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Study On Deep Learning Approach For Face Recognition And Identification

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ABSTRACT :

The most important feature for identifying a person is their face. Even twins have different faces from each other. Therefore, in order to differentiate one another, face recognition and identification are needed. The system used to verify an individual's identity using biometric data is called a face recognition system. In many applications these days, including phone unlocking, criminal identification, and even home security systems, face recognition has gained popularity. This technology is more secure because it only requires a face image rather than a card or key. Face detection and face identification are the two stages that a typical human recognition system goes through. This paper presents the idea behind creating a deep learning-based face recognition system with OpenCV in Python. Because of its great accuracy, deep learning appears to be a suitable technique for carrying out face recognition. The accuracy of the suggested face recognition system is shown by the experimental results.

Keywords : Face Recognition, Accuracy, Biometric, Deep Learning, Algorithm.

INTRODUCTION

Artificial intelligence has been evolving quickly in the last several years.[1] The self-driving car and the self-service supermarket are examples of modern inventions. The fields of computer vision and artificial intelligence are closely related. Computer vision works to replicate human vision by electronically perceiving and interpreting images, whereas humans use vision to adapt to and understand the environments in which they are surrounded. In addition to seeing, computer vision also has to respond. The system must possess the capability to recognize, locate, and interpret images in a manner similar to that of human vision. A driver must, for instance, respond swiftly and take action when someone crosses in front of their moving vehicle. Identification, processing, and decision-making are the three main processes a driver's brain goes through when looking through his eyes. Computer vision aims to carry out these tasks effectively. But a vital component of intelligence is vision.[2] There are numerous components

that make up vision, such as estimation, recognition, reasoning, memory, coordination, and retrieval. One of these abilities alone disqualifies a system from being considered a vision. It is true that computer vision imitates human systems. Because our visual sensors typically only produce two-dimensional images despite the fact that our environment is three-dimensional, it becomes more challenging for computers to analyze objects in three dimensions.

OVERVIEW

- **Face Recognition**

Face recognition is part of computer vision.[3] Face recognition is used to identifying a person in biometric method based on image on their face. A person is identified through biological traits. Human eyes can easily recognize people by simply looking at them but the concentration span for human eyes has its limit. Hence, a computerized method is invented to perform face recognition. Face recognition includes the operations of automatically detecting followed by verifying a person from either picture or video. Although face recognition has been researched extensively but there are still challenges to overcome several issues such as:

  - Misalignment
  - Pose Variation
  - Illumination Variation
  - Expression Variation

Multiple approaches have to be tested to improve the accuracy and degree of precision of the face recognition.[4]

- **Deep Learning**

Deep learning is a product of development of artificial neural network. At the beginning, practice of training MLPs (Multi-layers Perceptron) where a linear layer is added from input of network connection to that of output. Subsequently, G. Thomson had proposed a new idea known as deep learning, where it is a new model training as shown in Figure 1.

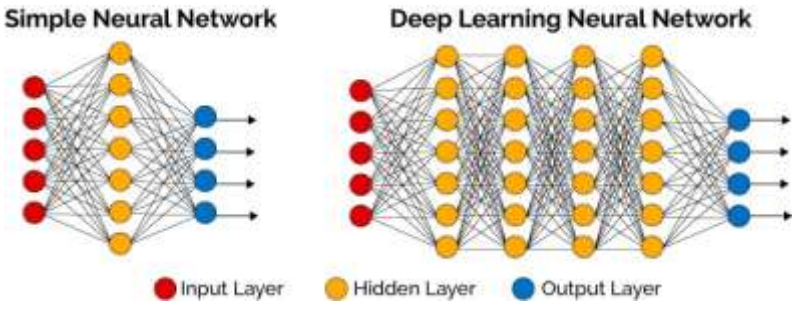

Figure 1. Simple Neural Network vs Deep Learning Neural Network[5]

Deep learning can achieve a nice approximation of a complex function through increment of hidden layers, hence, it is capable to achieve astonish result in the face recognition. It is a part of machine language that teaches computer to do as what human does naturally. Thus, deep learning is chosen to be implemented in this paper.

- **Interface**

S.Matuska et al. did the comparison of the speed between OpenCV and Matlab. Basic algorithm of image processing is presented and the time consumption in OpenCV and Matlab is the main focus point as presented in Figure 2. It is experimented that OpenCV is much faster than Matlab up to 30 times and can be up to 100 times for Erosion algorithm.[6]

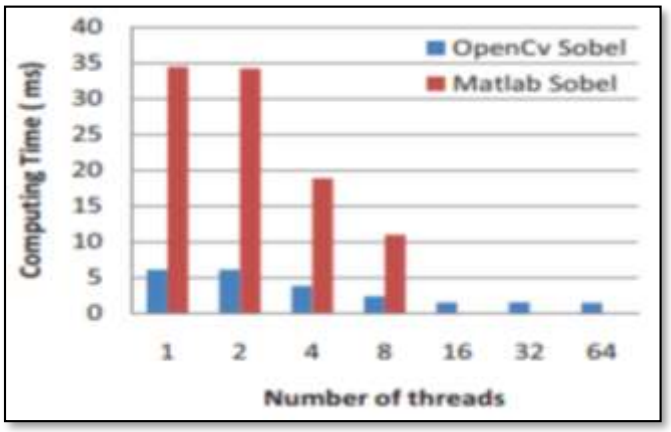

Figure 2. Time consumption between OpenCV and Matlab

However, Matlab environment is simpler and more user-friendly as it provides various function and algorithm. Memory allocation and memory leak are not the issues in Matlab but they are significant task for OpenCV.

Matlab is written in high level language and it is built on Java while Java is built upon C language. Hence, when a Matlab program is ran, the computer takes time to interpret the coding. It then turns them into Java Code and lastly executes the code. In contrary, OpenCV is generally a library written in C language. Operations taken are major in processing but not interpreting. Thus, program in OpenCV can runs faster than that in Matlab.[7]

Furthermore, OpenCV can be said more efficient than Matlab. Matlab wasted system resource as it use them excessively as to ensure that memory allocation and memory leak will not be problem. However, in modern computer, the RAM element is not a point to be concerned. Therefore, in general, OpenCV runs faster than Matlab and it is the most comprehensive open source library for computer vision. Besides, it has large user community which means that more guidance can be obtained from various inputs. In contrary, Matlab is not open source and quite expensive to be obtained. Therefore, OpenCV is chosen to be applied in this paper.

DESIGN METHODOLOGY

- **Face Recognition**

Figure 3 shows the flowchart of the face recognition steps. To do face recognition, there must be an input to be detected and verified. Hence, an image sensor or typically a camera has to be set up for recording or capturing images. The camera should be compatible with the software used. The next step is the input image. The input can be images and recorded video or real-time video. After the input is provided, faces in the images or videos are to be detected. When the classifier is trained, it can be utilized to start to recognition work. It can be used in either video or image to recognize one or more person. Different set of python scripts are provided to run the different type of recognition. The python script will import the classifier that is trained in previous step in order to carry out the recognition for the person from the camera or from an image.

Figure 3. Process of Face Recognition

In face detection, Haar feature-based cascade classifiers is used and the classifier used is Haar Cascade for frontal face. A Haar Cascade is basically a classifier which is used to detect the object for which it has been trained for, from the source. The Haar Cascade is performed by superimposing the positive image over a set of negative images. The training is generally done on a server and on various stages. Better results are obtained by using high quality images and increasing the amount of stages for which the classifier is trained. TensorFlow is the framework that is being used in the system classifier section. Classifier is trained and used in the recognition process. The training process takes a long time to achieve a better classifier. The longer the time of the training runs, the better the classifier is. In the proposed face recognition system, the training period taken is 3 days. If the training is allowed to run longer, the loss can be reduced further and hence the accuracy can be increased. [8]

- **Accuracy**

The accuracy of the system will be tested via recognition of three peoples with multiple times at different locations, mainly to test how light intensity affect the accuracy of the system. The accuracy is verified using confusion matrix. The calculation is based on (1).

$$((TN + TP) / Total) \times 100\% \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where TN is true negative while TP is true positive. [9]

RESULTS

- **Distance of Face Detection**

Figure 4 and 5 show the distance between face and camera is affecting the recognition process. When the distance is close or less than 60cm, the proposed system can% barely detect the face. In the other hand, when the distance is extended to more than 60cm, the recognition takes place.

Figure 4. Distance between face and camera <60cm

Figure 5. Distance between face and camera >60cm

Figure 6. Low Lighting Intensity

Figure 7. High Lighting Intensity

- **Accuracy of Face Recognition based on Image**

Multiple photos either in group or individual are loaded into system to verify the accuracy. A person should had appeared in those photos for 20 times. When the photos are all tested with the proposed face recognition system, the data is computed in confusion matrix to calculate the accuracy of the system. From Table 1, it can be observed that the true and false recognition done by the proposed face recognition system. For the first person, 17 out of 20 recognitions are true. The true statement means that the identity of person in the photo that is recognized by the system is matched with real identity of the person. For second person, 18 of his photos are recognized correctly while for the last person, all photos are recognized correctly. Thus, the accuracy of the system can be calculated.

Table 1. Confusion matrix for image recognition

Number of Face Recognition			Result
Person 1	Person 2	Person 3	
17	1	2	Person 1
1	18	1	Person 2
0	0	20	Person 3

Figure 8 shows the accuracy obtained with respect to each person. The overall accuracy of the system for face recognition from images is 91.7%.

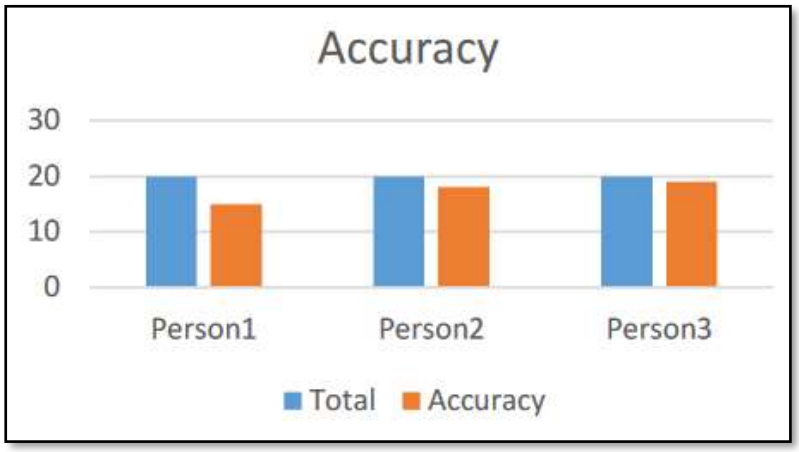

Figure 8. Total accuracy per person based on image

When collection of data is done, the data is computed into confusion matrix as shown in Table 2.

Table 2. Confusion matrix for real-time video recognition.

Number of Face Recognition			Result
Person 1	Person 2	Person 3	
15	1	4	Person 1
1	18	1	Person 2
1	0	19	Person 3

From Table 2, Person 1 has 15 true recognitions out of total of 20 recognition process. Person 3 has a quite high probability to be recognised as compared with Person 1 by the proposed system. For Person 2, the true recognitions are 18 out of 20. The overall accuracy of the face recognition on real-time video is 86.7%.

Figure 12. Total accuracy per person based on Real-Time Video

DISCUSSION

From the results, it can be concluded that the accuracy of face recognition on image is higher than the accuracy on the real-time video. It can be observed that the resolution of image is a lot better than the real-time video. Due to the limitation of processing system, the fps of the video is low and causing the face captured is not as clear as in the photo. Hence, the classifier tends to assume that a particular person exists the characteristic of the other person. Therefore, the accuracy of the real-time video recognition has been reduced to 86.7%.

This model is trained using large number of images per candidate and using CNN approach. This led to huge dataset and improve the overall accuracy. By analysing the results, the light conditions can be seen as a factor that influences the recognition process. The recognition system tends to do false recognition when the light intensity is low. This could potentially be corrected by adding more training images which are captured in low light intensity in generating the face classifier.

For both recognitions either in image or real-time video, the accuracy for Person 3 is higher compared to the other two. The reason is probably related to the classifier. The classifier is more sensitive in recognizing Person 3. This might due to photos of Person 3 contain more variation such as different orientation of face and different background or lighting. Thus, the classifier can recognise Person 3 in more efficient manner.

CONCLUSION

In this paper, a face recognition and identification system is designed and developed using deep learning approach. The overall procedure of developing this face recognition system from training the data using CNN approach to face recognition is described. It is verified that with the large number of face images being trained into a classifier can achieve accuracy of 91.7% in recognising image and 86.7% in real-time video. There are few factors that can affect the accuracy of the system. When the light intensity

is insufficient, the accuracy is relatively low compared to higher light intensity. Other than that, classifier is the main element in the recognition process. The longer the classifier is trained, the better the classifier is performed. The images that are used to train the classifier must be in variety of conditions in order to generate a robust classifier.

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