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Face Detection and Recognition System

Aryan Narayan[1], Maaz Modak[2], Kunal Lele[3], Yoshik Karnawat[4]

[1,2,3,4]*Student, Dept. of Computer Engineering, MAEER's MIT Polytechnic Pune, Maharashtra, India*

Abstract - *A facial recognition system is one which tracks and analyzes facial structures. It then compares the distinct characteristics created by making a model of the face to a dataset of models and compares particular tracking points to find a match. This system utilizes a machine learning algorithm to "learn" the various changes in facial structures, which may occur due to external factors, such as lighting, angles, clothing or other factors which may distort it. The machine learning algorithm allows for these discrepancies to pass and produce a positive result. The software can accommodate an additional functionality. The system can be configured to raise a flag or alert the user when a match is not found between the face and any facial model from the dataset. This is a form of contact-less biometric security, and allows for a high level and efficient way of security. It reduces time taken to verify a visitor with a fairly accurate scan using the data points generated by the system. Multiple cameras can also be implemented to provide as much coverage to generate multiple angles of the face making the system more efficient and accurate, while ensuring security.*

Key Words: **Security, face detection, face recognition, biometric, alert, machine learning**

1. INTRODUCTION

Security is becoming an ever-increasing concern in today's world, and the need for quick, accurate and convenient security is paramount. In a fast-paced society, manually entering a password or PIN hampers productivity and wastes time. This project aims to develop a reliable, quick and efficient face detection and recognition system. The software utilizes OpenCV and Python, and is accommodative of other features that can improve the overall functionality of the system. While the current version of the project is capable of detecting and identifying faces from a video stream, additional features such as an alert system could be implemented, which gets triggered when an unrecognized person is detected. This project has a vast range of applications due to its discrete and contact-less system. A person could simply walk past a camera and the system would verify whether the person is registered with the database and is not an intruder. This system need not be implemented for security reasons, it could also serve for domestic purposes, say, an attendance system in colleges.

1.1 Background

In this project, we have improved upon previous advancements made in the field of face recognition and detection technology. While the concept of face recognition and its use in security is not relatively new, this project aims to implement both the concepts into a cohesive and efficient application. The application was created with a vision to make the process of contact-less, biometric security as simplified and user-friendly as possible, while also not compromising on accuracy of intruder detection. We have even implemented an interface with a simple face training module, which can be used to train the machine to recognize changes in facial structure (for example, if a person gets a scar or grows a beard). These subsequent changes to the person's face will be added to the dataset, to make the whole model an evolving and adaptive one, leading to minimal error.

1.2 Need of the project

As stated before, the need for quick and reliable security is quintessential. The low-cost and accurate nature of this project makes it perfect for implementation in a range of fields. Institutions and small establishments that cannot accommodate large equipment, or conduct manual recording of people are need of a compact system that can accurately distinguish registered people from intruders. Also, places that observe large crowds (such as classrooms or offices) can benefit from a contact-less system which does not require the person to halt at a place to perform some security check. This system only requires a video camera connected to a computer, hence making it the most suited choice for such applications.

2. LITERATURE SURVEY

Paper 1: Background Subtraction Techniques: A review. [1]

Published by Piccardi, M. (n.d.). in the 2004 IEEE International Conference on Systems, Man and Cybernetics (IEEE Cat. No.04CH37583). doi:10.1109/icsmc.2004.1400815

Background Subtraction is a technique used to differentiate the foreground from the background of an image or frame of a video. The paper weighs the benefit to costs of various methods and algorithms used to conduct background subtraction. It deftly reviews methods such as the running Gaussian average and median filter, and rates their functionality based on certain parameters. The parameters are formulated keeping in mind real-life usage of the methods on computer systems, and are categorized based on speed, memory requirements and accuracy.

Paper 2: An efficient illumination compensation scheme for face recognition. [2]

Published by Xudong Xie, & Kin-Man Lam. (n.d.) in ICARCV 2004 8th Control, Automation, Robotics and Vision Conference, 2004.

This paper focuses on the critical problem of uneven illumination of the face, which is a hindrance to facial recognition systems that rely on alpha channels to categorize facial features. The lack of proper lighting often leads to capture of data which deviates greatly from that stored in the dataset, leading to incorrect and inconsistent outputs from the system. The paper suggests the usage of a local contrast enhancement method called block-based histogram equalization (BHE). This method is used to process images and then compared with the same image processed using histogram equalization (HE). Experimental results showed an increase in recognition rate and addresses the problem of face reconstruction and recognition under varying illuminations.

3. PROPOSED METHODOLOGY

3.1 Motion Detection

First step is to detect the human motion at the entrance of sensitive area. We cannot verify a face if we do not know what to recognize. Background subtraction (BGS) technique is adopted to detect the human's face. The reason this is important is to distinguish between the background and foreground. Background subtraction is a commonly used scheme which takes the difference of the current frame and the background frame to detect the motion region. The background image serves as a reference frame and any significant changes in its composition essentially means a change in the foreground, hence necessitating the detection of a face. Moreover, the background needs to be updated in a real-time environment to adapt the light variations so as to allow the accurate segmentation of a moving person. This ultimately makes the security provided by the system more accurate, and the protection of a sensitive area more reliable and trust worthy.

3.2 Face Detection

Automatic face detection and recognition using a camera is a challenging task because of the large differences between images of the same person due to variation in illumination variation, pose and expression. It mostly depends on the position of the camera, and the quality of the video stream it provides. Most importantly, illumination variation due to light source at absolute position and intensity may sometimes give rise to large variability. To cope with this situation, the image is normalized by employing the lighting compensation technique which uses white as a reference to normalize the colour's appearance.

3.3 Face Recognition

Face recognition is the most important module of the security system. It decides whether the person is authorized to enter the sensitive area or not. After face localization, pre-processing is done to extract the region of interest. Here we crop face part from the image to start the recognition process. The test images of all the authorized persons are stored in training database, while the cropped image after face detection is used to place in test database. We then use a Haar Cascade classifier which is trained using faces and other non-faces to detect faces in real-time. The classifier uses categories of features such as line and edge features to delineate the various facial features, such as the bridge of the nose, edge of the lips/eyes etc.

3.4 Tracking

Once a face has been detected and recognized, its associated details can be cross-referenced from the dataset. In our system, we've created a basic square box that encompasses the person's face being detected. If the face is recognized, the person's name is also shown below the box in the output. This output is completely dynamic and the box moves in accordance with the face, disappearing if the face moves too quickly or no face is detected.

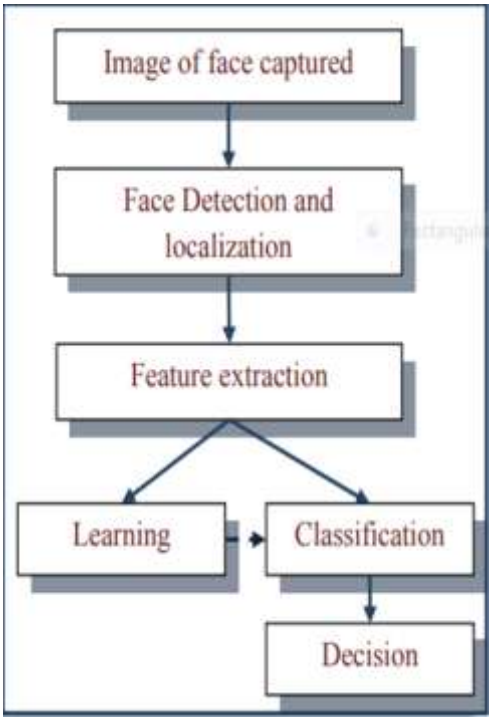

Fig -1: System Architecture

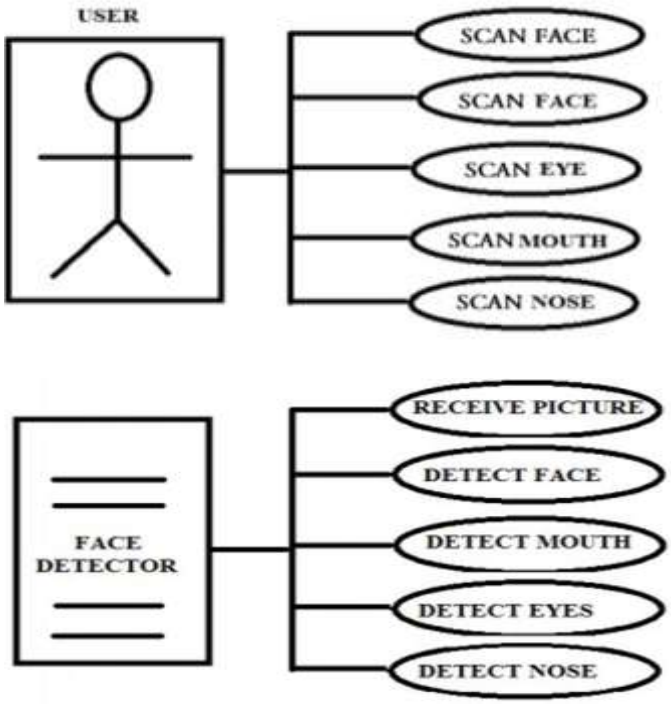

Fig -2: Use Case diagrams illustrating the user and system side of things.

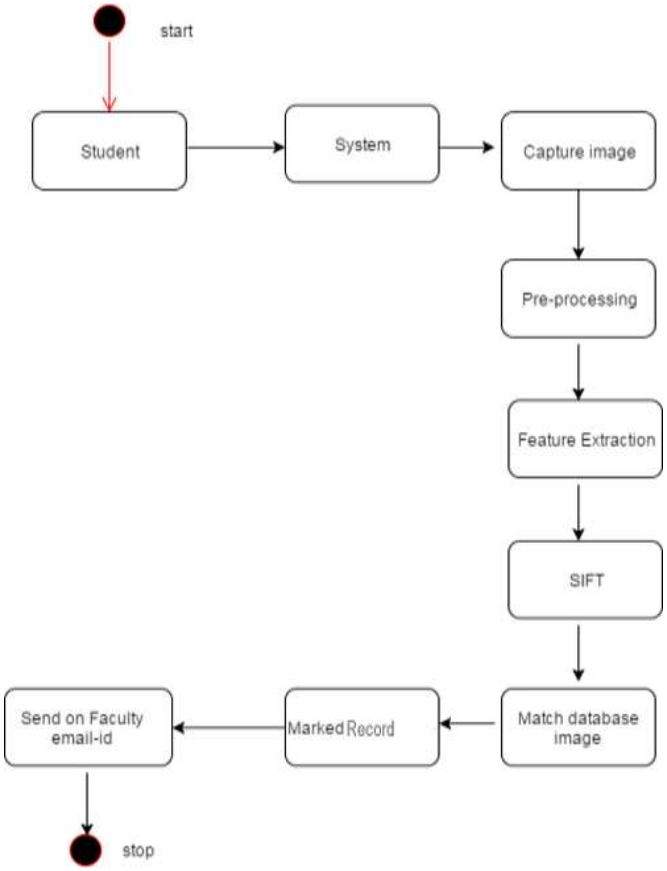

Fig -3: Activity Diagram

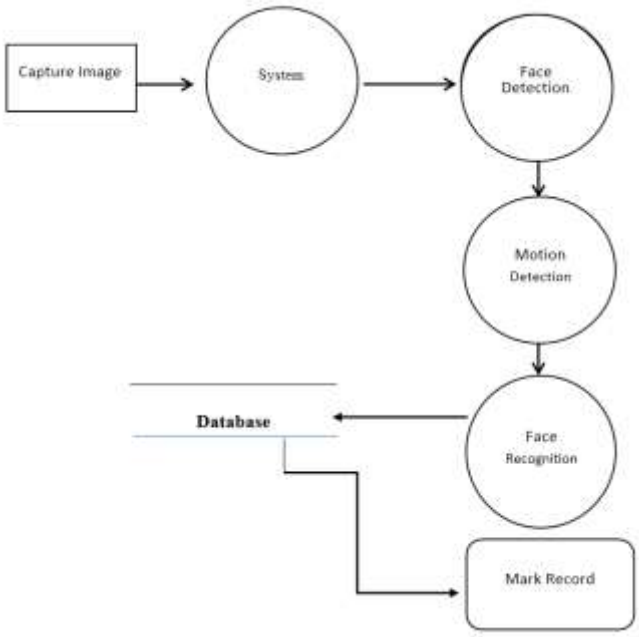

Fig -4: Data Flow Diagram

3. OUTPUTS

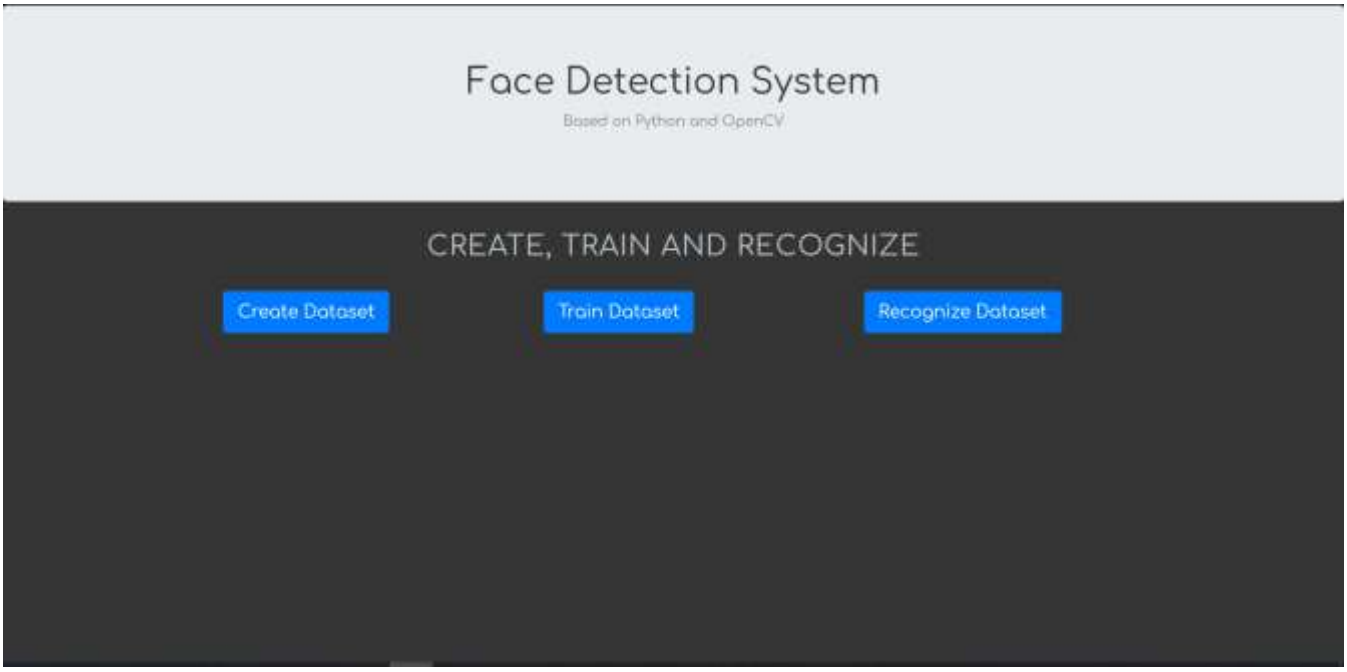

Fig -6: Project Interface

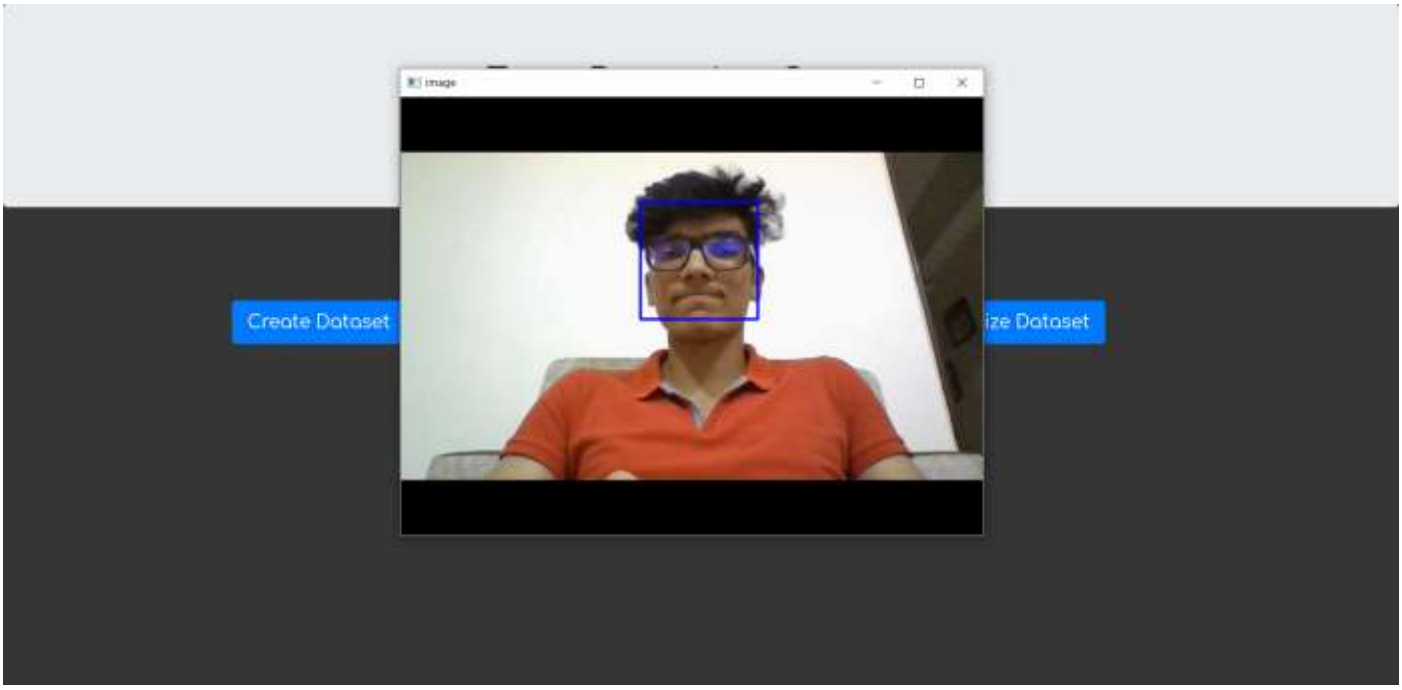

Fig -7: Capture face

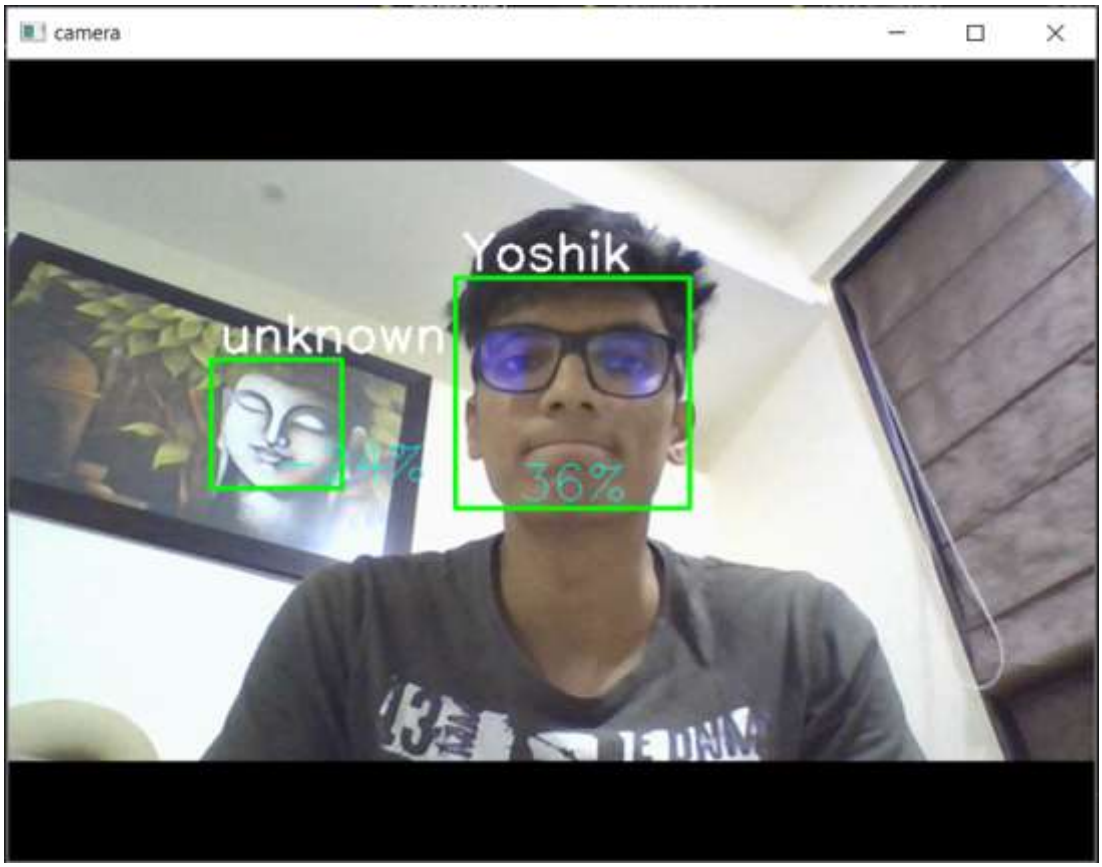

Fig -8: Recognize face

4. CONCLUSIONS

The project created as a result of in-depth understanding of the various methods employed for face detection and recognition has culminated to a highly efficient and reliable system, as envisioned at the start. This system is very easy to adapt to and modify, hence allowing for other functionalities to be added on without much effort required.

Acknowledgement

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REFERENCES

[1] Piccardi, M. (n.d.). Background subtraction techniques: a review. 2004 IEEE International Conference on Systems, Man and Cybernetics (IEEE Cat. No.04CH37583). doi:10.1109/icsmc.2004.1400815

[2] Xudong Xie, & Kin-Man Lam. (n.d.). An efficient illumination compensation scheme for face recognition. ICARCV 2004 8th Control, Automation, Robotics and Vision Conference, 2004.