A Major Project Final Report On

Face and Facial Expression Recognition System

Submitted in Partial Fulfillment of the Requirements for the degree of
Bachelor of Engineering in Information Technology
Under Pokhara University

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22/11/2019

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ACKNOWLEDGEMENT

ABSTRACT

Face recognition is a rapidly growing research area due to increasing demands for security in commercial and law enforcement applications. In this paper, we investigated the method for face recognition on laptop. Face recognition are used for unlocking screen and are alternatives for passcode and pin codes and can also be used as a system for identifying criminals based on their facial features matching it with the criminals records stored. First step in any face recognition system is face detection. We investigated Viola Jones algorithm for face detection and LBPH (Local Binary Patterns Histogram) for face recognition. There are many challenges to be faced while implementing a face recognition system due to poor illumination and pose variance .So to overcome these problems and to as much as possible high accuracy we used SIFT Algorithm and increased no of data stored in dataset to have high accuracy. Also human facial expressions system that is implemented classifies into 7 basic emotions i.e. happy, sad, surprise, fear, anger, disgust, and neutral. We are able to measure the effects that content and services have on the audience/users through an easy and low-cost procedure as with the help of facial expression recognition system.

KEYWORDS: Face recognition, Facial expression recognition, accuracy, LBPH, SIFT, Dataset

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1. INTRODUCTION

PROJECT OVERVIEW

Face & facial expression recognition has become an important aspect of biometric authentication in recent researches. As computer are becoming increasingly powerful, security of the data stored in computer like email, addresses, sensitive, documents, etc, becomes very important. However, a face recognition scheme is much more secure and flexible as it provides distinctive print to gain access and also the user need not remember passwords. The goal of this project was to implement a face & facial expression recognition application on computers, which gave a system that recognizes a person based on their facial feature comparing with the stored dataset and also gave the person's minor details with it & also facial expression system could know about users' emotional state. The challenges we faced in face recognition module project are as as:

- Illumination variation: Same face may appear different in varying lights.
- Disguised face: Simple changes in face such as moustache and beard, makeup or a fake nose may highly differ the face.

In our previous project we had many limitations associated with our face recognition system like due to poor illumination variance mistook a person real time face detection with another person face which was available in the dataset giving their name and details. So in this project we tried to make a system which is to some extent tolerant to illumination.

PROBLEM STATEMENT

The human face is a very challenging pattern to detect and recognize, because while its anatomy is rigid enough so that all faces have the same structure. Human face recognition is considered as a challenging task due to following environmental and personal factors:

- Large Variability of the recorded images due to pose.
- Disguised face: Simple changes in face such as moustache and beard, makeup or a fake nose may highly differ the face.

Facial recognition is computer-based security systems that are able to automatically detect and identify human faces. These systems depend on a recognition algorithm. But the most of the algorithm considers somewhat global data patterns while recognition process. This will not yield accurate recognition system. So, we propose a face recognition system which can able to recognition with maximum accuracy as possible. Some other limitations of our project are:

- Security issues.
- Poor lightning can cause error in the recognition.
- Camera quality causes main error.
- Blurred or too gray image and less images stored in dataset can cause error in recognition.

PROJECT OBJECTIVES

The main objective of the face & facial expression recognition systems are:

- To create a complete module for facial expression detection & recognition.
- To build an complete module of face recognition model.
- To read individuals facial expressions for knowing their emotional state.
- To create a face recognition system tolerant to illumination variance.

SCOPE AND LIMITATIONS

Computational models of face & facial expression recognition system, in particular are interesting because they can contribute not only the theoretical insight but also to practical applications. Computers that recognize faces & their expressions could be applied to avoid variety of problems, including criminal identification, security systems, images and film processing along with human computer interaction. For example, the ability to model a particular face and distinguish it from a large number of stored face models with expression would make it possible to vastly improve computer security as well as improve in different sector that is concerned about human expression state like in shops to know about customers interest, in hospital to give better treatment.

Some application of FRS (Face Recognition System) are described below:

- Access and Security: Facial biometrics can be integrated with physical devices and objects. Instead of using Pass codes, mobile phones and other consumer electronics will be accessed via owners' facial feature. Apple, Samsung, have already installed Face Tech in their products.

- Criminal Identification: Face recognition can be used to scan & detect suspected people by analyzing through the criminal records by comparing their feature components (mouth, eye, nose, frontal overall face) to the one in the dataset records. It can be used in banks, hospital, mart, airport & many other areas.

- Health Care: Application of facial biometrics within healthcare is to secure patients data by using a unique patients' photo instead of passwords and usernames.

- Facial expression recognition: The face detection system could also be used to develop a system that analyses the facial expression of a person. It can be used in many field like could be used in hospital to know more specifically how the patient is feeling, for getting a honest review in a movie threatre just by analyzing audience

Some limitations of FRS are described below:

- The system don't recognize properly in poor light so may give false results.
- It can only detect face from a limited distance.
- Security issues.
- Accuracy is the major limitation as it may not be 100%.
- Poor camera quality can result in blurred images which gives less accuracy.

2. REQUIREMENT ANALYSIS AND FEASIBLE STUDY

SOFTWARE REQUIREMENTS

- Windows xp, Windows 7(ultimate, enterprise), Windows 10

HARDWARE REQUIREMENTS

- Processor – i3
- Hard disk – 5GB
- Memory – 1GB RAM

FEASIBILTY STUDY

A feasibility analysis is detailed analysis of project to determine whether the project is operationally, economically and technically realistic to proceed with a particular course of action. Feasibility analysis can be used in each of the steps to assess the financial, technical and operational capacity to proceed with particular activities.

ECONOMIC FEASIBILITY

A system development project may be regarded as economically feasible or good value to the organization if its anticipated benefits outweigh its estimated costs. Many development costs are easier to identify. These costs may include the time budget and staff resources invested during the design and implementation phase, as well as infrastructure, support, training and maintenance costs incurred after implementation.

OPERATIONAL FEASIBILITY

A systems development project is likely to be operationally feasible if it meets the 'needs' and expectations of the organization. User acceptance is an important determinant of operational feasibility. It requires careful consideration of corporate culture, staff resistance or receptivity to change management support for the new system. The nature and level of user involvement in the development and implementation of the system; direct and indirect impacts of the new system on work practices anticipated performance and outcomes of the new system compared with the existing system.

TECHNICAL FEASIBILITY

A systems development project may be regarded as technically feasible or practical if the organization has the necessary expertise and infrastructure to develop, install, operate and maintain the proposed system. Organizations will need to make this assessment based on knowledge of current and emerging technological solutions, availability of technically qualified staff in house for the duration of the project and subsequent maintenance phase, availability of infrastructure in-house to support the development and maintenance of the proposed system.

STRUCTURING SYSTEM REQUIREMENTS

2.4.1 DATA MODELLING

This includes Entity relationship diagram of face recognition system.
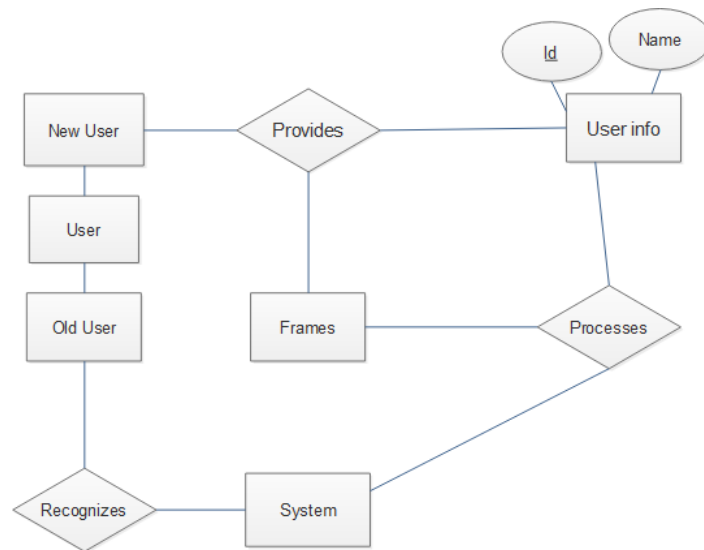
Fig1: ER-diagram of face recognition system

3. SYSTEM DESIGN

DATA COLLECTION

Face recognition identify facial features by extracting features, from an image of the subject's face. For example, an algorithm may analyze the relative position, size, and/or shape of the eyes, nose, cheekbones, and jaw. These features are then used to search for other images with matching features. For face & facial expression recognition we collect data from camera. The image required can be obtained from:

- Camera
- Scanner
- Internet

PROCESS DESIGN

Input Image

Face Detection

Feature Extraction

Face Recognition

Identification/Verification
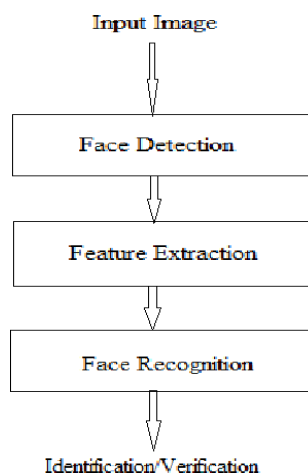
Figure2: Block Diagram of Face Recognition System

In Face Recognition System, we input the image in the system. After inserting the image in the system, it detects or tracked of face-like objects in cluttered scenes. Face recognition involves feature matching through a database using similarity measures. Then the evaluation and benchmarking of numerous of face recognition algorithms based on the database and test methods are reviewed.
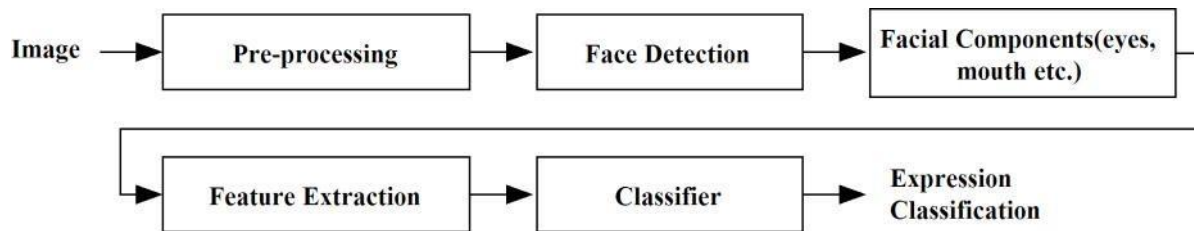
Figure3: Block Diagram of facial Expression Recognition System

The system automatically detects the face using HAAR cascade then it crops it and resize the image to a specific size and give it to the model for prediction. The model will generate seven probability values corresponding to seven expressions. The highest probability value to the corresponding expression will be the predicted expression for that image.

INPUT OUTPUT DESIGN

Input:

Image is provided as input with name, id and face associated with it.

Output:

Recognize a face & its expression giving output.

4. IMPLEMETATION, TESTING AND ANALYSIS

IMPLEMENTATION

The implementation methodology outlines key activities that should be considered and planned for when developing or implementing a system.

The system has been implemented using three types of algorithm:

- Viola Jones algorithm for face detection
- LBPH for face recognition
- SIFT Algorithm

AlGORITHM IMPLEMENTED

Viola Jones Algorithm

This algorithm is the first framework for object detection which gave viable results for real time situations. Paul Viola and Michael Jones had proposed the algorithm in year 2001. It was aimed at targeting the problem of face detection but can also be trained for detecting different object classes. It is implemented in Open CV as cvHaarDetectobjects( ). It is preferred for its robust nature and its fast detection of faces (full frontal upright faces) in practical situations. It comprises for four stages namely:

1. Haar Feature Selection
2. Creating an integral image
3. Adaboost training
4. Cascading amplifiers

Haar feature selection matches the commonalities found in human faces. The integral image calculates the rectangular feature in fixed time which benefits it over other sophisticated features in fixed time which benefits it over other sophisticated features integral image at (x, y) coordinates gives the pixel um of the coordinates above and on to the left of the (x, y). Adaboost training algorithm is used to train the classifiers and to construct a strong classifiers by cascading the previously used weak classifiers.
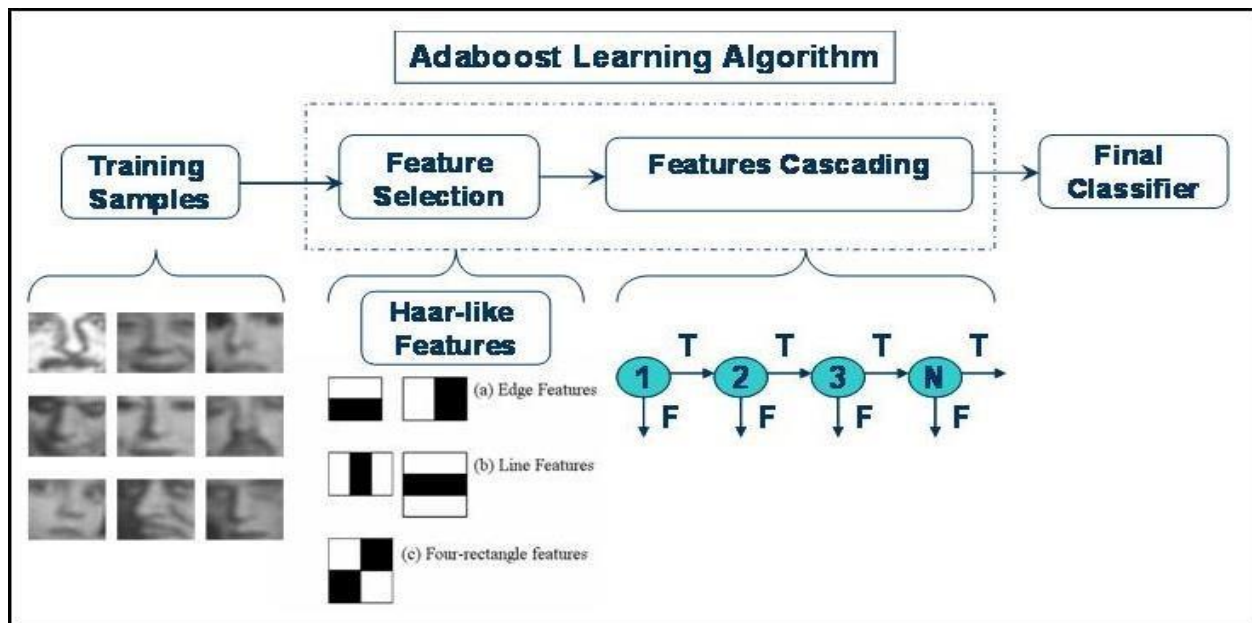
Figure4: Viola Jones algorithm for face detection

LBPH Algorithm

LBPH considers texture description which is useful to symbolize Faces because face data can be splits as compositions of pattern of micro textures. LBPH has been widely applied in various applications due to its high discriminative power and tolerance against illumination changes such as texture analysis and object recognition. Basically LBPH is carried out in 3 stages they are

- Feature extraction:-The face recognition is carried out as stages first stage the image capturing and converting into grey scale then the haar features are checked if the features

are their then it is considered as face if not non face, after that the pixels are mapped and checked the faces.

- Matching:-The image that should be recognized, the image is matched using openCV.
- Classification:- The unique and at most useful features are extracted and face image is compared with images in database during last stage .In this local binary pattern for person's face recognition consider both shape and texture information for evaluation.

But our system encountered many limitations due to poor illumination and pose variance.

SIFT (Scale Invariant Feature Transform)

The Scale Invariant Feature Transform (SIFT) is a feature detection algorithm in computer vision to detect and describe local features in images. It was patented in Canada by the University of British Columbia and published by David Lowe in 1999. Applications include object recognition, robotic mapping and navigation, image stitching, 3D modeling, gesture recognition, video tracking, individual identification of wildlife and match moving. SIFT keypoints of objects are first extracted from a set of reference images and stored in a database. An object is recognized in a new image by individually comparing each feature from the new image to this database and finding candidate matching features based on Euclidean distance of their feature vectors. From the full set of matches, subsets of keypoint that agree on the object and its location, scale, and orientation in the new image are identified to filter out good matches. The determination of consistent clusters is performed rapidly by using an efficient hash table implementation of the generalized Hough transform. Each cluster of 3 or more features that agree on an object and its pose is then subject to further detailed model verification and subsequently outliers are discarded. Finally the probability that a particular set of features indicates the presence of an object is computed, given the accuracy of fit and number of probable false matches. Object matches that pass all these tests can be identified as correct with high confidence.

IMPLEMENTATION LANGUAGE

It is implemented in Python environment

PYTHON:

One of the main reasons of using the python language for our project is that it is easier language for machine learning as in python testing and debugging process is easier. Python syntax allows programmer to express concept in fewer line of code as compared to other language.

IMPLEMENTATION TOOLS

OpenCV2:

Open CV (Open Source Computer Vision) is a bunch of programming functions which is used for real-time computer vision. Open CV makes easy for businesses to modify and utilize the code since it is a BSD-licensed. More than 2500 algorithms are included in the library, which includes both machine learning algorithms and state of the art and classic computer vision. It has C++, C, Python and Java interfaces and supports Windows, Linux, Mac OS, ios and Android.

NUMPY:

Numpy is the fundamental package for scientific computation of array with python.

TENSORFLOW:

Tensor Flow is an open-source software library for dataflow programming across a range of tasks

SQLITE3:

SQLite is an in-process library that implements a self-contained, server less, zero configurations, transactional SQL database engine. The code for SQLite is in public domain and is thus free for use for any purpose, commercial or private. Unlike most other SQL databases, SQLite doesn't have a separate server process. SQLite reads and writes directly into ordinary disk files. The database entries made by our program will be stored in SQLite database.

TESTING

Testing is the integral part of software development process. Software system testing identifies defects, flaws, or error in the application code that be fixed.

Validation refers to the process of using the new software for the developed system in a live environment i.e., new software inside and organization, in order to find out the errors. The validation phase reveals the failures and bugs in the developed system. It will help to know about the practical failures and difficulties in the software faces when operated in the true environment.

During the development process this system has few bugs which were debugged one by one. This project has gone through following procedures.

UNIT TESTING

Separately each and every functional module is tested and analyzed the result of the module. The module interface is tested to ensure that the information flows in and out of the program under unit testing.

INTEGRATION TESTING

While integrating all separate modules as one, errors that were detected were analyzed and debugged.

SYSTEM TESTING

System testing is conducted on a complete, integrated system to evaluate the system with its specified requirements. The overall function performance of the system is tested. We checked the system for validity of the overall function and performance.

USER ACCEPTING TESTING

User accepting testing is done in order to verify whether the application is user friendly and meets the user requirements or not. The application was provided to few friends and the feedbacks were acknowledged.

5. LITERATURE REVIEW

Literature review is a text written by someone to consider the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Main goals are to situate the current study within the body of literature and to provide context for the particular reader (Cooper, 1998). We had referred research journals, existing system and analyze the results of same, also take the experts opinion. Literature review is focused on a research questions, trying to identify, appraise, select any synthesize all high quality research evidence and argument relevant to that question. This paper assumes that the application described would be a prototype that would shape the future & there still remains much to do in terms of development and improvement of the existing models.

5.1 REVIEW

Face recognition has been the motivation for research around the globe. The interest and time frame of studies in this field is indicative of its value and complexity, and has become an increasingly important form of biometric authentication.

The first semi-automatic face recognition system was developed by Woodrow W. Bledse under the contract of US government. The system required administrator to manually locate features such as eyes and ears on photograph.

Goldstein Harmon and Lesk used twenty one specific subjective markers such as hair color and lip thickness to automate face recognition. Measurement and locations was still manually completed causing program to require more labor time. They have applied principle component analysis, a standard linear algebra technique, to Face Recognition problem. It's considered a milestone because it showed that less than 100 values were required to accurately code a suitable aligned and normalized face.

Turk and Pentland discovered that while using Eigen faces techniques, residual error could be used to detect faces in images, a discovery that enabled real-time automated face recognition

systems. Although the approach was constrained by environmental factors, it created significant interest in further development of FRTs. The technology first captured the public attention from the media reaction to a trial implementation at January 2001 Super Bowl, which captured surveillance images and compared them to database of digital mug-shots. It found 19 people with pending arrest warrants.

They have drawn upon classic and contemporary studies of facial expression. They have examined the emergent studies of individual differences in facial expression of emotion.

6. TASK DIVISON

Our project overall will be completed with an estimated time of one month in total. At first step we reasearched about the algorithm that can be used in implementing the system with more accuracy. We concluded with many algorithm like fisherface, Eigenface but at last the system was implemented using SIFT (Scale Invariant Feature Transform) and Viola Jones algorithm for face detection and LBPH algorithm was used for face recognition. SQLite was used for storing the small minor details of the required person (or database).

WORK DIVISON

TASK AND ROLES	NAMES OF TEAM MEMBER AND THEIR ROLES
Algorithm Research, System Designing Planning	Simran Basnet, Prabin Bista, Monalisa Ulak, Mandip Panta
System Design	Monalisa Ulak (Facial Expression Recognition System), Simran Basnet(Face Recognition System)
Training The Dataset	Simran Basnet, Monalisa Ulak
Data Collection	Simran Basnet, Prabin Bista, Monalisa Ulak, Mandip Panta
Documentation	Simran Basnet, Prabin Bista, Monalisa Ulak, Mandip Panta

Table 1: Work divison of team members in the project
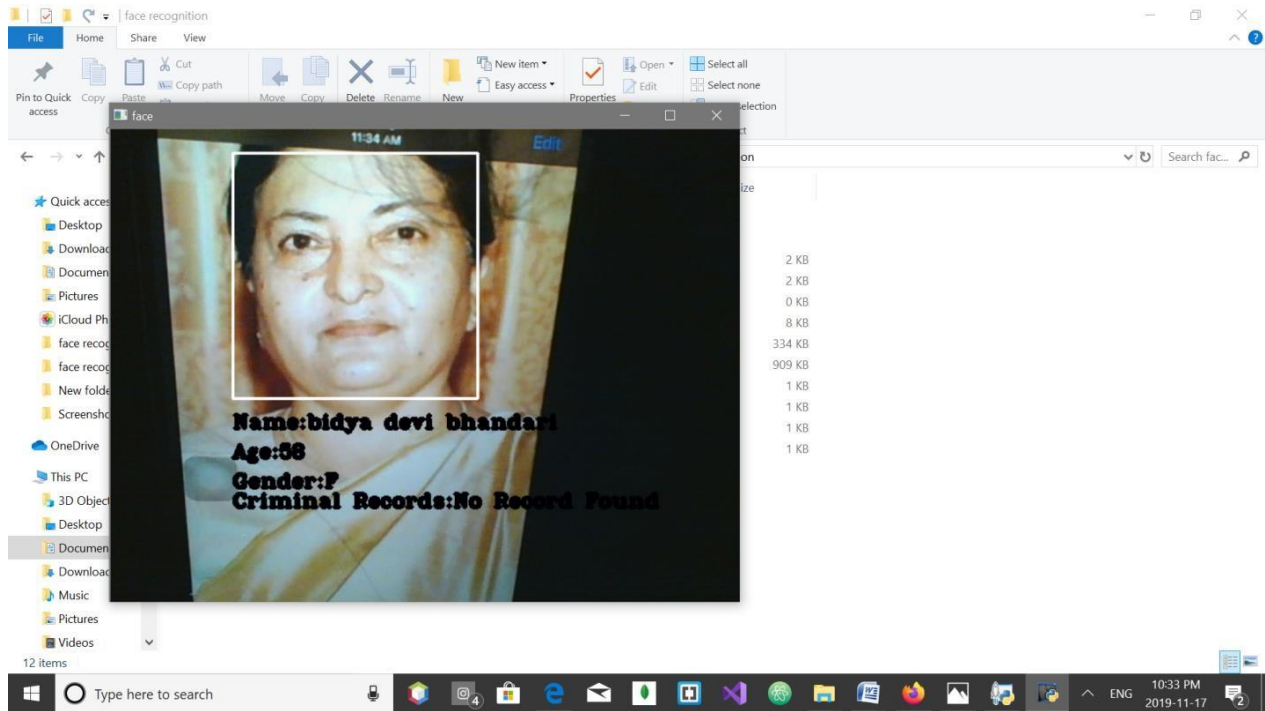
7. RESULTS AND DISCUSSION

Figure 5: Face Recognition Sample

Face is recognized in this given sample of screenshot from PC. The result obtained gives us information about the person Name and their other personal information i.e. Age, Gender, Criminial Records whose database are created at SQLite. Due to poor illuminance condition and lack of data (i.e. images) on the dataset, system sometimes can give less accuracy.
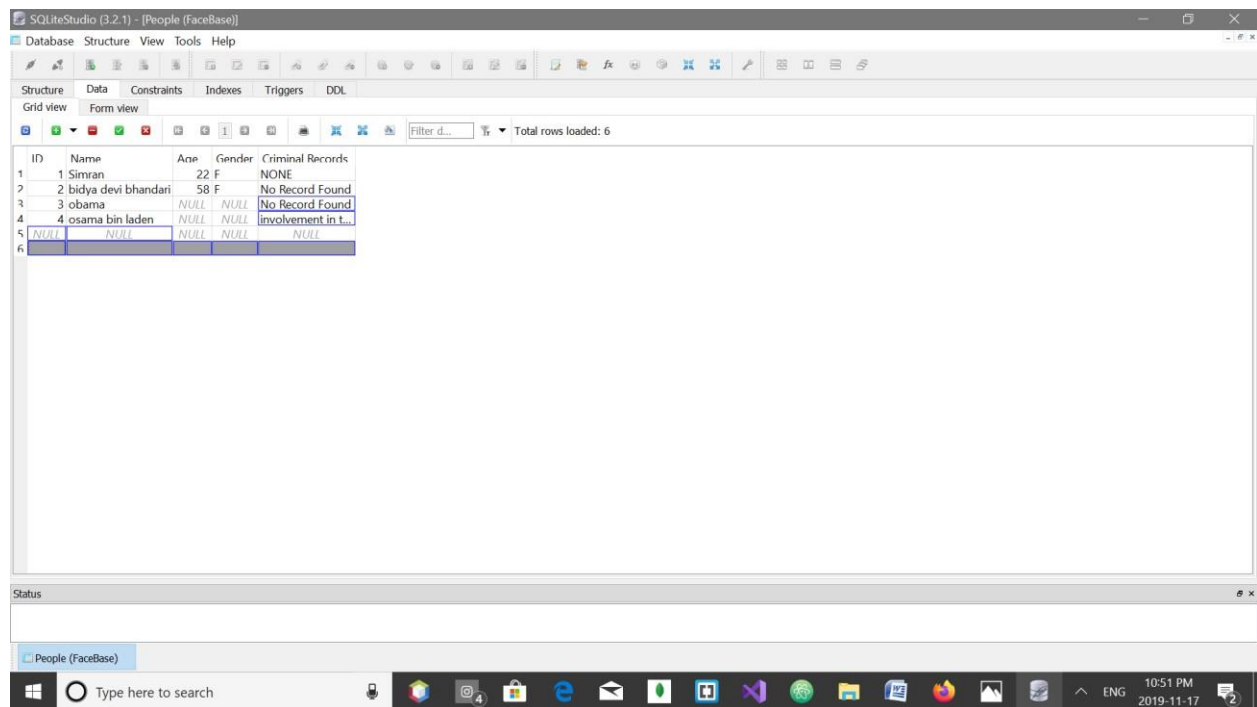
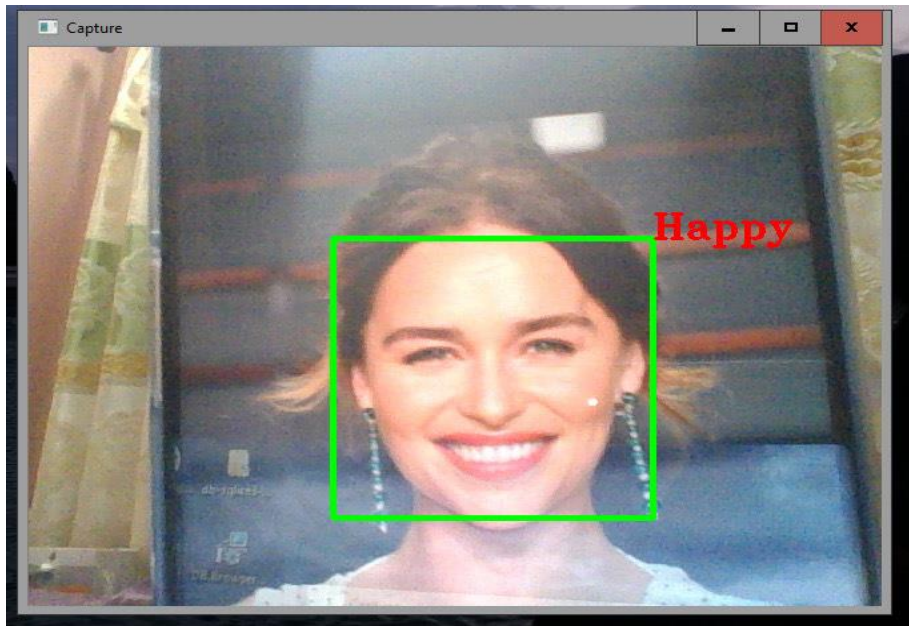Figure 6: Database creation using SQLiteStudio (3.2.1)

Figure7 : Facial Expression Recognition sample

The face was recognized as happy in given face expression sample which was created using tensorflow.

8. CONCLUSION

In this project, we investigated various algorithms for implementing face &facial recognition system. This system will be able to detect one's face as well as their expression through webcam by simply extracting the feature components of eye, mouth, lips, nose, frontal face, and others and then compare it with the one available on the dataset that is recorded before. However, sometimes due to poor Illuminance condition the system could no give accurate result. However, we trained the system 20 times more to get some extent of accurate result. Similarly in Facial expression system, the system will be able to distinguish whether the person was sad, happy, anxious etc in say way after the face detection process.

9. RECOMMENDATION

This project was implemented through lots of ups and downs, and as a result, a perfect output wasn't reached after all. Although this application seems to lack of more features, it still stands out to be an effective application for the anticipated users. After the overall application analysis and reporting, we found out that there are limited precincts to this application that can be improved in future with the help of innovative and better technologies that are in the progressive stage right now. The future scope can be done to automate the entire process or partially.

Some of the future enhancements that can be applied are as follows:

- It can be used for screen locking such as lock pattern in laptop or mobile phone.
- It can be expanded further into gesture recognition.

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