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Face recognition access control system based on ResNet Model

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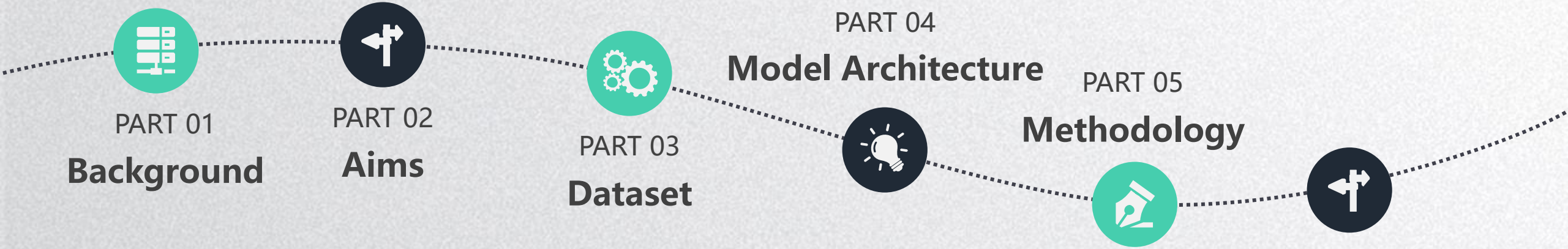
Contents



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01 Background

Facial recognition technology is increasingly vital in applications such as security access controls and payment verification, offering a non-intrusive and efficient method for identity verification. This technology surpasses traditional methods by using biometric data, thereby enhancing security without the inconvenience associated with physical tokens like ID cards or keys.

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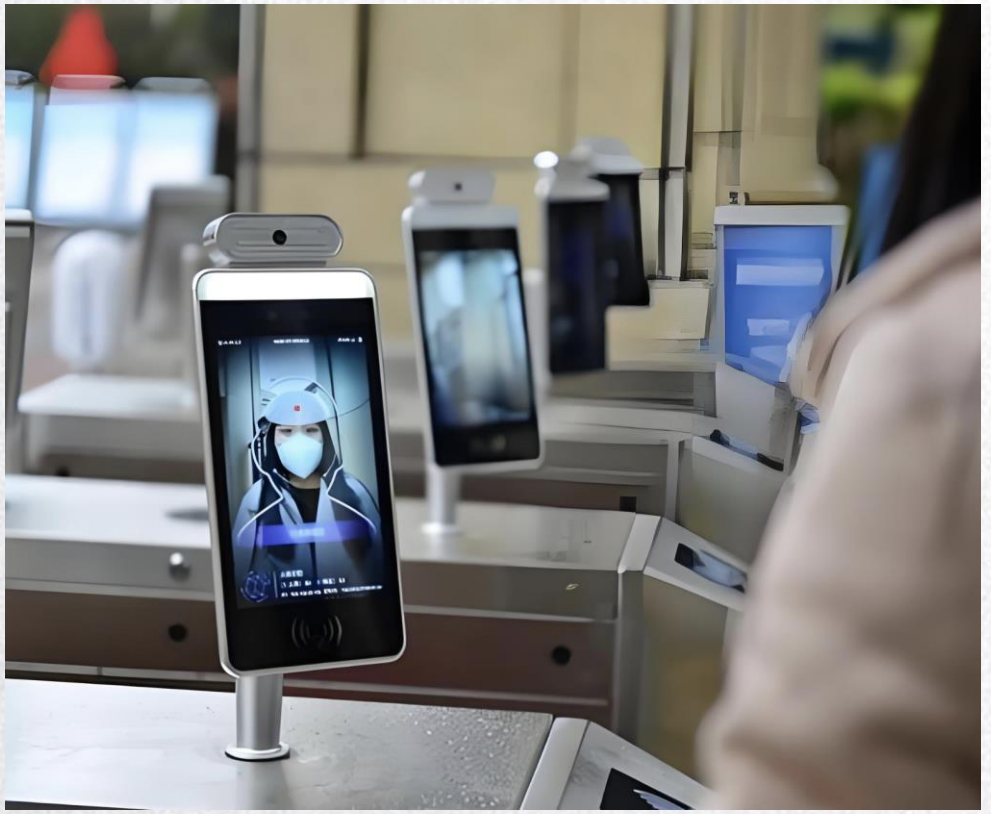
02 Aims

The aim of the project is to train a ResNet model to recognize different faces. Finally, the trained model is applied to the design of access control system.



Audience:

- Businesses and Organizations
- Residential Communities
- Schools and Educational Institutions

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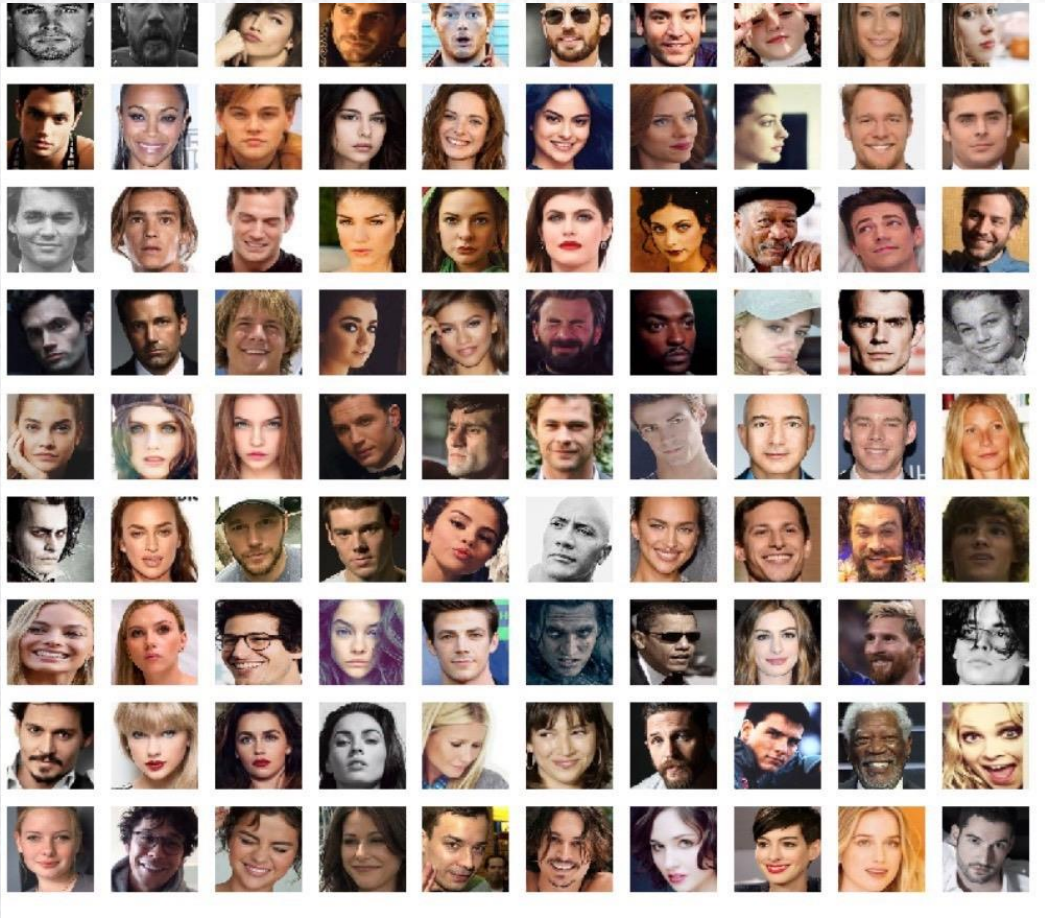
03 Dataset

The dataset is download from Kaggle website. This images has been collected from Pinterest and cropped.



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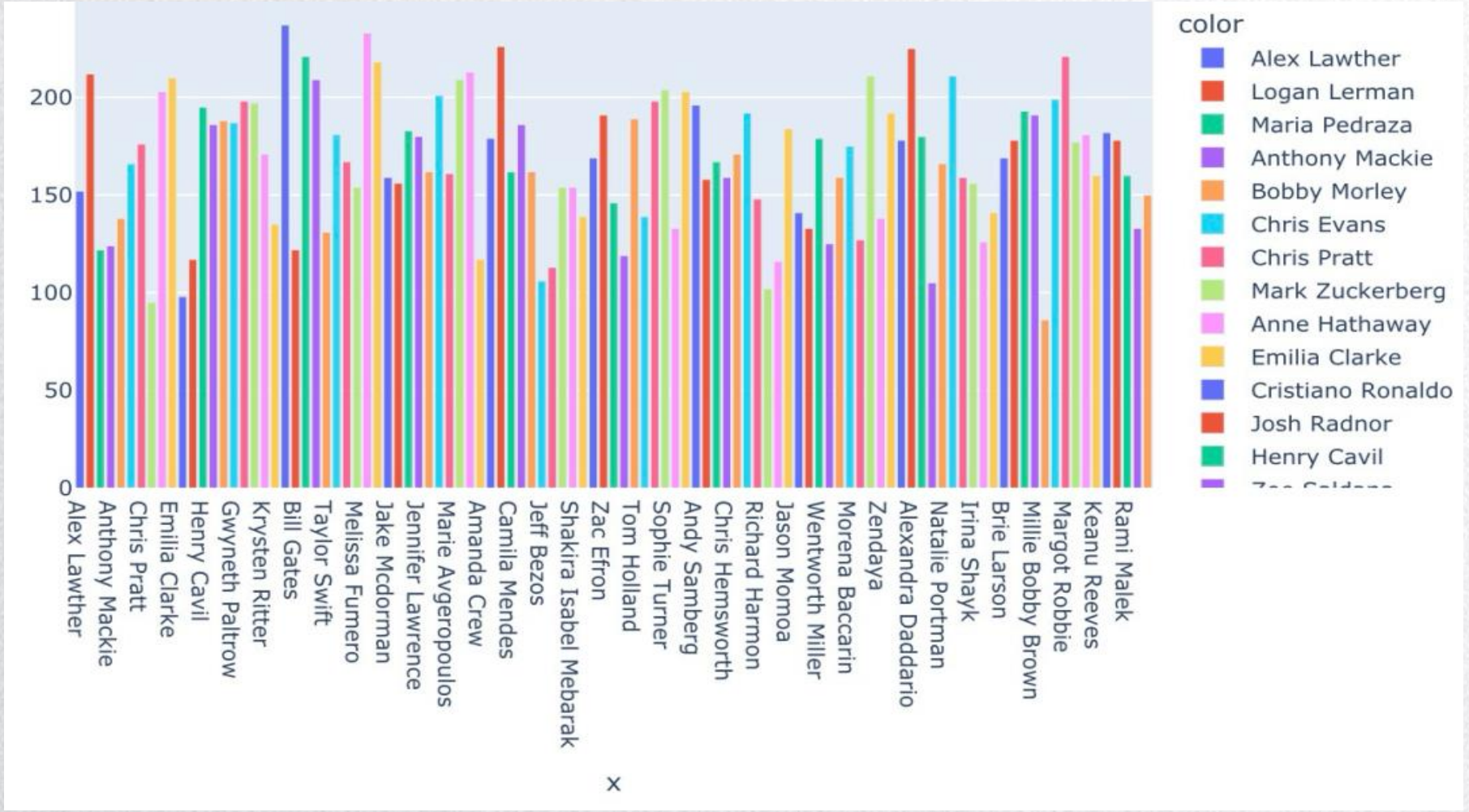
03 Dataset



There are 105 celebrities and 17534 faces.

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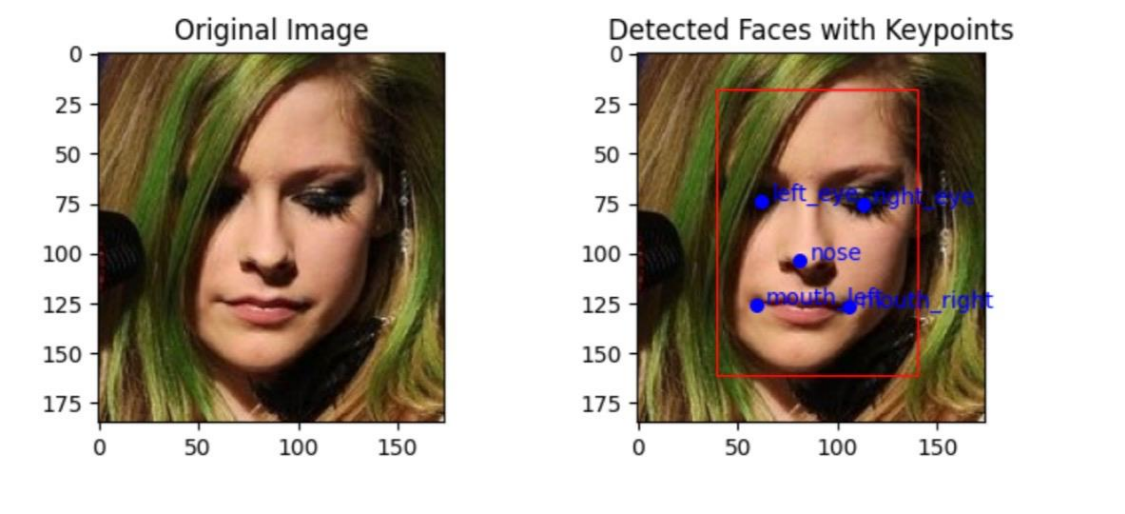
Dataset Processing

Step 1: Use MTCNN to find five marks on a face

Step 2: Calculate the Angle of the face offset by the obtained point

Left eye: (x_{left}, y_{left}) Right eye:(x_{rignt} , y_{right})

$$\Delta_x = x_{right} - x_{left}$$
$$\Delta_y = y_{right} - y_{left}$$
$$angle = arctan(\frac{\Delta_x}{\Delta_y})$$



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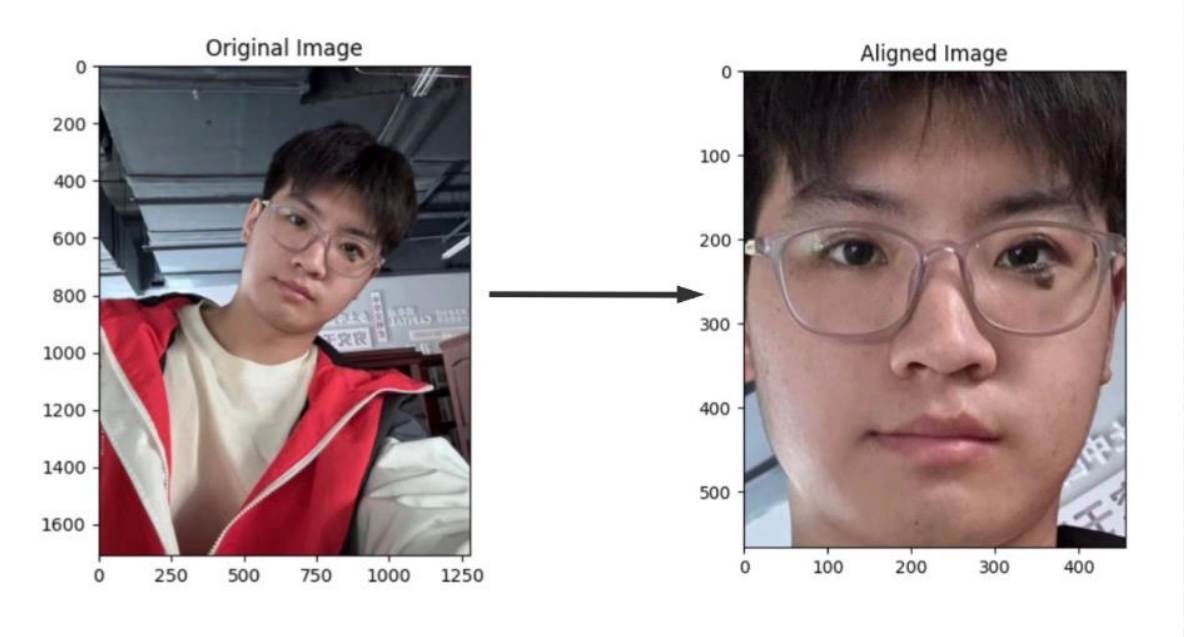
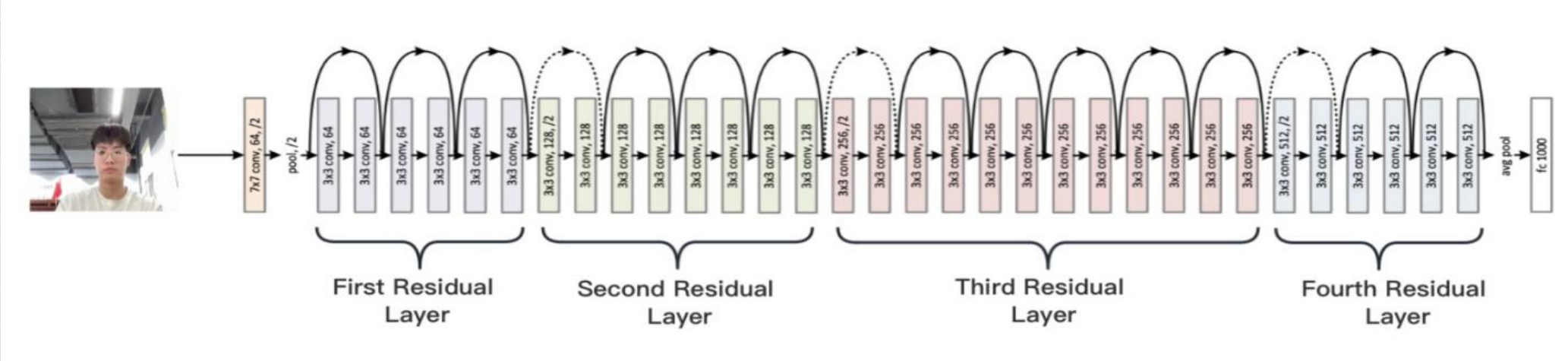
Dataset Processing

Step 3: Rotate the face through the previously calculated Angle.

Step 4: Crop the aligned face



04 Model Architecture



ResNet-34 consists of multiple stacked “residual blocks” designed to learn residual functions with reference to the layer inputs. Each block includes convolutional layers followed by batch normalization and ReLU activation functions. Shortcut connections help in propagating gradients effectively throughout the network depth, enabling the training of much deeper models than was previously feasible.

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05 Methodology

Software	Framework	PyTorch, Flask
	Language	Python, HTML, CSS, JavaScript
	Libraries	Numpy, Pandas, OpenCV, Scipy, Scikit learn
	Version management plan	Git repository
	Online server	Kaggle: T4 x 2 (GPU)
Hardware	Central processing unit (CPU)	Intel(R) Core(TM) i5-9300H CPU @ 2.40GHz 2.40 GHz
	Graphic Processing Unit (GPU)	Intel(R) UHD Graphics 630

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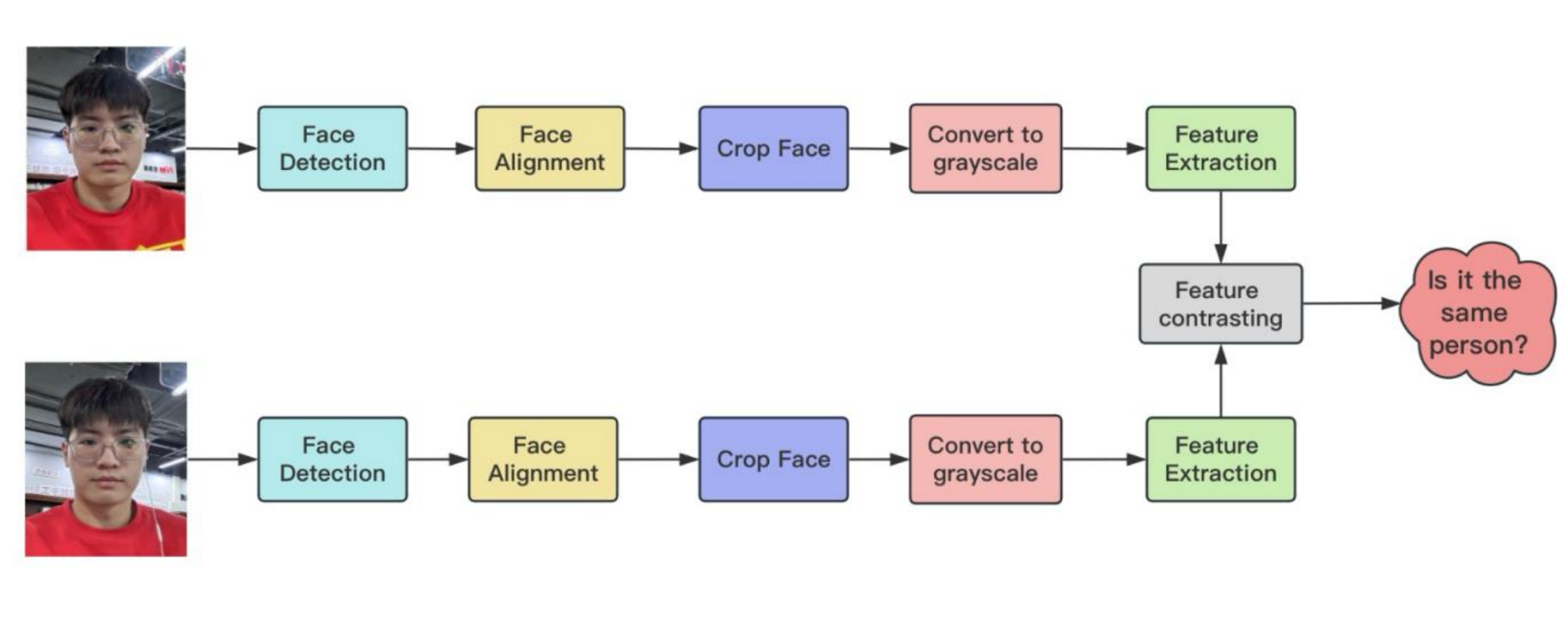
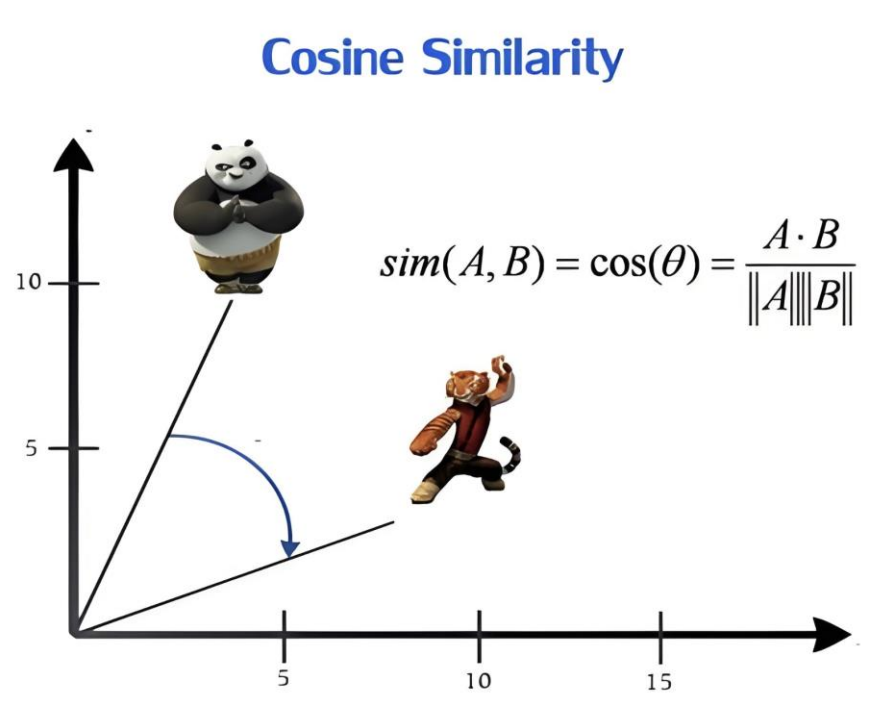
Face recognition process



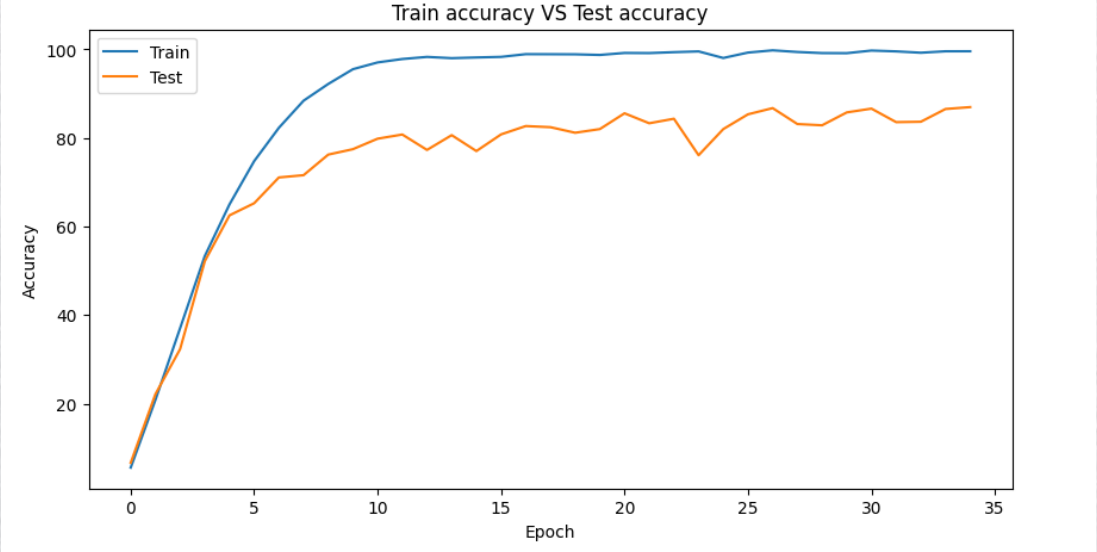
Cosine Similarity

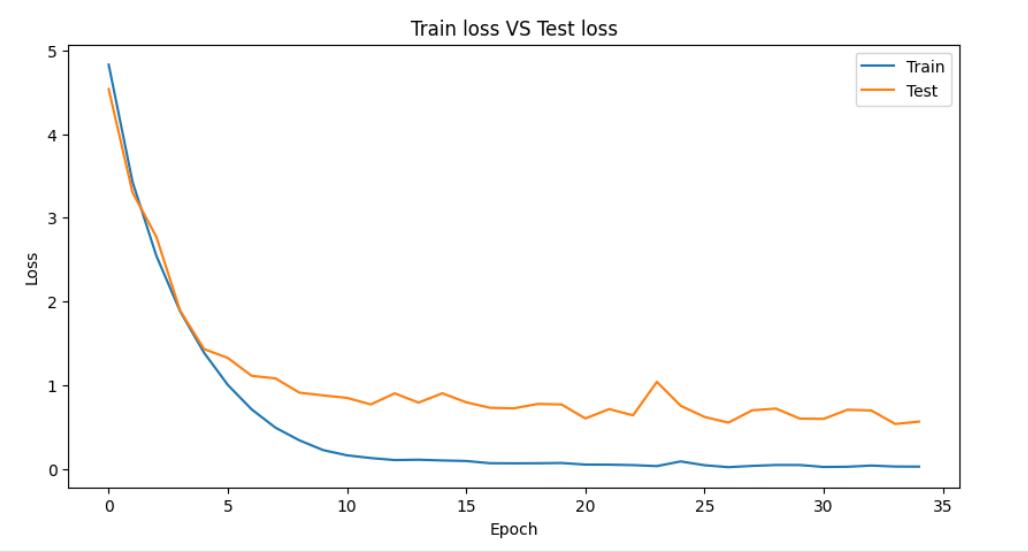
Cosine similarity is a mathematical measure that measures how similar two vectors are in multidimensional Spaces, especially in higher-dimensional Spaces, by calculating the cosine value of the Angle between them. It is widely used in text processing, recommendation system, face recognition and other fields to measure the similarity of two vectors in direction.



$$Similarity = cos(\theta) = \frac{A \cdot B}{|A| * |B|}$$

06 Results





As can be seen from the figures, the accuracy rise rapidly, and the loss value of the model decreases rapidly, leveling off after ten epochs, which is typical of deep learning. This shows that the model is learning and improving its predictions for the training set over time. It is common for training to perform relatively better than testing because the model learns directly from the training set.

06 Results

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```
Epoch 26/30, Train Loss: 0.08911391997875344, Train Accuracy: 97.91830042061738%, Train precision: 0.97964230708211
5, Train recall: 0.9793345353000751, Train F1:0.979449422050078
Eopch 26/30, Test Loss: 0.8554784113710577, Test Accuracy: 77.44510978043913%, Test precision: 0.8055088680632398,
Test recall: 0.7769427012226786, Test F1: 0.7782019919714891
Epoch 27/30, Train Loss: 0.029595432267365194, Train Accuracy: 99.68631924146 29%, Train precision: 0.99676655871954
6, Train recall: 0.9967406185354474, Train F1:0.9967425852816235
Eopch 27/30, Test Loss: 0.5611213287846608, Test Accuracy: 85.42914171656687%, Test precision: 0.860638935725659, T
est recall: 0.8540934393915646, Test F1: 0.8530314068931307
Epoch 28/30, Train Loss: 0.020448980325512622, Train Accuracy: 99.72909389035432%, Train precision: 0.9972990177355
477, Train recall: 0.997290318997154, Train F1:0.9972881022814489
Eopch 28/30, Test Loss: 0.6923005735332316, Test Accuracy: 82.40661534074708%, Test precision: 0.83909261327912, Te
st recall: 0.8254364528523429, Test F1: 0.8248910949902882
Epoch 29/30, Train Loss: 0.07705795103874999, Train Accuracy: 98.48149996435446%, Train precision: 0.98499837419580
32, Train recall: 0.9848768604782303, Train F1:0.9849016301358702
Eopch 29/30, Test Loss: 0.9385770166462118, Test Accuracy: 75.990875392073%, Test precision: 0.7992295327900454, Te
st recall: 0.7652940393751266, Test F1: 0.7636661397816901
Epoch 30/30, Train Loss: 0.03760715764798733, Train Accuracy: 99.44392956441149%, Train precision: 0.99458149166098
67, Train recall: 0.9945992205686334, Train F1:0.9945784513313339
Eopch 30/30, Test Loss: 0.5291132940148765, Test Accuracy: 86.22754491017965%, Test precision: 0.8698476987750832,
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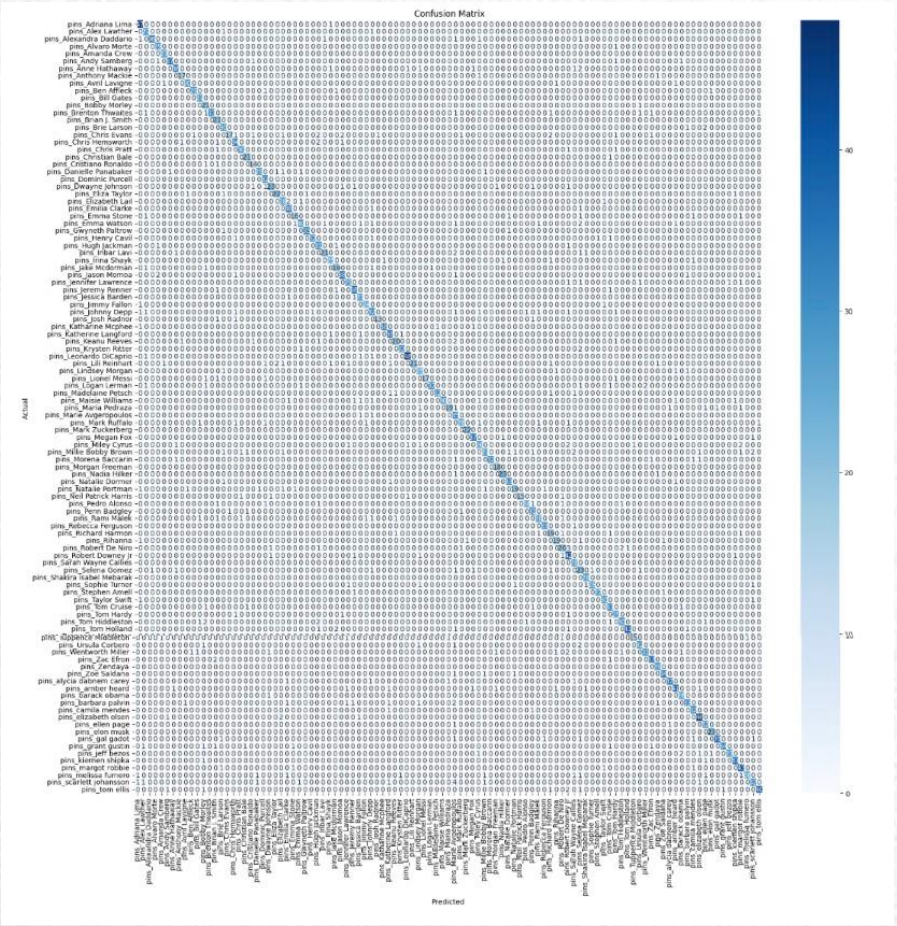

Epoch 30/30, Train Loss: 0.03760715764798733, Train Accuracy: 99.44392956441149%, Train precision: 0.99458149166098
67, Train recall: 0.9945992205686334, Train F1:0.9945784513313339
Eopch 30/30, Test Loss: 0.5291132940148765, Test Accuracy: 86.22754491017965%, Test precision: 0.8698476987750832,
Test recall: 0.8628944487634488, Test F1: 0.8619164558298757

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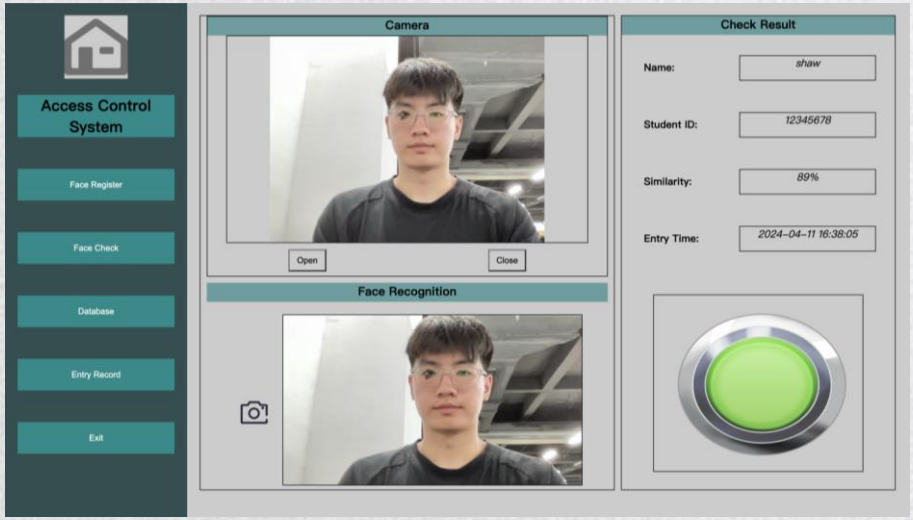
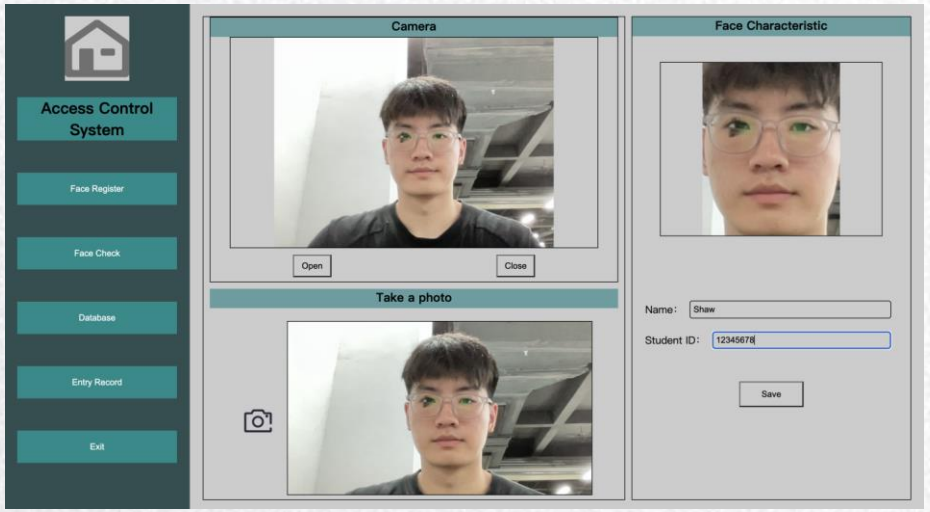
06 Results

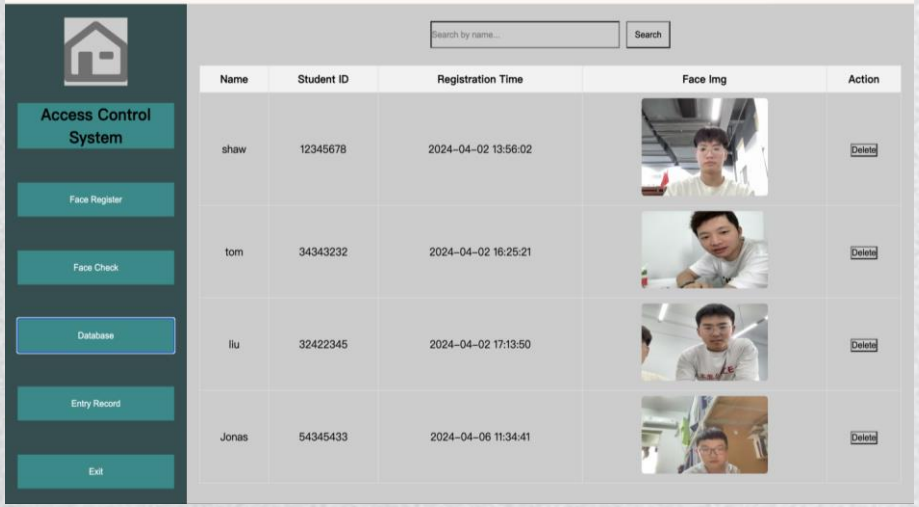
- Result Comparation

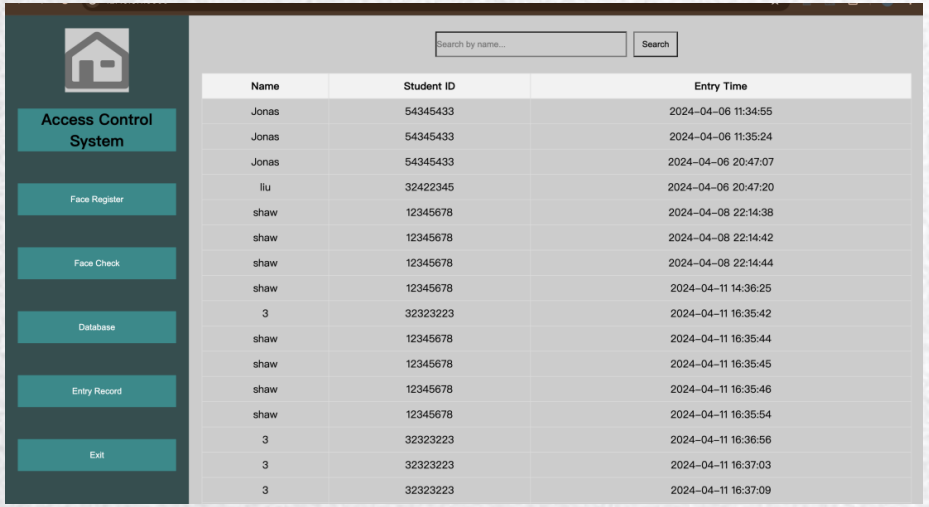
Model	Learning rate	Epochs	Optimizor	Accuracy
ResNet-34	0.001	35	Adam	0.869
ResNet-34	0.001	25	Adam	0.823
ResNet-50	0.001	35	Adam	0.862
ResNet-50	0.0005	60	Adam	0.865
ResNet-34	0.0005	60	Adam	0.858

06 Results


Access Control System
Face Register
Face Check
Database
Entry Record
Exit
Camera
Open
Close
Face Recognition
Check Result
Name:
shaw
Student ID:
12345678
Similarity:
89%
Entry Time:
2024-04-11 16:38:05


Access Control System
Face Register
Face Check
Database
Entry Record
Exit
Camera
Open
Close
Take a photo
Face Characteristic
Name:
Shaw
Student ID:
12345678
Save


Access Control System
Face Register
Face Check
Database
Entry Record
Exit
Search by name...
Search
Name
Student ID
Registration Time
Face Img
Action
shaw
12345678
2024-04-02 13:56:02
Delete
tom
34343232
2024-04-02 16:25:21
Delete
liu
32422345
2024-04-02 17:13:50
Delete
Jonas
54345433
2024-04-06 11:34:41
Delete


Access Control System
Face Register
Face Check
Database
Entry Record
Exit
Search by name...
Search
Name
Student ID
Entry Time
Jonas 54345433 2024-04-06 11:34:55
Jonas 54345433 2024-04-06 11:35:24
Jonas 54345433 2024-04-06 20:47:07
liu 32422345 2024-04-06 20:47:20
shaw 12345678 2024-04-08 22:14:38
shaw 12345678 2024-04-08 22:14:42
shaw 12345678 2024-04-08 22:14:44
shaw 12345678 2024-04-11 14:36:25
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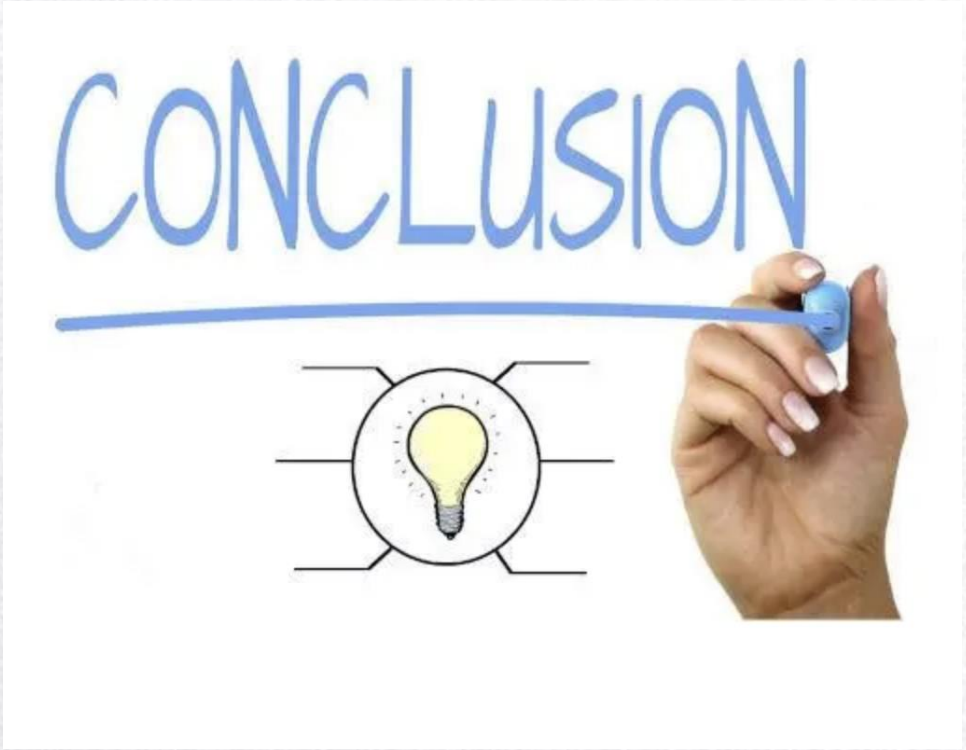
shaw 12345678 2024-04-11 16:35:46
shaw 12345678 2024-04-11 16:35:54
3 32323223 2024-04-11 16:36:56
3 32323223 2024-04-11 16:37:03
3 32323223 2024-04-11 16:37:09

Reflection and conclustion

This project marks a significant step towards integrating advanced machine learning technologies into practical applications, setting a foundation for future innovations in security and access control systems. The results not only reflect the effectiveness of the implemented models but also open avenues for broader applications and improvements.



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Thank you for listening