

## **Individual Contribution Report**

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In this capstone project, I have designed the face recognition model.

The face recognition model consists of face detection stage (using Haar Cascade) , followed by face alignment stage (using MTCNN), face encoding stage (using Dlib-based face\_recognition library) and final face recognition stage ( using voting ensemble of KNN, MLP, Logistic Regression and SVM classification model).

I have involved myself in choosing the method (Haar Cascade, MTCNN, face\_recognition, voting ensemble) to be used for each face recognition stage.

For training sample collection, I have collected extra samples that can reflect face feature under different light exposure and face alignment. Training python script is largely based on these augmentation methods.

I also involve myself in training of the model after each face sample is being encoded. Managed to enhance the system training result by reviewing the training samples and encoding model. I also perform augmentation of training samples using different gamma value, Laplacian of Gaussian filter, Gaussian Filter and rotation/translation matrix.

With all the models are trained, writing the final program which will be used for real-time face recognition. The program able to label and put the frame on the recognized face.

By putting these stages in place, training and testing program are ready in time. The model can be deployed in real time application.

I have also involved myself in face detection model by enhance sensitivity of the model using histogram equalization.

By implementing the face recognition model, I have gained extra knowledge about Haar Cascade, Ada Boost method using weaker classifier, triplet loss method, Histogram of Gradient.

Haar Wavelet and Histogram of Gradient is more for face/body recognition model, it is helping to understand on how face/body feature can be captured effectively.

Ada Boost and triplet loss method is wider in scope, it helps me in understanding on how a model accuracy can be improved.

With this project, I realize that the training sampling is important since it will determine the system accuracy under different condition. In this case, images must be collected under different light exposure and face alignment. I also realize that augmentation is important since it is impossible to capture all possible face image combinations with different alignment and light exposure. In terms of timeline, I

also realize that sampling and augmentation is time consuming. Sample size and number of augmentation approach can also be increased when the training or testing result is not reaching the intended target.

In terms of face encoding, I have learnt that consistency of model in giving similar encoding for a face under different lighting and alignment is important. Face\_recognition library is chosen over Facenet since it gives stable encoding for similar faces under different lighting. This is because the Histogram of Gradient method used in face\_recognition library is less sensitive to the light exposure.

I also learn that while longer face encoding(>128-bits) gives more details over shorter face encoding (128-bits), the shorter face encoding can make the classifier training to be easier. The training time of SVM will increase exponentially with the encoding length is increased.

When applying the classifier on the encoded faces, it is found that the SVM is accurate, but its training time increases with the number of sample increases.

KNN accuracy can be enhanced by applying distance weighing on the nearest neighbor without much increasing the training time. This means points with further distance is less weighed. This greatly enhance the accuracy.

MLP is not based on distance or boundary. With a greater of number of neuron, it is able to increase the accuracy of the prediction.

Logistic regression can perform classification based on the logistic function. With optimization of the parameter, it will be able to give extra coverage on SVM, KNN and MLP.

I have also learnt that voting mechanism is able to enhance the accuracy. SVM, KNN, MLP and Logistic Regression are classifying the encoded image using different model. To maximize the accuracy and reduce false positive, voting helps when one of the classifiers is giving different result. On the other hand, with high accuracy on each classifier, it is less likely for a voting classifier to give wrong result based on majority vote.

In real time application, we have learnt that face alignment and light exposure affects the face recognition result greatly. Re-sampling of image and change of mage encoding method are usually leads to higher accuracy.

In real time application, it is also important to have a short processing time. Hence, if no face is detected, the next frame should be processed rather than going through the full recognition process. It is also important that the classifier or network model are preloaded. So, the processing time can be greatly reduced.

In my working environment, the triplet loss and Ada Boosting method can have other application. Since my work involves testing of IC chips, I have network implemented to capture abnormal failing pattern of IC chips in testing environment. Ada Boost and triplet loss may be useful in continuous improvement of the pattern detection network.

After realizing importance of sample collection and augmentation, I will be more careful in choosing the training sample for the abnormality detection network that I will implement in my working environment.

KNN, MLP, Logistic regression and SVM are having its pros and cons. Hence, in my working environment, when I apply the classifier in analyzing failing trend of IC, I can choose a more suitable classifier. Voting classifier can also be applied when I need to use multiple classifiers.

Although face recognition may not be directly applicable, similar encoding method can still be used for IC X-ray image. It can be helpful in finding the defect in the IC.