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Face Recognition-Based Attendance System for Education Institute

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Abstract: *Facial recognition technology is a crucial aspect of human identification, making it an ideal solution for attendance monitoring in educational institutions.[2] Traditional methods of attendance taking, such as roll calls and sign-in sheets, have proven to be time-consuming and inefficient. Consequently, there is a pressing need to enhance and upgrade the current attendance system to be more user-friendly and effective. This project aims to develop a face recognition-based attendance monitoring system that overcomes the limitations of the existing system. The current system suffers from ambiguity, leading to inaccuracies and inefficiencies in attendance tracking. Furthermore, it faces challenges in enforcing attendance regulations. By utilizing face recognition technology, which leverages the unique and difficult-to-duplicate characteristics of the human face, this project aims to address these issues. The system scans the faces of newly admitted students, capturing sample images (up to 100 samples per student), which are stored for training the model to ensure accurate predictions. During attendance sessions, the student's face is compared against the stored images to verify their identity. Once identified, the system automatically records the attendance by saving the necessary information, including the attendance status, in an Excel sheet. At the end of each day, the attendance information for all individuals is compiled into an Excel sheet and emailed to the respective faculty. This paper provides insights into the functionality and implementation of this project in educational institutes, showcasing its potential to revolutionize the attendance management system*

Keywords: Face recognition, Attendance, Python open Cv, Numpy, Pythontkinter, Images, Training

I. INTRODUCTION

In today's technologically advanced era, classroom management methods have largely remained unchanged. However, one of the crucial aspects of effective classroom management is attendance, as it directly impacts students' academic performance.

A well-functioning attendance system promotes increased class participation and learning. Unfortunately, traditional methods such as roll numbering and sign-in sheets are not only prone to proxy attendance but also time-consuming.

Recognizing the need for an efficient and disciplined classroom environment, we propose automating the attendance process using modern technologies. Face recognition, a widely utilized technology in security systems, offers a promising solution that can be compared to other biometric methods like fingerprint or iris recognition systems.[1] As educational institutes and organizations face an increase in student or employee numbers, attendance control becomes more complex. This project aims to address these challenges by providing an explanation and potential solution. By automating the attendance process through face recognition, the system accurately identifies students present in a lecture hall, enabling the maintenance of attendance information. This innovative approach streamlines the attendance tracking process, leading to a more efficient and disciplined classroom environment. This paper presents the implementation and functionality of a face recognition-based attendance monitoring system, highlighting its potential to revolutionize classroom management in educational institutes and organizations.

II. OVERVIEW

Face recognition being a biometric technique implies determining if the image of the face of any particular person matches any of the face images that are stored in a database.[1] This difficulty is tough to resolve automatically because

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of the changes that several factors, like facial expression, aging, and even lighting can affect the image.[1] Facial recognition among the various biometric techniques may not be the most authentic but it has various advantages over the others.[1] Face recognition is natural, feasible, and does not require assistance.[1] The expected system engages the face recognition approach for automating the attendance procedure of students or employees without their involvement.[1] A webcam is used for capturing the images of students or employees.[1] The faces in the captured images are detected and compared with the images in the database and the attendance is marked. [1]

III. IMAGE PROCESSING

The facial recognition process can be split into two major stages: processing which occurs before detection involving face detection and alignment and later recognition is done using feature extraction and matching steps.[1]

3.1 Face Detection

The main purpose of this step is to determine whether human faces are present in a given image and to identify the specific locations of these faces.[1] The desired outcome of this process is to generate patches or regions of interest that encompass each detected face within the original image. This step is crucial for developing a reliable and customizable face recognition system.

3.2 Feature Extraction

In the following face detection step the extraction of human face patches from images is done. After this step, the conversion of the face patch is done into a vector with fixed coordinates or a set of landmark points. [1]

3.3 Face Recognition

After the facial representation step, the subsequent stage involves face identification. To facilitate automatic recognition, a face database is constructed Multiple images of individuals are captured, and their facial features are extracted and stored in this database.[1] When an input image is processed, face detection and feature extraction are performed. The extracted features are then compared with each face class stored in the database, and the corresponding similarity scores or matching results are recorded.

IV. ALGORITHM

There are various algorithms used for facial recognition. In this project we have used the following algorithms:

LOCAL BINARY PATTERNS HISTOGRAMS (LBPH)

This approach requires grayscale images specifically for the training phase. In comparison to other algorithms, it is not considered a holistic approach.

PARAMETERS

LBPH uses the following parameters:

- **Radius:** Typically, the radius parameter for the circular local binary pattern in the LBPH (Local Binary Patterns Histogram) method is set to 1. This value signifies the distance or radius around the central pixel.
- **Neighbours:** The number of sample points surrounding the central pixel which is generally 8. The computational cost will increase with the increase in number of sample points.
- **Grid X:** The number of cells along the horizontal direction is represented as Grid X. With the increase in the number of cells the grid becomes finer which increases dimensional feature vector.[1]
- **Grid Y:** The number of cells along the vertical direction is represented as Grid Y. With the increase in the number of cells the grid becomes finer which increases dimensional feature vector.[1]

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ALGORITHM TRAINING

For the training purpose of the dataset of the facial images of the people to be recognized along with the unique ID is required so that the presented approach will utilize the provided information for perceiving an input image and providing the output. Same images requiresame ID.[1]

COMPUTATION OF THE ALGORITHM

To convert a facial image into grayscale, the image is processed by considering a 3x3 window or matrix. Each pixel in the matrix represents the intensity value ranging from 0 to 255. The central value of the matrix is chosen as the threshold.

Next, the values of the 8 neighboring pixels are compared to the threshold value. If a pixel's value is equal to or greater than the threshold, it is assigned a binary value of 1; otherwise, it is assigned a binary value of 0. This results in a matrix containing only binary values. Concatenation is then performed at each position to obtain new binary values for each position in the matrix.

The binary values are further converted into decimal values, which become the central value of the matrix. This process is repeated for each pixel in the original image. As a result, a new image is generated, capturing the essential characteristics of the original image.Then the conversion of this binary value into a decimal value is done which is made the central value of the matrix. It is a pixel of the actual image. As the process is completed, we get a new image which serves as the better characteristics of the original image.

EXTRACTION OF HISTOGRAM

In the previous step, the image is divided into multiple grids using the parameters Grid X and Grid Y. This allows for the extraction of histograms based on the image as follows:

- The image is in grayscale, and each histogram will consist of 256 positions (0-255) representing the existence of each pixel intensity.
- Individual histograms are created for each grid, and a new, larger histogram is constructed. For instance, if there are 8x8 grids, the final histogram will have a total of 16,384 positions. This aggregated histogram captures the features present in the original image.

FACE RECOGNITION

Once the algorithm is trained, the next step involves finding an image that is similar to the input image. This is achieved by comparing the two histograms and determining the nearest match. Various approaches can be used to calculate the distance between the histograms, with the Euclidean distance being a common choice. The Euclidean distance is calculated using the following formula:

$$D = \sqrt{\sum_{i=1}^{n} (hist1_i - hist2_i)^2}$$

The outcome of this method is the ID of the image that corresponds to the nearest histogram. Additionally, the calculated distance can be interpreted as a measure of "confidence." To automatically evaluate the recognition, a threshold value is established. If the confidence (distance) is below the threshold, it indicates that the image has been correctly recognized by the algorithm

ADVANTAGES OF USING LBPH ALGORITHM:

- The LBPH algorithm stands out as a straightforward approach for face recognition. It effectively captures and characterizes the local features present in facial images, allowing for a comprehensive analysis.
- By employing this algorithm, significant outcomes can be achieved in terms of face recognition accuracy and performance. Its ability to effectively recognize faces has made it a widely used method in various applications.

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- Implementation of the LBPH algorithm often involves leveraging the OpenCV library. OpenCV provides a robust set of tools and functions that facilitate the seamless integration and execution of the LBPH algorithm within different software systems.

HAAR CASCADE FRONTAL FACE CLASSIFIER(IN OPEN CV)

Haar feature-based cascade classifiers offer an effective approach for object detection. This machine learning-based method involves training a cascade function using a large set of positive and negative images.[3] The trained classifier can then be applied to detect objects in new images.

To train the classifier, a substantial number of positive images (images containing the desired object, such as faces) and negative images (images without the object) are required. Feature extraction is a crucial step in this process. Haar features, similar to convolutional kernels, are utilized for feature extraction. Each Haar feature corresponds to a single value obtained by subtracting the sum of pixel intensities within a white rectangle from the sum of pixel intensities within a black rectangle[3]

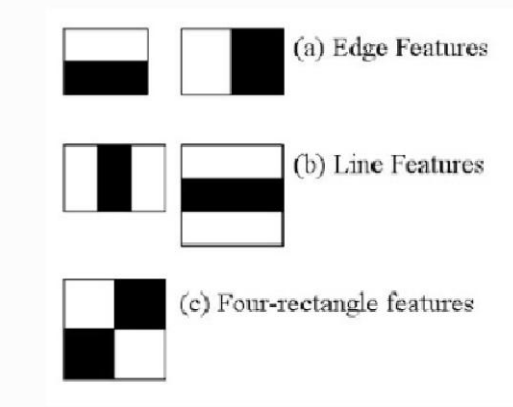

Fig. 1

Face detection using Opencv with Haar cascade classifier[3]

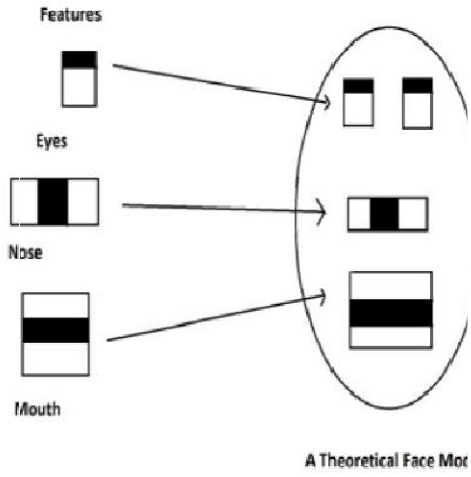

Fig. 2

The first step is to collect the features of Haar. The Haar element is a calculation performed on nearby rectangular areas. The calculation involves summarizing the intensity of the pixel in each area and calculating the difference between the calculations (i.e. the difference between the positives and the negatives). The next step includes the selecting of features with minimum error rate as those are the features which best differentiate a face from a non-face while other features are discarded (this would eventually reduce the number of features to some handful) In the next

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step the features are further divided or split into a number of stages (cascading) and each input is then evaluated independently in stage-by- stage manner

In Fig. 2, the algorithm uses training data to best identify features that it can consider a face. The face has different features like eyes, nose, and mouth. Feature extraction is used in this algorithm. In the eye region, one coordinate is taken at a time, and get the rectangular data from the grey image. This serves as the input for the eye model, as the model will be detecting the eye coordinates within a face. Haar Cascades uses machine learning techniques in which a function gets trained from a group of positive and negative images. The process in the algorithm is feature extraction

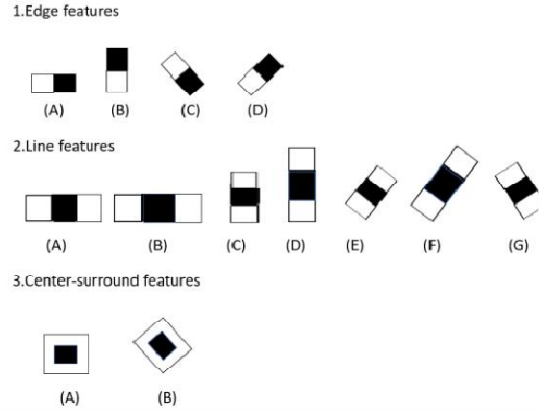


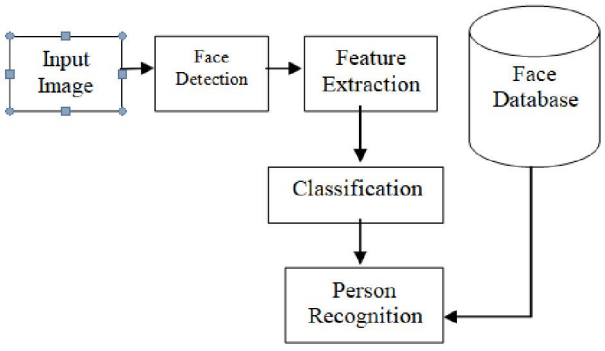
Fig. 3

The different features that can be extracted from facial images in the process are shown in Fig. 3.

In Fig. 3 different types of features are given which can be extracted to find a face. It is to be kept in mind that more than one feature should be used to detect a face more accurately.[4] Some features which can be used to detect faces are edge features, line features, or center-surround features.

The edge feature is mostly used on disc-like objects in an image to accurately find the center position of the image. The line feature is better used to detect lips where light-dark-light pixels are formed.[4] Similarly, the center-surround feature can be used in places where there is a dark pixel surrounded by a lighter pixel like in a mole, or black spot on the face.[4]

The main regions which have importance in the context of face detection areEyes-this region tend to be darker than cheeks, and the Nose- this region has brighter pixel than the eyes. There are many features for face detection (160000+ features).[4] To select the best feature Adaboost is used. Here the training of the image is done while applying every feature. For every feature, Adaboost finds the best threshold which will separate face images into positives and negatives. But obviously, while dividing there will be some error or misclassification.[4] The features with minimum error rate are selected as those are the features that best classify a face with a non-face



DATABASE CREATION

The initial stage of the Attendance System involves building a database of faces to be utilized. Various individuals are enrolled, and a camera is employed to detect and capture frontal face images.

The number of frames captured for each individual can be adjusted to achieve the desired accuracy levels. These collected images, along with corresponding Registration IDs, are then stored in the database.

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TRAINING OF FACES

Once the images are captured by the camera, they are saved in grayscale format. To train these faces, the LBPH (Local Binary Patterns Histogram) recognizer is utilized. Training is crucial as it sets the resolution and ensures that the recognized face resolutions can be highly variable.

During training, a portion of the image is selected as the center, and its neighboring pixels are compared against it using a threshold. If the intensity of the center pixel is greater than or equal to its neighbor, it is assigned a value of 1; otherwise, it is assigned a value of 0. This process generates binary patterns, commonly known as LBP (Local Binary Pattern) codes.

FACE DETECTION

The data of the trained faces is stored in a format compatible with Python, such as .py files.[1] To detect the faces, the Haar cascade frontal face module is utilized. This module applies Haar cascade classifiers specifically designed for frontal face detection.

FACE RECOGNITION

The data of the trained faces is stored, and during the face recognition process, the detected faces are compared with the registered IDs of the students to identify them. The face detection and recognition are performed in real-time to ensure the accuracy and efficiency of the system. It is crucial to note that the performance of this system is highly dependent on the condition and quality of the camera being used.

V. BLOCK DIAGRAM

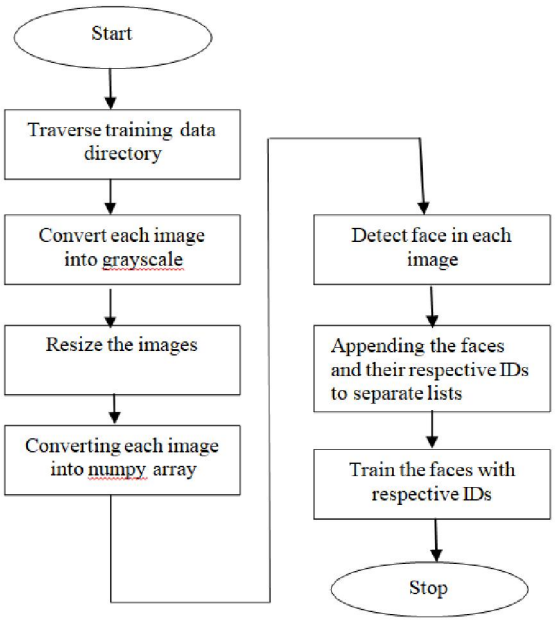

Fig.4. Flow-chart of the methodology used for Training Process

The training process starts with traversing the training data directory.[1] Each image in the training date is converted into a grayscale. A part of the image is taken as the center and threshold its neighbors against it. If the intensity of the middle part is more or equal to its neighbor then denote it with 1 and 0 if not. After this, the images are resized. Then the images are converted into a numpy array which is the central data structure of the numpy library. Each face in the image is detected. Creation of separate lists of each face is done and the faces are appended into them along with their respective IDs. The faces are then trained with their respective IDs

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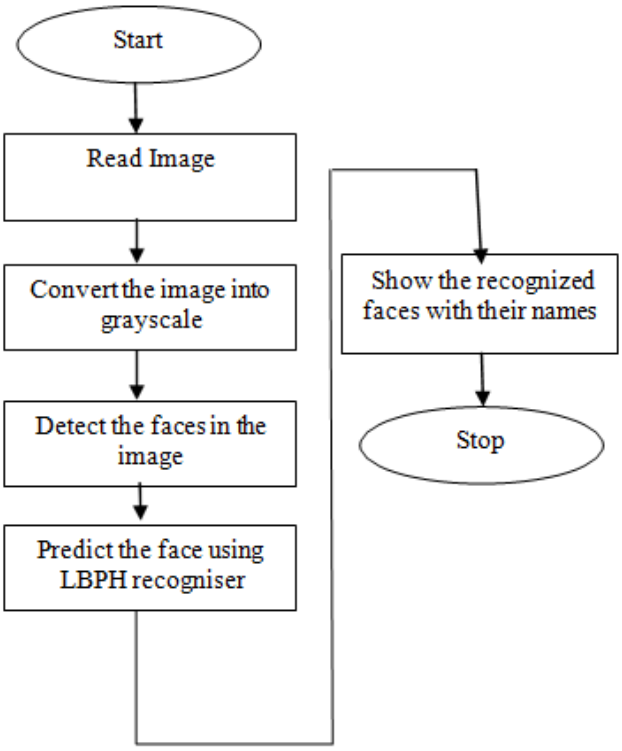

Fig.4. Flow-chart of the methodology used for Face Detection and Recognition

The input image is captured by the phone's camera. Once captured, the image is converted to grayscale for further processing. The Haar Cascade frontal face module is employed to detect the faces within the image. The LBPH algorithm is then utilized to predict the identities of the detected faces.

Upon prediction, the recognized faces are visually indicated by drawing a green box around them. Additionally, the names or labels associated with the recognized faces are displayed alongside the respective green boxes.

VI. SOFTWARE DESCRIPTION

Open Cv

OpenCV (Open Source Computer Vision Library) is a freely available software library designed for computer vision applications and machine learning. Its primary purpose is to facilitate the usage of machine perception in commercially viable products. OpenCV is distributed under a BSD license, providing flexibility for code utilization and modification. The library boasts an extensive collection of more than 2500 advanced algorithms, encompassing a wide range of computer vision and machine learning techniques. These algorithms can be leveraged for various tasks, including face detection and recognition, object identification, 3D model extraction, stereo camera-based 3D point cloud generation, image stitching for panoramic views, image database search for similar images, red-eye removal, eye tracking, scene recognition, augmented reality marker placement, and more. OpenCV supports multiple programming languages, including C++, Python, Java, and MATLAB, and offers interfaces for Windows, Linux, Android, and macOS platforms. It also provides optimized implementations that leverage MMX and SSE instructions for real-time vision applications. Furthermore, efforts are underway to develop comprehensive CUDA and OpenCL interfaces. With over 500 algorithms and a multitude of functions supporting them, OpenCV offers a rich and versatile toolkit. It is primarily implemented in C++, with a template interface that seamlessly integrates with STL (Standard Template Library) containers. Idle. IDLE is Python‟s Integrated Development and Learning Environment. IDLE is completely coded in Python, using the tkinter GUI toolkit. It works mostlyuniformly on Windows, Unix and macOS. It has a Python shell window (interactive interpreter) with colorizing of error messages, code input and code output. There is a multi-window text editor with multiple undo, Python colorizing, smart indent, call tips, auto completion, and other features. Searching within any window, replacing within editor windows and searching through multiple files is possible. It also has configuration, browsers and other dialogs as well.

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Microsoft Excel

Microsoft Excel is a spreadsheet program that is part of the Microsoft Office suite of applications. It allows users to create tables of values organized in rows and columns, which can be manipulated using a wide range of arithmetic functions and operations. In addition to its standard spreadsheet features, Excel provides programming support through Microsoft's Visual Basic for Applications (VBA), enabling users to automate tasks and create customized functionalities

Excel also offers the ability to access data from external sources through Microsoft's Dynamic Data Exchange (DDE), allowing for real-time data updates. Furthermore, Excel provides extensive graphing and charting capabilities, enabling users to visualize data effectively. As an electronic spreadsheet program, Excel is designed to store, organize, and manipulate data. It builds upon the concept of paper spreadsheets traditionally used for accounting purposes. The layout of computerized spreadsheets follows a similar structure to their paper counterparts, with data organized into tables consisting of rows and columns. This flexibility makes Excel a versatile tool that can be utilized for various tasks, such as tracking daily attendance of students

Tkinter

Tkinter is a Python binding to the Tk GUI toolkit, serving as the standard Python interface for creating graphical user interfaces (GUIs). It is widely recognized as Python's de facto standard GUI library and is included with standard installations of Python on Linux, Microsoft Windows, and macOS.

The name 'Tkinter' is derived from 'Tk interface'. Originally developed by Steen Lumholt and Guido van Rossum, Tkinter has undergone subsequent revisions by Fredrik Lundh. Released under a Python license, Tkinter is free software.

Tkinter is implemented as a Python wrapper around a complete Tcl interpreter embedded within the Python interpreter. This design allows Tkinter to translate its function calls into Tcl commands, which are then executed by the embedded interpreter. As a result, developers can seamlessly combine Python and Tcl within a single application

VII. RESULT ANALYSIS

This is the main project of the project. It has eightmodules. We will understand each module:

Student Panel:-

Fig.5. is the student panel module, it collects the data of the new students taking admission in the school/ college along with the sample images of the student face. The data of new students include the name, date of birth, department, semester, etc and it takes the sample images. It scans the students face and takes 100 grayscale images per students which will further be used for prediction. This data along with the images is stored in the database for further prediction purpose.

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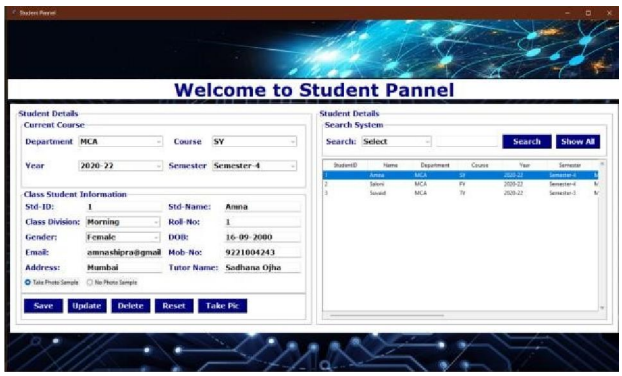

Fig. 5

Photos

Fig.6. is the photos module. It stores the sample images of the students taken in the student panel.All the images are stored in the grayscale format.

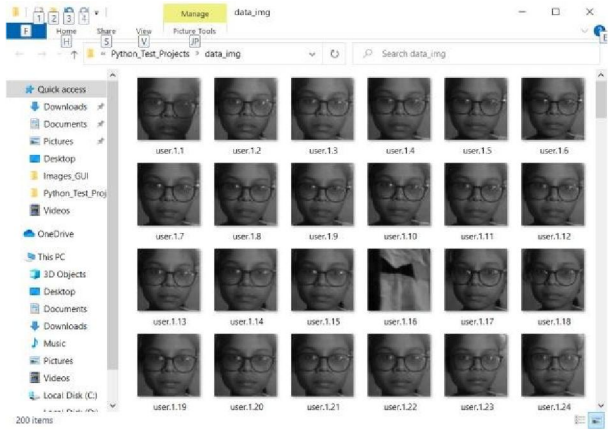

Fig. 6.

Data Train

Fig.7. is the data train module. This module trains the attendance system with the images stored in the photos module taken in the student panel so that the system will give proper predictions.

Fig. 8 Shows how the images are trained in the data train module by clicking the Train datasaet button

Fig. 7

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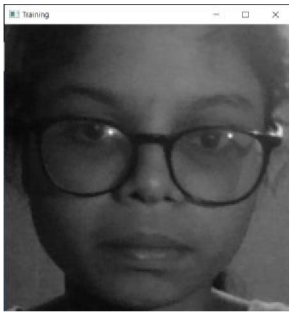

Fig. 8

Face detector:-

Fig. 9. Is the face detector module. This module predicts the students name, roll.no., Student ID, by scanning the students face. This is achieved using theweb camera.

Fig.11. Shows that the students‟ details arepredicted and the result is shown using the green box around the face along the details of a particular student.

Fig. 10. Shows that if a particular student has not provided the details along with the sample images, then the face detector shows a red box around that face written with message “unknown face”

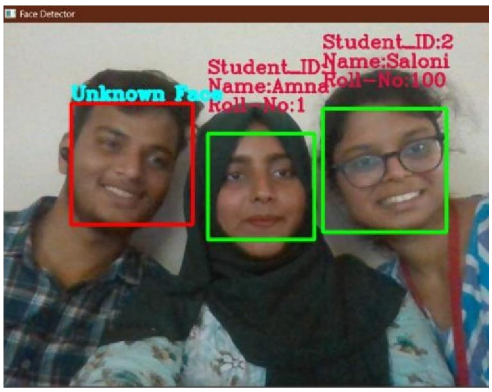

Fig. 9.

Fig. 10

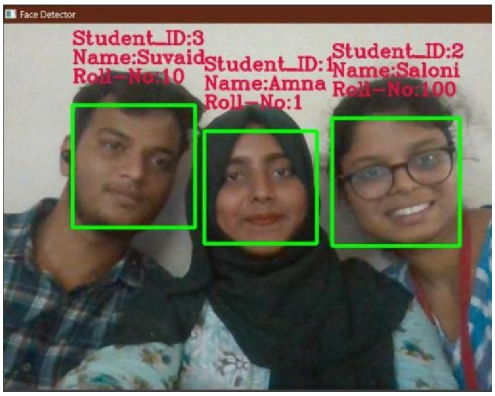

Fig. 11

Help-Support:-

Fig.12. is the help-Support module. With the help of this module the user can get help if there is any fault in the system thorung various sites

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Fig. 12.

Developer:-

Fig. 13. Is the developer module. This module gives the information about the developers of this project.

Fig. 13

Attendance:-

Fig. 14. Shows the attendance panel. This module displays the attendance taken in the face detector module. The attendance taken in the face detector module is automatically stored in a default excel sheet named attendance.csv along with the date, time, name of the student and the status of the attendance. Then on clicking the import csv button we can display the attendance sheet stored in the attendance.csv file. We need to save the attendance separately in another excel sheet so that it could be send to the respective faculty. Using the export csv button we can save the attendance in the attendance.csv in a separate csv file and send it to the respective faculties.

Fig. 14.

VIII. ACKNOWLEDGEMENT

We would like to express our deep gratitude to our project guide, a youtube channel code with Kiran for his/her guidance with unsurpassed knowledge and immense encouragement. We are very much thankful to the Director Dr. Minesh Ade, for their encouragement and cooperation to carry out this work. We express our thanks to all teaching faculty of Department of ,MCA, whose suggestions during reviews helped us in accomplishment of our project. We would like to thank all non-teaching staff of the Department of MCA for providing great assistance in accomplishment of our project. We would like to thank our parents, friends, and classmates for their encouragement throughout our project period. At last but not the least, we thank everyone for supporting us directly or indirectly in completing this project successfully.

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IX. CONCLUSION

The interface for the Smart Attendance System has been created. Using the interface the images of the individual students is being recorded and stored in the training dataset. Simultaneously their information is stored in the database i.e. excel sheet. Finally the images of the students is being tracked and recognized.

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