Software Design Document for Face Recognition Based Attendance System

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1 Introduction

1.1 Purpose

The main purpose of this project is to develop a **Face Recognition Based Automated Student Attendance System**. We will be building a system that will be able to detect and recognize frontal faces of students in classroom, and then mark their respective attendance. The system is exclusively designed for marking attendance in various educational institutes like in colleges and schools. The aim of this project is to eliminate the traditional system of **Manual Attendance System** which is usually a time consuming process with chances of human error and replace it with a **Automated Attendance System**.

1.2 Scope

The scope of the project is to design an automated system which will be able to find and recognize human faces in a fast and precise manner from images and videos that are captured through a surveillance camera and subsequently mark their attendance. The main objectives of the project are

- To detect and precisely locate the face segments in a video frame.
- To count the face instances in a frame for crowd/students numbering.
- To extract the useful invariant features of the detected face.
- To classify the features for subsequent face recognition through feature matching.

Figure 1: Block Diagram of the General Framework

- To record the attendance of the identified student.

1.3 Overview

As we know that technology aims to impart tremendous technical innovations these days. Machine Learning, Computer Vision, Deep Learning have gained prominence in the recent years which has led to solving many problems like Image Classification, Object Detection, Image Segmentation and so on. From the very beginning, attendance is considered as a crucial component in education system which makes it a target area to bring some kind of automated innovation. This can help discard the traditional tiresome physical methods of marking attendance in many oriental institutions.
This project therefore hopes to deploy an easy and a secure system capable of marking attendance of students entering a classroom, by using Computer Vision and Deep Learning based face recognition techniques. The system is going to include some data and model paralleling/distribution techniques for fast computation and detection of faces.

2 Technical Requirements

2.1 Hardware Requirements

- A standalone computer needs to be installed in the office room where the system is to be deployed.
- Cameras must be positioned in the classrooms to obtain the snapshots.
- Secondary memory to store all the images and database.

2.2 Software Requirements

- Linux OS.

3 System Overview

The two main building blocks of this system are **Face Detection** and **Face Recognition**.

3.1 Face Detection

Face detection is a computer technology being used in a variety of applications and algorithms that detects and locates human faces in digital images. It is a subset problem of challenging object detection tasks in computer vision. The extended task in the proposed system is to detect and locate all faces present in an image with the notion of their different sizes. The task is a bit challenging because of the variability present across human faces such as difference in lighting, facial expressions, skin tone, image resolution, facial position, facial hair etc.

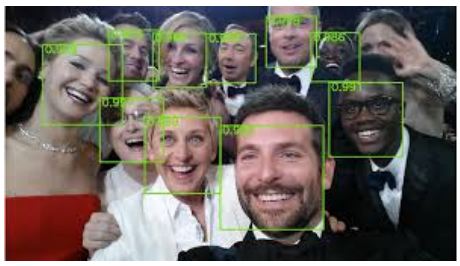


Figure 2: Automatic face detection with OpenCV

In object detection, region-based CNN detection methods are now the main paradigm. As face detection is a pat of object detection we will be using the same methods for face detection. The significance of using CNN based methods is that it brings high accuracy on classification tasks. In technical terms we will be using a variant of Faster R-CNN. It uses a Regional Proposal Network which is a fully convolutional network for generating object proposals. These regions are then fed into the detector module which further refines the proposals. The whole network is trained against a large dataset containing images of faces. The dataset has great variations in scale, pose, and the number of faces in each image, making training efficient.

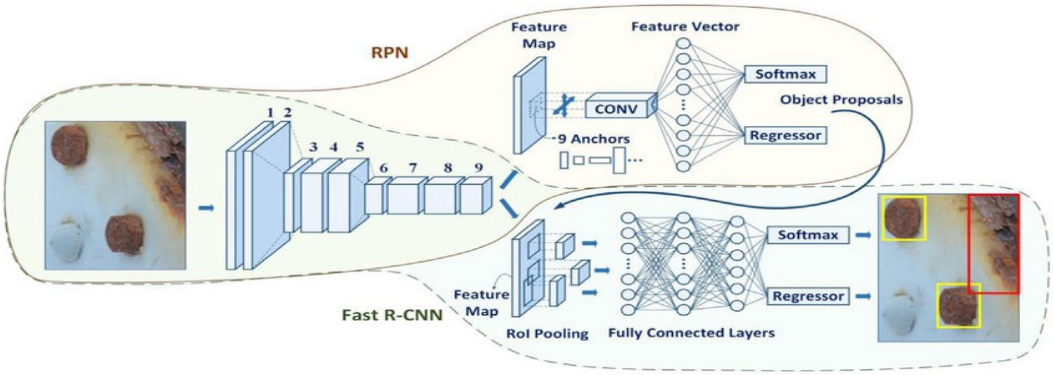


Figure 3: Faster R-CNN Architecture

3.2 Face Recognition

A facial recognition system is a technology capable of identifying a person present in an image or video. There are dedicated algorithms for the task where the general

idea is selection of various face features from a given input image and comparing it with the features of image present in the existing database. Our subsystem is a part of recent trend of Biometric Artificial Intelligence based applications that can uniquely identify a person by analyzing patterns based on the person's facial textures and shape.

The main step in Face Recognition is extracting out features from the image. After preprocessing the image, the features which are extracted are used by the network to identify he face. They play a crucial role in the final accuracy of the result. It is therefore paramount that we try to find such viable features for better output. In our project we will be using Openpose as a black box to extract a 70 keypoint feature vector which will be fed to the network along with the image feature vector. These 70 keypoints will very effective in helping the network understand the input image better and make correct decisions.

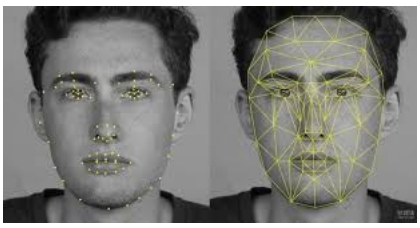


Figure 4: Face Recognition Through Facial Keypoints

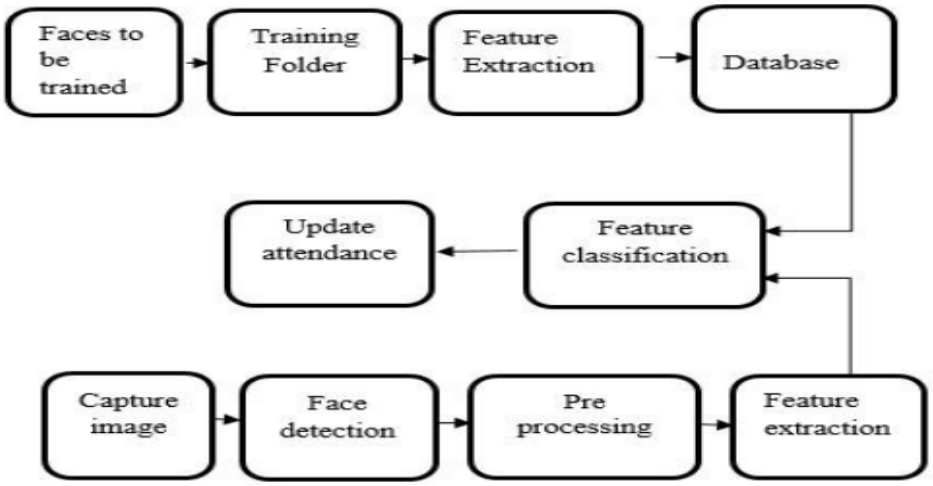


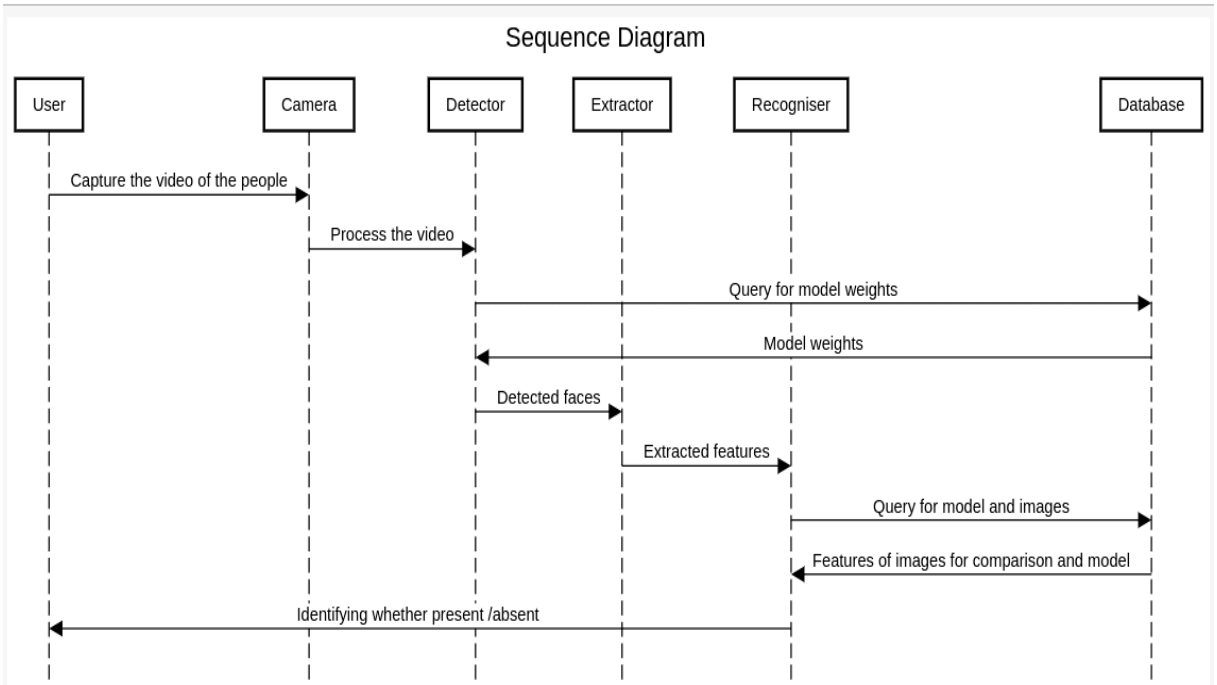
Figure 5: Face Recognition Block Diagram

4 System Architecture

4.1 Architectural Design

Our automated Attendance system is composed of different modules for different sub-tasks which bring together the main objective of fast and reliable attendance of students in a sequential manner.

- The image captured through the video camera is passed through the face detection module. This module has two sub-modules working in a coordinated manner to precisely locate the faces. The face detector is trained on images from face database to predict the bounding boxes around faces for further downstream processes.
- We are also preparing a system of eye database and eye localizer. The presented module helps in feature extraction of different facial structures by computing absolute location of eyes and relative facial positions of other sense organs.
- The facial feature extraction module helps in robust features extraction from images of different subjects/students. The module eventually builds a strong base for feature matching between input and target images.
- The face recognition module is composed of face recognizer and face database containing information of students. The recognizer sub-module is trained on face database to classify the input image to a target permissible student id in database through feature matching. The outcome is Recognized **Face Id** or **Reject** alert.



5 Pipeline

5.1 Image acquisition

Image is acquired from a high definition camera that is connected on the attendance system. This camera is connected to the computer. It captures images and sends these images to the computer for processing.

5.2 Normalization

Captured image sometimes have brightness or darkness in it which should be removed for good results. First the RGB image is converted to the gray scale image for enhancement.

5.3 Noise Filtering

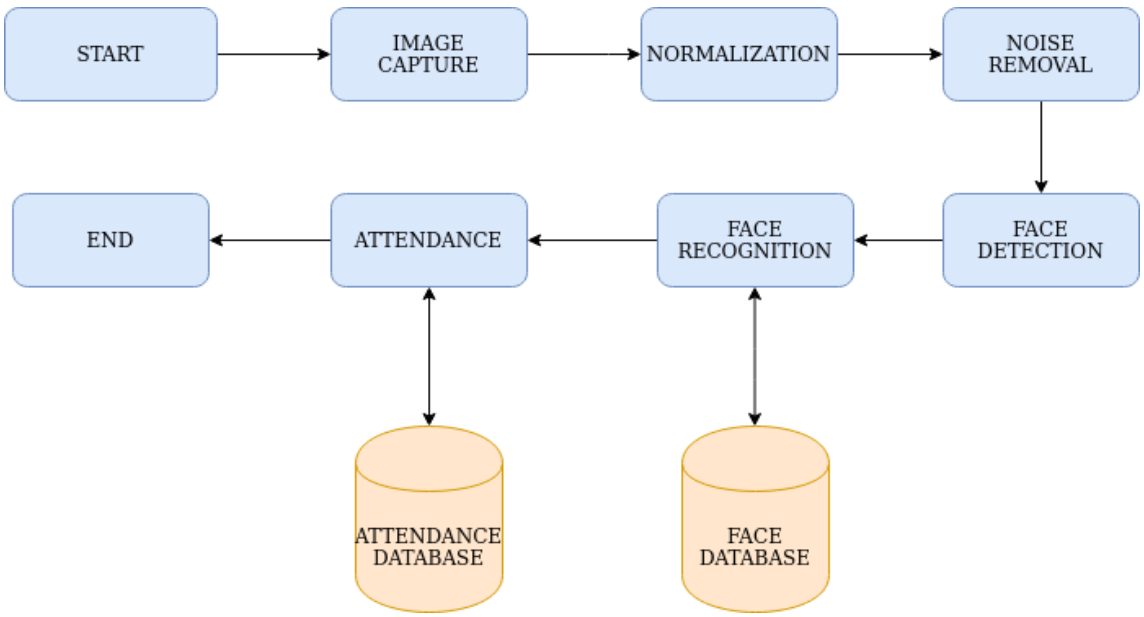
Many sources of noise may exist in the input image when captured from the camera. There are many techniques for noise removal. Low pass filtering in the frequency domain may be a good choice but this also removes some important information in the image. In our system median filtering in is used for the purpose of noise removal in the histogram normalized image.

5.4 Face Detection

Algorithm is **trained** for the images of faces and then applied on the class room image for detection of multiple faces in the image. After the detection of faces from the images next step is cropping of each detected face. These detected face is then used for recognition.

5.5 Face Recognition and Attendance

After the face detection step the next is face recognition.This can be achieved by cropping the first detected face from the image and compare it with the database. This is called the selection of region of interest. In this way faces of students are verified one by one with the face database using the EigenFace method and attendance is marked on the server.



Pipeline