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MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

FINAL PROJECT
AGE PREDICTION MODEL

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ABSTRACT

The technological progress made by mankind makes the 21st century the beginning of a period of unfathomable accomplishments. The technologies indicated above may be utilized to our advantage to determine someone's age just based on their glance into a camera, photograph, or even a video. Our project introduces the whole procedure, methodology, and algorithms used for age detection, which is one of the most common ways today and has high accuracy. Our objective for this project is to build a system for age detection. Dataset is used by using WIKI dataset. We will apply VGGFace model. Moreover, to get a higher accuracy so transfer learning method is used. Some applications of our project can be used in real life such as automatic detection age of viewers in the cinema, placing the ads in types of media most consumed by your target audience…

CHAPTER I
INTRODUCTION

1.1 Benefits

Face detection involves identifying human faces in digital images or video frames. Face detection algorithms use various techniques to locate facial features in an image and then compare those features to a database of known faces. If a face is found, the algorithm assigns a score indicating the probability that the face matches the database entry.

Figure 1: Benefits of Face Detection

There are a few different ways that age detection is used. One way is to determine the eligibility of someone to vote. In the United States, you must be 18 years old to vote. Other countries have different age requirements. Another way is to determine how many years someone has been alive. This is often used for things like life insurance policies. The insurance company wants to ensure that they are not paying out a policy to someone not old enough to receive the benefits.

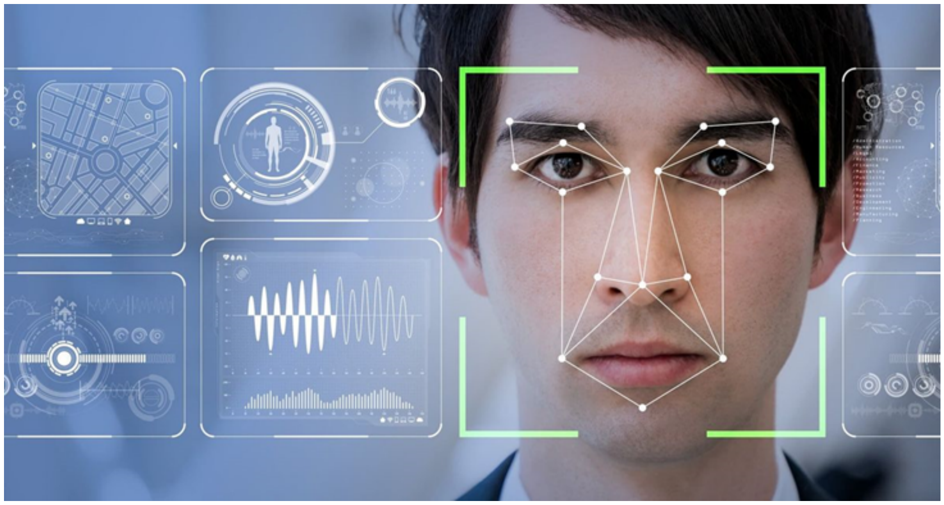

Figure 2: Why is Age Prediction is important

1.2 Technical Solution

There are many ways to detect a person's age and face. One way is to use a computer to see the person's age by measuring the person's face. The computer measures the person's face to find standard features in people of a certain age. For example, the computer may measure the person's eyes, nose, and mouth to identify standard features in people of a certain age. The computer can then use these measurements to guess the person's age.

Another way to detect a person's age is to use a person's eyes. The eye has a "lens" structure that changes as a person ages. The lens becomes more curved as a person gets older. This curvature can be measured using a computer to detect a person's age.

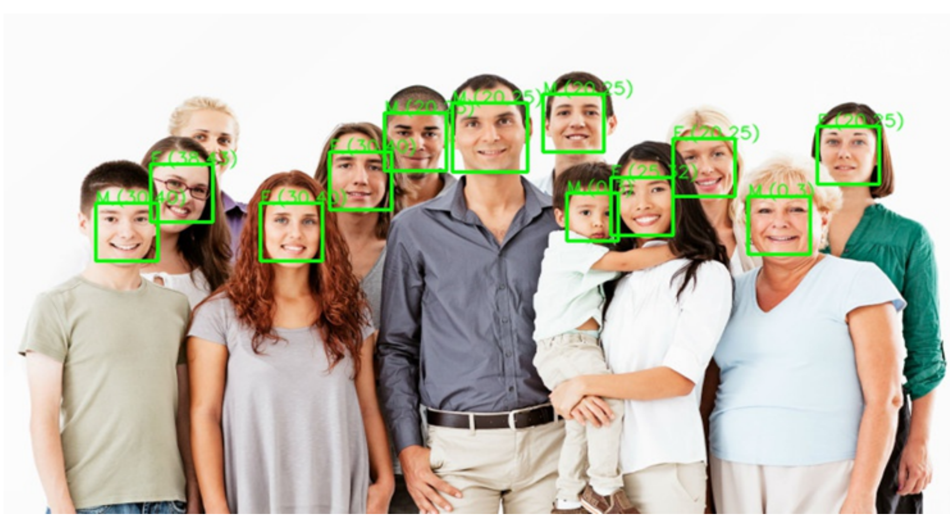

Figure 3: Advantages of Age Prediction

One of the benefits of identifying people by their face and age is that it can improve security. If a person tries to enter a space where they are not supposed to be, face identification software can assist them in identifying them. Moreover, it can enhance marketing efforts. For example, a company can use face detection to determine which age group is most interested in its product. This information can assist the company in directing its marketing efforts more effectively.

Figure 4: Age Prediction is an optimal solution

CHAPTER II
LITERATURE REVIEW

2.1 Omkar M. Parkhi, Andrea Vedaldi, Andrew Zisserman. Deep Face Recognition

For dataset, they propose a strategy to collect hundreds of sample images for thousands of identities (Table1).

Dataset	Identities	Images
LFW	5,749	13,233
Chen *et al.* [4]	2,995	99,773
CelebFaces [25]	10,177	202,599

Dataset	Identities	Images
VGG Face (ours)	2,622	2.6M
FaceBook [29]	4,030	4.4M
Google [17]	8M	200M

Table 1: **Dataset comparisons:** Our dataset has the largest collection of face images outside industrial datasets by Goole, Facebook, or Baidu, which are not publicly available.

The strategy includes bootstrapping a list of candidate identity names, filtering a list of candidate identity names, collecting more images for each identity and automatic filtering, near duplicate removal and final manual filtering. This combination of using Internet search engines, filtering data using existing facial recognition methods, and limited manual care can produce a large-scale, accurate dataset of faces tagged with their identities.

In the end they make a direct comparison to Labeled Faces in the Wild (LFW) dataset and the YouTube Faces (YTF) dataset and it is recognized that they achieve results comparable to the prior datasets with much less training data and a much simpler network architecture using a triplet loss embedding method.

No.	Method	Images	Networks	Acc.
1	Fisher Vector Faces [21]	-	-	93.10
2	DeepFace [29]	4M	3	97.35
3	Fusion [30]	500M	5	98.37
4	DeepID-2,3		200	99.47
5	FaceNet [17]	200M	1	98.87
6	FaceNet [17] + Alignment	200M	1	99.63
7	VGG Face (ours)	2.6M	1	98.95

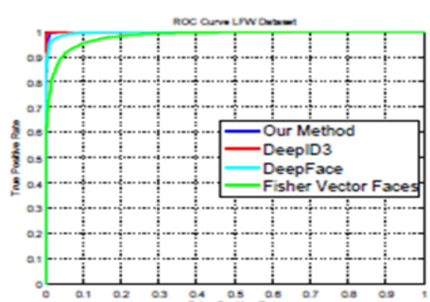

Figure 5: LFW unrestricted setting. Left: they achieve comparable results to the state of the art using much less training data. Right: ROC curves.

No.	Method	Images	Networks	100%- EER	Acc.
1	Video Fisher Vector Faces [15]	-	-	87.7	83.8
2	DeepFace [29]	4M	1	91.4	91.4
3	DeepID-2,2+,3		200	-	93.2
4	FaceNet [17] + Alignment	200M	1	-	95.1
5	VGG Face (ours)	2.6M	1	92.8	91.6
6	VGG Face - Embedding Learning (ours)	2.6M	1	97.4	97.3

Figure 6: Results on the Youtube Faces Dataset, unrestricted setting

2.2 Deep Convolutional Neural Network for Age Estimation based on VGG-Face Model - Zakariya Qawaqneh, Arafat Abu Mallouh, Buket D. Barkana

The proportions and size of human head are used in early method. The human head changes substantially throughout the adulthood, therefor the early methods are limited to young ages. After, other models are proposed: the active appearance model (AAM), ages pattern subspace (AGES), age manifold, 3D morphable model.

They used VGG-Face, which has been trained for facial recognition on a large database, to make age predictions based on facial images. The model is then modified and refined. The model used outperforms previous work by 9% in the Adience database, the latest challenging benchmark for age detection. GoogleLenet is trained on a very large database containing millions of training images, its performance in age prediction is not comparable to the proposed model used by VGG-Face.

2.3 Transfer Learning with Deep CNNs for Gender Recognition and Age Estimation - Philip Smith, Cuixian Chen

Due to the sheer size and complexity of deep neural network architecture, designing and testing the model is costly and time consuming. Quick results can be achieved using transfer learning. In transfer learning, the weights and convolution filters experienced in one activity can be reused for another activity that requires only a small amount of retraining. This involves using a network architecture with preloaded weights, modifying it slightly, and then retraining some or all of the model to make predictions for the new task. In their article, the deep convolutional neural network known as VGG-Face is used to study transfer learning.

CHAPTER III
METHODOLOGY

In this chapter, the methodology is described in detail for each of the objective. In addition, the constraints the experiment is provided. In this project we use python Programming to develop codes. The VGGFace Model is used for Deep Face Recognition. We will apply transfer learning method with VGGFace model, WIKI dataset is used for data training and testing. There are 4 main step shows in figure 7 below:

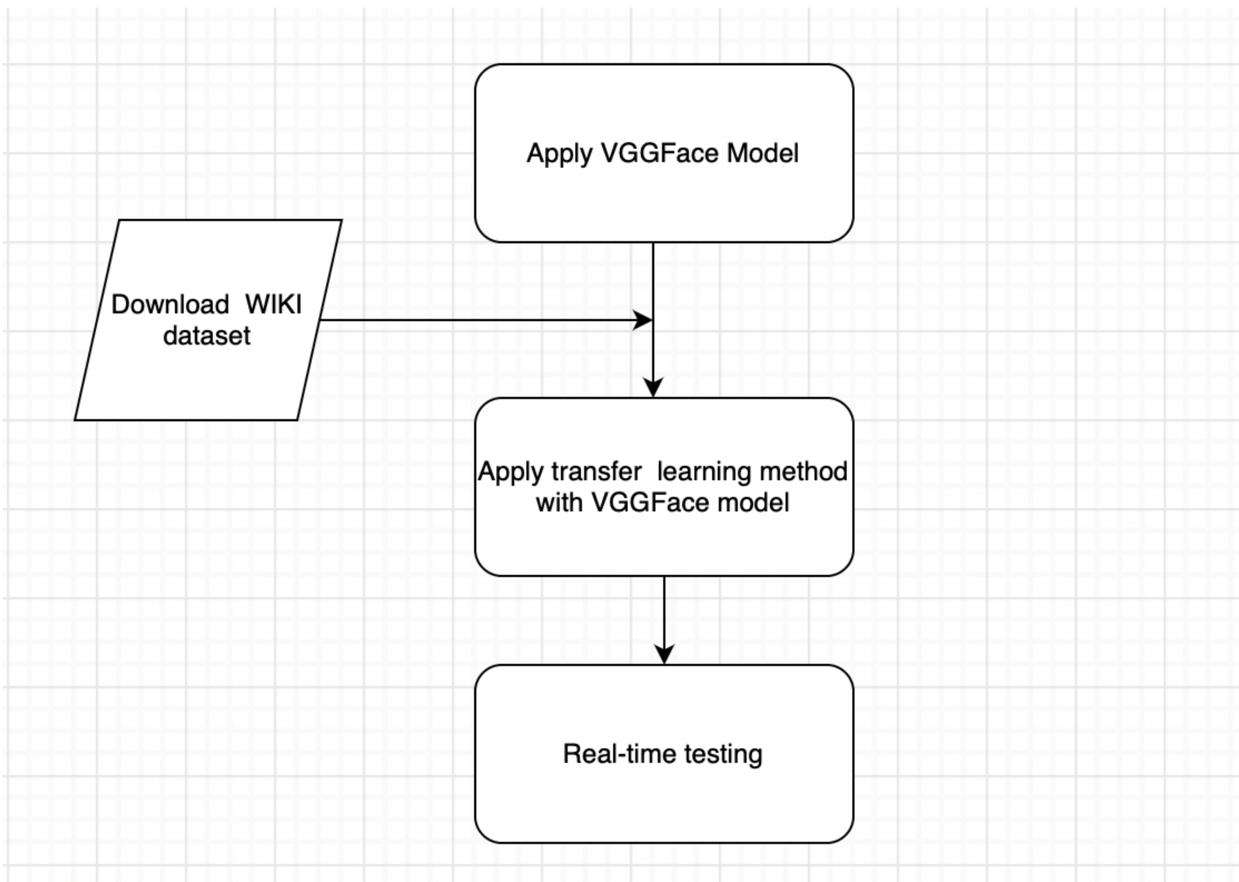

Figure 7: the flowchart of objective

3.1 The constraints of the experiment:

3.1.1 Apply VGGFace Model

VGGFace model is announced in 2015 in “Deep Face Recognition” by Omkar Parkhi and his partner. VGGFace contains 2.6 mill.VGGFace is used as the basis for developing deep CNNs for face recognition tasks such as face verification and identification.

VGG Face model uses architecture with blocks of convolutional layers with small kernels and ReLU activations followed by using max pooling layers and the end of the network contains fully connected layers.

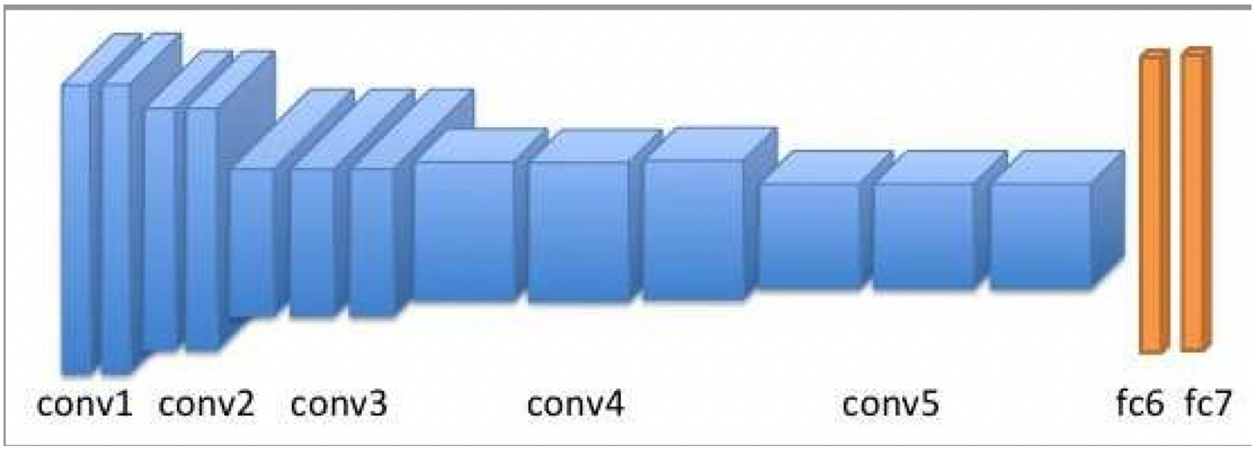

Figure 8: VGGFace Architecture

We will create and load_weights the VGGFace model in Python:

```
model = Sequential()
model.add(ZeroPadding2D((1, 1), input_shape=(224, 224, 3)))
model.add(Convolution2D(64, (3, 3), activation='relu'))
model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D((2, 2), strides=(2, 2)))

model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(128, (3, 3), activation='relu'))
model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(128, (3, 3), activation='relu'))
model.add(MaxPooling2D((2, 2), strides=(2, 2)))

model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(256, (3, 3), activation='relu'))
model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(256, (3, 3), activation='relu'))
model.add(ZeroPadding2D((1, 1)))
```

```
model.add(Convolution2D(256, (3, 3), activation='relu'))
model.add(MaxPooling2D((2, 2), strides=(2, 2)))

model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(512, (3, 3), activation='relu'))
model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(512, (3, 3), activation='relu'))
model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(512, (3, 3), activation='relu'))
model.add(MaxPooling2D((2, 2), strides=(2, 2)))

model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(512, (3, 3), activation='relu'))
model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(512, (3, 3), activation='relu'))
model.add(ZeroPadding2D((1, 1)))
model.add(Convolution2D(512, (3, 3), activation='relu'))
model.add(MaxPooling2D((2, 2), strides=(2, 2)))

model.add(Convolution2D(4096, (7, 7), activation='relu'))
model.add(Dropout(0.5))
model.add(Convolution2D(4096, (1, 1), activation='relu'))
model.add(Dropout(0.5))
model.add(Convolution2D(2622, (1, 1)))
model.add(Flatten())
model.add(Activation('softmax'))

model.load_weights('models/vgg_face_weights.h5')
```

Figure 9: Create and load VGGFace model

3.2 The WIKI dataset

Our dataset is a collection of more than 6000 informations of people such as data of birth, photo_take, full_path, gender, name, face_location, face_score, second_face_score. In this project, we are only concern with face_score, date of birth and photo_take.

3.3 Apply datenum to date year by using datenum_to_datetime to calculate age

In WIKI dataset, the data we used to calculate age include: photo_take (exactly the day he/she take this photo), dob(date of birth), face_score.

Firstly, we need to convert dob to a year of birth, then the age is calculated by photo_take minus year of birth.

```python
# Chuyen truong DOB thanh nam sinh
df['date_of_birth'] = df['dob'].apply(datenum_to_datetime)

# Tinh tuoi cho tung face
df['age'] = df['photo_taken'] - df['date_of_birth']
```

Figure 10: datenum_to_datetime algorithm.

Secondly, we need to preprocessing data by doing some step such as : remove some images not include face images, remove images which has more than two face images, remove some information not need in our project(gender, name, face_location,……)

```python
df = df[df['face_score'] != -np.inf]
df = df[df['second_face_score'].isna()]
df = df[df['face_score'] >= 3]
df = df.drop(columns = ['name','face_score','second_face_score','date_of_birth','face_location'])
df = df[df['age'] <= 100]
df = df[df['age'] > 0]
```

Figure 11: Preprocessing data

3.4 Apply Transfer Learning method with VGGFace model

During the model building process, we encountered a situation where our model did not predict accurately. Although it has adopted complex architectures and is considered state-of-art

Firstly, we check with basic errors like:

- **Small data** is not representative: Our dataset is too small in size. Therefore, the trained model does not learn general features to apply to classification tasks.
- **Data imbalance model:** When the model is out of data, it is more difficult to predict minority samples.
- **Model architecture is too complex:** For large datasets up to several million images, a model with a complex architecture can bring high accuracy. But with

small data sets, the complex model reduces accuracy. I think the main reason is because complex models often overfitting.

- **The optimization process is difficult:** Maybe you have not set the learning rate well, so the training model takes a long time to converge or has not reached the global optimal point. You can then consider changing the method of updating gradient descent and setting the schedule learning rate. On tensorflow.keras we can set up schedule learning through CheckPoint as follows:

```
check_point = ModelCheckpoint(
    filepath='models/classification_age_model.hdf5'
    , monitor="val_loss"
    , verbose=1
    , save_best_only=True
    , mode='auto'
)
```

Figure 12: checkpoint on tensorflow.keras

Here we load weights images of VGGFace and apply transfer learning for training model again.

```
model.load_weights('models/vgg_face_weights.h5')

# Dong bang cac layer ko can train
for layer in model.layers[:-7]:
    layer.trainable = False

base_model_output = Sequential()
base_model_output = Convolution2D(classes, (1, 1), name='predictions')(model.layers[-4].output)
base_model_output = Flatten()(base_model_output)
base_model_output = Activation('softmax')(base_model_output)

age_model = Model(inputs=model.input, outputs=base_model_output)

#sgd = keras.optimizers.SGD(lr=1e-3, decay=1e-6, momentum=0.9, nesterov=True)

age_model.compile(loss='categorical_crossentropy'
                  , optimizer=keras.optimizers.Adam()
                  # , optimizer = sgd
                  , metrics=['accuracy']
                  )

return age_model
```

Figure 13: Transfer learning with VGGFace

Then the data will be trained on the training dataset and testing on the validation set. Some of the more rigorous model development processes even further divide the dev set to fine tune the parameters between the models and the test set to test the model on actual user-generated data sets. However, to simplify, we will only use the train/validation set.

Finally, we will retrain the model. The first thing to do is to initialize the base network for the model. The essence of transfer learning is to freeze the existing layers of the VGGFace model and then train again. Re-train of age recognition model to increase accuracy more than an available model.

CHAPTER IV
PRELIMINARY RESULTS

This is the final result after we are carefully testing multiple times and successfully gave the best results without errors. Through Webcam, the data was read and returned the number of ages correctly based on our faces.

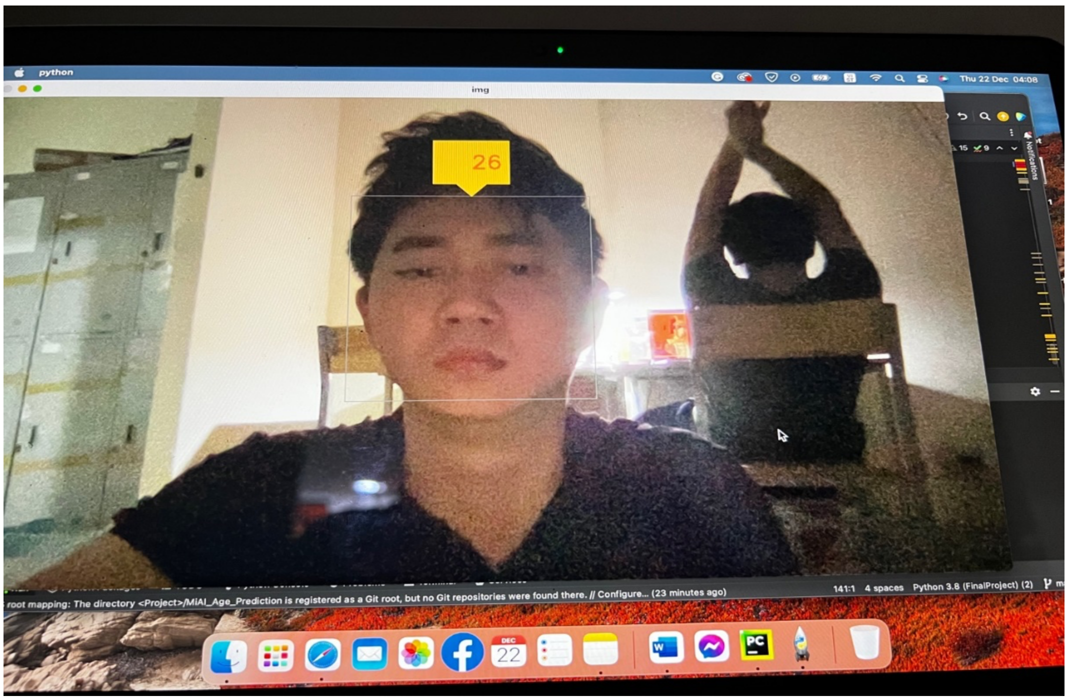

Figure 14: Testing Result

CHAPTER V
CONCLUSION AND FUTURE WORK

5.1 Conclusion

In this chapter, we completely perform this project with several achievements

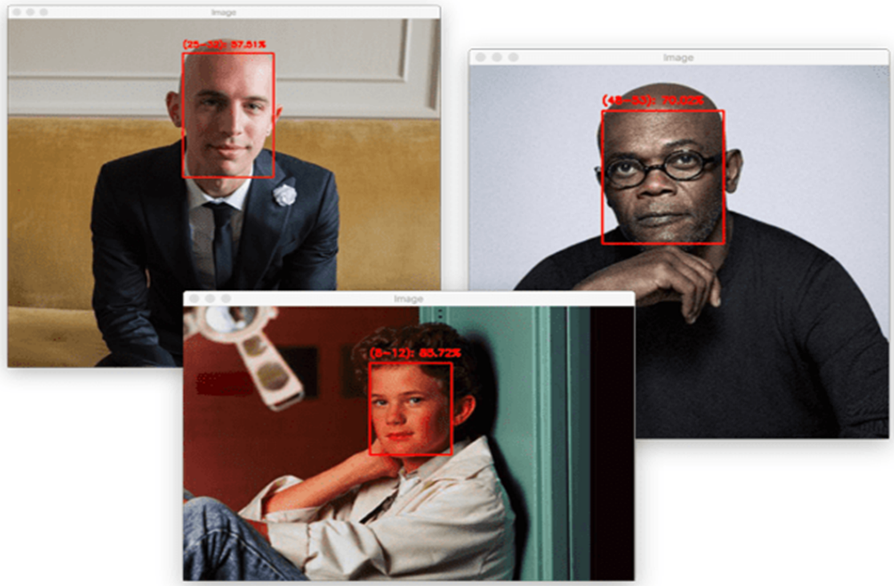

Figure 15: More Improvements in the Future

- Successfully building the Age Detector Model.
- Face age detection is becoming increasingly important in our increasingly digital world.
- Provides an overview of the different face and age detection methods and their benefits and limitations.
- This Detection would be extremely useful in industries.

5.2 Future Work

However, there are some difficult issues we need to study more and advanced improvements can be done in the future:

- Detecting faces and estimating age is a difficult task.
- Many challenges need to be considered when trying to achieve accurate results.
- Many environmental factors can affect the results, such as lighting conditions and the angle of the face.
- Another challenge is that people's ages can vary significantly, so it is essential to have a system that can estimate age accurately within a specific range.

REFERENCES

[1]	https://tiensu.github.io/blog/53_face_recognition_vggface/?fbclid=IwAR2D53zOW7LevCOhB2xzbRuJZb_61u-KZ6xSGWprGCNl1F3AV-0VmDCLpic
[2]	https://ora.ox.ac.uk/objects/uuid:a5f2e93f-2768-45bb-8508-74747f85cad1
[3]	https://ieeexplore.ieee.org/document/9377041
[4]	https://arxiv.org/abs/1709.01664
[5]	https://ieeexplore.ieee.org/abstract/document/8621891/
[6]	https://www.miai.vn/2019/10/08/xay-dung-model-doan-tuoi-qua-khuon-mat-age-prediction-model/