Real Time Face Detection and Tracking Using OpenCV

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ABSTRACT

In this paper, we intend to Implement a real-time Face detection and tracking the head poses position from high definition video using Haar Classifier through Raspberry Pi BCM2835 CPU processor which is a combination of SoC with GPU based Architecture. SimpleCV and OpenCV libraries are used for face detection and tracking the head poses position. The experimental result computed by using computer vision SimpleCV and OpenCV framework libraries along with above mentioned hardware results were obtained through of 30 fps under 1080p resolutions for higher accuracy and speediness for face detection and tracking the head poses position.

Keywords—Raspberry Pi; Haar Filter; OpenCV; Processing; Servos.

1. INTRODUCTION

Face detection is a computer technology that determines the locations and sizes of human faces in arbitrary (digital) images. It detects facial features and ignores anything else, such as buildings, trees and bodies. Human face perception is currently an active research area in the computer vision community. Human face localization and detection is often the first step in applications such as video surveillance, human computer interface, face recognition and image database management. Locating and tracking human faces is a prerequisite for face recognition and/or facial expressions analysis, although it is often assumed that a normalized face image is available.In this paper we intend to implement the Haar-Classifier for Face detection and tracking based on the HaarFeatures.

2. RELATED WORKS

Robust and real-time face detection plays a vital role in many of the application scenarios like in biometrics, often as a part of (or together with) a facial recognition system. It is also used in video surveillance, human computer interface and image database management. Some recent digital cameras use face detection for autofocus. Face detection is also useful for selecting regions of interest in photo slideshows that use a pan-and-scale Ken Burns effect. Face detection is gaining the interest of marketers. A webcam can be integrated into a television and detect any face that walks by. The system then calculates the race, gender, and age range of the face. Once the information is collected, a series of advertisements can be played that is specific toward the detected race/gender/age. This paper shows prototype or partial implementation of this type of work. Face detection is also being researched in the area of energy conservation [Energy Conservation]

3. DESCRIPTION OF TOOLS

In this section, the tools and methodology to implement and evaluate face detection and tracking using OpenCV are detailed.

OPENCV

OpenCV (Open Source Computer Vision Library) is a library of programming functions mainly aimed at real time computer vision, developed by Intel. The library is cross-platform. It focuses mainly on real-time image processing.

Figure 3: Object Detection Pattern using OpenCV

The library was originally written in C and this C interface makes OpenCV portable to some specific platforms such as digital signal processors. Wrappers for languages such as C#,

Python, Ruby and Java (using JavaCV) have been developed to encourage adoption by a wider audience. However, since version 2.0, OpenCV includes both its traditional C interface as well as a new C++ interface. This new interface seeks to reduce the number of lines of code necessary to code up vision functionality as well as reduce common programming errors such as memory leaks (through automatic data allocation and deallocation) that can arise when using OpenCV in C. Most of the new developments and algorithms in OpenCV are now developed in the C++ interface. Unfortunately, it is much more difficult to provide wrappers in other languages to C++ code as opposed to C code; therefore the other language wrappers are generally lacking some of the newer OpenCV 2.0 features.

FACE DETECTION

In this section, the base algorithm used to detect the face is discussed. AdaBoost algorithm is discussed first then feature selection is discussed.

ADABOOST

In 1995, Freund and Schapire first introduced the AdaBoost algorithm . It was then widely used in pattern recognition.

The AdaBoost Algorithm

1. **Input**: Give sample set S = **(**x1, y1), ...(xn, yn) xiϵ X, yiϵ Y = {-1, +1}, number of iterations T

2. **Initialize**: $w_{i,j} = \frac{1}{N} i = 1, \dots N$

3. **For** t = 1, 2,…,T,

i) Train weak classifier using distribution Wt.

ii) Calculate the weight (w_i) training error for each hypothesis.

$$h_n \varepsilon_t = \sum_{i=1}^{N} W_{t,i} |k_i - y_i|$$

iii) Set:$a_t = \frac{1}{2} log \frac{1-\varepsilon t}{\varepsilon t}$

iv) Update the weights:

$$W_{t+1,i} = 1 + \frac{W_{t,i}}{Z_t} \times \begin{cases} e^{-a_t} \\ e^{a_t} \end{cases}$$

$$= \frac{w_{t,i} \exp(-a_t y_i h_t(x_i))}{Z_t}$$

4.Output: the final hypothesis, also the stronger classifier.

$$H(x) = sign\left(\sum_{t=1}^{T} a_t h_t(x)\right)$$

Feature Selection using Haar like Features

In the implementation of face detection, Xi contains a huge number of face features, and some of the features with low ϵ i to train our strong classifier are selected. By AdaBoost algorithm this can be achieved automatically. For each iteration ϵ i with each feature in Xi can be calculated and then the lowest one is what we need. For doing this, the face detection rapid could be very fast. In next part, you will find there are many haar-like features, so it is hard to make use of all them. Face features are abstracted from the input image and are used to train the classifier, modify weights.

Face features are abstracted from the input images and are used to train the classifiers, modify weights as mentioned . In 2001, Viola et al. first introduced the haar-like features. The haar-like features are rectangle features and value is that **the**

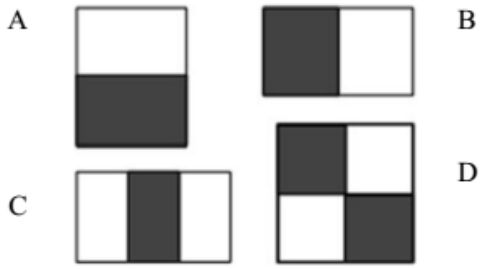


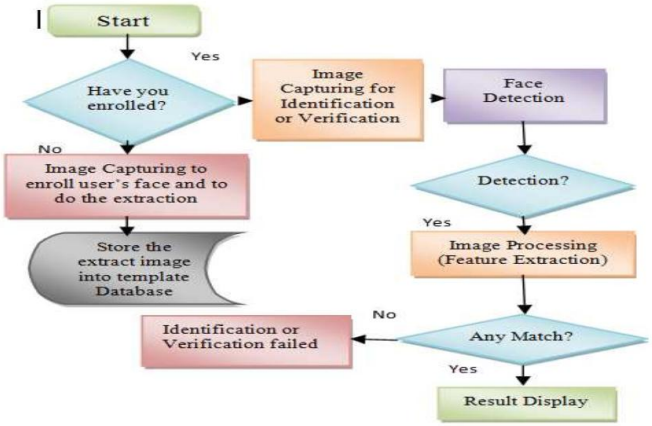
Figure 6: Haar-like Features Introduced in Viola's Paper

sum of pixels in black district subtracts the sum of pixels in white district. Rainer Lienhart had done an extended set of haar-like features which significantly enrich the basic set of simple haar-like features, and can get a better hit rate. Two-rectangle features are „A" and „B" . „C" is three rectangle feature and „D" is four-rectangle feature. At a size of 24x 24, there are more than 180,000 rectangle features.

4. FACE DETECTION AND DESIGN ANALYSIS

This section will describe about the Face detection with itself which has several modules that are working together as one to make the system runs smoothly. The phase consists of capture image; Detect faces in the image, feature extraction, template comparison, declaration of matching template. The acquisition of face images can be done by acquiring the real-time image from the OV5647 CMOS Image sensor interfaced with Raspberry pi High speed processor with GPU Processing. Furthermore, the acquisition can also be done through real

time remote monitoring either with Ethernet connectivity. The function of the face detection module is to clarify whether the face is available during real time monitoring for detection or not. The face detection is done by scanning up an image for different scales and looking for some simple patterns. When the system detects the face, it will produce an sub-image and this sub-image is scaled such that the face appears in the center and presented at a uniform size. OpenCV already provide an algorithm to locate faces in still image and videos stream. Haar classifier algorithm scans the image and creates a bounding box as returns for each detected face.

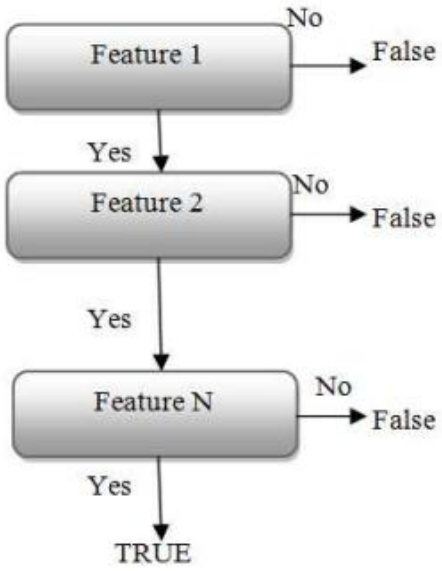


The feature extraction in face detection is done by localizing of the characteristics of face components (i.e., eyes, mouth, nose etc.) in an image. In other terms, the feature extraction is a step-in face detection and recognition where the system locates certain points on the faces such as corner and center of the eyes, tip of the nose, mouth etc. It analyzes spatial geometry of differential feature of a face. Result of this analyzing is a set of template generated for each face. The template consists of a reduced set of data which represent the real-time face detected in bounded box. The template comparison is done with the template stored in the database. Two phases are there in this phase identification and verification. These two-term identification to detect the face in real time video and verification application for face recognition which scope out of this paper. The final phase of face detection is to declare the highest matching score resulted in the previous step. The configuration will determine how the application should behave based on the desired security and operational consideration. The face detection methodology is shown in figure.

A. Face detection

This System is capable of detecting the faces from the captured image from HD Video for the purpose of analyzing and detecting the face. From the above Section IV, face detection determines where in an image, a face is located and it is being done by scanning the different image scales and extracting the exact patterns to detect the face. The Prototype is built with Haar-Like Feature function from OpenCV. Haar classifier face detection is used to create a search window that slide through a image and check whether a certain region of an image looks likes face or not. Haar like features and a large set of very weak classifier use a single feature to define a certain image as face or non-face. Each feature is described by the template and its coordinate relative to the search window which is the origin of the size of the feature.

The search window quickly scans the first classifier on the cascade as shown in the Figure 9, if the classifier returns false then the computation on that window also ends and results no detected face (false). Moreover, if the classifier returns true, then the window will be passed down to the next classifier in the cascade to do the exact same thing. When all classifiers return true for that window, then the result will return true also



for that certain window face is detected.

Figure . Decision tree based on Haar –like features (Cascade of classifier)

Software Required

OpenCV 2.3.1 super pack for windows, Raspbian OS, Putty,etc.

Hardware Required

PC preferably running windows, Rapberry Pi 3 model B , standard servos *2, webcam w/usb interface, breadboard, jump wires, hobby wire to tie pan/tilt servos and webcam together. Breadboard is used to make connections. The various connections required are as given below

SERVOS :

A **servomotor** is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable **motor** coupled to a sensor for position feedback.

WEBCAM:

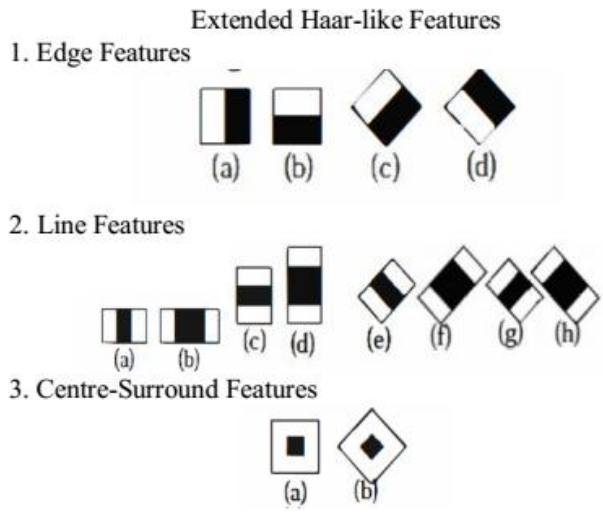
The webcam's USB goes to the pc. The code will identify it via a number representing the USB port its connected.

RASPBERRY PI :

All models feature a broadcom system on a chip (SoC), which includes an ARM compatible central processing unit (CPU) and an on-chip graphics processing unit (GPU, a VideoCore IV). CPU speed ranges from 700 MHz to 1.2 GHz for the Pi 3 and on board memory range from 256 MB to 1 GB RAM. Secure Digital (SD) cards are used to store the operating system and program memory in either the SDHC or MicroSDHC sizes. Most boards have between one and four USB slots, HDMI and composite video output, and a 3.5 mm phone jack for audio. Lower level output is provided by a number of GPIO pins which support common protocols like I²C. The B-models have an 8P8C Ethernet port and the Pi 3 has on board Wi-Fi 802.11n and Bluetooth.

5.IMPLEMENTATION

After a classifier is trained, it can be applied to a region of interest (of the same size as used during the training) in an input image. The classifier output is "1" if the region is likely to show the face and "0" otherwise. To search for the object in the whole image one can move the search window across the image and check every location using the classifier. Here we



use two different codes for face detection and tracking respectively. The algorithm used for both the codes (Processing & Raspberry Pi).

Implementation of Software

Processing takes the video input from the webcam and uses the OpenCV library to analyze the video. If a face is detected in the video, the OpenCV library will give the Processing sketch the coordinates of the face. The processing sketch will determine where the face is located in the frame, relative to the centre of the frame, and send this data through a serial connection to the Raspberry Pi. The Raspberry Pi will use the data from the Processing sketch to move the servos connected the Servo setup.

a) Basically haar-cascade classifier is used for detecting the faces.

b) The input video frame is read from camera and temporary memory storage is created to store

c) A window is created to capture the display frame and frame is continuously monitored for its existence.

d) A function is called to detect the face where the frame is passed as parameter.

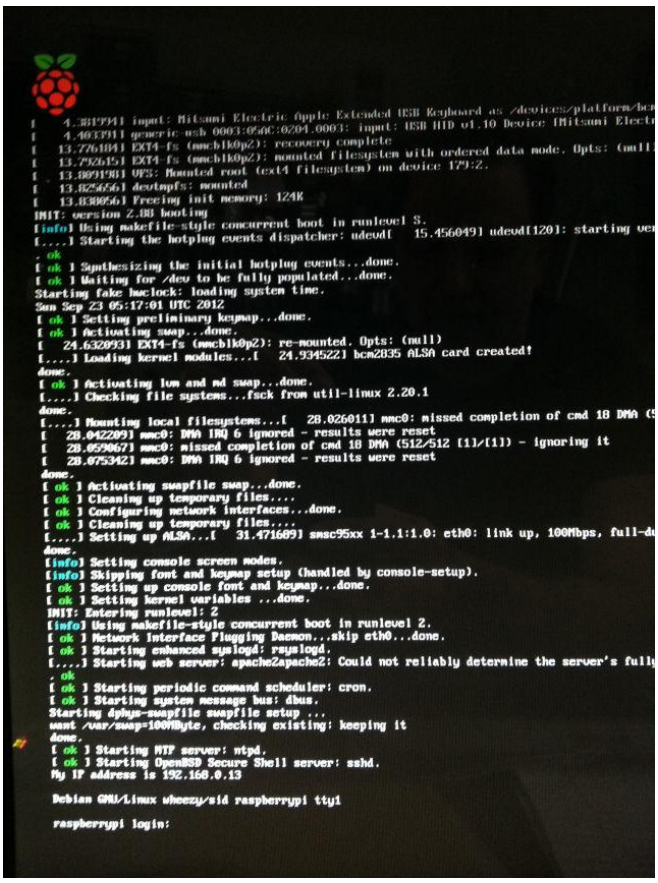
e) Steps b-d is kept in a continuous loop until the user defined key is pressed.

f) The classifier, frame, memory storage & the window are destroyed.

g) The (X, Y) coordinate of the image is plotted according to movement of face.

g) The (X, Y) coordinate of the image is plotted according to movement of face.

h) The difference between face position and centre is calculated and sent to Raspberry Pi serially.



6. RESULT AND ANALYSIS

The result of face detection is shown in Figure. Those are the frames extracted from the HD video streaming. Sometimes, face detection algorithm may get more than one result even there is only one face in the frame. In this case, a post image processing is been used for extracting the exact face coordinates with OpenCV and SimpleCV Haar Classifier libraries. If the system output provides more than one

rectangle, which indicates the position of the face, the distance of center points of these rectangles has been calculated. If this distance is smaller than a pre-set threshold, the average of these rectangles will be computed and set as the final position of the detected face. In this paper we also implement the face tracking application in Python language by using face detection. This method is verified and the limitations of the scheme are observed through testing and debugging our codes. And then, limited by Python performance, we shift to OpenCV to evaluate the speed of this face tracking scheme, We found the Viola and Jones face detection is more suitable for real-time face detection since they requires less CPU resource and costs shorter time.

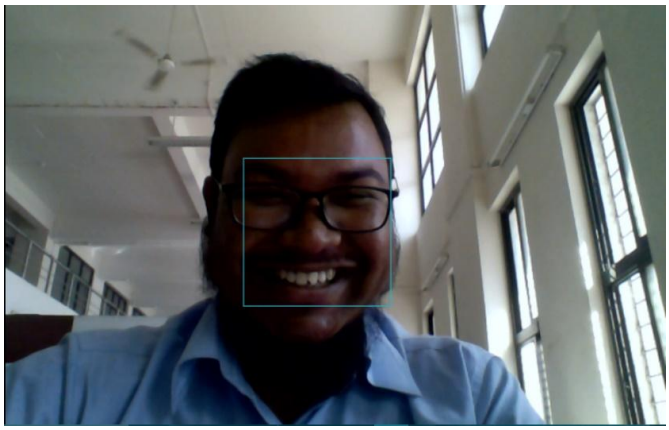


Fig. Output of Algorithm Showing the face detection

7.CONCLUSION

Face detection and tracking is being a challenge for many researchers with real time Image sensor. With the advancement the real time face detection in remote monitoring is helpful for building many efficient industrial and commercial applications. Moreover such technology can be useful in tracking the lost object under dynamic environment. Further enhancement of this work can be extended with stereo depth analysis of face detection using two image sensor interfaced with High speed Processor.

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Face Recognition Based Attendance System

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ABSTRACT--- Automatic face recognition (AFR) technologies have made many improvements in the changing world. Smart Attendance using Real-Time Face Recognition is a real-world solution which comes with day to day activities of handling student attendance system. Face recognition-based attendance system is a process of recognizing the students face for taking attendance by using face biometrics based on high - definition monitor video and other information technology. In my face recognition project, a computer system will be able to find and recognize human faces fast and precisely in images or videos that are being captured through a surveillance camera. Numerous algorithms and techniques have been developed for improving the performance of face recognition but the concept to be implemented here is Deep Learning. It helps in conversion of the frames of the video into images so that the face of the student can be easily recognized for their attendance so that the attendance database can be easily reflected automatically.

Keywords: Face recognition, Face detection, Deep Learning, Convolution Neural Network(CNN).

INTRODUCTION

The technology aims in imparting a tremendous knowledge oriented technical innovations these days. Deep Learning is one among the interesting domain that enables the machine to train itself by providing some datasets as input and provides an appropriate output during testing by applying different learning algorithms. Nowadays Attendance is considered as an important factor for both the student as well as the teacher of an educational organization. With the advancement of the deep learning technology the machine automatically detects the attendance performance of the students and maintains a record of those collected data.

In general, the attendance system of the student can be maintained in two different forms namely,

- Manual Attendance System (MAS)
- Automated Attendance System (AAS).

Manual Student Attendance Management system is a process where a teacher concerned with the particular subject need to call the students name and mark the attendance manually. Manual attendance may be considered as a time-consuming process or sometimes it happens for the teacher to miss someone or students may answer multiple times on the absence of their friends.

So, the problem arises when we think about the traditional process of taking attendance in the classroom. To solve all these issues we go with Automatic Attendance System(AAS).

Automated Attendance System (AAS) is a process to automatically estimate the presence or the absence of the student in the classroom by using face recognition technology. It is also possible to recognize whether the student is sleeping or awake during the lecture and it can also be implemented in the exam sessions to ensure the presence of the student. The presence of the students can be determined by capturing their faces on to a high-definition monitor video streaming service, so it becomes highly reliable for the machine to understand the presence of all the students in the classroom. The two common Human Face Recognition techniques are,

- Feature-based approach
- Brightness-based approach.

The Feature-based approach also known as local face recognition system, used in pointing the key features of the face like eyes, ears, nose, mouth, edges, etc., whereas the brightness-based approach also termed as the global face recognition system, used in recognizing all the parts of the image.

LITERATURE SURVEY:

2.1 A Counterpart Approach to Attendance and Feedback System using Machine Learning Techniques:

In this paper, the idea of two technologies namely Student Attendance and Feedback system has been implemented with a machine learning approach. This system automatically detects the student performance and maintains the student's records like attendance and their feedback on the subjects like Science, English, etc. Therefore the attendance of the student can be made available by recognizing the face. On recognizing, the attendance details and details about the marks of the student is obtained as feedback.

2.2 Automated Attendance System Using Face Recognition:

Automated Attendance System using Face Recognition proposes that the system is based on face detection and recognition algorithms, which is used to automatically detects the student face when he/she enters the class and the system is capable to marks the attendance by recognizing him. Viola-Jones Algorithm has been used for face detection which detect human face using cascade classifier and PCA algorithm for feature selection and SVM for classification. When it is compared to traditional attendance marking this system saves the time and also helps to monitor the students.

2.3 Student Attendance System Using Iris Detection:

In this proposed system the student is requested to stand

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in front of the camera to detect and recognize the iris, for the system to mark attendance for the student. Some algorithms like Gray Scale Conversion, Six Segment Rectangular Filter, Skin Pixel Detection is being used to detect the iris. It helps in preventing the proxy issues and it maintains the attendance of the student in an effective manner, but in one of the time-consuming process for a student or a staff to wait until the completion of the previous members.

2.4 Face Recognition-based Lecture Attendance System:

This paper proposes that the system takes the attendance automatically recognition obtained by continuous observation. Continuous observation helps in estimating and improving the performance of the attendance. To obtain the attendance, positions and face images of the students present in the class room are captured. Through continuous observation and recording the system estimates seating position and location of each student for attendance marking. The work is focused on the method to obtain the different weights of each focused seat according to its location. The effectiveness of the picture is also being discussed to enable the faster recognition of the image.

EXISTING RECOGNITION SYSTEMS:

3.1 Fingerprint Based recognition system:

In the Fingerprint based existing attendance system, a portable fingerprint device need to be configured with the students fingerprint earlier. Later either during the lecture hours or before, the student needs to record the fingerprint on the configured device to ensure their attendance for the day. The problem with this approach is that during the lecture time it may distract the attention of the students.

3.2 RFID(Radio Frequency Identification) Based recognition system:

In the RFID based existing system, the student needs to carry a Radio Frequency Identity Card with them and place the ID on the card reader to record their presence for the day. The system is capable of to connect to RS232 and record the attendance to the saved database. There are possibilities for the fraudulent access may occur. Some are students may make use of other students ID to ensure their presence when the particular student is absent or they even try to misuse it sometimes.

3.3 Iris Based Recognition System:

In the Iris based student attendance system, the student needs to stand in front of a camera, so that the camera will scan the Iris of the student. The scanned iris is matched with data of student stored in the database and the attendance on their presence needs be updated. This reduces the paper and pen workload of the faculty member of the institute. This also reduces the chances of proxies in the class, and helps in maintaining the student records safe. It is a wireless biometric technique that solves the problem of spurious attendance and the trouble of laying the corresponding network.

3.4 Face Based Recognition System:

The facial recognition technology can be used in recording the attendance through a high-resolution digital camera that detects and recognizes the faces of the students and the machine compares the recognized face with students' face images stored in the database. Once the face of the student is matched with the stored image, then the attendance is marked in attendance database for further calculation. If the captured image doesn't match with the students' face present in the database then this image is stored as a new image onto the database. In this system, there are possibilities for the camera to not to capture the image properly or it may miss some of the students from capturing.

PROPOSED SYSTEM:

The task of the proposed system is to capture the face of each student and to store it in the database for their attendance. The face of the student needs to be captured in such a manner that all the feature of the students' face needs to be detected, even the seating and the posture of the student need to be recognized. There is no need for the teacher to manually take attendance in the class because the system records a video and through further processing steps the face is being recognized and the attendance database is updated.

RESULTS & DISCUSSIONS

The main working principle of the project is that, the video captured data is converted into image to detect and recognize it. Further the recognized image of the student is provided with attendance, else the system marks the database as absent.

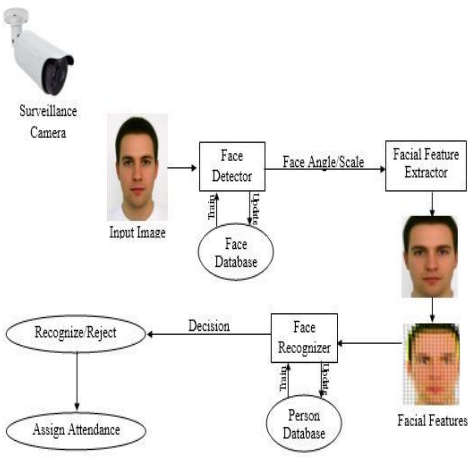


Figure 1.1

5.1 Capture video:

The Camera is fixed at a specific distance inside a classroom to capture videos of the frontal images of the entire students of the class.

5.2 Separate as frames from the video:

The captured video needs to be converted into frames per second for easier detection and recognition of the students'

face to generate the attendance database.

Figure 1.2

5.3 Face Detection:

Face Detection is the process where the image, given as an input (picture) is searched to find any face, after finding the face the image processing cleans up the facial image for easier recognition of the face.CNN algorithm can be implemented to detect the faces.

Figure 1.3

5.4 Face Recognition:

After the completion of detecting and processing the face, it is compared to the faces present in the students' database to update the attendance of the students.

Figure 1.4

5.5 Post-Processing:

The post-processing mechanism involves the process of updating the names of the student into an excel sheet. The excel sheet can be maintained on a weekly basis or monthly basis to record the students' attendance. This attendance record can be sent to parents or guardians of students to report the performance of the student.

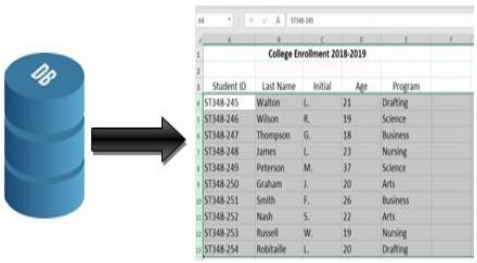
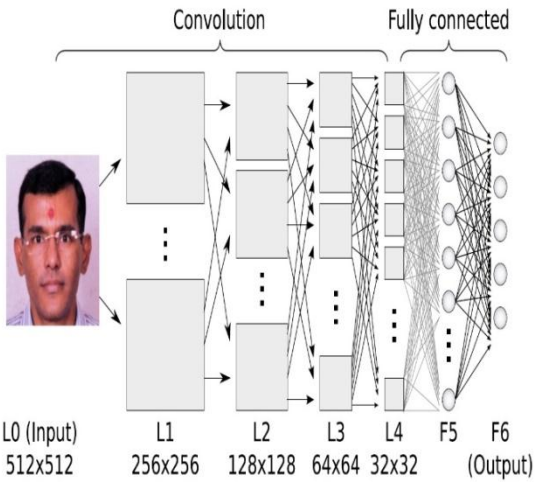


Figure 1.5

NETWORK DIAGRAM:

A CNN (Convolution Neural Network) uses a system like a multilayer perceptron that has been designed to process the requirements faster. The CNN layer consist of an input layer, an output layer and a hidden layer that includes multiple convolution layers, pooling layers, fully connected layers, and normalization layers. The removal of limitations and increase in efficiency for image processing results in a system that is far more effective, simpler to trains limited for image processing and natural language processing.



CONCLUSION:

Thus, the aim of this paper is to capture the video of the students, convert it into frames, relate it with the database to ensure their presence or absence, mark attendance to the particular student to maintain the record. The Automated Classroom Attendance System helps in increasing the accuracy and speed ultimately achieve the high-precision real-time attendance to meet the need for automatic classroom evaluation.

FUTURE ENHANCEMENTS:

- Automated Attendance System can be implemented in larger areas like in a seminar hall where it helps in sensing the presence of many people.
- Sometimes the poor lighting condition of the classroom may affect image quality which indirectly degrades system performance, this can be overcome in the latter stage by improving the quality of the video or by using some algorithms

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