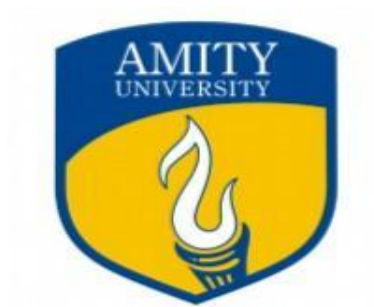Term Paper

on

IMPLEMENTATION OF FACIAL RECOGNITION USING PYTHON

Submitted to

Amity University Uttar Pradesh

In partial fulfilment of the requirements for the award of the degree

of

Bachelor of Technology

in

Computer Science and Engineering

by

ANCHAL KUMARI

A12405218083

Under the guidance of

DR. SUMIT KUMAR

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

AMITY SCHOOL OF ENGINEERING AND TECHNOLOGY

AMITY UNIVERSITY UTTAR PRADESH

ACKNOWLEDGEMENT

The satisfaction that accompanies that the successful completion of any task would be incomplete without the mention of people whose ceaseless cooperation made it possible, whose constant guidance and encouragement crown all efforts with success. I would deeply like to thank **Prof. (Dr) Abhay Bansal**, Head of Department-CSE, and Amity University for giving me the opportunity to undertake this project. I would like to thank my faculty guide **Dr.Sumit Kumar** who has been the biggest driving force behind my successful completion of the project. He has been always there to solve any query of mine and also guided me in the right direction regarding the project. Without his help and inspiration, I would not have been able to complete the project. Also, I would like to thank my batch mates and my guardians who guided me, helped me and gave ideas and motivation at each step.

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Anchal Kumari

A12405218083

Declaration

I, **Anchal Kumari** Com, student of B. Tech (4-C.S.E.-3(X)) hereby declare that the project titled "**Implementation of facial recognition using python**" which is submitted by me to Department of Computer Science and Engineering, **Amity School of Engineering Technology**, Amity University Uttar Pradesh, Noida, in partial fulfilment of requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering, has not been previously formed the basis for the award of any degree, diploma or other similar title or recognition.

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Date: _____

Anchal Kumari

A12405218083

4CSE-3X (2018-22)

CERTIFICATE

This is to certify that **Ms. Anchal Kumari**, student of B. Tech in Computer Science and Engineering has carried out work presented in the project of the Term paper entitle "**Implementation of facial recognition using python**" as a part of Second year program of Bachelor of Technology in Computer Science and Engineering from Amity University, Uttar Pradesh, Noida under my supervision.

_____

DR. Sumit Kumar

Department of Computer Science and Engineering

ASET, Noida

Abstract

Various pinnacle technologies have arrived in this era, especially from the computer science field. The varied applications of these technologies are what makes them used at such a global scale. Facial recognition is one such technology which has emerged out to be a major tool used as a privacy protector, user authentication, database creator, etc. It is still a growing industry with more technologies coming to aid it with more options. In this generation, technology has successfully pierced almost every known household in form of smart phones, laptops, smart TVs, etc, hence making it easier to come up with numerous applications for the technology and applying it to a mass spread audience. Though the facial recognition technology comes with its pros and cons, it is still developing day by day and has a wide scope for its use in the future.

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Introduction

A human face is made up of 80 differential features by which it can be recognized as an individual entity. Our brains use this information to observe and analyse a person's face to recognize it. When we look at a person, we register their unique facial traits and try to retain them in our memory. So, the next time we look at the same person, we compare their facial traits with the ones stored in our memory, or in technical terms our database, to recognize the person.

Similarly, we have used artificial intelligence to develop a facial recognition technology, where a computer system is responsible to recognize the user, every time they appear in front of its camera input source [3].

Facial recognition is the technology used to identify people in images or in videos by the process of analysing and comparing patterns. It is an application of computer vision, where we try to infer information from an input image and its contents [2].

Using this technology, we not only recognize an individual, but can also link it with a database of various information linked to the person in question. With the increasing development of the technology, there are systems in existence currently which are able to execute facial recognition with 99% accuracy, and it only takes 2 seconds to analyse a face in the system.

The Facial recognition system has become an essential biometric application and is widely used for the purpose of increasing security at a global stage. By 2024, the global facial recognition market could generate $7 billion in revenue [4]

Big companies like Google, Apple, Facebook, Amazon, and Microsoft (GAFAM) are also very much in the mix, regarding the technology. In 2014, Facebook announced the launch of its DeepFace program, which is able to determine whether two photographed faces belong to the same person, with an accuracy rate of 97.25%. When taking the same test, humans answer correctly in 97.53% of cases, or just 0.28% better than the Facebook program. In June 2015, Google went one better with FaceNet**.** On the widely used Labeled Faces in the Wild (LFW) dataset, FaceNet achieved a new record accuracy of 99.63%[4].

Using an artificial neural network and a new algorithm, the company from Mountain View has managed to link a face to its owner with almost perfect results. This technology is even available to the general public as its incorporated into Google Photos and used to sort pictures and automatically tag them based on the people recognized.

My paper aims to demonstrate an application of the facial recognition system. I have developed an attendance system based on facial recognition, using Python and SQlite3. The program is responsible to store the details and information of the student and mapping it with the respective student's facial ID. The system is then able to recognize the student and displays his/her information on the screen at run time. The main feature of the program stands out to be the toggle to update the attendance at run time. The program gives control to the user, to increment the student's attendance, which will reflect the changes in the database.

The main aim of this program is to automate the process of recording attendance in schools and universities. This not only makes the process easier and more efficient; it also helps in increasing security and maintaining a more accurate database. By eliminating the human factor involved in the process, the possibilities of inaccuracies, proxy attendances, etc are taken well care of.

The program can also help automating many processes, if put into further development, across the school or university campus. For example, maintaining records of students in the library, canteen, storing faculty records, etc. The process will not only be more reliable but also efficient.

Theory Behind the Technology

On observing the human face, we will notice that it is made up of certain distinguishable features and landmarks. All of these landmarks are used to make up the different facial features.

There are 80 such nodal points on the human face, some of them being:

• The distance between the eyes

• The width of the nose

• The depth of the eye sockets

• The height of the cheekbones

• The angle of the jaw line

• The turn of the chin

The measurement of these nodal points is encoded into a numerical code, effectively turning the face into a string of numbers in the database. This code is called a 'Face Print' [5].

Only 14 to 22 nodal points are needed for the software to finish this process.

Facial recognition software falls into a larger group of technologies known as Biometrics. Biometric security makes the use of the physiological and behavioural traits of an individual for the task of their recognition.

Out of all the available recognition techniques employed in the biometric security field, Facial Recognition is by far the most non-invasive technology.

The methods to carry out this task may vary, but they typically involve a series of steps that serve to capture, analyse and compare an individual's face to a database of stored images.

In order to implement a successful face recognition program, four steps are followed:

• Face Detection: The very first step is to detect a face from an image or a live feed.

• Processing: After a face has been detected, the next step is to process or normalize the face by adjusting the brightness, fixing the resolution, changing the orientation, etc. This is done with an aim to make the face consistent with the data already present in the database.

• Extraction of features: In this step, the face is analysed, and the features that are going to be helpful in the recognition task are extracted.

• Facial Recognition: The actual process of matching these extracted features to the pre-existing database is the very last step.

Implementation of Facial Recognition Technology

There are certain stages which need to be fulfilled in order to implement the technology:

3.1. Face Detection

At first, the camera source will detect and recognize a face, isolated or in a crowd depending on the technology being used. The face detected best when the person is looking directly at the camera.

3.2. Face Analysis

Next, a picture or frame of the face is captured and analysed. Distinguishable landmarks or nodal points make up each face. As discussed earlier, each human face has 80 nodal points, which can be used to distinguish one individual from another. Facial recognition software will then analyse the nodal points.

3.3. Converting an Image to Data

The analysis of your face is then converted to a mathematical formula. These facial features become numbers in a code. This numerical code is called a *faceprint*. Similar to the unique structure of a thumbprint, each person has their own faceprint. This makes the recognition of the face possible, when the system observes the person again.

3.4. Finding a Match

At last, the code is then compared against a database of other faceprints. This database has photos with identification that can be compared. Once a match is found, with appropriate accuracy, the system returns the identity of the individual. Once that determination is carried out, various other application can be brought into play by manipulating the existing data or simply inferring information from the existing data, linked to the face

Positives

Facial recognition systems are quite an advanced technology that is widely employed in various fields of work, be it security, surveillance or even in a mundane task as unlocking your phone. This field is at a stage where it is providing itself to be quite useful and has an ample amount of advantages, but as is the case with most technologies, there are some disadvantages that need to be taken into consideration, with an aim of improvement [6].

4.1.Convenience and Social Acceptability

As it was mentioned earlier, the face recognition technology is the most non-invasive technology out of all the other available techniques. In the case of this technology being used in the field of security, an individual need not remember passwords or carry around their identification cards with them.

4.2.Use in Surveillance & Security

The use of this technology by law enforcement authorities coupled with CCTV footage would help immensely in tracking down certain individuals. Be it criminals or even missing persons.

4.3.Cost Effective

By far, the face recognition technology is considered to be quite inexpensive and hence can be used even by small businesses also.

4.4.No-touch technology

Taking in account the recent pandemic of COVID-19, it is without doubt that right now facial recognition systems are the most popular and in-demand due to the highly contagious nature of the virus.

Concerns

Although the face recognition technology has broken certain barriers and created a new technological pathway for exploration of identities, it faces its fair share of drawbacks. From facing the problem of false positives [1] to the privacy issues, the technology has still a long way to go.

5.1. Differentiating Between Identical Individuals

Although the facial recognition system is considerably reliable, the technology falls short when it comes to being able to differentiate between identical twins.

5.2. Privacy Concerns

Face Recognition is capable of analysing millions of faces, even if the aim is to only identify one particular individual. Without proper boundaries being set, a lot of the population worries about their privacy.

5.3. Need of a Good Angle

It is quite reliant in a good angle of the face, working best if it is provided with a full-frontal view. In other cases, it becomes difficult for it to work efficiently.

5.4. Reliance on Quality of Input

The technology would not be so useful if the input image we are using is of low quality.

5.5. Misuse of data

Many facial recognition databases are public and several private entities have access to the data. This means that any person, including those with spiteful intent, can find access the data on the database and track one down

Applications

Facial recognition technology finds its use in several fields, ranging from security and surveillance to attendance systems and is being used intensively at a global level [8].

6.1.Preventing Retail Crime

Facial recognition systems are being used in shops and malls to identify individuals who have already been convicted on the grounds of shoplifting, or who have a history of defrauding individuals.

Databases which contain these images and data are compared with CCTV footages and images and retail workers are informed of any activity so that they can avoid any disturbance.

6.2.Unlocking Phones

With the ever-evolving technology, almost all the new smartphones being rolled out come with a 'Face-Lock'. The smartphone first records the owner's facial data and stores it into its memory, and the next time the phone needs to be unlocked, it prompts the user for a face scan. On successful matching of the user's face to the face in its memory, the phone gets unlocked. This is very useful in the case where an individual's phone is stolen, as it would protect their data.

6.3.Finding Missing Persons

This technology has already been proven to be a major help in finding missing individuals. All that is needed to be done is to enter the data of the missing persons in the database and the moment a camera captures a particular face that matches one in the database, the law enforcement authorities are informed so that immediate action can be taken.

6.4.Tracking School Attendance

While this technology can and is used in making schools a safer place, it can also be used to track a student's attendance. With the case of pre-existing attendance sheets, where a student signs against their name, it is possible for a student to sign against another student's name, who is not present on campus. Facial recognition can help in solving this issue, where the faces of the students will be scanned and will be used as proof of their presence.

6.5.Facilitating Secure Transactions

To ensure safe and secure transactions, retails and banks can use this technology to scan that individual's face. It can be further solidified with the addition of a person's mobile number to generate an OTP.

6.6.Protecting the Law Enforcement

The very job of the law enforcement authorities leads them to endanger their lives to be able to catch criminals. With the help of facial recognition, cops are able to identify individuals from a secure enough distance and get appropriate information about who they are and what can be expected from them. The cops would know whether to proceed with caution or not. For example, if there is a routine traffic stop, this technology would help in identifying a seemingly innocent individual as a dangerous criminal.

6.7.Identifying People on Social Media Platforms

The most widely used facial recognition technology on social media is done by Facebook. Whenever a user uploads an image without specifying the identity of other individuals present in the image, Facebook uses their facial recognition technology to automatically tag pre-existing users of this platform in these images.

6.8.Protecting Schools from Threats

Face recognition systems can be used to identify individuals who pose a threat to the safety of the staff and students of a school. Said individuals may be expelled students, drug dealers, etc. If any such individual is identified, the school security would immediately be informed so that action can be taken.

6.9.Making Air Travel Convenient

The process of checking in and boarding flights is quite a lengthy task and requires quite a lot of manpower if the process is needed to be made faster. Apart from enhancing airport security, facial recognition systems can help in making the necessary procedures much faster and convenient. This can be used to help people check-in their bags, check-into their flights and board the planes quicker.

6.10. Recognizing Drivers

In the field of automobiles, facial recognition systems have several applications. One such application is to replace the key to start a car with the face of the driver. It can also be used to customize settings based on which person is driving the car, like changing the radio station or adjusting the seat. The most crucial application being detecting a driver's drowsiness and alerting them in that scenario.

6.11. Controlling Access to Sensitive Areas

Areas like laboratories, bank vaults, training centres for athletes and various other sensitive areas can be secured with the help of the facial recognition technology. This means, only authorized personnel would be granted access into these areas, leading to less risk of breach.

Working

Face recognition usually take three distinct steps:

1. Prepare Training Data**:**

    Read training images for each person/subject along with their labels, detect faces from each image and assign each detected face an integer label of the person it belongs.
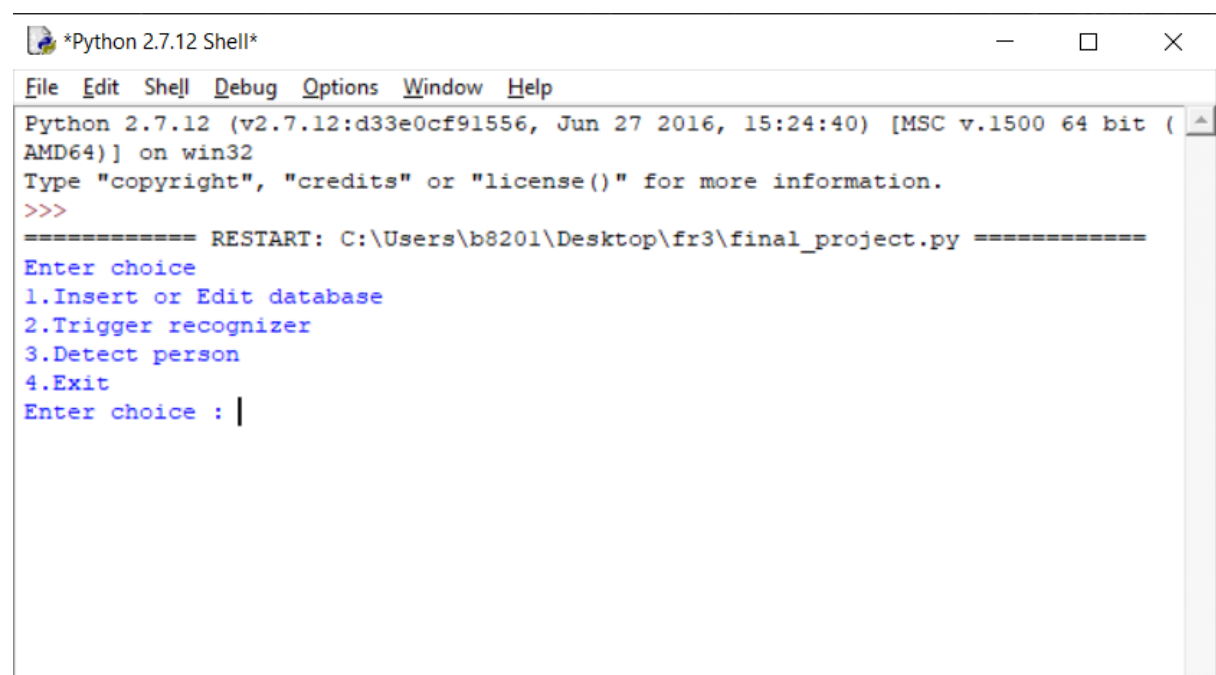
2. Train Face Recognizer:

    Train OpenCV's LBPH recognizer by feeding it the data which was prepared in the initial step [7].

3. Prediction:

    Introduce some test images to face recognizer and see if it predicts them correctly

This program uses the face recognition technology to store the images of the student, detect them and display all the relevant details with respect to every student, at run time. The code also adds a provision for the user by giving him/her the control to update the recognized student's attendance at run time. The code is divided into three parts, the database creator, the recognizer and the detector. The main program is menu driven, and has four choices.
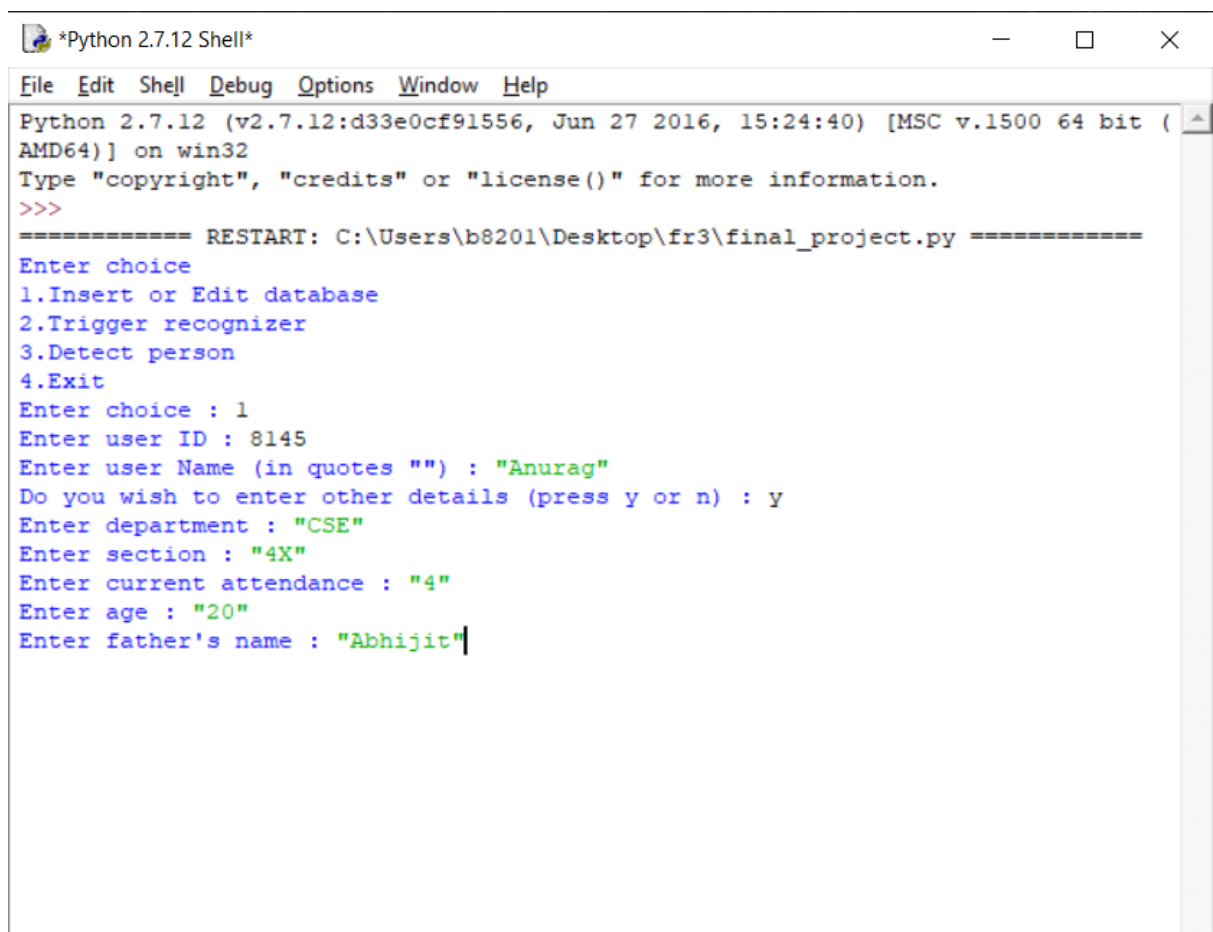

Fig: Main screen of the menu driven program

7.1. Database Creator

This is the initial part of the code. At the first step, the student is supposed to enter his/her roll number (numeric value), followed by their name (in double quotes for character recognition). After that, the student can choose to enter his/her additional details in the system at that point.

Once this is done, the system opens up the camera source, tries to recognize a face by drawing a rectangle around it, and takes 20 images of the subject, and stores it in the program folder with the user ID tag and number of the image. At the same time, the SQL database is accessed and it compares the new entries input by the student with the existing entries.

```
*Python 2.7.12 Shell*                                          —    □    ✕
File  Edit  Shell  Debug  Options  Window  Help
Python 2.7.12 (v2.7.12:d33e0cf91556, Jun 27 2016, 15:24:40) [MSC v.1500 64 bit (
AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
============= RESTART: C:\Users\b8201\Desktop\fr3\final_project.py =============
Enter choice
1.Insert or Edit database
2.Trigger recognizer
3.Detect person
4.Exit
Enter choice : 1
Enter user ID : 8145
Enter user Name (in quotes "") : "Anurag"
Do you wish to enter other details (press y or n) : y
Enter department : "CSE"
Enter section : "4X"
Enter current attendance : "4"
Enter age : "20"
Enter father's name : "Abhijit"
```

Fig: Inserting student details in the database

If, a profile already exists with the same user ID in the database, the program simply overwrites all the information on the specific tuple of the table.
Else, a new profile or tuple is created in the database with the new information and new images are stored in the program folder associated with the user ID.
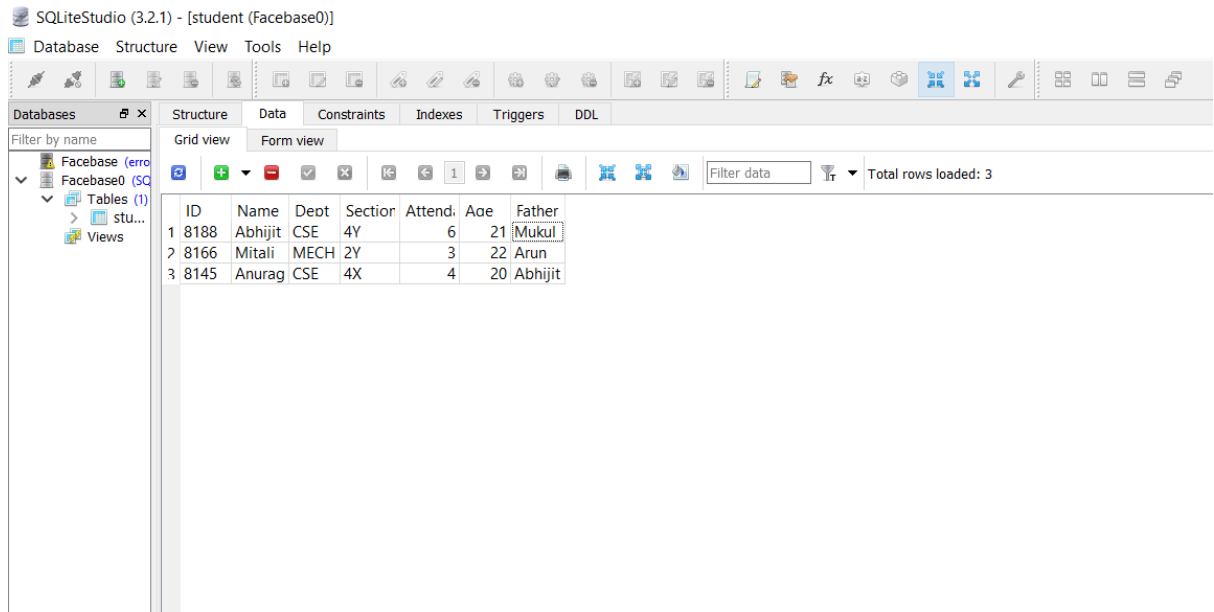
Fig: SQLite3 database

Conditions for database creation:

- The input camera device is to be placed at a suitable location where there is adequate amount of lighting and no obstructions
- The student is supposed to take off his/her glasses whenever in front of the camera
- There should be a pre-existing database for student with defined attributes prior to the acquisition of the images for database creation

7.2. Recognizer

The recognizer is coded with the purpose of training the system, to identify and differentiate students by their faces. The face data collected and stored in the program folder, along with their unique ID, are fed to the recognizer so that it can learn. In this program we have used Local binary patterns histograms (LBPH) Face Recognizer. The recognizer goes through all the stored images and creates a 'trainingData.yml' file. Before triggering the recognizer, the faces stored are converted into grayscale, in order to make the prediction analysis of the face easier and more accurate.

```
*Python 2.7.12 Shell*                                    —    □    ✕

File  Edit  Shell  Debug  Options  Window  Help

Python 2.7.12 (v2.7.12:d33e0cf91556, Jun 27 2016, 15:24:40) [MSC v.1500 64 bit (▲
AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
============= RESTART: C:\Users\b8201\Desktop\fr3\final_project.py =============
Enter choice
1.Insert or Edit database
2.Trigger recognizer
3.Detect person
4.Exit
Enter choice : 2
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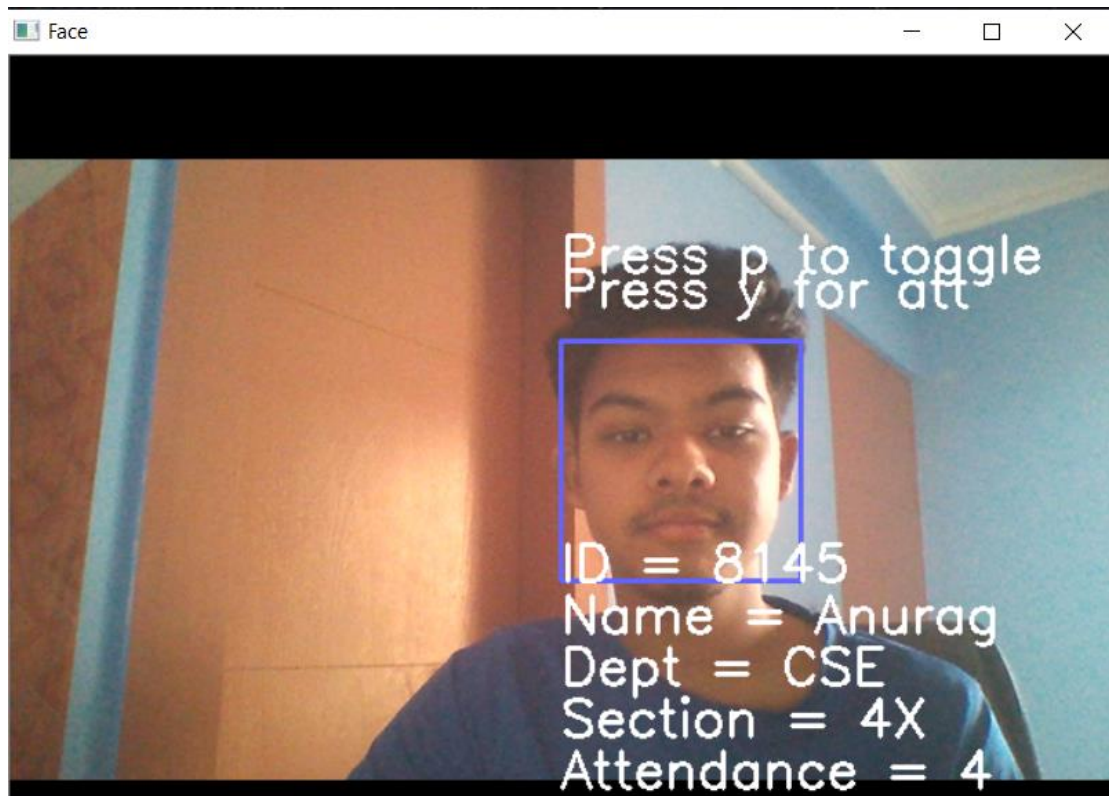
Fig: Training of the data present in the database

7.3. Detector

As soon as the detector is triggered, the camera source is opened and the images of the student standing in front of the camera are taken as the input. It is at this point we get to know how well our recognizer is able to predict the presented face. If a face is detected a rectangle is drawn around the face to distinguish it. Then, if the face is recognized, with a confidence of prediction less than 50, the ID associated with the face is passed through and the SQL database is accessed. The respected record associated to the ID is then reached and displayed on the screen, around the rectangle. The user can update the student's attendance or quit the program by pressing their respective toggles, while the camera source is active and open. All the manipulation of the data takes place at runtime.
In case a face is present but not recognized by the system, a simple text message, "Unknown Identity", is displayed on screen around the detected face.

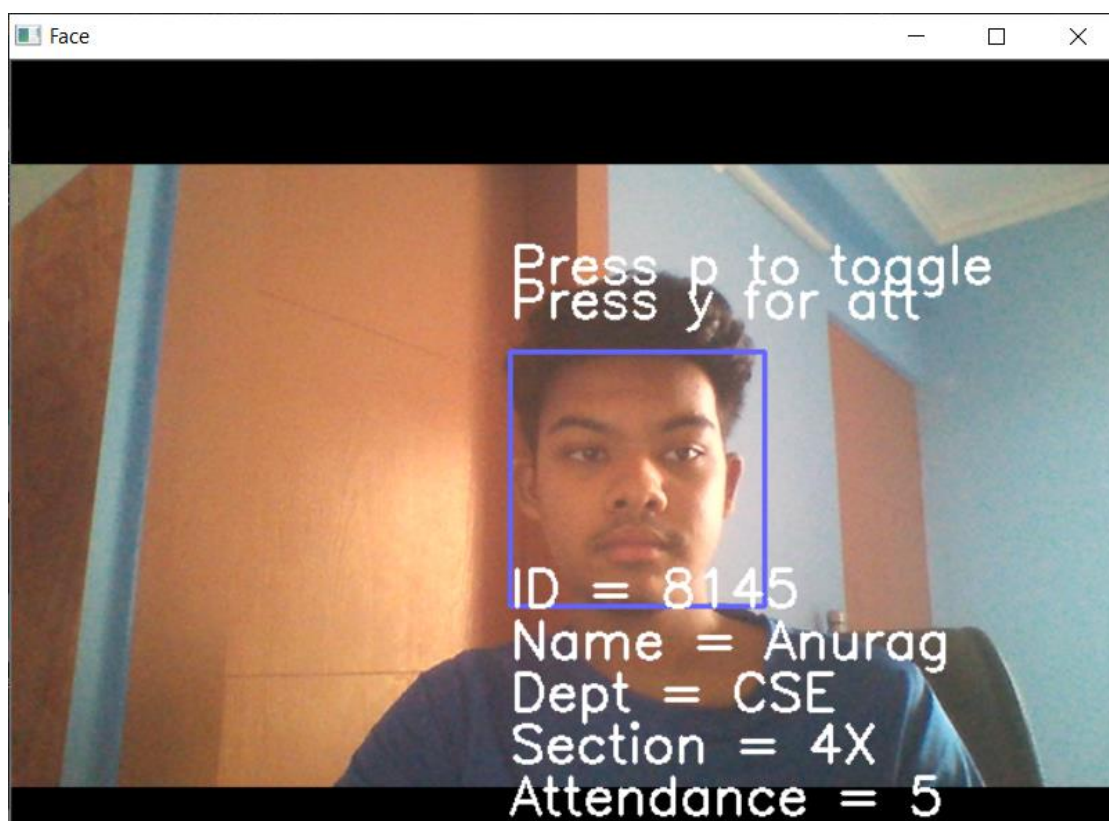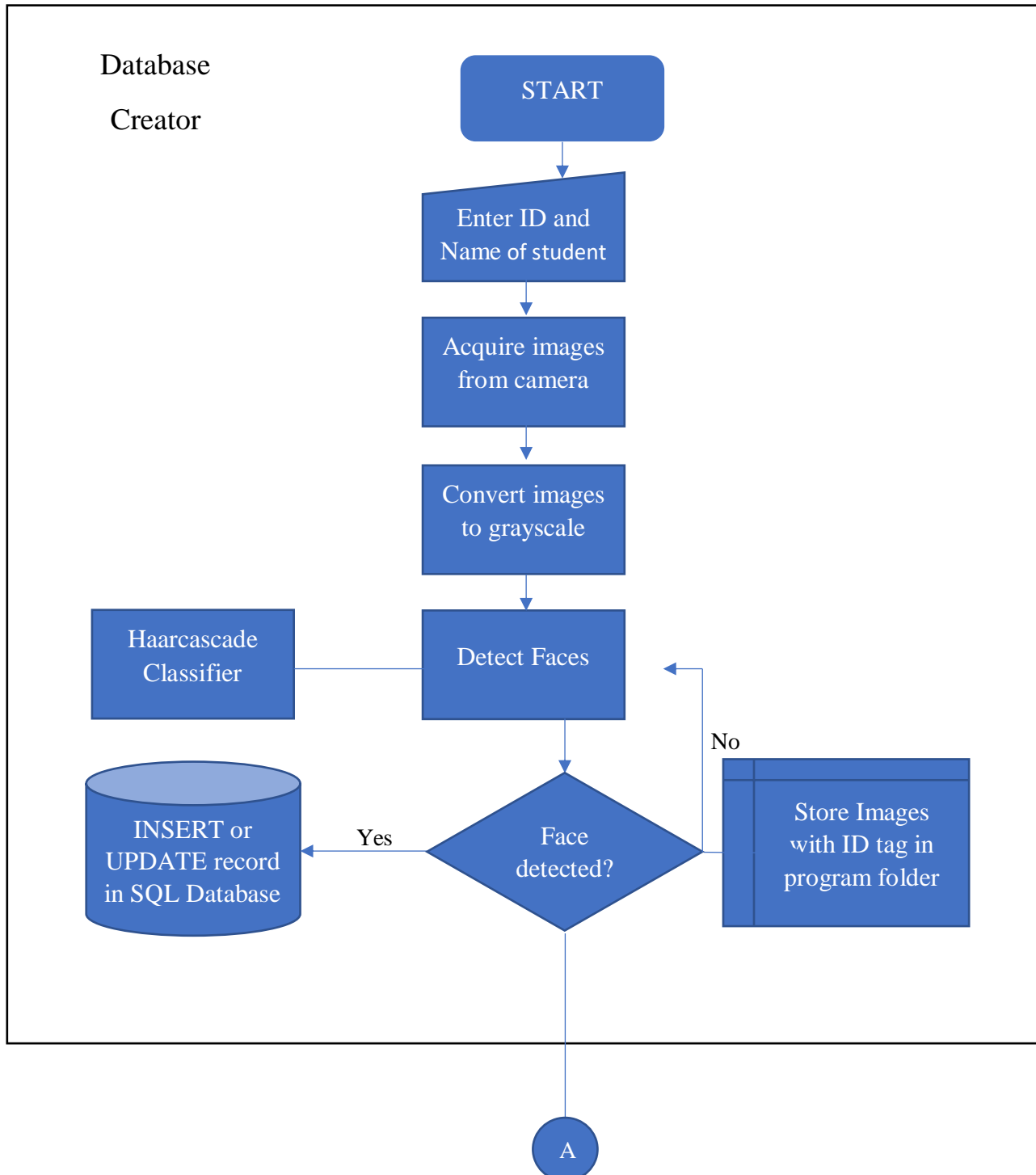*Fig: Face recognized and information displayed at run time*

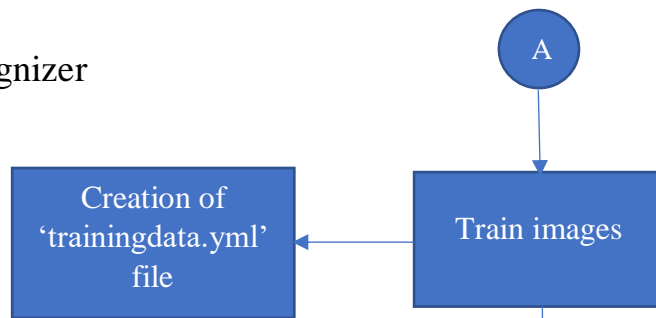*Fig: Attendance updated at run time using toggle key('y')*

Flow chart

The whole program is divided into three main parts:

1. Database Manipulator
2. Recognizer
3. Detector

The working of the program can be illustrated via the following flowchart:

Database Creator
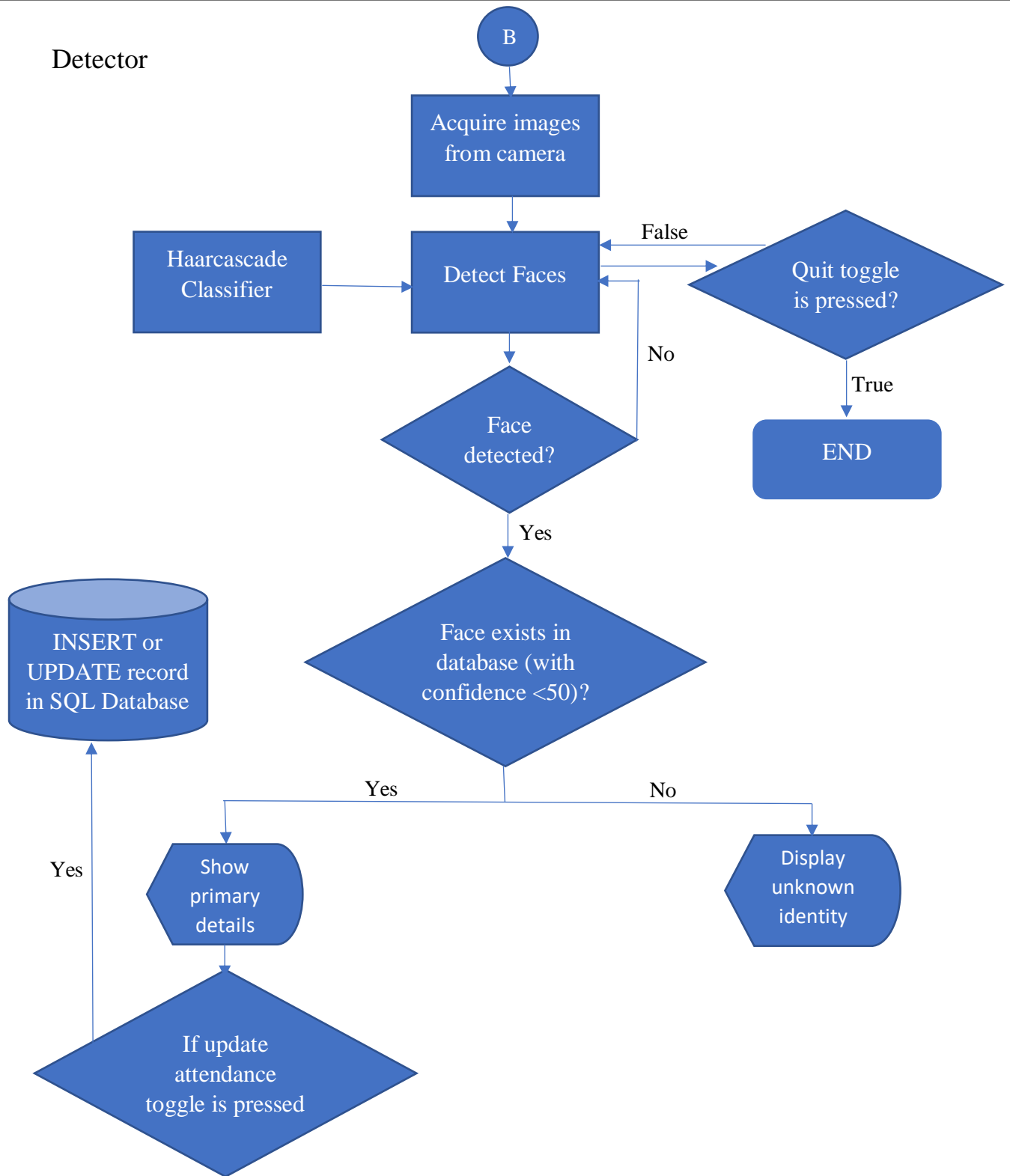
START

Enter ID and Name of student

Acquire images from camera

Convert images to grayscale

Haarcascade Classifier

Detect Faces

No

Face detected?

Yes

INSERT or UPDATE record in SQL Database

Store Images with ID tag in program folder

A

Recognizer

A

Train images → Creation of 'trainingdata.yml' file

B

Detector

B

Acquire images from camera

Haarcascade Classifier → Detect Faces

Quit toggle is pressed? — False → Detect Faces

Quit toggle is pressed? — True → END

Face detected? — No → Detect Faces

Face detected? — Yes → Face exists in database (with confidence <50)?

Face exists in database (with confidence <50)? — Yes → Show primary details

Face exists in database (with confidence <50)? — No → Display unknown identity

Show primary details → If update attendance toggle is pressed

If update attendance toggle is pressed — Yes → INSERT or UPDATE record in SQL Database

Future Scope

In today's time, Facial Recognition is used in a great many number of fields. The most common and popular one being Security. And with constant improvement, its accuracy and hence efficiency will greatly increase. It will make the job of Law Enforcement authorities much safer and easier, therefore leading to a drop in crime rates.

We might be able to use it in sensitive areas such as ATMs, or in accessing confidential files. One day it might also be possible for it to completely replace passwords and keys, effectively rendering them obsolete.

This system can also be used to create a fair voting system. When an individual would cast their vote, their face would be scanned and stored in the database, effectively removing any chances of duplicate voters.

Another field in which this technology can be used is Public Transport. This would help in reducing the never-ending queues at ticket booths and provide a hassle-free transaction. All one would need to do would be to create an account for the payment process, and when their face would be scanned at the entry point of the transport, a fixed amount would be deducted.

If a way is found to reassure the population that they need not have any privacy concerns, the facial recognition technology might just be unbeatable in its field.

Conclusion

In this paper, we have proposed a digital attendance management system, which is supported by facial recognition. The system eradicates the intermediate step of using physical registers to record attendance by the teacher and then entering data in the database.

The results of our preliminary experiment show that continuous observation has significantly improved the performance of estimation of the attendance. The aim would be to be able to incorporate as many students as possible, as the maximum number of students present in a class varies from one institution to the other.

The products used for this project fails to have a recognition confidence under 45, due to the use of only one classifier to recognize the faces, but the problem can be easily resolved by putting the application through a more intense development phase.

In spite of the issues, the current proposed model is fully functioning for a small database. The totally automatic frontal read face detection system displays nearly excellent accuracy and within the researcher's opinion more work needn't be conducted during this space, as far as research is concerned.

Individual Contribution

The research on the topic, development of the working program and inscribing of this research was done by my partner, Anurag Ghosh and I, Anchal Kumari. We worked diligently towards the formulation of this paper and delivering a working prototype model, based on our research.

I assisted my partner in developing the prototype by providing him various links and resources for reference, as well as had a hand in coding the recognizer in the program. I was responsible for understanding and writing the theory behind the technology. I also jotted down the advantages and disadvantages faced by the technology in recent times. I also compiled various real-life applications of the technology, through which we took inspiration of our project. Finally, I mapped out the future scope of the project.

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