A PROJECT REPORT

On

FACE RECOGNITION SYSTEM

For the partial fulfilment for the award of the degree of

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Declaration

We hereby declare that the project work presented in this report entitled

"FACE RECOGNITION SYSTEM" in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science & Engineering, submitted to A.P.J. Abdul Kalam Technical University, Lucknow, is based on my own work carried out at Department of Computer Science & Engineering, G.L. Bajaj Institute of Technology & Management, Greater Noida. The work contained in the report is original and project work reported in this report has not been submitted by me/us for award of any other degree or diploma.

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Certificate

This is to certify that the Project report entitled **"FACE RECOGINITION SYSTEM"** done by **AYUSH PRATAP SINGH** (2101920100088) and **GAURAV MAURYA** (2101920100116) is an original work carried out by them in Department of Computer Science & Engineering, G.L Bajaj Institute of Technology & Management, Greater Noida under my guidance. The matter embodied in this project work has not been submitted earlier for the award of any degree or diploma to the best of my knowledge and belief.

Date:

Mr. Pawan Kumar Singh **Dr. Sansar Singh Chauhan**

Signature of the Supervisor Head of the Department

Acknowledgement

The merciful guidance bestowed to us by the almighty made us stick out this project to a successful end. We humbly pray with sincere heart for his guidance to continue forever.

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Abstract

The Face Recognition System Project aims to develop a robust and efficient solution for the identification and verification of individuals based on their facial features. Leveraging machine learning techniques, the project encompasses key stages such as data collection, preprocessing, feature extraction, model training, face detection, recognition, and decision-making. The system utilizes a diverse dataset for training, allowing it to handle variations in lighting, facial expressions, and poses. Various machine learning models, including Support Vector Machines and Convolutional Neural Networks, are explored for their effectiveness in mapping facial features to specific individuals.

The implementation includes a face detection step to locate and extract facial regions from input images or video streams, enhancing the system's efficiency. During the recognition phase, the trained model compares the features of the input face with those stored in the system's database, producing a confidence score or distance metric for decision-making. Post-processing steps are employed to refine results, ensuring accurate and reliable identification.

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Chapter 1

Introduction

Face recognition is a technology that involves identifying or verifying a person's identity by analyzing and comparing their facial features. It has gained significant attention in recent years due to its wide range of applications, including security systems, surveillance, user authentication, and human-computer interaction. Machine learning plays a crucial role in the development of effective face recognition systems.
Here is a brief overview of the key components and steps involved in building a face recognition system using machine learning:

1. Data Collection:
Face recognition systems require a substantial amount of :labeled data for training. This data typically consists of images or videos containing faces with corresponding identity labels.

2.Data Preprocessing:
Cleaning and preparing the data are essential steps. This involves tasks such as resizing images, normalizing pixel values, and aligning faces to a standard position for consistency.

3.Feature Extraction:
Machine learning models can't directly process raw images, so feature extraction is necessary. Techniques like Principal Component Analysis (PCA), Local Binary Patterns (LBP), or deep learning-based methods (using Convolutional Neural Networks - CNNs) are commonly employed to extract relevant features from facial images.

4.Model Training:
The heart of a face recognition system lies in training a machine learning model to learn patterns and features that distinguish one face from another. Popular algorithms include Support Vector Machines (SVMs), k-Nearest Neighbors (k-NN), and deep learning models like FaceNet, VGGFace, or OpenFace.

5.Database Creation:
he system stores the encoded representations of known faces in a database. During recognition, the system compares the input face with these stored representations.

6.Recognition and Verification:
When a new face is presented to the system, the trained model compares its features to those in the database. The system then makes a decision based on the similarity or dissimilarity of the input face to the stored faces.

7.Performance Evaluation:
The accuracy and efficiency of the face recognition system are evaluated using metrics such as precision, recall, and F1 score. Continuous monitoring and updates to the model may be necessary to improve performance over time.

8.Deployment:
Once the model is trained and evaluated, it can be deployed in real-world applications such as security systems, access control systems, or any scenario requiring face recognition.

9.Challenges and Considerations:
Face recognition systems face challenges such as variations in lighting, pose, and expressions, as well as privacy concerns. Ethical considerations regarding the use of such technology should be taken into account during development and deployment.

ace recognition systems leverage machine learning techniques to enable computers to identify and verify individuals based on their facial features. Advances in deep learning, especially CNNs, have significantly improved the accuracy and robustness of these systems, making them widely applicable in various domains.

1.1 Problem Statement

Problem Statement 1:

To develop an automated attendance system using face recognition. Concept In a classroom with large number of students, it is a very tedious and time-consuming task to take the attendance manually. Therefore, we can implement an effective system which will mark the attendance of students automatically by recognizing their faces.

The process of this face recognition system is divided into various steps, but the important steps are detection of face and recognition of face. Firstly, to mark the attendance of students, the image of students' faces will be required. This image can be snapped from the camera device, which will be placed in the classroom at a suitable location from where the whole classroom can be covered. This image will act as input to the system. For the effective face detection, the image needs to be enhanced by using some image processing techniques like grayscale conversion of image and histogram equalization.

To identify the students sitting on the last rows neatly, the histogram equalization of image needs to be done. Hence, there is a need to develop a real time operating student attendance system which means the identification process must be done within defined time constraints to prevent omission.

The extracted features from facial images which represent the identity of the students have to be consistent towards a change in background, illumination, pose and expression. High accuracy and fast computation time will be the evaluation points of the performance.

1.2 Aims and objectives

To identify the student faces accurately. To mark the attendance automatically. To reduce the time and the efforts required for manual attendance to provide a valuable attentive system for both teacher and students. It provides flexibility and reduces the time loss. There will be no chance for a proxy.
The objective of this project is to develop face recognition based automated student attendance system. Expected achievements in order to fulfil the objectives are:

• To detect the face segment from the video frame.

• To extract the useful features from the face detected
• To classify the features in order to recognize the face detected
• To record the attendance of the identified student

Objectives for Facial Recognition Attendance System:

- Enhance the accuracy of attendance tracking by implementing sophisticated facial recognition algorithms capable of reliably identifying individuals in diverse conditions and facial expressions.
- Streamline the attendance management process to reduce administrative overhead and manual errors, ultimately improving operational efficiency.
- Develop a user-friendly enrollment module that enables individuals to easily register their facial features, ensuring a seamless onboarding process for users into the facial recognition system.
- Strengthen the security of facial templates and attendance data by incorporating robust encryption measures, access controls, and regular security audits to prevent unauthorized access and protect user privacy.

Chapter 2

Literature Survey

2.1 Introduction

Face recognition has always been one of the most challenging tasks in the field of target recognition. Meanwhile, as one of the most effective ways of personal identity verification in modern society, face recognition has important application value. It has been extensively used in monitoring, security, communication, human-computer interaction and other fields . Therefore, efficient and accurate algorithms are especially significant for face recognition in limited embedded system resources such as mobile phones and chips. In recent years, there have been more and more researches on the field of face recognition algorithms applying on embedded platform . With the rapid development of artificial intelligence, and its wide application in face recognition, how to integrate artificial neural network into an embedded face recognition system comes to be a new topic . Taking the speed, stability and accuracy of face recognition system in an embedded system into consideration, a combination of traditional feature recognition algorithm based on LBP and deep learning algorithm based on MTCNN is proposed in this paper to meet these requirements in a certain degree.

2.2 Existing systems

2.2.1 Face Detection and Alignment based on MTCNN

Mengyue Zhang et al.In face recognition system, face detection and alignment are two important steps. For these two steps, we apply MTCNN to increase the accuracy and stability of system. In common situation, various poses of head, illuminations of the environment will affect the stability of face recognition system. Researches have shown that compared with traditional algorithms, deep learning methods have better performance on face detection and alignment . MTCNN is essentially a cascading architecture to integrate the problem of multi-task CNNs learning. Under a deep cascading multitask framework which makes full use of the inherent relationship between detection and alignment, the performance of processing, dividing into three parts: face classification, bounding box regression, and facial landmark localization. The whole architecture contains three steps which is shown. The first network, the network separates the task of face detection and alignment from coarse to fine

step, a shallow CNN quickly generates candidate facial windows and conduct non-maximum suppression to remove overlapped windows; the second step, through more complex CNNs, refining candidate facial windows, and discarding a large number of overlapped facial windows again through NMS; the third step, using more powerful CNNs, selecting out which windows to keep and meanwhile displaying five key points in faces. The network at each step is a multitasking network.

2.2.2 Feature Extraction and Recognition based on LBP

The extraction of LBP feature is fast, and it is widely applied in face feature extraction. The original LBP operator is defined as following: in a 3*3 window, the gray level of 8 adjacent surrounding pixels is compared with the center pixel as a threshold, and if the gray.For the detected face image, we perform binarization processing and LBP feature extraction. During the processing, we select a circular LBP operator. The radius of the operator is 1 and the number is 8. Considering the rotation invariant mode of LBP, as shown in Fig.4, we divide the binary image to 8*8 blocks, and then count the number of each LBP pixel value in each small block horizontally and vertically in order.

2.3 Related work

Over last years, several studies have been published illustrating the evolution of tracking and recognition methods.This section shows some of these studies and focus on the improvements and limitations of KLT and 2DPCA methods. In an improved KLT-tracker that can handle scale-changes is proposed. This method introduces a scale invariance index which determines the closeness between the Hessian matrix and a singular matrix with scale warp parameter. The original KLT tracking method with a fixed wrap is difficult to track both kinds of patches. The modified KLT method can handle the tracking by selecting wraps according to SII. In face tracking framework which is capable of tracking faces in real time is proposed. Camshift algorithm and KLT algorithm implemented and then comparison study has been done between them to find which algorithm is better. The Camshift algorithm includes other objects along with the face and part of the face is excluded while tracking the face. The experimental results show that the KLT algorithm performs better than the Camshift algorithm. Though we have seen that KLT algorithm also has one problem in tracking. In an improved 2DPCA for overwhelming the illumination effect in face recognition is proposed based on two assumptions. The main contributions of the proposed methods are:

1 speeding up the computing time of the training step by using a single zero mean image for creating the covariance matrix.
2 Increasing the accuracy of face recognition under illumination effect conditions by selecting the suitable interval of eigenvectors. Based on the Extended Yale Face Database B+ containing 60 illumination conditions, the experimental results show that the proposed

method decrease the computing time and also improves the recognition rate up to 95.93%.
In a facial expression recognition system is presented which can classify basic facial expressions. The proposed algorithm integrates 2DDWT (Two-Dimensional Discrete Wavelets Transform) and 2DPCA for feature extraction and dimension reduction. Then it uses SVM (Support Vector Machine) for recognition. The experimental results show that 2DPCA is simpler and more straightforward to use for image feature extraction since it is based on the image matrix. The recognition accuracy in all experiments shows that 2DPCA is better than PCA.

In this work, face tracking and recognition system is proposed based on KLT (Kanade-Lucas-Tomasi) and 2DPCA (Tow-Dimensional Principle Component Analysis) methods. This system is mainly depending on face detection step which must detect all faces that appear on screen using Viola-Jones algorithm. The system must be able to track all the detected faces based on feature points and frame sequence using KLT method. The last step is to recognize all faces using 2DPCA.Face gender recognition has wide application prospects, attracting the attention of a large number of researchers. Some early studies can quickly review the face gender recognition task through a review . In recent years, with the rise of DCNN, many computer vision tasks have been greatly improved. DCNN has the advantage of end-to-end training and automatic extraction of effective features for classification tasks, avoiding the tedious process of manually designing features. In 2015, Levi et al. used DCNN to predict the gender and age of human faces, which greatly improved the recognition results. In 2017, Dehghan et al.Proposed a fully automatic age, gender, and expression recognition system based on DCNN, called DAGER. In The author proposes a method of age and gender recognition based on hybrid DCNN and extreme learning machine. In 2018, Philip Smith et al. Proposed gender and age recognition methods based on transfer learning. Jhang proposed a model ensemble method based on softmax for gender classification. The research on face gender recognition is constantly developing. There are not only DCNN-based methods for gender recognition, but other methods have also been continuously proposed.

In 2016, **Zhou et al**. proposed a real-time face gender recognition algorithm based on eigen-features combining principal component analysis and genetic algorithm. In 2019, Geetha et al. proposed a method.based on multi-scale mixed image pixel, shape, and texture features. A multi-feature face gender recognition method is proposed. Khan et al. Proposed a face gender recognition method using probability maps generated by conditional random field segmentation of faces combined with random decision forest. In this paper, we use the feature vector extracted by the face recognition model from the face as the face representation to recognize the gender of the face. Next, we will describe the method we proposed in detail.There are basically two prevailing approaches to the problem of face recognition namely, Geometric approach i.e. the feature based and the other one is the photometric approach i.e. the view based. As the field of face recognition fascinated many researchers resulting which there were many contrasting algorithms developed, out of which three of them have been widely studied in the literature of face recognition[3][4]. We can classify the

recognition algorithm into two main approaches:
1 Geometric: This approach mainly deals with the spatial correlation uniting the profile (i.e. face) features, also we can simply that dimensional layout of the facial attributes. Some of the main geometrical attributes of a human face are nose, eyes and the mouth. Based on these attributes firstly the face is categorized and then based on these attributes respective spatial intervals and the respective associated gradients are estimated, thereby advancing the process of face recognition.

2 Photometric stereo: It is a methodology of computer vision technology which mainly recuperates the structure of an underlying object from the images that were shot in varying circumstances that were affected by the lighting environment .

An arrangement of the surface standards shown by the slope chart that finallyelucidate the retrieved entity's configuration.One of the sub divided image frame makes one class i.e. the one consisting the faces in the image, which marks the first step towards the process of face detection. It is inconvenient because in spite of the congruity exist among faces but several factors like age, skin color and facial expression can vary considerably. Then this problem is furthermore intricate by the arrival of factors like environment factors affecting light, risk of imitation and also probability of limited obstruction in image. The face detection system that can easily recognize any face from a given image that too under any circumstance with any kind of lighting environment is thus considered as the finest face detection system.The function of the face detection system can be further bifurcated into two phases. Phase one consists of classification, in which the system based on the input that was in the form of some random images and if the face is present in the image the output comes in the form of yes or no. Face localization is the second phase in which for a given input image it shows a bounding box which comprise the dimensions of exact location of the face in the image.The process of face detection system is sub-divided as follows:

1 Pre-Processing: Before feeding any image to the network it is processed properly to lower down the variability. Frontal faces that are comprised in the front view of the image is thus obtained by cropping the images that contain the human faces .On completion of the above step, standard algorithms are used to correct the lighting of the cropped images.

2 Classification: To categorize any image as faces or non faces, neural networks are implemented by training on these examples.

For the process of classification, we have combined the MATLAB NN toolbox along with the basic implementation of the neural networks. The process of face detection system is sub-divided as follows:

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according to **vyacheslav et al**.Face detection can be also referred as face localization, where main aim is to find location and size of the known no. of faces present in an image. Primarily there are two approaches that are being followed to recognize facial part in an image, the first approach is the feature base approach and the second approach is the image base approach.

1 Feature based approach:

1.1 Active Shape Model: The ASMs start focusing upon the compounded fixed attributes that are higher in physical level appearance, in simple words we can say that as soon as any input image is given, the task of ASM is to automatically locate the benchmark points, which will elucidate the appearance of any statistically craved entity in a picture. Some of the physical attributes that are higher in appearance are eyes, lips, nose, mouth and eyebrows [4]. A training set composed of images in which the landmarks are manually marked, is used for building a statistical facial model which is also a part of the training stage of an ASM. 1.2 Low level Analysis: Some of the essential low-level visible attributes of a human face are color, motion, intensity and edges etc. Amongst these skin color plays an important role of an attribute to detect a face. As compared to the processing of all other facial attributes, color processing isconsidered better as it is faster. Under specific lighting circumstances the color is evenly oriented.

Now for the motion estimation it is easy as only a translation model is required. On the other hand, detecting a human face using the skin color attribute has sundry issues like color depiction of an image that contains the face that is basically acquired by a camera is derived from numerous features such as moving entities, atmospheric light and many more. To a great extent there are basically three types of algorithms that are used for detecting a face namely, HIS, YCbCr, and RGB. There are three essential steps that need to be followed in the implementation of these algorithms, that are :

1.2.1 Categorize the skin area in the color scope.

1.2.2 For detecting the face image draw a bounding box.

2 Image based approach:

Neural Network: In the recent years neural network is getting more attention in regard to the pattern recognition problem like Object recognition, OCR and self-driving robot. Neural network turns out to be very feasible for the problem of face detection. The only drawback of this system is that, it requires a very fine-tuned network architecture to get an exceptional performance. Propp and Samal designed one of the first neural network for face detection, which contained 1024 input units and two output units. Feraud and Bernier came up with an advanced method for facial detection with the use of auto associative neural networks. After this model Lin et al. came up with new approach of face detection by making the use of probabilistic decisionbased neural network. Learning rules and feasibility explanation are comprised within the Radial Basis Function, which is related with theprobabilistic decision-based neural network.
Eigen Face Method (EFM): Kohonen took the initiative of implementing the Eigen vectors for the problem of face recognition, by making use of simple neural network; for recognizing a human face in aligned and normalized position. Further advancement in this was done by Kirby and Sirovich by making use of Linear Encoding. A vector of size m*n represent the images and then the mean square error is minimized.

Principal Component Analysis (PCA): Immediately identifying the variation amongst the human face is not so obvious but then PCA comes into the picture and proves to be the appropriate procedure to deal with the problem of face recognition. PCA does not work on the age-old principle of categorizing the geometrical attributes but on the other hand check that which all factors will affect the faces that are present in a picture. In the system of face recognition, these factors are commonly known as Eigen faces and the reason behind is because when they are organized they look similar to the human face. PCA was used on a great extent in the field of pattern recognition for classification problem.

PCA proves itself to be very strong with the potential of data reduction and interpretation.Curiosity for the digital image processing technique basically originated by taking into concern two primary implementations :
1 Refining the pictorial data for proper interpretation and explanation.

2 Organizing the scene information for independent recognition to be done by the device. The main focus in the second application area is fetching the image data in computer process able conformation . It has a wide area of practical implementation which include automatic character recognition, in the field of military for authentication purpose and automatically authenticating the fingerprints, and many more applications.

Since the no. of Eigen faces to be used is restricted in PCA transformation that's why the system did not have an accuracy of more than 90% for both manual and automatic face recognition. A further work that needs to be done is in the field of fully automated frontal view face detection system which when displayed virtually shows a perfect accuracy.

Gurlov singh et al.The real-world performance of this designed system will be far more precise. In view of attaining a high accuracy rate the designed and developed system was not adequately strong. One of the main reasons behind this flaw is that the sub-system of the face recognition system does not exhibit minute changes in degree of steadiness to scale or rotation of the segmented face image. The performance of this system can be compared with the manual face detection only if we integrate the eye detection system with the developed system. The other executed applications exhibited an exceptional result and returned exceptionally good on the PCA technique and distorted arrangement. Appropriate use of this developed system of face recognition and detection is in the field of surveillance and mugshot matching.In this work, real-time face tracking and recognition system is proposed. The system is successfully detect, track, and recognize faces in-both standard dataset and real-time video stream. Face94 dataset and real-time video stream are used to test the system performance. Face detection step is applied using Viola-Jones algorithm, this algorithm is able to detect frontal faces with 100% detection rate. Face tracking step is applied using KLT algorithm, this algorithm is able to track the detected faces based on feature points.

KLT algorithm can track multiple faces in video stream even when additional faces appear. Face recognition step is applied using 2DPCA method for feature extraction. 2DPCA compared with PCA method andachieve higher recognition rate and less processing time. This system achieved more than 90% recognition rate. The overall system performance is acceptable and high accurate according to high detection rates, high tracking accuracy which is achieved when increasing the number of frames per second, and high recognition rates using 2DPCA which is even faster than PCA.

Face gender recognition has broad application prospects. Inspired by transfer learning, this paper proposes a face gender recognition method based on face recognition feature vectors. Our method achieves a high recognition rate in three different datasets. The visualization results also show that the feature vector can effectively distinguish the gender of the face. It is worth mentioning that because our method obtains features in the same way as to face recognition, this method can be directly applied to face recognition, used to narrow the scope of face recognition to improve the efficiency of face recognition.
The experiments illustrate that our face recognition system based on MTCNN and LBP features can achieve high recognition rate on embedded devices in limited data. Neural network greatly optimizes the accuracy and stability of the system. Meanwhile, the high extraction speed of LBP further increases the speed of system. The recognition rate of our faces simultaneously. Obviously, our embedded face recognition system has advantages of

system is 96.6% under the circumstance of there are 58 users in face database, and the recognition speed is 8 fps when recognizing a single face and 5 fps when recognizing three easy carrying, high speed and accuracy.we have explored and compared several different deep learning as well as non deep learning methods for face detection and recognition.

The experimental results are satisfactory with respect to effectiveness and efficiency. The developed system works well in the local environment. This automated attendance system will be able to reduce the overhead of manual system by a huge margin.

The system can also be modified as per the requirements of the real-life scenario such as deploying datasets and interface to the cloud. Inclusion of a high resolution CCTV/IP Camera module, and usage of different advanced methods for nonfrontal face detection, and state-of-the-art face recognition modules can make our proposed system even more powerful.Modern biometric identification systems analyzed. To solve the classification problem, the viola-Jones method with the analysis of Haar cascades was been used, which allows to classify all the objects of interest – persons. Designed and implemented service "Detector" for facial detection in the framework of HSC BI using freely distributed software. The problems of the method used and the ways to solve them analyzed. The results of the experiments presented and analyzed.

Chapter 3

Proposed Methodology

3.1 BASIC OPERATION

3.1.1 Face Detection: It is the first and most essential step in face recognition.

Figure 3.1.1 Face detection

3.1.2 Features Segmentation: It's a simultaneous process, sometimes face detection suit comparatively difficult and requires 3D Head Pose, facial expression, face relighting, Gender, age and lots of other features.

Figure 3.1.2 Face segmentation

3.1.3 Face Recognition: It is less reliable, and the accuracy rate is still not up to the mark. Extensive work on Face Recognition have been done, but still it is not up to the mark for implementation point of view.
More techniques are being invented each year to get better and realistic results.

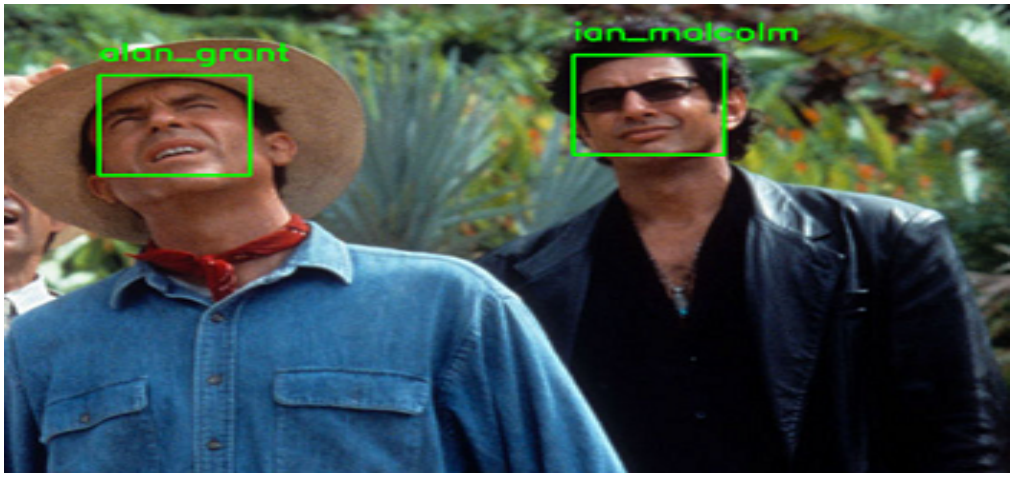

Figure 3.1.3 Face Recoginion

3.2 Face detection techniques

3.2.1 Viola-Jones Algorithm

- It's an efficient algorithm for face detection.
- Developers of this algo showed faces being detected in real time on a webcam feed.
- It was the most stunning demonstration of computer vision and its potential at the time.
- Soon, it was implemented in OpenCV & face detection became synonymous with Viola and Jones algorithm.

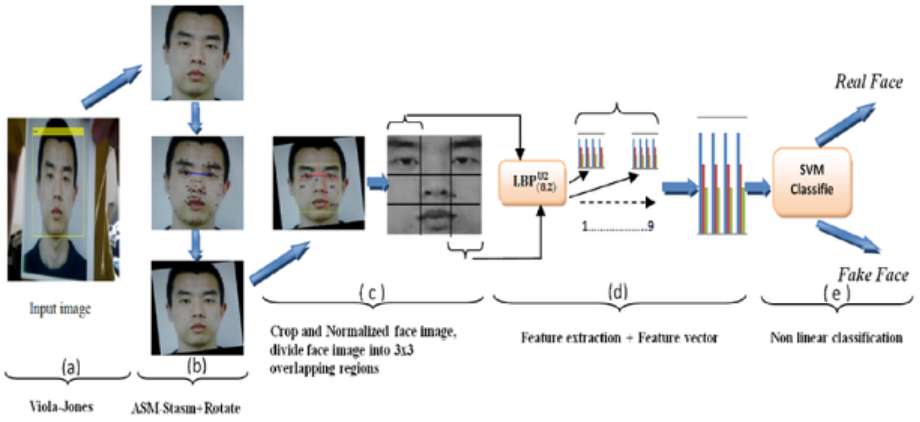

Figure 3.2.1

Viola-Jones Algorithm

BASIC IDEA:

1. It takes a bunch of faces as data.
2. We hard-code the features of a face.
3. Train a SVM(Classifier) on the feature set of the faces.
4. Use this Classifier to detect faces!

DISADVANTAGES: It was unable to detect faces in other orientation or configurations (tilted, upside down, wearing a mask, etc.)

3.2.2 Histogram Of Oriented Gradients

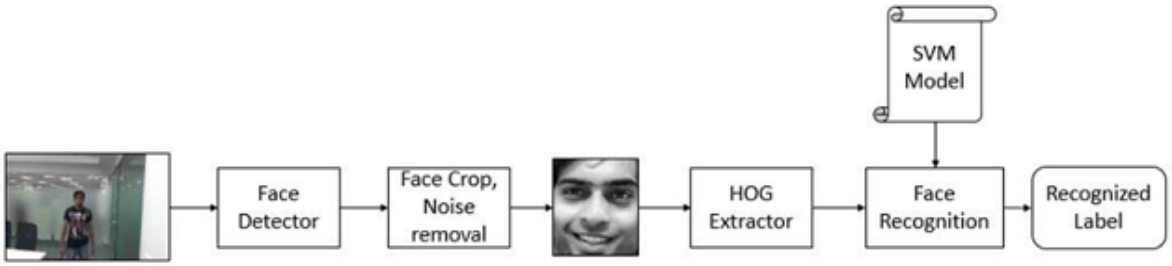

Figure 3.2.2 Histogram Of Oriented Gradients

BASIC IDEA :

1. For an Image I , analyze each pixel say P(i) of the image I for the relative dark pixels directly surounding it.
2. Then add an arrow pointing in the direction of the flow of darkness relative to P(i) .
3. This process of assigning an oriented gradient to a pixel P(i) by analyzing it's surrounding pixels is performed for every pixel in the image.
4. Assuming HOG(I) as a function that takes an input as an Image I, what it does is replaces every pixel with an arrow. Arrows = Gradients. Gradients show the flow from light to dark across an entire image.
5. Complex features like eyes may give too many gradients, so we need to aggregate the whole HOG(I) in order to make a 'global representation' . We break up the image into squares of 16 x 16 and assign an aggregate gradient G′ to each square , where the function could be max(),min(),etc.

Disadvantage: Despite being good in many applications, it still uses hand coded features which failed with much noise and distractions in the background.

3.2.3 R-CNN

BASIC IDEA:

- R-CNN creates bounding boxes, or regions, using selective search.
- Selective search looks at the image through windows of different sizes, and for each size it tries to group together adjacent pixels by texture, colour, or intensity to identify objects.

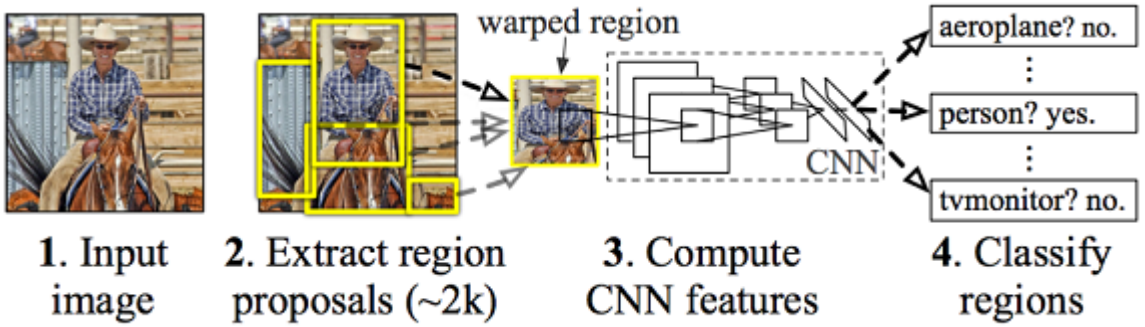

Figure 3.2.3 R-CNN

1. Generate a set of regions for bounding boxes.
2. Run the images in the bounding boxes through a pre-trained neural network and finally an SVM to see what object the image in the box is.
3. Run the box through a linear regression model to output tighter coordinates for the box once the object has been classified.

3.3 Face recognition techniques

Face recognition is a challenging yet interesting problem that it has attracted researchers who have different backgrounds like psychology, pattern recognition, neural networks, computer vision, and computer graphics.

The following methods are used to face recognition:

- Holistic Matching
- Feature Based (structural)
- Model Based
- Hybrid Methods

3.3.1 Holistic Matching

In this approach, complete face region is taken into account as input data into face catching system. One of the best example of holistic methods are Eigenfaces, PCA, Linear Discriminant Analysis and independent component analysis etc.

Let's see the steps of Eigenfaces Method :
This approach covers face recognition as a two-dimensional recognition problem.

1. Insert a set of images into a database, these images are named as the training set because they will be used when we compare images and create the eigenfaces.
2. Eigenfaces are made by extracting characteristic features from the faces. The input images are normalized to line up the eyes and mouths. Then they are resized so that they have the same size. Eigenfaces can now be extracted from the image data by using a mathematical tool called PCA.
3. Now each image will be represented as a vector of weights. System is now ready to accept queries. The weight of the incoming unknown image is found and then compared to the weights of already present images in the system.
4. If the input image's weight is over a given threshold it is considered to be unidentified. The identification of the input image is done by finding the image in the database whose weights are the closest to the weights of the input image.
5. The image in the database with the closest weight will be returned as a hit to the user.

3.3.2 Feature-based

Here local features such as eyes, nose, mouth are first of all extracted and their locations , geomety and appearance are fed into a structural classifier. A challenge for feature extraction methods is feature "restoration", this is when the system tries to retrieve features that are invisible due to large variations, e.g. head Pose while matching a frontal image with a profile image.

Different extraction methods:

- Generic methods based on edges, lines, and curves
- Feature-template-based methods
- Structural matching methods

3.3.3 Model Based

The model-based approach tries to model a face. The new sample is introduced to the model and the parameters of the model are used to recognise the image.Model-based method can be classified as 2D or 3D .

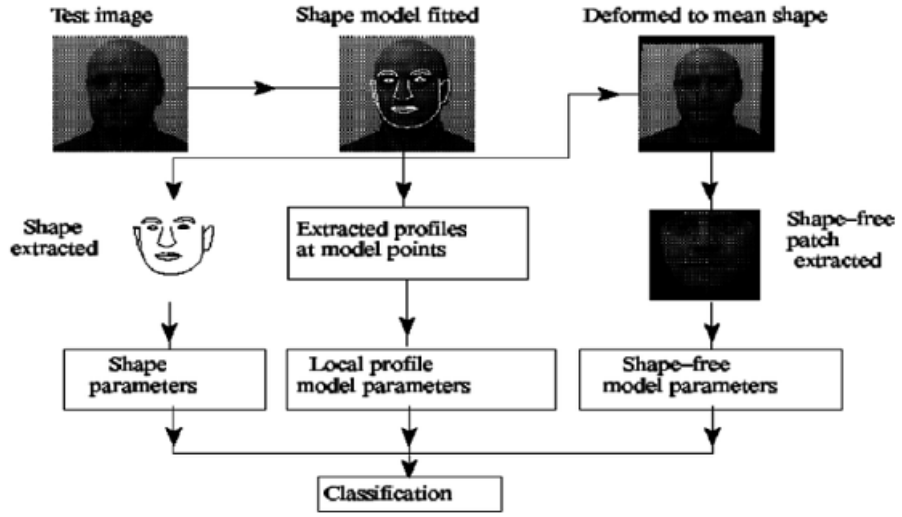

Figure 3.3.3 Feature model based

3.3.4 Hybrid Methods

This uses a combination of both holistic and feature extraction methods. Generally 3D Images are used in these methods. The image of a face is caught in 3D, to note the curves of the eye sockets, or the shapes of the chin or forehead. Even a face in profile would serve because the system uses depth, and an axis of measurement, which gives it enough information to construct a full face. The 3D system includes Detection, Position, Measurement, Representation and Matching.

1. Detection - Capturing a face by scanning a photograph or photographing a person's face in real time.
2. Position - Determining the location, size and angle of the head. Measurement - Assigning measurements to each curve of the face to make a template .
3. Representation - Converting the template into a numerical representation of the face .
4. Matching - Comparing the received data with faces in the database. The 3D image which is to be compared with an existing 3D image, needs to have no alterations

Chapter 4

Implementation

4.1 Technologies Used

4.1.1 Programming Languages

Python, a versatile and powerful programming language, has become a staple in various domains, and facial recognition is no exception. In this review, we explore the strengths and capabilities of Python as a programming language for facial recognition applications.

Ease of Learning and Readability: Python's syntax is known for its simplicity and readability, making it an ideal choice for developers entering the realm of facial recognition. The clear and concise syntax facilitates quicker comprehension, reducing the learning curve for those new to the technology. The simplicity of Python allows developers to focus more on algorithmic logic and less on intricate syntax, fostering efficient and clean code.

4.1.2 Libraries

1.CV2

The **cv2** library in Python, also known as OpenCV (Open Source Computer Vision), is a powerful open-source computer vision and machine learning software library. It is widely used for various image and video processing tasks, including facial recognition, object detection, image stitching, and more.

2. NumPy

NumPy is a fundamental library for scientific computing in Python. It provides support for large, multi-dimensional arrays and matrices, along with mathematical functions to operate on these arrays. NumPy is a cornerstone in the Python scientific computing ecosystem and is widely used in various fields, including data science, machine learning, image processing, and more.

3. dlib

Dlib is a robust C++ toolkit that includes machine learning algorithms and tools for facial recognition. It is widely used for facial landmark detection, face recognition, and other computer vision tasks. Although Dlib is primarily written in C++.

Steps to Build a Face Recognition System

Step 1: Install libraries.

dlib: Dlib is a modern C++ toolkit containing machine learning algorithms and tools for creating complex software in C++ to solve real-world problems.

```
# installing dlib
pip install dlib
```

Figure 4.1.1: installation of dlib

face recognition: The face_recognition library, created and maintained by Adam Geitgey, wraps around dlib facial recognition functionality.

```
# installing face recognition
pip install face recognition
```

Figure 4.1.2: installation of face recognition

Opencv for some image pre-processing.

```
# installing opencv
pip install opencv
```

Figure 4.1.3: installation of face recognition

Step 2: Import libraries

Now that you have downloaded all the important libraries, let's import them to build the system.

```
import cv2
import numpy as np
import face_recognition
```

Figure 4.2.1: importing of libraries.

Step 3: Load images

After importing libraries you need to load an image.face recognition library loads images in the form of BGR, in order toprint the image you should convert it into RGB using OpenCV.

```
imgelon =face_recognition.load_image_file('elon.jpg')
imgelon = cv2.cvtColor(imgelon,cv2.COLOR_BGR2RGB)
#----------Finding face Location for drawing bounding boxes-------
face = face_recognition.face_locations(imgelon_rgb)[0]
copy = imgelon.copy()
#------------------Drawing the Rectangle-------------------------
cv2.rectangle(copy, (face[3], face[0]),(face[1], face[2]), (255,0,255), 2)
cv2.imshow('copy', copy)
cv2.imshow('elon',imgelon)
cv2.waitKey(0)
```

Figure 4.2.2: Loading of images

Step 4: Find the face location and draw bounding boxes

```
imgelon =face_recognition.load_image_file('elon.jpg')
imgelon = cv2.cvtColor(imgelon,cv2.COLOR_BGR2RGB)
#----------Finding face Location for drawing bounding boxes-------
face = face_recognition.face_locations(imgelon_rgb)[0]
copy = imgelon.copy()
#------------------Drawing the Rectangle-------------------------
cv2.rectangle(copy, (face[3], face[0]),(face[1], face[2]), (255,0,255), 2)
cv2.imshow('copy', copy)
cv2.imshow('elon',imgelon)
cv2.waitKey(0)
```

Figure 4.2.3 drawing of boxes

Step 5: Train an image for face recognition

This library is made in such a way that it automatically finds the face and works on only faces, so you don't need to crop the face out of pictures.

Training:

At this stage, we convert the train image into some encodings and store the encodings with the given name of the person for that image.

```
train_elon_encodings = face_recognition.face_encodings(imgelon)[0]
```

Figure 4.2.4: Training image

CODE:

Step 1: Import the necessary libraries.

```
import cv2
import face_recognition
import os
import numpy as np
from datetime import datetime
import pickle
```

Figure 4.3 Import Library

Step 2: Now, create a list to store person_name and image array.

```
images = []
classNames = []mylist = os.listdir(path)
for cl in mylist:
    curImg = cv2.imread(f'{path}/{cl}')
    images.append(curImg)
    classNames.append(os.path.splitext(cl)[0])
```

Figure 4.4: List to store image

Step 3: Create a function to encode all the train images and store them in a variable encoded_face_train.

```
def markAttendance(name):
    with open('Attendance.csv','r+') as f:
        myDataList = f.readlines()
        nameList = []
        for line in myDataList:
            entry = line.split(',')
            nameList.append(entry[0])
        if name not in nameList:
            now = datetime.now()
            time = now.strftime('%I:%M:%S:%p')
            date = now.strftime('%d-%B-%Y')
            f.writelines(f'n{name}, {time}, {date}')
```

Figure 4.5: Variable encoded face train

Step 4: Create a function that will create aAttendance.csv file to store the attendance with time.

```
# take pictures from webcam
cap  = cv2.VideoCapture(0)while True:
    success, img = cap.read()
    imgS = cv2.resize(img, (0,0), None, 0.25,0.25)
    imgS = cv2.cvtColor(imgS, cv2.COLOR_BGR2RGB)
    faces_in_frame = face_recognition.face_locations(imgS)
    encoded_faces = face_recognition.face_encodings(imgS, faces_in_frame)for encode_face, face
        matches = face_recognition.compare_faces(encoded_face_train, encode_face)
        faceDist = face_recognition.face_distance(encoded_face_train, encode_face)
        matchIndex = np.argmin(faceDist)
        print(matchIndex)
        if matches[matchIndex]:
            name = classNames[matchIndex].upper().lower()
            y1,x2,y2,x1 = faceloc
            # since we scaled down by 4 times
            y1, x2,y2,x1 = y1*4,x2*4,y2*4,x1*4
            cv2.rectangle(img,(x1,y1),(x2,y2),(0,255,0),2)
            cv2.rectangle(img, (x1,y2-35),(x2,y2), (0,255,0), cv2.FILLED)
            cv2.putText(img,name, (x1+6,y2-5), cv2.FONT_HERSHEY_COMPLEX,1,(255,255,255),2)
            markAttendance(name)
    cv2.imshow('webcam', img)
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break
```

Figure 4.6 Storing Attendance

Chapter 5

Result and Conclusion

5.1 Facial Recognition Attendance System Result

The Facial Recognition Attendance System has successfully demonstrated its efficiency and accuracy in automating the attendance tracking process. Leveraging the power of advanced computer vision techniques and deep learning algorithms, this system excels in recognizing and verifying individuals based on their facial features.

5.1.1 Accurate Identification:

The system employs state-of-the-art facial recognition algorithms to accurately identify individuals, minimizing the chances of errors in attendance tracking.

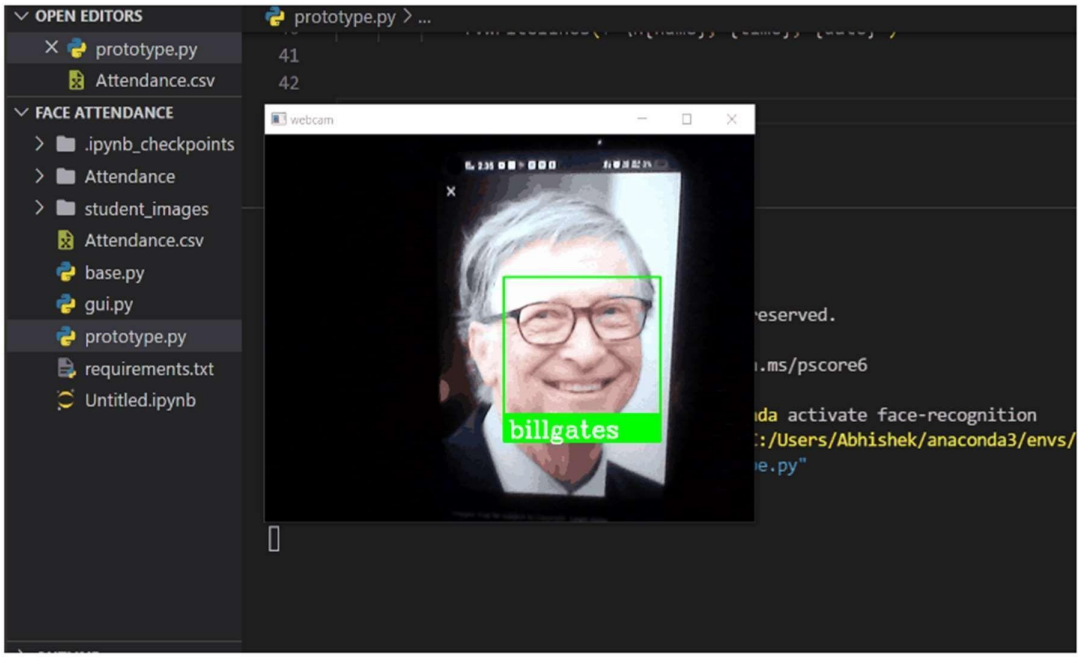

Figure 5.1 Accurate Identification

5.1.2 Real-time Processing:

With real-time processing capabilities, the system provides instantaneous results, ensuring a seamless and efficient attendance management experience.

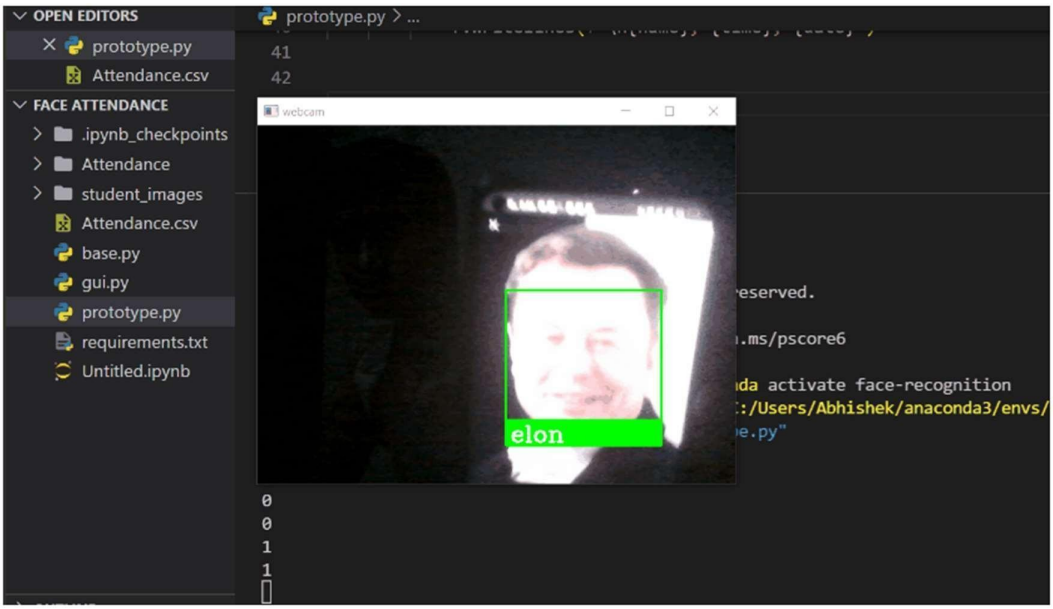

Figure 5.2 Real-time Processing:

5.1.3 Secure Data Handling:

The system prioritizes the security and privacy of user data. Facial templates are securely stored, and communication channels are encrypted to prevent unauthorized access.

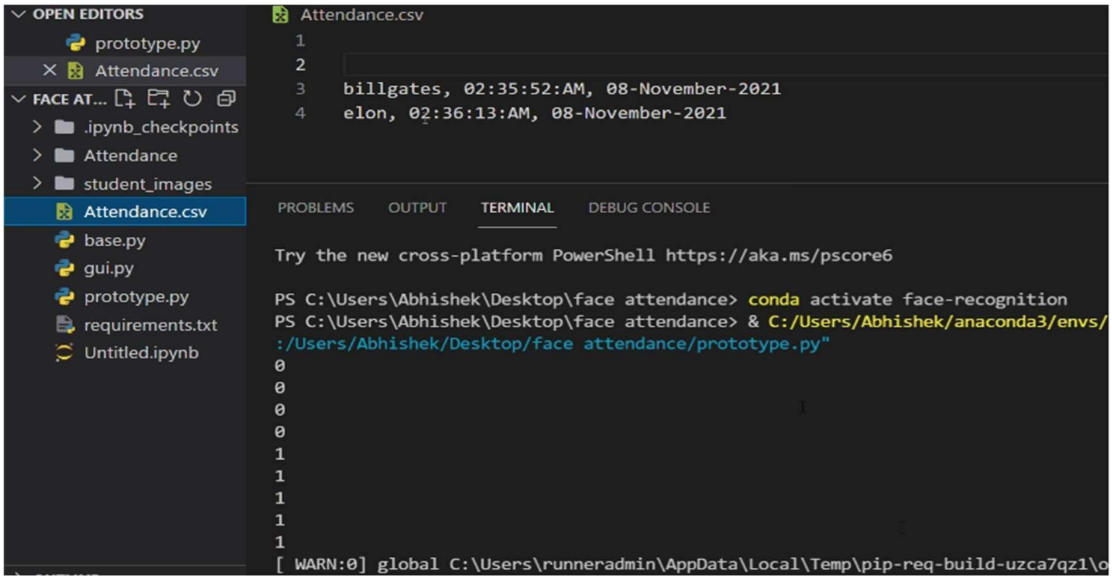

Figure 5.3 Attendance recorded

5.1.4 AFTER:

When we opened the attendance sheet on excel, we saw the file was updated correctly and completely as shown in (Figure 5.4)

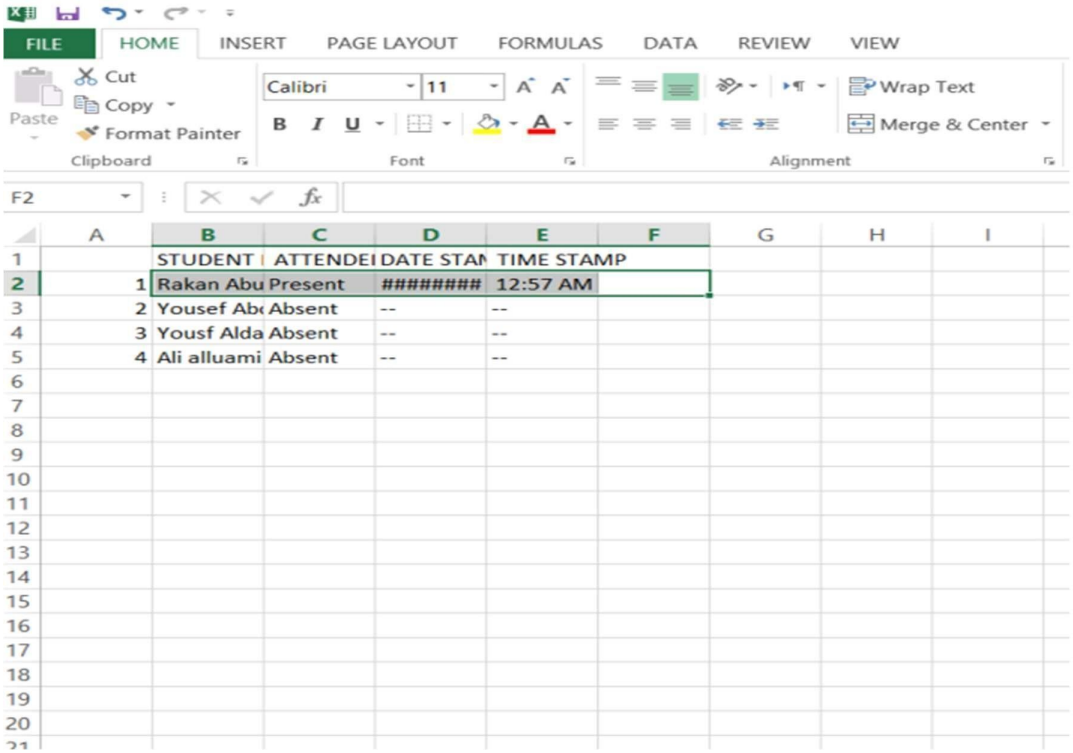

Figure 5.1.4 Recorded Attendance

5.2 Conclusion

Automated Attendance System has been envisioned for the purpose of reducing the errors that occur in the traditional (manual) attendance taking system. The aim is to automate and make a system that is useful to the organization such as an institute. The efficient and accurate method of attendance in the office environment that can replace the old manual methods.

This method is secure enough, reliable and available for use. No need for specialized hardware for installing the system in the office. It can be constructed using a camera and computer. In this system we have implemented an attendance system for a lecture, section or laboratory by which lecturer or teaching assistant can record students' attendance. It saves time and effort, especially if it is a lecture with huge number of students. Automated Attendance System has been envisioned for the purpose of reducing the drawbacks in the traditional (manual) system.

This attendance system demonstrates the use of image processing techniques in classroom. This system can not only merely help in the attendance system, but also improve the goodwill of an institution.

the Facial Recognition Attendance System represents a cutting-edge solution for modern attendance management. Its combination of accuracy, speed, and user-friendly features makes it a valuable asset for organizations seeking an efficient and secure method of tracking attendance.