Viola-Jones Face Detector along with a classifier, Eigen feature extractions, and principal component analysis. The models presented overcame the limitations of accuracyand speed that affected these models.

1 Introduction

The technological implications in the attendance systems have been a new thing that develops the systematic overview of attendance. The researchers, the evolution of techno-logical implications such as face recognition software has been taken into consideration to describe its impact on the attendance system. It is further concentrated on the significance of technical installations in colleges and the following information has been backed by the present attendance system in Irish colleges.

1.1 Motivation and Project Background

Attendance taking system in educational institutions or colleges is this standard system that allows the mentors or professors to call out the name of the students or the roll number (Mishra *et al.*, 2020). The responses to the calling out decide the mark on the attendance book. Although it has been the correct way of taking attendance, the tricks of the students are often causing inaccuracy in the system. Any student can respond to the calling out and that would lead the teachers to mark the student as present even if he or she is not. In Irish colleges, the traditional method of attendance-taking was creating a lot of trouble that increased the inaccuracy (Faas, Smith, and Darmody, 2018). The traditional cultural system followed in the colleges is one of the causes that refrained the institutions from implementing technological procedures such as face recognition to secure a proper attendance system. Thereare potential barriers and future potential regarding

the implementation of technologies in institutions. The colleges have been utilizing ICT to structure the management operations of the colleges; however, the traditional aspect of the attendance system refrained the colleges from fully practicing the face recognition system (Fussey and Murray, 2019). A complete research and literature review on the same has the potential to facilitate the practicality of the idea that will help comprehend the current situation and the possibility of its betterment. The positive impacts of the technological implication in the Iris institution increase the significance of using the local binary pattern method to facilitate accuracy in the attendance-taking system. The AI-based face recognition system would be good to record the attendance of students in colleges or educational institutions (Singh, Bhatt, and Gupta, 2021). It is the machine learning algorithm that is involved in the operating system of face recognition software which thereby contributes to theaccuracy of the attendance approach. It is believed that in future the face recognition-based attendance will be mostly used to monitor the presence and absence of students compared to the current attendance system which is a manual process.

Although the idea of technological importance in the attendance system of the ideal colleges is an optimistic factor that regulates the accuracy and helps improve the performance of the students, it comes with potential barriers (Almaiah *et al*., 2022). In the attendance-taking process, the installation of the face recognition system would not be smooth due to cultural differences and the regular practice of the traditional attendance policy. Therefore, the research includes addressing the potential barriers as well so that remedies can be found. If theCCTV cameras installed in the colleges produce blur images the entire conventional system would not be able to recognize the faces. Proper recognition would have required proper installation of the cameras or the PI cameras and also collection of the faces of the student as asample so it can be related later if any confusion arises. Given this fact, the idea of incorporating artificial intelligence in the colleges in the form of a face recognition system hasfuture potential as well that will contribute to the objective of defining accuracy in theattendance system, especially in Irish educational colleges. The recognition of the face of the students would be the future situation in the colleges that would enhance the attendance system and secure its accuracy of it. No students would be able to copy the signature of their classmates or friends to mark as a present. The surveillance videos that would be captured during the installation of the CCTV cameras would obliterate the presence of any error that has been caused in the manual recording system.

The attendance system followed in Irish institutions or colleges is the traditional system followed at a workplace that required recording attendance manually. This process formed issues in the process in the colleges. The problems and the inaccuracy in the traditional process can be solved with the implementation of technological ideas. This research paper concentrates on the technological implication that would help institutions or colleges accurately take attendance without any manual issues. However, the current attendance system in third-level Irish colleges focuses on gender identity and sexuality which has improved the level of accuracy due to the implementation of ICT. Originally, it is the Catholicculture that influenced the Irish institutions. It is due to the same that the face recognition software could not be optimally implemented in the attendance-taking process. The approach towards attendance-taking policy in Irish colleges is performed in a manual aspect that causedinaccuracy (Gulson, Sellar, and Webb, 2022). In the educational institution of the country concerned, national policies have been followed that

focus on performing the manual attendance process. Although they have tried to use the national policies as the basis of an accurate approach to attendance taking and have focused on authenticity the process has not been as successful as expected which derives the idea of implementing technology such as face recognition in the attendance system. Since the people in the Irish institutions believed that the manual aspect of recording attendance will help enhance the performance of the Institution and impact positively improve the experience of the student, the technology could not make its place. However, it has a future potential that would improve the situation of Irish institutions in terms of the attendance-taking process.

Proper attendance systems in Irish colleges required the implementation of technological ideas (Dowling-Hetherington *et al*., 2020). The researchers focused on the technical system that is believed to design an accurate attendance system that will maintain the attendance system in the colleges without any error. Face recognition systems would be an additional technological implementation in the colleges since the management process has been effectively run with computer and information technology (ICT) (Bah and Ming, 2020). This approach has the potential to bring in the expected technology with the objective improve the attendancesystem. Also, it is the growth of AI and faces recognition software that brought up the urge and the idea of introducing the same in the attendance system of Irish colleges (Almeida, Shmarko, and Lomas, 2022). The rapid development of technology help improve the performances it is implied on. Artificial intelligence technology and its intervention in the education ground have developed the system in various aspects allowing the education institutions to improve the management system and operations with help of the automation process. Artificial intelligence is significantly known to enhance the attendance registration process at universities (Bhatia *et al.*, 2020). Any biometric data system in this case facial recognition system would help maintain privacy and improve the accuracy of the attendance- taking process for the students. Due to these causes and the potential of technological ideas, institutions or colleges are contemplating implementing technological variation.

1.2 Research Questions for Facial Recognition system

- RQ: ***"****To what extent facial recognition technology aid in the development of an automated system of attendance?"*

Discussion on the probable technology and its features that would help in the attendance-taking system.

Sub RQ: "What is the effect of the image processing model (CNN, and Histogram of Oriented Gradients (HOG) with SVM) in facial recognition than with OpenCV"?

Identification of the potential barriers in the process of installing the technology for the betterment of the system of attendance taking.

To, Solve the RQ, the Following objectives were tackled.

1.3 Research Objectives

Obj1: A critical literature review on the attendance in third-level Irish institutions (2018-2022).

Obj 2: Implementation and Evaluation of Face Recognition System.

Obj 2(a): Analyze the current attendance-taking systems in Irish colleges or institutions.

Obj 2(b): Evaluation of the historical approach in attendance-taking systems in colleges.

Obj 2(c): Assessing the implications that the introduction of technologies would bring in thecolleges?

Obj 2(d):Evaluation of the growth of AI and face recognition.

Obj 2(e):UI Implementation and Evaluation of UI.

Obj 2 (f):Implementations and models of face recognition.

Obj2 f(1): The convolutional neural network (CNN)

Obj2 f(2): Histogram of Oriented Gradients (HOG) with SVM

Obj3:Defining the prospective possibility of a face recognition system in Irish colleges or institutions regarding the attendance-taking process.

Obj 4: Evaluation and Results of Developed Models.

Obj 5: Comparison of Developed Models Verse Exiting recognition models.

The rest of the technical report is organized as follows: Chapter 2 presents an investigation of existing literature in detection of face recognition based on the literature results. Chapter 3 discusses Data Chapter 4 presents implementation evaluation and results after pre-processing and design.

2 Literature Review on Face Recognition (2018-2022)

Attendance at a University course has played a very major part in the knowledge purpose. Mainly, attendance is marked by calling the name or roll number of students to mark as present and otherwise mark as absent. Moreover, students signing a signature of a close friend have been taking along issues in maintaining the accuracy level. In that case, the chapter will analyze the effectiveness of using face recognition approaches at the university of Irish to bring authenticity to the attendance system. The evolution of technology will be recognized to maintain the attendance system with the help of the AI process which will help to record the attendance of students automatically by recognized face.

2.1 The Evolution of technological implications in the attendance system

The process of identifying individuals and authenticating their presence is not a new thing in human activity. Moreover, historically it was based on the observations of humans andexpertise through the development of the process with multiple techniques. Most universities in the third level are using manual or semi-structured automated attendance systems.

According to author Helmi *et al.* 2019, a semi-structured system has been considered as the new approach to replace the manual attendance structure where the computerized system has been recording the attenuation of learners in the universities at the third

level automatically. The evaluation of technological implications is highly adopted by universities by using new attendance approaches such as QR-code approaches, thumb recognition and face recognition processes. Akhir and Hasan, 2020, stated that advance-ment and improvement of technology have emerged effectively to provide more efficient education processes in universities or institutions for maintaining the attendant system. The techniques of the biometric-based are considered one of the major trends in the attendance system in the context of the evaluation of technology.

On the other hand, Al-Sheikh *et al.*,2019; the revolution of Technology has influenced every sector of industry in the present day where educational applications for the real world have highly increased. The algorithm of artificial intelligence day has been providing effective solutions to the universities for monitoring the attendance system positively by recognizing the face pattern of learners. A smart attendance system is based on face recognition in every University of third-level to take the attendance of students correctly without any kind of error with the face encoding implication process. As stated by Weinberg *et al.*, 2021; the recent rise of digital technology has delivered effective support to universities in managing their attendance system properly by analyzing data with technological evaluation. The author has stated that the evaluation of Technology with considering the big data analysis to manage the attendance system of students in university can create effective challenges regarding breaching issues.

According to Habib *et al.*, 2021; Information and Communication Technology has beenhighly implemented in education institutes in a global context including in Irish colleges to enhance the attendance systems effectively. Through the evaluation of technology, the author has claimed to use radio frequency identification to manage the attendance systems of classrooms and sustain the monitoring process effectively.

2.2 Growth of AI and face recognition software

According to author Samala *et al.*, 2020; Artificial intelligence technology is one of the most innovative interventions that has revolutionized the education industry in the global context. AI has been refed as the development of computer systems that can perform tasks and activities. The effective growth of AI allows education institutes to keep a large amount of data and helps to improve computing powers effectively. The power of technology helps to focus on the development of the face recognition automation process for enhanced educational work in a systematic way with hassle-free check-ins.

The author Almeida *et al.*, 2022; Claims that the rapid development of facial recognition technologies by using AI and algorithms has significantly enhanced the automation process to maintain attendance registered at universities through biometric data such as facial recognition. The effective growth of facial recognition technology helps to keep the privacy of the data in the university and benefits maintain the accuracy of the attendance process of learners.

The writer c Borenstein and Howard, 2021; Claims that the growth of artificial intelligence is becoming an important technology to bring efficiency to the management process of all industries. The local government of all countries has been focused on facial recognition to identify each and every individual in the public area to monitor their performance and behavior effectively. Teaching ethical design of AI algorithms needs to be considered in the university to familiarize the students and bring transparency to the attendant system.

The author Dauvergne, 2021; claims that the potential growth of artificial intelligence helps to increase the facial recognition software to identify individuals from real life or photographs. With the help of innovative facial recognition technology, teachers can be able to identify the protesters, track activities and monitor the leader without their knowledge or consent. Marsot *et al.*, 2020; Stated that In the growth of artificial intelligence, face recognition has been performed by every industry as a deep conventional neural network. Human face recognition has been used by the computer vision approach and it has been applied in the education system of all countries to maintain the attendant system of learners in the third Level learning programs. The development of a face recognition algorithm has been helping to identify learners through biometric approaches and maintain attendance effectively.

2.3 Importance of Installing Proper Attendance System in Institutions and Colleges

According to Zhuang, J. and Huang, 2021; believed that the design and implementation of an intelligent teaching attendant system are highly important to incorporate in higher education institutions at the Third Level to maintain the attendance system without errors properly. That will help the management of universities to check the overall performance of the students by implementing monitoring cameras for all image recognition purposes. The author has claimed that installing a face recognition system in attendance to process can bring the accuracy of attendance management and help to conduct real-time tracking of students in the university. Anal and Naraginti, 2022; internet communication technology is another effective and important approach that needs to be facilitated in the university to maintain the attendancesystem in the proper way as ICT has been helping to implement artificial intelligence day in the management process. ICT has facilitated photocopy and scanner machines in universities which are essential for maintaining the attendance of learners by connecting to the internet. ICT has helped universities to increase the level of prosperity in the higher study and secure their entire study operation with improved attendance approaches effectively.

On the other hand, KAHAR, 2018, believed that radio frequency identification is highly important to implement at the universities of the third level. That helps to improve the attendance system effectively and capture the performance of learners in education. The author has suggested using a ’drive-thru’ attendant system which is the best user interface affecting the performance of students in university. ’Drive-thru’ is essential in the facility of the University to improve the flow of the performance and reduce the time to maintain the attendance system.

In accordance with Qureshi,2020; proposed that artificial intelligence is highly important to implement in the educational domain to solve the issues of manual attendance methods by incorporating RFID technology. It is highly required for the instructor to Mark the attendance of their students in each lecture with utilize of an artificial intelligence algorithm. The author has said that control signal interfaces and data institution systems can help to maintain the vulnerability of the particular technology in the attendant system.

According to Khan, 2020; believed that CNN is a deep learning algorithm that takes images as input and gives importance to certain features in images in the context of face recognition. The author has claimed to implement particular algorithms in the attendant

system to increase the connectivity pattern of the human nervous system and maintain the face detection approaches properly. In this way, the faculties of the University can track the performance of learners and maintain a good learning program.

2.4 Present Attendance System Followed in Third-Level Irish Institutions and College

In accordance with Kieran and Mullally, 2021; stated that the third-level Irish institution has followed the attendance system in the workplace at traditional aspects when recording the attendance of learners manually. That creates complexity among the faculties to maintain records properly and observe the performance of individuals.

On the other hand, according to Houghton, 2022; the Iris third-level institute has been focused on gender identity and sexuality in the attendance process through the implementation of ICT that helps to promote accuracy in attendance management. The Irish Institutions are influenced by the Catholic culture; hence the implementation of artificial intelligence is not done properly. The Internet of things is highly influential in these organizations to conduct the entire facilitations for learners and maintain the attendance process positively. Bruen *et al.*,2020; claimed that attendance policies are maintained in the present Iris Third Levelinstitutions to understand the positive attitude towards the attendance policy of learners and track their performance at the manual aspect. The attendance policy approach has had an impact positively on the performance and progressions of learning for students.

The author Émon and Timonen, 2019; claimed that national policies are followed in the education institutes of third-level in Irish and they focused on controlling the manual attendance process properly. The author has stated that the third-level education institute of Irish has been recording the regular attendance process by delivering all national policies effectively to make the approach attendance system more authentic. Scriver *et al.*, 2021;stated that a collaborative approach with a manual recording system of attendance has been performed in the Irish education institute properly. It is considered a novel approach to enhancing the student experience and performance effectively.

2.5 The Future Potential of Face Recognition System in The Attendance-Taking Process in Irish Institutions

The author Elias *et al.*, 2019; stated that attendance is highly important in universities through the face recognition process. In that case, in future, face recognition can be using the local binary pattern method as the system will be ensured that the attendance-taking process will be more accurate and faster without error. On the other hand, Suresh, *et al.*, 2019 believed that the face recognition process can be improved in future by using NumPy through python and open CV in the context of AI. The effective methods will help the Irish third-level institute to conduct motion tracking and understand of faces of learners to record more authentically.

According to Son *et al.*, 2020; CCTV based attendance-taking process will be performed in future effectively by recognizing the face of learners in the institute. The closed-circuit television can be more secure to recognize the face of learners with security aspects in the context of developed AI technologies. Mohammed, *et al.*, 2021; has claimed that

AI-based face recognition can be more potential in future for taking attendance of learner by incorporating the machine learning algorithm. The technology will help to maintain AI-based face recognition with generate effective measurements of the face by creating distinguished from other faces.

The writer Tan,2018; has believed that face recognition-based attendance can potentially be more in future of Irish education third-level institutes to monitor the attendance system more accurately to enhance the current attendance system.

2.6 Potential Barriers to Installing Face Recognition System in Attendance Taking

The author Yang and Han, 2020; believed that faces in surveillance videos have created serious posture changes, image blur, and occlusion issues. That creates barriers for the educational institute of Irish at the third level to recognize the faces of learners in attendance.

The Author Salim *et al.*,2018; stated that class attendance system management have effective barriers to proceeding in third-level Irish institution as it is highly cost-effective. The Pi camera in the management system has been creating blur images to recognize faces properly for lack of proper installation. Pei *et al.*, 2019; stated that it is important to collect samples of the faces of learners important to recognize by using the convolutional neural network to maintain daily attendance effectively. That increased barrier to implementing the process in the attendance system and it is highly time-consuming. Andrejevic and Selwyn, 2020; the facial recognition system in attendance has been creating effective issues in foregrounding fixed attribution of students regarding race and gender in the institute for decision-making. Khan *et al.*,2019; claimed that face recognition through the AI process increased barriers to recognized faces. The processing system increased beard, tilted and glass faces in the recognition of faces of learners in institutes.

2.7 Comparison of Reviewed Techniques

Table 1: Comparison of Literature in Face detection-based Attendance System

Author(s)	Research	Outcomes
Bhattacharya et. al. (2018)	Viola Jones detector with Deep CNN	82% accuracy in face recognition
Sutaria et. al. (2019)	Adaboost for face detection along with Eigen faces extraction and modeled with Neural Network	UI developed for automated attendance; however the model is trained for 1 person only.
Wagh et. al. (2015)	Viola Jones with Principal Component Analysis (PCA)	The outcomes of the study are not clearly mentioned
Winarno et. al. (2019)	Hybrid feature extraction using CNN and PCA	The model showed accuracy of up to 98% for self-created dataset

2.8 Identified Gaps and Conclusion

In the previous literature, all contexts of studies have analyzed the different concepts and processes of AI and faced recognition process. The different algorithm has been measured in the literature to implement the attendance system in a digital aspect. Even, several challenges have been identified in the literature that creates issues to operate the system positively. In that case, the major gap in the literature is that solutions to challenges are not given in the literature properly to sustain the process in future effectively.

The entire context of the report has been focused to analyze the implementation of the AI- based face recognition process in the attendance system of the third-level institute in Ireland. After analyzing the entire literature, it has been understood that every institute in Ireland needs to implement the attendance system by considering different algorithms of the face recognition process. That can be increased the authenticity of the attendance recording process and able to analyze of the performance of learners positively in the institute.

3 Data Pre-processing and Design

3.1 Face recognition Methodology

The methodology that has been incorporated in the study to develop the attendance system is depicted in figure 1 below. The figure shows the steps in the flow of methodology that are implemented in the study. The steps in the presented methodology are discussed in depth below.

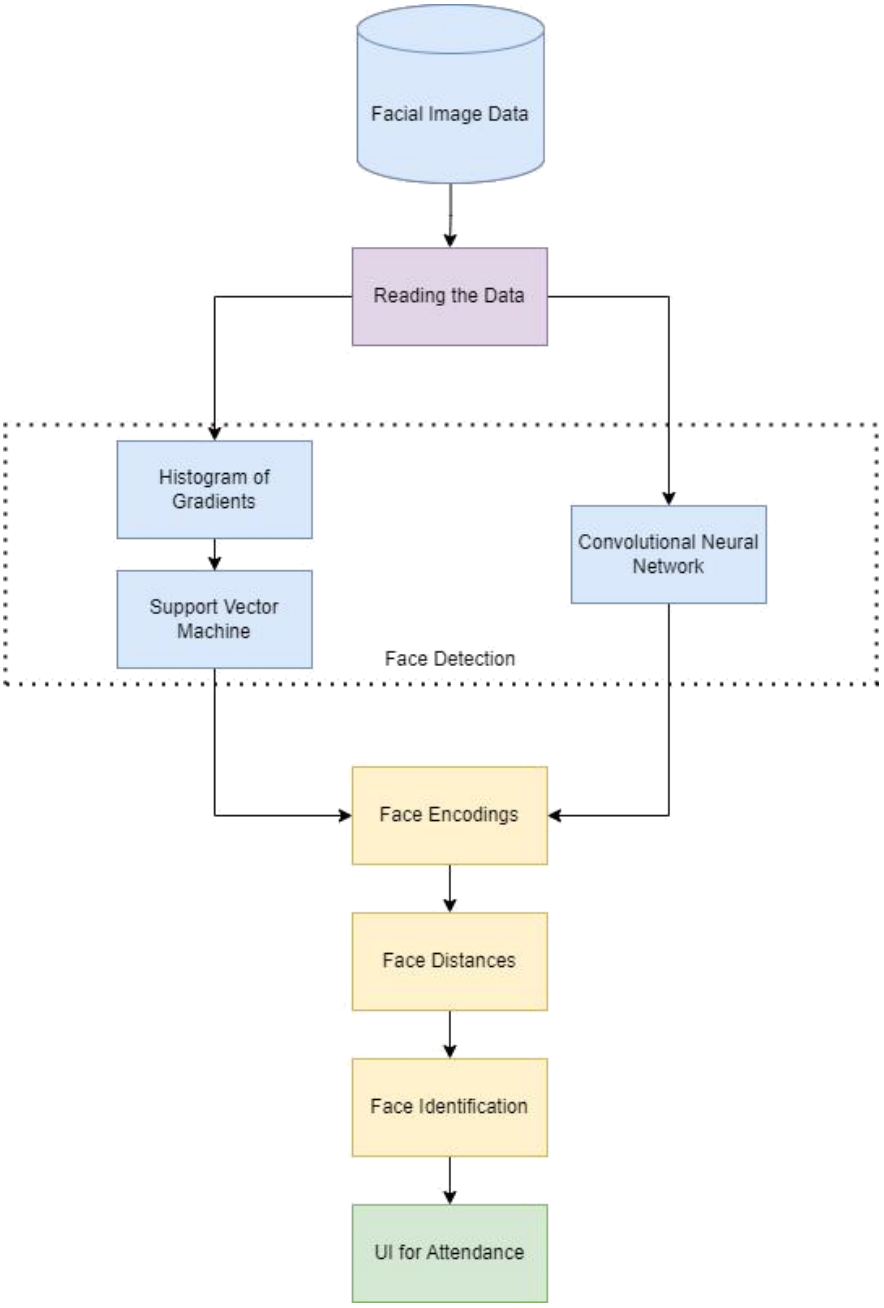

Figure 1: Methodology for Image-Based Attendance System

3.2 Dataset

The dataset that has been used in the study is created and hosted by the University of Massachusetts and is acquired from[1] and created in 2007. The dataset is prepared by the University for studying the problem of unconstrained facial recognition. The dataset consists of 13233 images acquired from the web. It contains the faces of people along with their names labeled. The images in the dataset correspond to 5749 persons among which around 1680 persons have multiple images corresponding to them. The images in the dataset are acquired using the Viola-Jones Face Detector Algorithm. The dataset is divided into two partsviz. the training set and the testing set. Figure 2 below depicts

[1] http://vis-www.cs.umass.edu/lfw/

the sample images in the dataset.

Figure 2: Sample images from the dataset

3.3 Modelling

3.3.1 Convolutional Neural Network

The convolutional neural network (CNN) is an architecture of a conventional neural network that is well known for its superior performance in the field of image recognition. A convolutional neural network architecture consists of three important layers of neurons viz.

- Convolutional Layer – The layer responsible for the convolution of the image with a weighted filter that moves over the image to identify features present in the image. The features such as facial structures are identified in the layer.
- Pooling Layer – The layer for dimensionality reduction in the model. It outputs the reduced components from the image through the convolution of a non-weighted filter and aggregative operation over the receptive field. Two methods can be applied in the pooling layer viz. max pooling and average pooling. Max pooling outputs the maximum value of the convolved feature and average pooling outputs the average value of the convolved feature.
- Fully-connected Layer – The output layer of the model is directly connected to the nodes in the previous layer. Generally, uses a sigmoid activation.

An implementation of a CNN can involve multiple convolutional layers, and pooling layers, however, its output is obtained at the fully connected layer. The complexity of a CNN increases with the addition of convolutional layers. The addition of these layers, however, identifies smaller structures in image data. Starting layers of the network are useful in detecting simple features that include colors and edges, smaller structures are then recognized as the data progresses through the subsequent layers. The layers of a CNN

model are explained in detail in the following sections. User-Interface for the Attendance System

3.3.2 Histogram of Gradients with Support Vector Machine (HOG model)

A histogram of gradients (HOG) is a feature descriptor used to capture the shape and structure of an object in an image. It works by dividing an image into small cells and then computing the gradient magnitude and orientation for each cell. These gradients are used to build a histogram, which represents the distribution of gradient orientations in the image. This histogram is then used as a feature vector for classification.

Support Vector Machine (SVM) is a supervised learning algorithm that can be used for classification and regression tasks. It works by finding a hyperplane in high-dimensional space that maximally separates different classes of data. In the case of face recognition, SVM is used to learn the differences between different faces and then classify new faces based on these learned differences.

To use HOG and SVM for face recognition, a training dataset of images containing faces is first collected. These images are then pre-processed to extract HOG features, which are then used to train an SVM classifier. Once the classifier is trained, it can be used to recognize faces in new images. When a new image is given to the classifier, the HOG features are extracted and then passed to the SVM, which predicts the identity of the face in the image based on the learned differences.

Overall, the combination of HOG and SVM offers a powerful approach for face recognition. The HOG features provide a robust and efficient representation of the shape and structure of faces, while the SVM classifier allows for accurate and reliable recognition of these faces.

3.4 User Interface for Facial Recognition based Attendance System

The last step of the methodology is to develop a UI for marking attendance. In this step an attractive UI is developed which takes in the query image from the user and the image is then classified by applying the previously trained model in the business layer of the UI. The input image is first resized to 224 x 224 size in order to process it efficiently and fast and then will be given to the model for identifying the label associated with it.

The architecture of the UI is presented in figure 3 below.

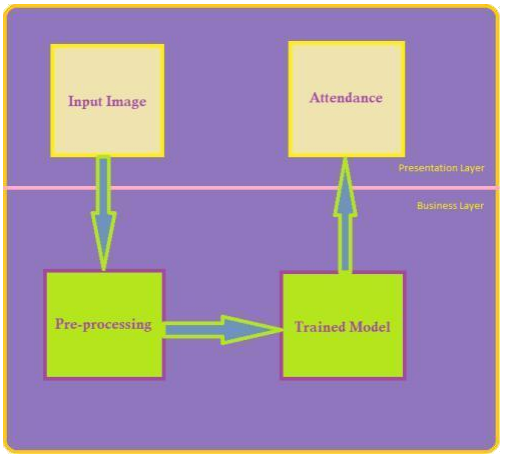

Figure 3: UI architecture

3.5 Conclusion

The methodology for the implemented study has been discussed in the section. The *'Labeled Faces in the Wild'* has been used in the implementation of the study. Also, the CNN model is discussed in the section with the aim to understand its working in the research. The implementation of the presented methodology is discussed in detail in the upcoming chapter.

4 Implementation of Face Recognition User Interface and Models

This section of the report presents the implementation of the system. The presented study is implemented using the Python programming language owing to its simplicity in programming as well as the vast number of resources available supporting the implementation.The implementation of the study is performed using the '*face recognition*' library available for Python. The library is built using the Convolutional Neural Network (CNN) to detect structure such as facial features to detect faces in the images.

4.1 Implementation of Face Recognition

The implementation of the experiment is done through the steps mentioned below.

1. Reading the Dataset
2. Detect faces in the image
3. Calculating face encodings
4. Identification of persons present

5. Display the matching score

The steps mentioned are explained in detail below.

4.1.1 Reading the dataset

This stage of the implementation is responsible for reading the dataset images as a list object. This is done using the '*glob*' library available for python. The glob object is a list consisting of the location of the files present in the dataset. The files in the list are then read using the '*load_image_file ()*' function of the 'face recognition' library. Once the data is read from the dataset, face encodings are obtained for the faces present in the dataset images. Face encodings are representations of face images using 128 computer-generated measurements. Face encodings of the same persons are similar to each other whereas for different persons they are dissimilar.

This process is done for all the images in the dataset where each image is labeled with a name. This gives a labeled dataset consisting of face encodings for the images.

4.1.2 Detecting Faces

When a test image is presented to the system, faces present in the images are detected using the '*face_locations ()*' function of the face recognition library. This function outputs thelocations of the faces present in the image. The location is represented as coordinates denoting the vertices of a rectangle in which the face resides. These locations are useful in showing a bounding box in the display.

4.1.3 Calculating face encodings

Once the locations are obtained for the faces, the '*face_encodings ()*' function of the face_recognition library calculates the face encodings for the faces present in the image. This is the most important step in the implementation of the algorithm. Once these encodings are obtained, they are compared with the labeled dataset for identification of the person present in the image.

4.1.4 Identification of persons present

The identification of the persons present in the image is done by finding the Euclidean distance between the face under processing with the labeled face encodings. This is done using the '*face_distance ()'* function. Among the distances obtained, the lowest distance is found which corresponds to the matched face from the labeled dataset.

4.1.5 Display the matching score

The identification of the persons is represented by the score with which the matching is done. The score is calculated by subtracting 0.25 from the highest distance in the calculations and multiplying it with 100.

4.2 Conclusion

The implementation of the system presented is discussed in the section along with the necessary functions and libraries used. The section discusses in detail the process to

implement the system and the considerations that need to make.

5 Evaluation of Face Recognition System

This section of the report discusses the evaluation of the implemented system in depth. It explains the output obtained through each step of the implementation. The evaluation of the system is done on 6 different test images. The results shown in the section is pertaining to three of the test images. Each of the images differs from the others such that the number of persons present in the images varies considerably.

5.1 Evaluation of the system for Test Image 1

Figure 4: Test Image 1

The results for the face locations obtained in the image are shown in figure 5 below.

```
[(325, 145, 415, 56),
 (319, 784, 426, 677),
 (53, 382, 182, 253),
 (297, 1013, 426, 884),
 (53, 139, 182, 10),
 (319, 581, 426, 474),
 (53, 812, 182, 683),
 (56, 581, 163, 474),
 (67, 999, 196, 870),
 (331, 366, 438, 259)]
```

Figure 5: Face locations detected in Test Image 1

The face encodings are then obtained for the faces detected in the image. These encodings are obtained for each of the faces detected and contains 128 values, due to the space constraints sample face encodings for one face are shown in figure 6 below.

```
-0.14725526,  0.06917019,  0.15527436, -0.09581816, -0.16688785,
-0.07636441,  0.00183002, -0.02379475,  0.14225592,  0.00961521,
 0.15802389, -0.05418752, -0.22153877, -0.03402377, -0.08742319,
 0.21341071, -0.16375339, -0.09732618, -0.0712935 , -0.00695918,
 0.07395394,  0.05365523,  0.08379962,  0.07298332, -0.14356939,
-0.2618027 , -0.06430677, -0.0686852 , -0.06217744, -0.04394777,
-0.01041849,  0.16115642, -0.19460459, -0.08229706,  0.00712025,
 0.12243944, -0.09099875, -0.12210134,  0.1889901 ,  0.03831176,
-0.18109912, -0.04173896,  0.09318606,  0.25335088,  0.27577558,
 0.03864734,  0.10843465, -0.03179435,  0.09738511, -0.42975903,
 0.01171303,  0.16039991, -0.05644435,  0.12099929,  0.0743188 ,
-0.19415098,  0.05097818,  0.17524704, -0.22646828,  0.11726837,
 0.04233723, -0.10688353, -0.0120056 , -0.12508689,  0.25171286,
 0.16021004, -0.11838822, -0.17073739,  0.22444335, -0.16073722,
-0.07972871,  0.16720936, -0.15880367, -0.19850841, -0.31304702,
 0.00618576,  0.28366584,  0.19239543, -0.07402011,  0.01819971,
-0.10320371,  0.03342473, -0.05840271,  0.07794787,  0.02693074,
 0.04094527, -0.1275567 , -0.00049673,  0.22408369, -0.05889404,
-0.01089684,  0.34383541,  0.06483036, -0.07027972, -0.01180133,
 0.07168175, -0.04278706,  0.00111269, -0.17484772,  0.01506125,
 0.04253892, -0.10166259,  0.00987381,  0.08693493, -0.16117528,
 0.11215328, -0.12978569,  0.00514412, -0.17407046, -0.18440235,
-0.10740069,  0.10178968,  0.20161301, -0.23388602,  0.22857457,
 0.20012213,  0.02646416,  0.1146565 ,  0.05986964,  0.07031359,
-0.01388921, -0.09981757, -0.07813925, -0.06159889,  0.06154766,
-0.03834742,  0.03559558,  0.12230461]),
```

Figure 6: Face encodings for the first face detected

The overall results obtained for Test Image 1 are shown in figure 7. The results show the detected name of the person along with the matching score. Higher the matching score ensures better detection.

```
Performance analysis for  Courtney cox has score of 86.0935
Performance analysis for  Jennifer aniston has score of 84.4227
Performance analysis for  Matt leblanc has score of 84.7549
Performance analysis for  Matthew perry has score of 81.8127
Performance analysis for  Tatjana gsell has score of 83.5797
Performance analysis for  Rob morrow has score of 83.7428
```

Figure 7: Face detection results obtained for Test Image 1.

The figure above shows that the prediction score of the presence of Courtney Cox in the image is 86% whereas the lowest prediction score of 81.81 is obtained for Matthew Perry.

5.2 Evaluation of the system for Test Image 2

Test image 2 is shown in figure 8 below.

Figure 8: Test Image 2

Following are the face locations obtained in the image (Figure 9).

```
[(297, 1343, 426, 1214),
 (163, 927, 271, 820),
 (319, 330, 426, 223),
 (236, 723, 325, 633),
 (259, 1130, 367, 1023),
 (283, 497, 390, 390),
 (196, 623, 285, 534)]
```

Figure 9: Face locations detected in Test Image 2

Face encodings for 1 of the faces detected in the image are shown in figure 10.

```
([-0.08578161,  0.12367325,  0.03600965, -0.0852559 , -0.01819319,
  -0.03750722,  0.00242131, -0.06212133,  0.21602379, -0.08343197,
   0.18504336, -0.00421056, -0.18255161,  0.00760681,  0.00593965,
   0.08653686, -0.23369935, -0.0522522 , -0.12482556, -0.10458986,
   0.03536621,  0.02667485,  0.02421421, -0.03833967, -0.13684575,
  -0.3165583 , -0.11117667, -0.10689011,  0.0855974 , -0.13712609,
   0.0740305 , -0.06601802, -0.21932237, -0.08062573, -0.00672718,
   0.04846759, -0.09634678, -0.08665051,  0.18394987, -0.05321274,
  -0.12436878,  0.03788501,  0.06505697,  0.1911076 ,  0.19291416,
  -0.02453387, -0.03481369, -0.02215946,  0.13252884, -0.2591832 ,
   0.0742811 ,  0.09472335,  0.12326674,  0.18586196,  0.12176555,
  -0.08108719,  0.04743519,  0.1395988 , -0.15774031,  0.10599947,
   0.10782775, -0.14778191, -0.0172283 ,  0.0099674 ,  0.14188465,
   0.06551781, -0.14465083, -0.13387565,  0.05123473, -0.1203648 ,
  -0.02459113,  0.03571245, -0.03048547, -0.14329413, -0.31238368,
   0.05442272,  0.31567252,  0.13523489, -0.14438196,  0.01757621,
  -0.14444271, -0.01444598, -0.00619211,  0.03189957, -0.04562852,
  -0.04450815, -0.07878958,  0.06801301,  0.15006891, -0.0114172 ,
  -0.08355335,  0.19188951, -0.09540727,  0.06648048, -0.03930775,
   0.10207059, -0.17758486, -0.06135725, -0.01455433,  0.02464553,
   0.1028046 , -0.10997393, -0.0603216 ,  0.11009003, -0.18002929,
   0.24351133, -0.01841604,  0.02729131,  0.02492501,  0.02613934,
  -0.07159568,  0.05718368,  0.14633052, -0.30023193,  0.32176277,
   0.19138411, -0.07673255,  0.15118764,  0.03951273,  0.00931807,
  -0.03101158,  0.02330798, -0.16035655, -0.14032242, -0.0632339 ,
   0.04196086,  0.051722  ,  0.04895225]),
```

Figure 10: Face encoding for the first face detected in Test Image 2

The results obtained for the face detection in test image 2 are shown in figure 11 on the next page.

```
Performance analysis for  Christian lirette has score of 83.5136
Performance analysis for  Victoria beckham has score of 83.3682
Performance analysis for  Rick dinse has score of 82.4194
Performance analysis for  Amanda bynes has score of 86.7693
Performance analysis for  Franco dragone has score of 81.1014
Performance analysis for  Tony blair has score of 79.5665
Performance analysis for  Walter mondale has score of 85.897
Performance analysis for  Maggie smith has score of 83.1819
Performance analysis for  Hank azaria has score of 80.8071
Performance analysis for  Rupert grint has score of 83.1714
Performance analysis for  Daniel radcliffe has score of 85.5605
Performance analysis for  Robbie coltrane has score of 83.5461
Performance analysis for  Michael schumacher has score of 75.3467
```

Figure 11: Performance of the system in face identification

The results above show the detection of some personalities in the images. However, most of these detections are wrong. E.g., The system detected the owl as Michael Schumacher, Emma Watson as Victoria Beckham, Bonnie Wright as Christian Lirette, Alan Rickman as Tony Blair, etc. The model also failed to identify Michael Gambon and Matthew Lewis. These misclassifications can be attributed to the absence of the images corresponding to misclassified celebrities in the dataset.

The results for the Test Image (figure 12) are shown below.

Figure 12: Test Image 5

Detection performances for test image 3 are shown in figure 13.

```
Performance analysis for  Monique ferreira has score of 82.7623
Performance analysis for  Andrew bernard has score of 90.4204
Performance analysis for  Julio cesar chavez has score of 87.612
Performance analysis for  Sebastien grosjean has score of 76.7071
Performance analysis for  Jennifer garner has score of 85.9189
Performance analysis for  Roger machado has score of 81.5859
Performance analysis for  Richard rodriguez has score of 86.3281
Performance analysis for  Ben affleck has score of 82.8726
Performance analysis for  Ken watanabe has score of 78.251
Performance analysis for  Jose maria aznar has score of 83.6168
Performance analysis for  Sharon stone has score of 82.0842
Performance analysis for  Ben affleck has score of 81.2924
Performance analysis for  Jennifer garner has score of 86.4318
Performance analysis for  Jennifer garner has score of 89.5364
Performance analysis for  Caroline dhavernas has score of 85.5062
Performance analysis for  Alvaro uribe has score of 90.76
Performance analysis for  Holly hunter has score of 83.4831
```

Figure 13: Results obtained for Test image 3

The model failed to detect many of the faces in the image.

5.3 Comparison of Developed Models with Existing Models

Author(s)	Research	Comparison
Bhattacharya et. al. (2018)	Viola Jones detector with Deep CNN	The implemented models in the study performed better with higher accuracy
Sutabri et. al. (2019)	Adaboost for face detection along Eigen faces extraction and modeled with Neural Network	The implemented models performed better with higher accuracy
Wagh et. al. (2015)	Viola Jones with Principal Component Analysis (PCA)	The implemented models performed better with better accuracy
Winarno et. al. (2019)	Hybrid feature extraction using CNN and PCA	The implemented models performed better with better accuracy
Jha A (2007)	PCA for feature extraction with Linear Discriminant Analysis for face identification	The implemented models performed better with better accuracy

5.4 Conclusion

The system of attendance hence can be implemented using the Convolutional Neural Network-based face recognition system. The study requires the dataset to be sufficient to ensure proper detection of persons present in the system.

6 Conclusion and Future Work

Various attendance systems have been proposed over the years to replace the generic attendance systems that include roll calls or punch cards. These systems have one major drawback that they are not automated. These systems in some sort or other require aninteraction between the system and the person making it slow and time-consuming.

However, modern advancements in computing technologies as well as neural networks have paved the way for unforeseen possibilities of applications that can be developed. Convolutional Neural Network is one such advancement. CNN is found to be showing superior performances in image data classification because of its inherent architecture that involves convolution at minute levels. This study introduced a novel face recognition-based attendance system that can be used across industries to avoid old generic attendance systems. This study makes use of the CNN model to detect faces present in images. Once detected the face encodings of these faces are obtained based on which the identification of the faces is performed.

This research's crucial step is in the development of a facial recognition-based attendance system. The model developed in the study works very well in the detection of faces in the images along with labeling them. The most important constraint for the same is that the dataset must contain the images for each of the persons present in the image. If this is not the case, the model fails to perform effectively arising misclassification which doesn't follow the important aspect that the attendance system should be very efficient as misclassification can lead to wrong attendance.

The only limitation of the research presented is that the system does not work when detectable faces are not present in the dataset that is being used to compare face detection with. However, as the face detection algorithm is already embedded in the system, real-time labeling can be performed on the detected faces. This will help improve the accuracy of the system.

According to Future Work This research work can be followed up by incorporating real-time face detection which is also possible through the use of the face_recognition library used in the research. The system can be extended with the inclusion of the modern CNN and HOGvariations such as VGGNet and ResNet based architecture to get the face encodings. The system also has important applications in variety of surveillance utilities.

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8 References

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