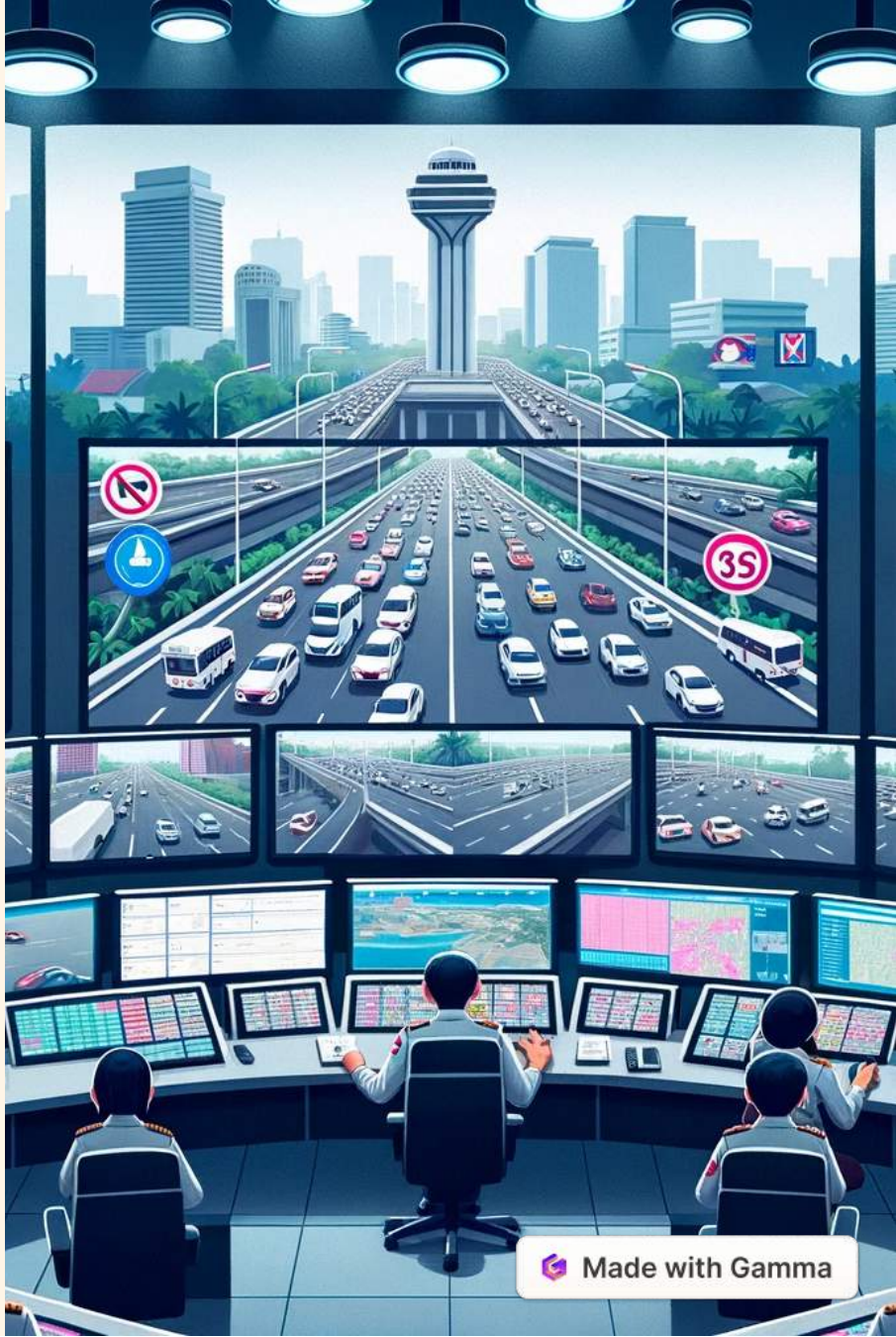
Smart Surveillance: Cambodia's Journey to AI-Powered Public Safety

Cambodia's transportation and public conundrums are about to be solved with the implementation of ANPR technology, revolutionizing management and safety.

by Songhieng Van



Problem Statement: Navigating Cambodia's Public Security

The existing security infrastructure in many urban areas, including Cambodia, lacks the integration of advanced technologies like Automatic Number Plate Recognition (ANPR) and real-time facial recognition. This limitation results in delayed response times, potential breaches in security, and inefficient use of resources. Additionally, the absence of sophisticated anti-spoofing measures in facial recognition systems poses a risk of deception and false identification, undermining the overall effectiveness of security measures.

Features and Functionalities

Core Features:

Automatic Number Plate Recognition (ANPR): Utilizing PyTorch and YOLOv8 along with Easy OCR, the system can identify and record vehicle number plates automatically. This feature is crucial for traffic management, law enforcement, and access control in sensitive areas.

Real-Time Face Detection and Recognition: With TensorFlow, FaceNet, and MMCN, the system can detect and recognize faces in real-time. This feature is vital for identifying known and unknown individuals, potentially aiding in security and criminal investigations.

Anti-Spoofing for Enhanced Authentication: The integration of anti-spoofing measures improves the reliability of face recognition, ensuring that the system is not easily fooled by photographs or masks, thus enhancing security.

Real-Time Alerts and Monitoring: The system can send real-time alerts to the concerned authorities or individuals via a React JS-based web interface when it detects unknown faces or vehicles. This feature ensures immediate response to potential security threats.

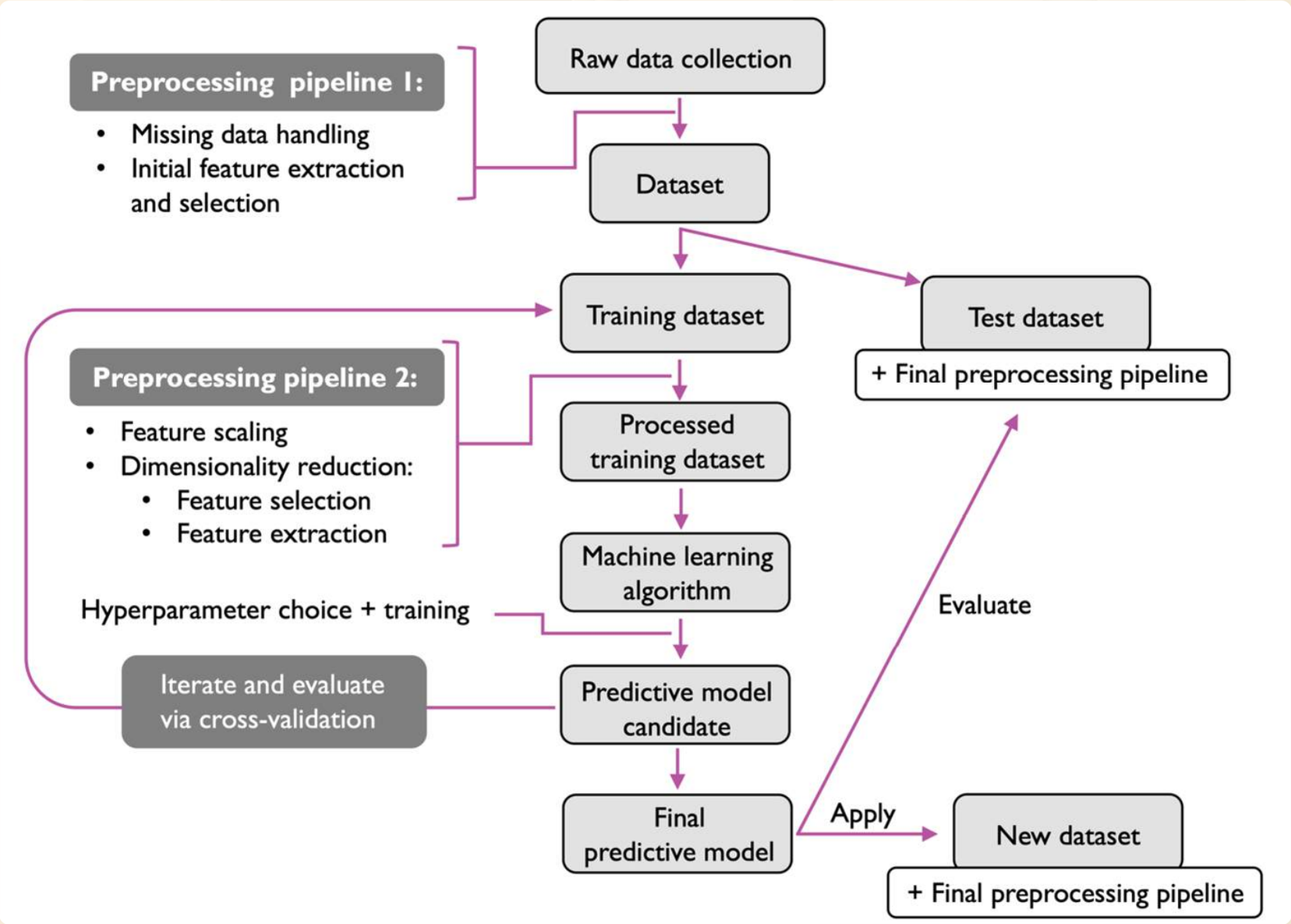
The COCO (Common Objects in Context) dataset is a large-scale dataset for object detection, segmentation, and captioning. COCO dataset is known for its diversity and the presence of multiple objects per image, which is closer to real-world scenarios than datasets with only one object per image. It includes 80 object categories with annotations for more than 1.5 million object instances in over 200,000 images.

Technology Overview

Components:

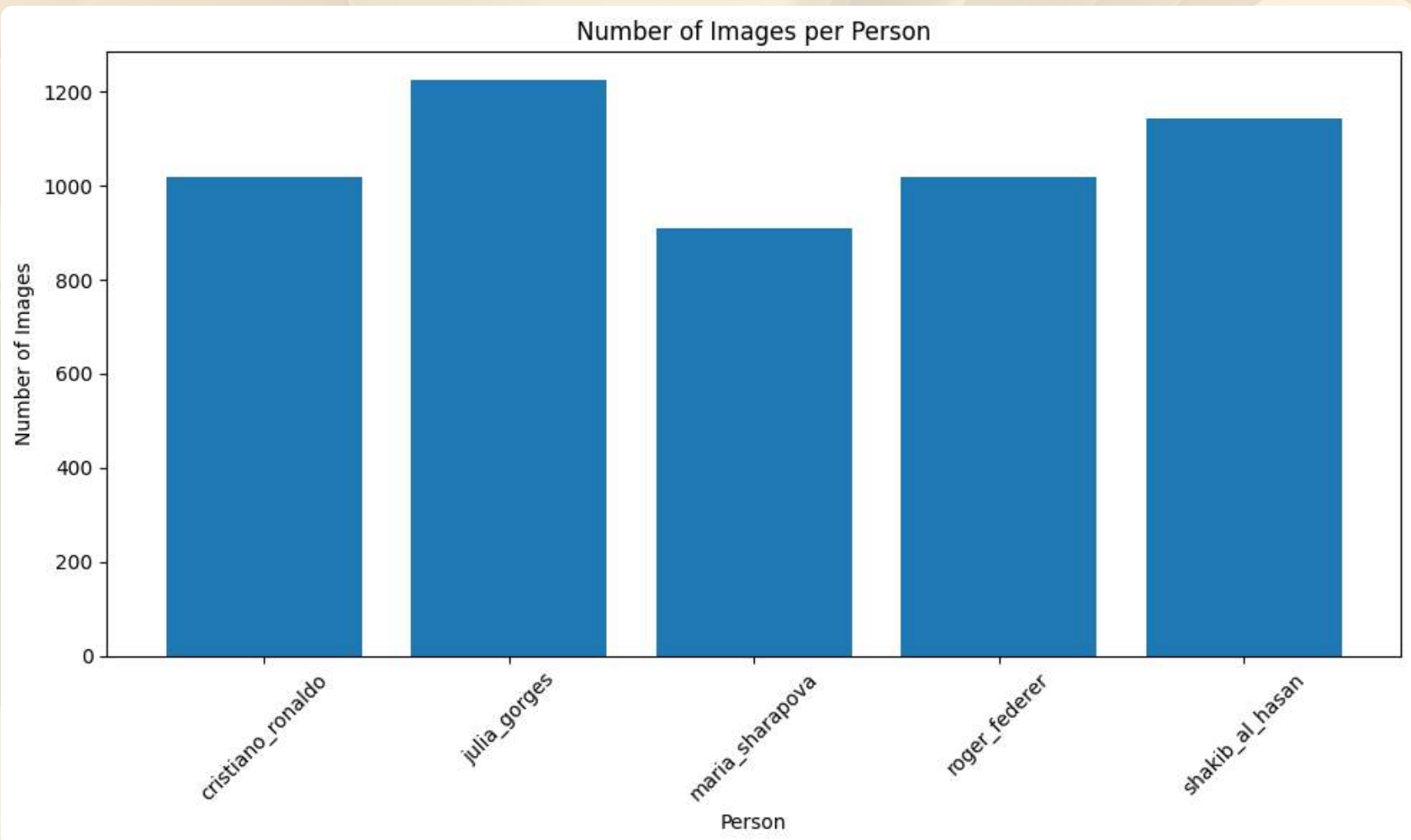
- **YOLO**: Our system utilizes YOLO (You Only Look Once) technology for fast and accurate object detection.
- **FaceNet**: We employ FaceNet, a facial recognition technology, to identify individuals and enhance security.
- **Firebase**: Our system integrates with Firebase, a powerful backend platform, to store and process data securely.
- **React**: The user interface of our system is built using React, a popular JavaScript library for building responsive web applications.

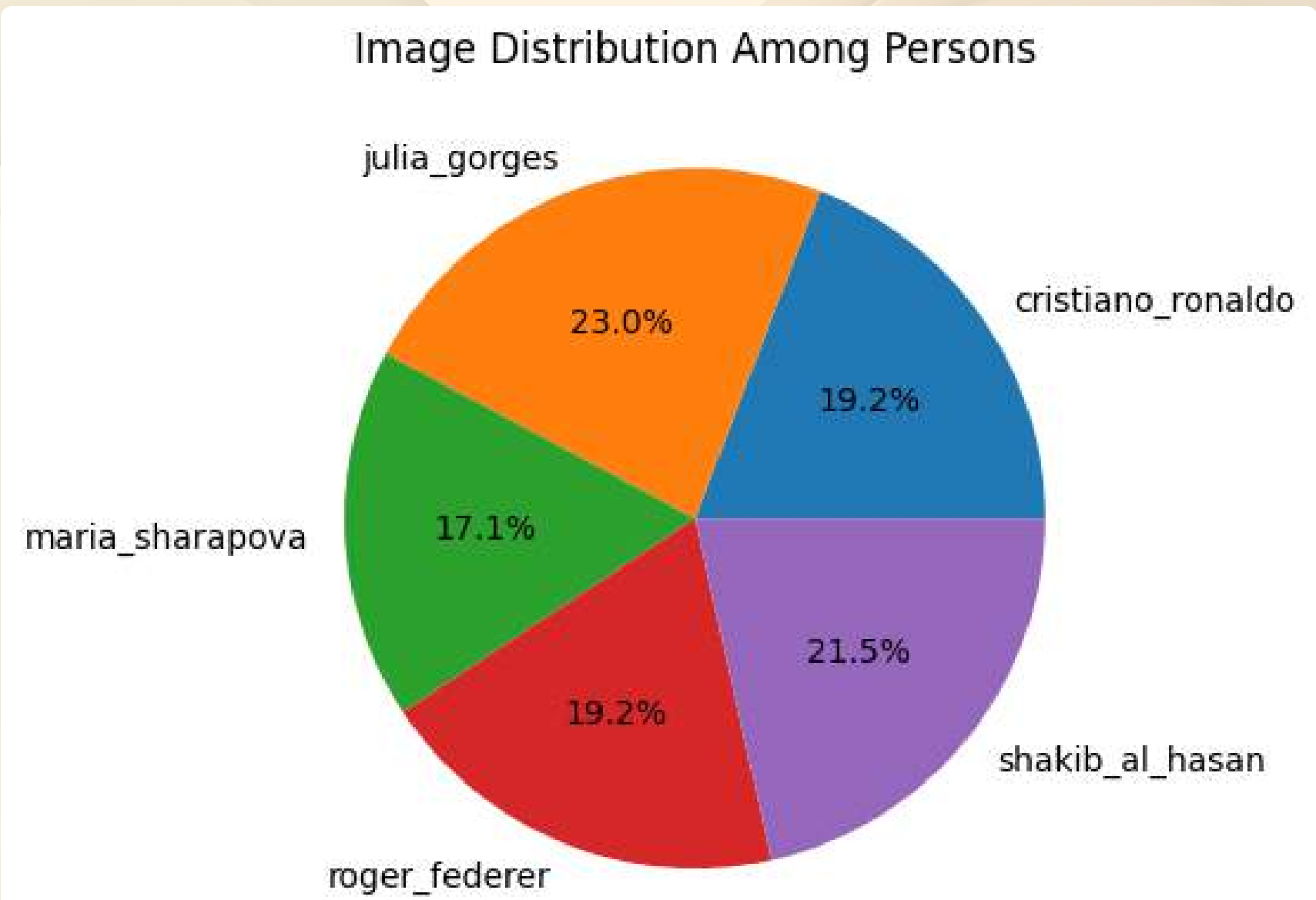
Artificial Intelligence



Dataset

Use the dataset represented in your bar chart to create a comprehensive gallery of images per individual.





Training Dataset

- Preprocess the images by resizing them to a uniform size (160x160 pixels as per your specifications) to ensure consistency when inputing into the neural network.

Cristiano Ronaldo

Julia Gorges

Maria Sharapova

Roger Federer

Shakib Al Hasan

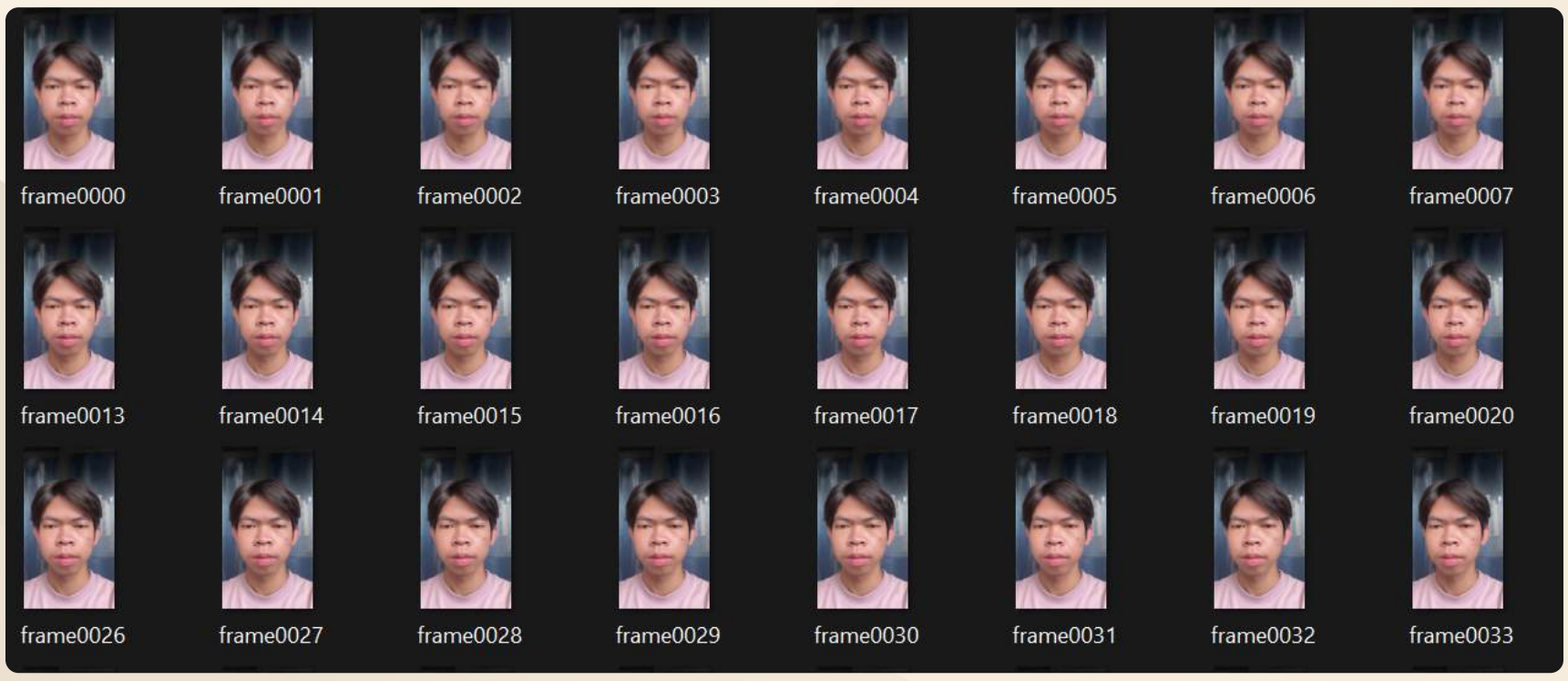
Processed Training Dataset

Drawing inspiration from **Apple's Face ID technology**.

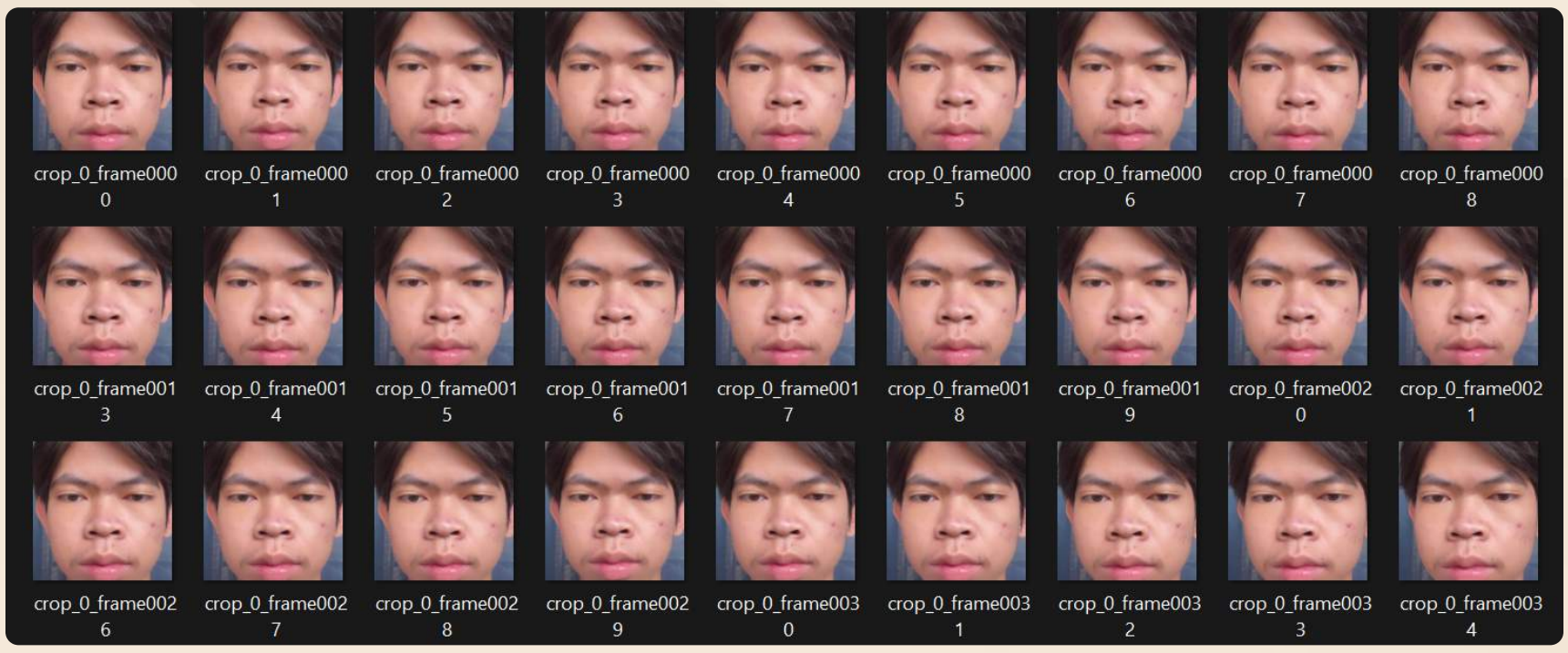
Google Docs

IMG1.mp4

We aim to construct a comprehensive dataset by devising a Python script capable of converting a video into a sequence of still images. From an **14-second video**, we anticipate the generation of approximately **448 individual image datasets.**



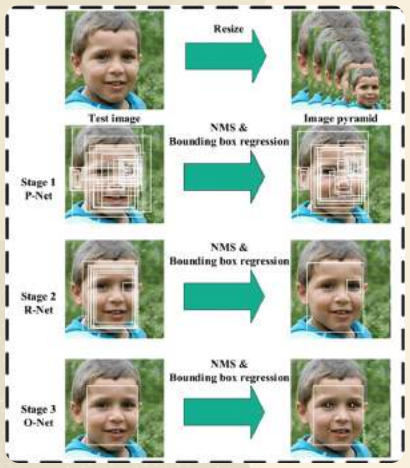
Subsequently, a second Python script will be utilized, employing the MTCNN algorithm to accurately detect and extract facial regions. This process involves resizing the original images from a resolution of **780x1280 pixels** to a more manageable size of **160x160 pixels.**



Further augmentation techniques will be applied to these images to enhance the dataset's diversity, simulating different **lighting conditions and color environments**. This is a strategic measure designed to bolster the **robustness of the dataset against environmental variations**. With these enhancements, the dataset is expected to expand to approximately **1388 images**, offering a rich and varied basis for training facial recognition models.

Machine Learning Algorithm

MTCNN stands for Multi-task Cascaded Convolutional Networks. It's a neural network architecture used for face detection, and it's particularly notable for its ability to detect faces with a wide range of scales and under challenging conditions. The MTCNN framework consists of a cascade of three stages of convolutional networks that predict face and landmark location in a coarse-to-fine manner.




```
[7]  results

...  [{'box': [463, 307, 259, 353],
       'confidence': 0.9999786019325256,
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        'right_eye': (684, 432),
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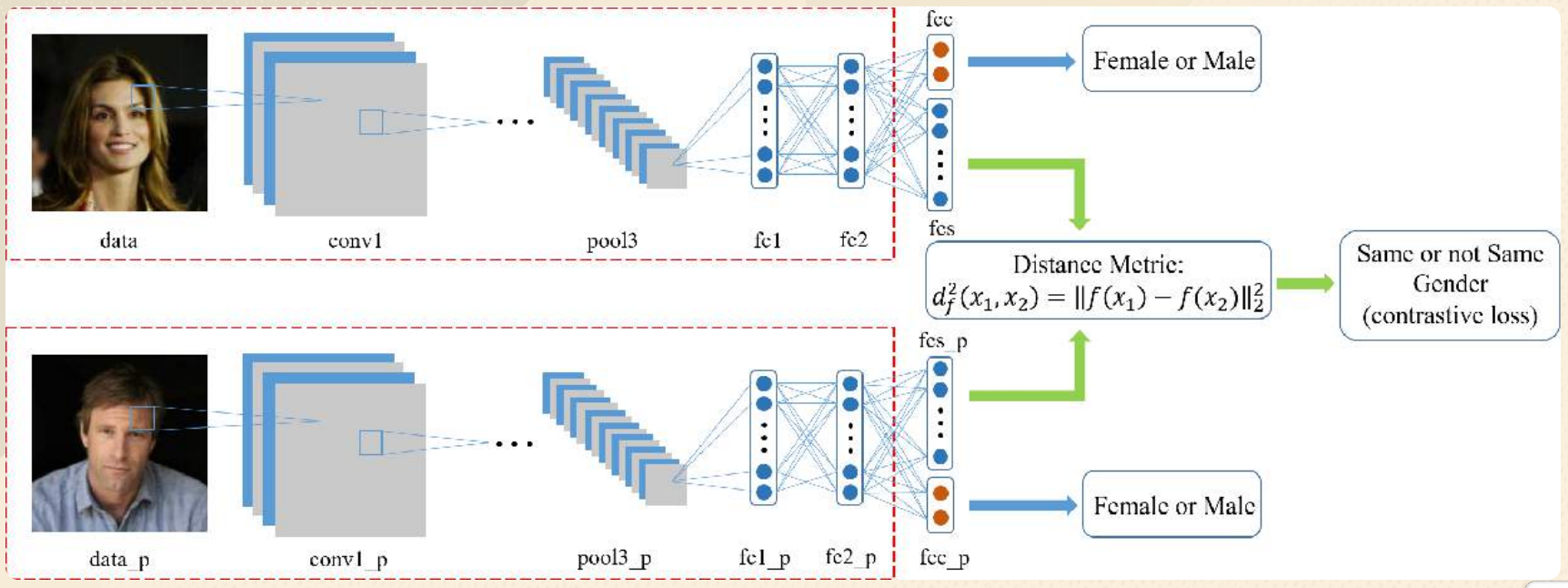
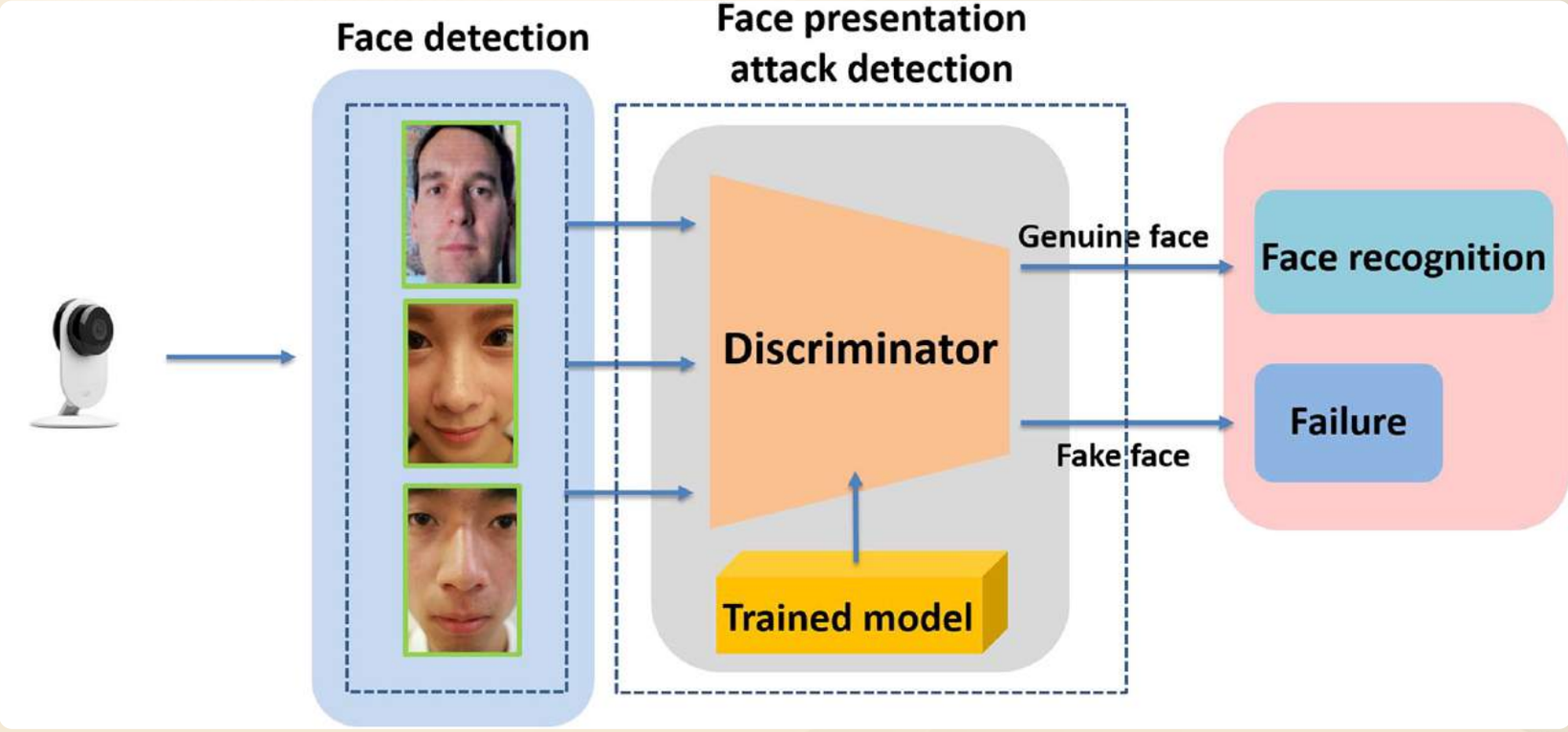
FaceNet is a face recognition system that was developed by researchers at Google and published in a 2015 paper by Florian Schroff, Dmitry Kalenichenko, and James Philbin. It is a neural network architecture that uses a deep convolutional network to learn a mapping from face images to a compact Euclidean space where distances correspond to a measure of face similarity.



Anti-Spoofing

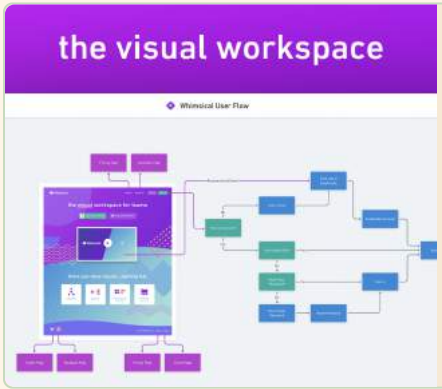
The main purpose of silent face **anti-spoofing** detection technology is to judge whether the face in front of the machine is real or fake. The face presented by other media can be defined as false face, including printed paper photos, display screen of electronic products, silicone mask, 3D human image, etc. At present, the mainstream solutions includes cooperative living detection and non cooperative living detection (silent living detection). Cooperative living detection requires the user to complete the specified action according to the prompt, and then carry out the live verification, while the silent live detection directly performs the live verification.



Workflow:

These technologies work together seamlessly in our system. YOLO enables real-time object detection, allowing us to identify potential threats or unauthorized access. FaceNet then compares detected faces with our database to authenticate individuals. Firebase handles the storage and processing of data, ensuring its security and reliability. Finally, React provides a user-friendly interface for easy navigation and interaction with our security system.

By using simple analogies or visuals, we ensure that even complex technical concepts are accessible to all audience members, making it easier to understand the power and benefits of our advanced security solutions.



Whimsical

The Visual Workspace | Whimsical

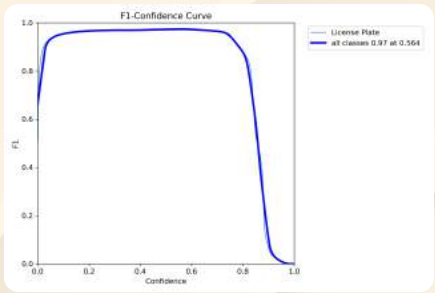
Whimsical combines whiteboards and docs in an all-in-one collaboration hub.

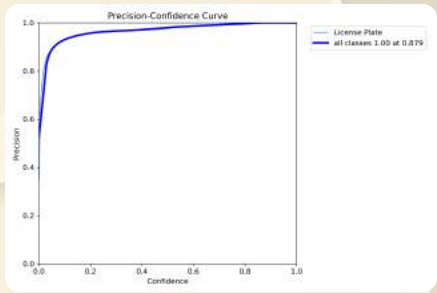
Demo part

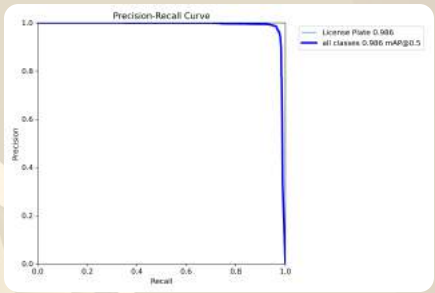
Algorithm Performance Analysis

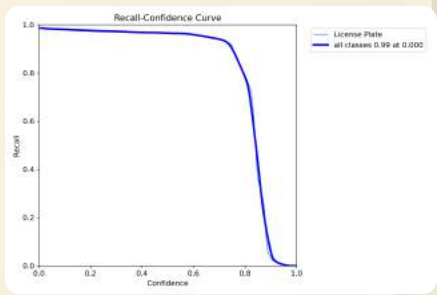
The ANPR algorithm demonstrates excellent performance in terms of accuracy, speed, and high recognition rates, enabling efficient traffic monitoring and enforcement actions.

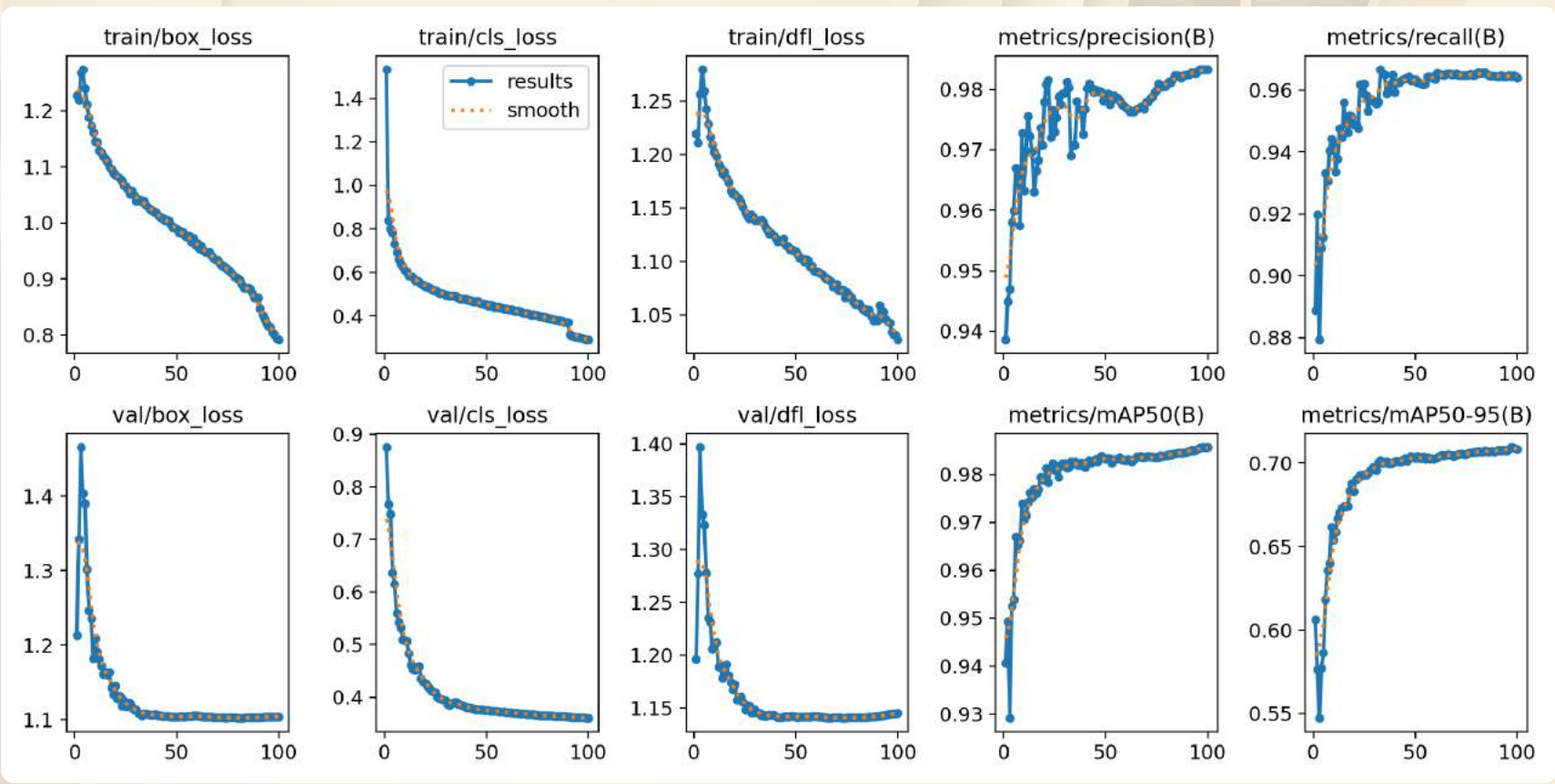
Results Analysis











Final Predictive Model

Google Docs

out1.mp4

State-of-Art ANPR

State-of-Art Face Detection

We have attained a leading-edge capability in facial detection with an accuracy **surpassing 99%**.

The area requiring **enhancement is Anti-Spoofing** detection to ensure the program's resilience across various environmental conditions.

Benefits in Cambodia

Improved Public Safety and Security:

The ability to detect and recognize faces in real-time can significantly enhance public safety. **It can help in identifying suspects or individuals who pose a potential threat in sensitive or crowded areas like airports, shopping centers, and tourist spots.**

Technological Advancement:

Implementing such a high-tech project can position Cambodia as a **forward-thinking nation in terms of adopting and developing advanced technologies,** potentially attracting more technological investments and collaborations.

Aid in Law Enforcement:

The system can be a powerful tool for law enforcement agencies. It can help in **identifying and tracking suspects, finding missing persons, and providing evidence in criminal investigations**.

Target Environments

Corporate Offices

Our system is tailored for corporate environments, providing robust security measures and efficient monitoring for office spaces.

Retail Stores

By monitoring store activities and identifying potential threats in real-time, our system ensures a safe and secure shopping experience.

Industrial Facilities

Our system strengthens security protocols at industrial facilities, safeguarding valuable assets and minimizing production risks.

Smart Cities

With AI-powered surveillance, our system contributes to the development of smart cities, enhancing safety and quality of life for residents.

Future Enhancement

Integration with Other Systems	Linking the system with other public and private security systems, traffic management systems, and emergency response networks can create a more cohesive and comprehensive security infrastructure.
Drone Integration	For wider area surveillance, integrating drone technology can be beneficial. Drones equipped with cameras can be deployed to monitor large areas, especially during events or in response to specific alerts.
3D Facial Recognition	Upgrading from 2D to 3D facial recognition can improve accuracy and reduce errors, as 3D models are not as affected by changes in lighting or angles.
Voice Recognition Integration	Adding voice recognition could provide another layer of verification, especially in scenarios where visual confirmation is not sufficient.
Automated Incident Reporting	Developing a system for automated reporting of incidents detected by the cameras can streamline the process of alerting law enforcement and emergency services.
Edge Computing for Faster Processing	Implementing edge computing can reduce latency, as data processing happens near the source of data collection. This is particularly beneficial for real-time applications.

Conclusion

Our comprehensive surveillance system, powered by AI, cloud storage, and an intuitive interface, enhances security and operational efficiency across targeted environments.