International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2020): 7.803

A CNN Based Embedded System for Improved Face Recognition

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Abstract: ***Face recognition with the help of deep learning and machine learning has become a key research objective of many researchers and academicians. The techniques and algorithms used earlier were restricted to preserve the information as much as possible and reduce information redundancy. This face recognition model involves gathering the substitute features and inserts the feature vectors as classifiers; these classifiers are widely used in Neural Networks. After the advancements in deep learning technology convolution, neural networks were used to imbibe a large number of face data. In practice, this neural network model was usually large and consists of more parameters and yields better performance results, also while considering different constraints like recognizance accuracy, speed of processing in data, then the deep learning method, using the neural network based on the triplet loss, and using the compression quantization method to optimize the face recognition on the embedded device is used to be designed. This paper aims at the design and construction of such an embedded device. This work involves CNN - based deep learning, Raspberry - pi, IoT, and Python Language.***

Keywords: face recognition, CNN, deep learning, Neural Networks, Raspberry - Pi, IoT

1. Introduction

Face recognition (FR) systems are widely used to spot a person from an image and video. Due to the advancements in the fields of deep learning, IoT, and big data analytics the capacity of improvement in computer vision and in FR is significant [1], [2]. In earlier days various conventional methods were used for this FR. After applying modern techniques like deep learning, improves the accuracy in FR. FR is a non linear concept in nature and hence it is best to use techniques like neural networks to handle such non linear inputs adequately [1], [2]. Face recognition (FR) is a method used for detection and identification of a person by analyzes the patterns depending on the facial features of the person, object detection is also special case of the Face Detection. Face detection is the inaugural step in Face Recognition process [3].

Deep learning is a technique depend on neural networks, in precise they depend s on Convolution Neural Networks (CNN) [1], [2]. In Deep Learning model neural networks are with deep structures. This deep learning is developed with inspiration of human brain system and become a large success in the area of computer vision. These are widely used in distinct applications like traffic signal identification and detection, object tracking, etc. But face detection is different and challenging compare to above mentioned applications, and this face detection is a fascinated research interest of many researchers and involves in various fields like psychology, model identification, computer vision, computer graphics, etc [1], [2].

This Convolution Neural Network is a deep learning algorithm used to distribute objects, and to assess the images and spot the face. This consists of the pattern of neural integration in the human brain and the organization of the visual cortex [3]. The CNN executes over various distinct specifications and competent with different datasets features to provide a suitable understanding of the image. This process involves a Multilayer Perception, which is a part of the feed forward artificial neural network [3].

A Convolution Neural Network is a type of neural network that consists of convolution layers, a sub sampling layer and fully connected layers. CNNs are useful in identifying patterns that have large variance and are robust to distortions and simple geometric transformations like translation, rotation and scaling [3], [4].

2. Literature Survey

Among all the biometric techniques FR is a dominant and become significant for its strong testimony in detection and identification and attracts its applications in many fields. Even from early 1990's this technique attains a huge attention and become popular for its wide and broader area of applications, after the launch of the historical Eigen face approach. [5] Afterwards feature - based FR which was a comprehensive approach which yields a small - dimensional representation through certain distribution assumptions, like linear subspace, manifold and sparse representation. But the major limitation associated with this method was, this method fails when it deals with uncontrolled facial changes and were differ from prior assumptions [6].

In the early 2000s local - feature - based FR with its multilevel and high - dimensional extensions gives a significant performance with the help of some invariant properties of local filtering [6]. During 2010 a learning dependent local descriptors are proposed, n which local

filters are used for best distinguishing of the object. This type conventional method used to identify the human face by one or two layer representations, such as filtering responses, histogram of the feature codes, or distribution of the dictionary atoms [8].

But still there are limitations in identification and detection of Face by using these conventional techniques, due to this inefficiency of these methods facial recognition (FR) systems were known for their ambiguous performance and become deteriorate because of generating uncountable false alarms in the applications of real world.

To overcome all the limitations CNN method was implemented for face recognition (FR).

3. Proposed Methodology

In earlier days face recognition (FR) days involves only in face detection, present days face recognition (FR) involves in both face detection and identification. For that many dedicated and sophisticated algorithms and methods are proposed and developed, most popular among such is CNN [6], [7].

The below case explains the distinction between face identification and face detection. Figure.1 explains the block diagram of the driver drowsiness [6], [7] the major intention is to capture the image of face by using camera and preprocessed that image and detect whether driver was drowsy or not. Here the major objective is to detect the face which was drowsy, but recognition of face was not possible [8].

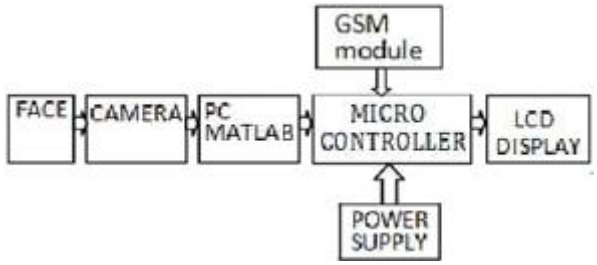

Figure 1: Block diagram of driver drowsiness detection system

The above proposed method has one major limitation is driver behavior only was checking but the details of driver was not available. Hence a dedicated system should be employed to check both driver behavior and details, which means a system for both face detection and identification is to be designed. The design of such setup is depicted in Figure.2

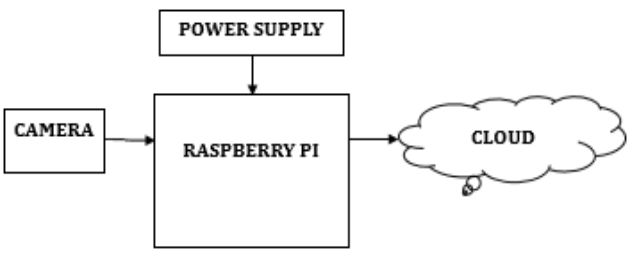

Figure 2: Block diagram of proposed system

The proposed system design is continuation to the existing design, face recognition is done by using Raspberry pi and the data of that corresponding person will uploaded to cloud, for that initially the data need to be enroll the image with a registration number, and then image to be trained and tested. Once the image matches with any of the image stored in database, then the corresponding registration number of the image will upload to server, so that identification of that particular person and data can be accessed easily. If the person is not identified with the stored image then the data will display in the python shell like unknown person

All the above discussed process can easily understand with the flowchart shown in Figure.3

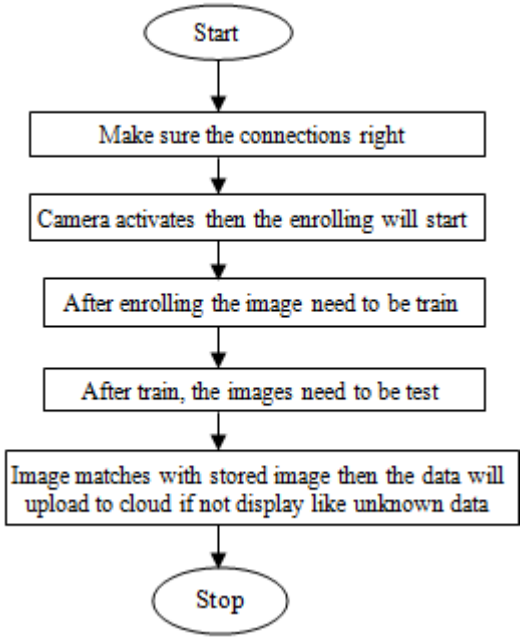

Figure 3: Functionality Flow chart of the proposed system

4. Design Implementation

For the design of the proposed method several hardware and software tools were used.

A. Hardware tools

1) *Raspberry PI:* This is a development board of pi series and work as a single board computer which operates on Linux operating system. . The board not only has tons of features it also has terrific processing speed making it suitable for advanced applications. In the proposed design this was used to upload the picture to cloud. (the board used in this design setup was *Raspberry PI 3*) [9], [10].
2) *Webcam:* A webcam is a typical digital camera which can conncected to any computer and enables the computer to broadcast video images in real time. In the proposed system webcam is used to pic the image of a person and sends it to cloud using Raspberry PI [12].

B. Software tools

1) *Noobs:* NOOBS (or "New Out Of the Box Software" to give it its full name) is a dedicated softtware used for unique installation image. An SD card loaded with NOOBS is used in installation of operating systems for

the Raspberry Pi, so that speedily set up of a Raspbian in a new Raspberry Pi can be done in easiest manner [11].

2) *VNC (Virtual Network Computing) Viewer:* The VNC allows a a graphical desktop sharing system and enables the users to control the desktop interface of one computer which acts as VNC Server from other computer or mobile device acts as VNC Viewer. This VNC Viewer transmits the keyboard and either mouse or touch events to VNC Server, and receives updates to the screen in return. [13] This VNC is connected to Raspberry PI, and enables the user to send and receive the files from Raspberry PI and PC. Sending of files to Raspberry PI, was done by using VNC viewer, in the similar and slight different manner the files are retrieved from Raspberry PI using VNC viewer [13] [14].
3) *Python3 IDE:* Python 3 is used to perfrom all the tasks like enrolling, testing, training. (before installing this software once check the compatible version of Python, in this project Python 3 is compatible) [15], [16]

5. Results and Analysis

The results of proposed face recognition (FR) algorithm implemented by using the designed setup are discussed in this section.

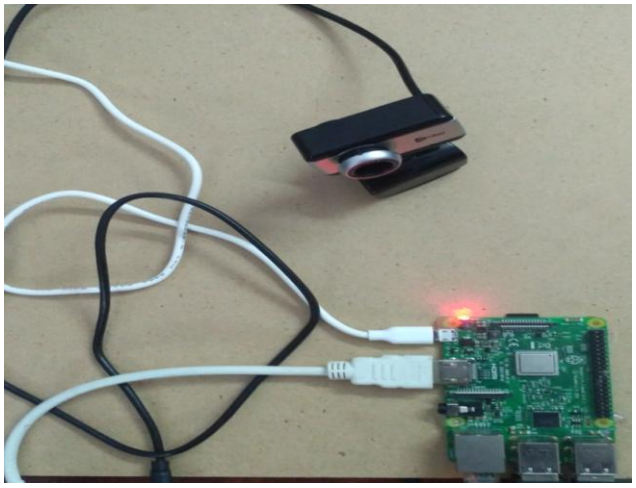

Figure 4: Circuit diagram of proposed design setup with connections

After connecting the circuit, camera start enrolling the details by capturing the image. This enrolment is done by using the program written in Python 3. Fig.4 shows the circuit diagram which depicts the connection between Raspberry PI 3 board and camera. After clicking on python3 (IDE), the program window will open like showing above. Next need to run or execute the program so for that need to click on Run button in tool bar. There need to click on Run module. Opening of Python IDE and running the code for enrolling were explained in Fig.5 and Fig.6 clearly. [15], [16]

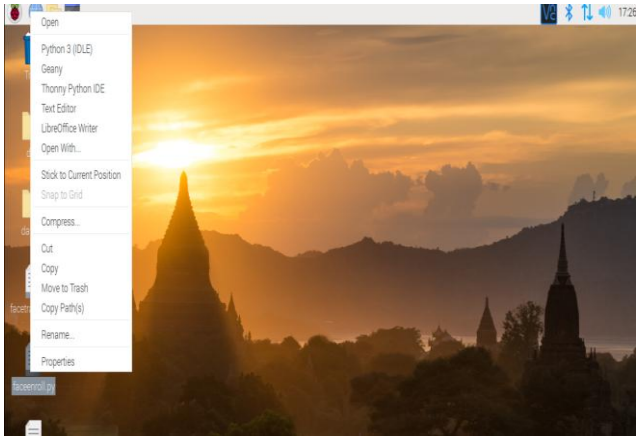

Figure 5: After clicking on Python IDE in PC

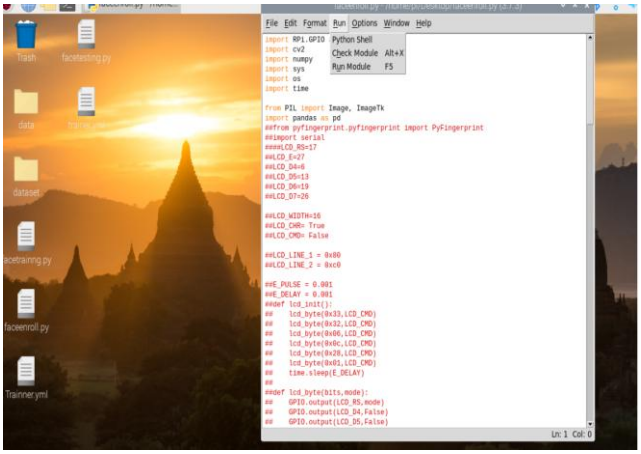

Figure 6: Running of code in Python IDE for enrollment

After running and executing the code the Python shell will open as shown in Fig.7

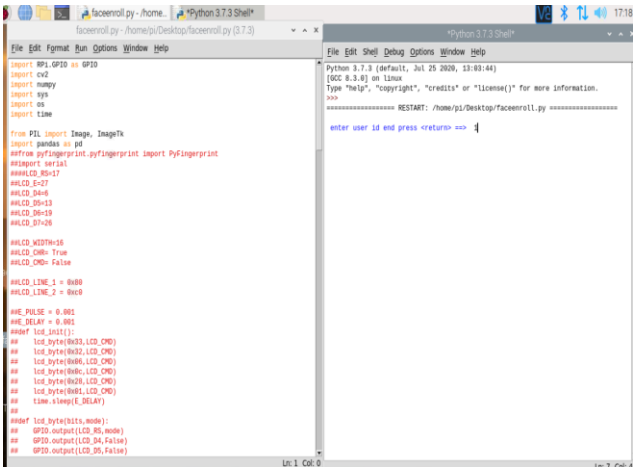

Figure 7: Python shell after execution of the code

That needs to enter ID (need to give numbering like 1, 2, 3 …. .). Here ID is given with number 2.

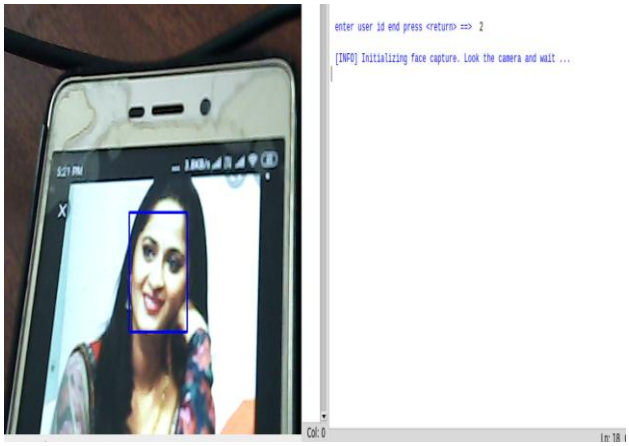

Figure 8: Capturing of image after enrolling

After entering the ID, then the camera will capture 60 images (60 images we are capturing for better quality).

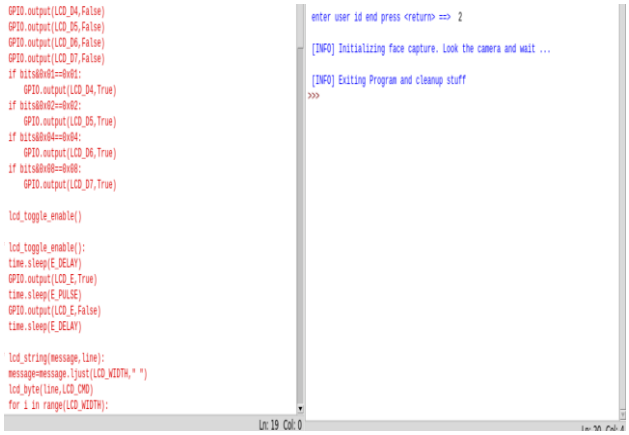

Figure 9: Python shell after enrollment of images.

After capturing the images, the program will exit automatically and the exiting status will also displayed on python shell. So here enrolling part finished. It is clearly shown in Fig.9. [9] [15] [16]

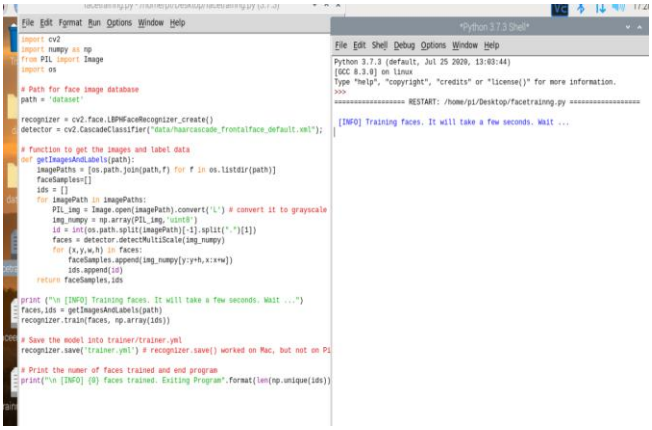

Figure 10: Running the code for training the image

Upon completion of enrolling process, the captured and enrolled images were needed to be trained, for that need to run the program, after running the program python shell will open and some time is required for training the images, all this process is clearly displayed in Fig.10. [15] [16]

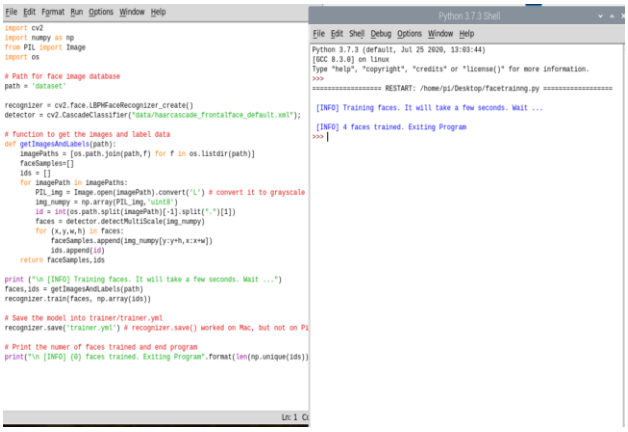

Figure 11: Completion of training and status of training

After completion of training then the status will display like faces trained. This was demonstrated in Fig.11. Following after these two steps the next step is to test the images for that needs to click on face testing python code, after that the code will open in that, in tool bar we need to click on Run option next need to click on F5 or Run module option. Next the camera will activate and then the camera will capture the image. The same was explained by Fig.12. [10] [15] [16]

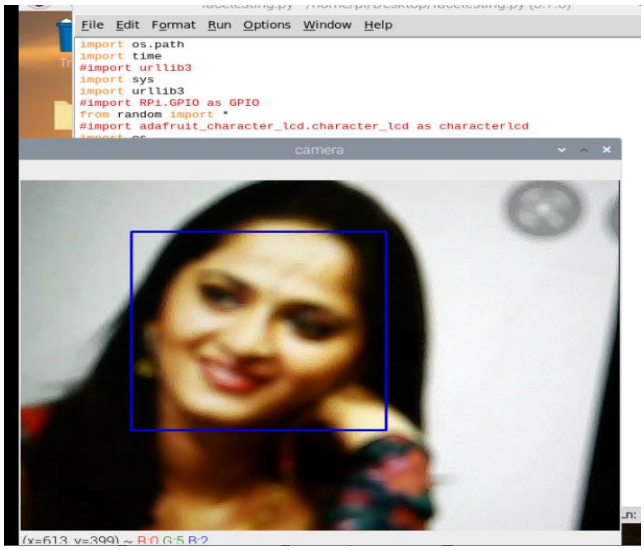

Figure 12: Testing of the image using Python IDE.

After testing if the image is not with clarity or image not matched with the images in data base it will show the face is not detected. Fig.13 explained it clearly.

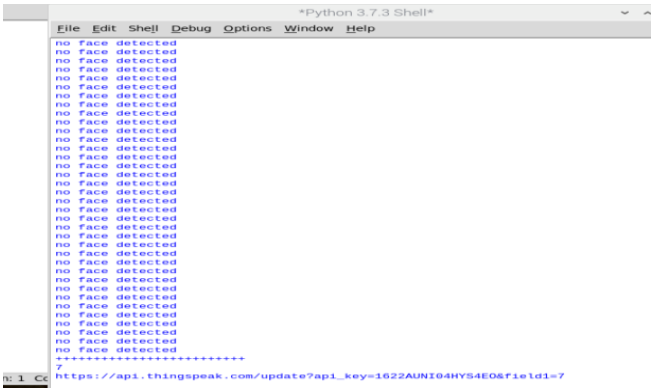

Figure 13: Results of testing the image.

6. Conclusion and Future Scope

This paper builds an embedded face recognition system and proposes a scheme to optimize the convolution neural network. The experimental results show that it is very helpful for improving the face recognition effect on embedded devices. Effect of Face alignment is not considered in this work. If we apply the face alignment to the dataset, all the faces should be centered in the image, be rotated such the eyes lie on a horizontal line, and be scaled such that the size of the faces is approximately identical. Since a lot of faces in the dataset are rotated in certain angles, face alignment is a important process to boost up the accuracy of the face recognition.

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