King Mongkut's University of Technology Thonburi

Research and Development of Tracking and Arresting Criminal Systems Using Artificial Intelligence Technology

Muang Chonburi Police Station

Dr.Thittaporn Ganokratanaa, KMUTT

Outline

- Problem Statement
- Environment Settings
- Methodology
- Results, Outputs, Impacts
- Conclusion

Problem Statement

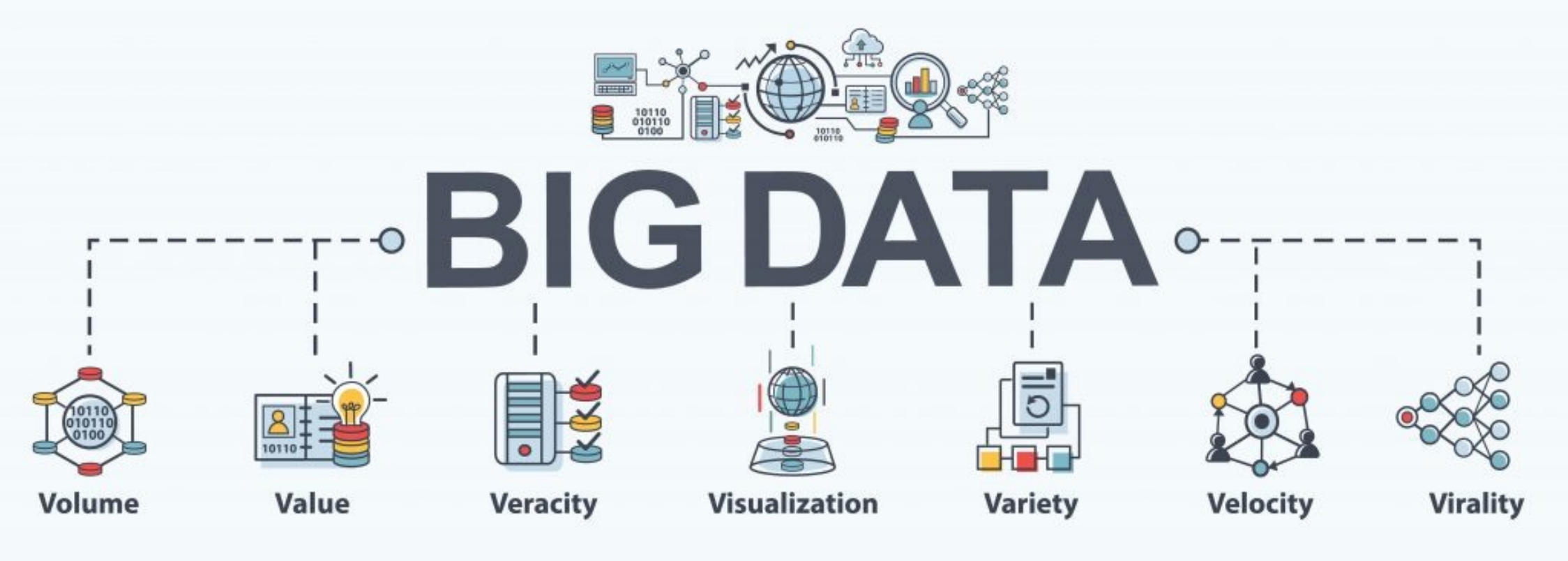
"Old Solution: Security Staffs watch the CCTV and people"

Example of CCTV Control Room at Chiang Mai

"More than 15,000 CCTV cameras in Three Southern Border Provinces."

Source: http://www.southdeepoutlook.com/ShowAllDetails/detail_south_editorial/50/

Big Data Storage



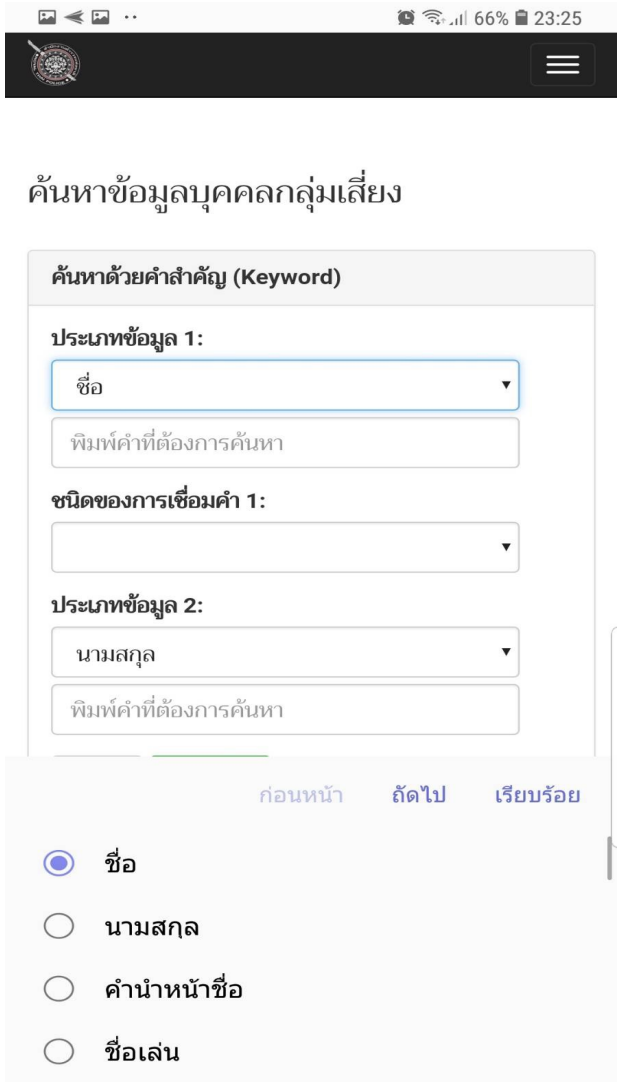
Source: https://www.tcgdigital.com/big-data-advanced-analytics/

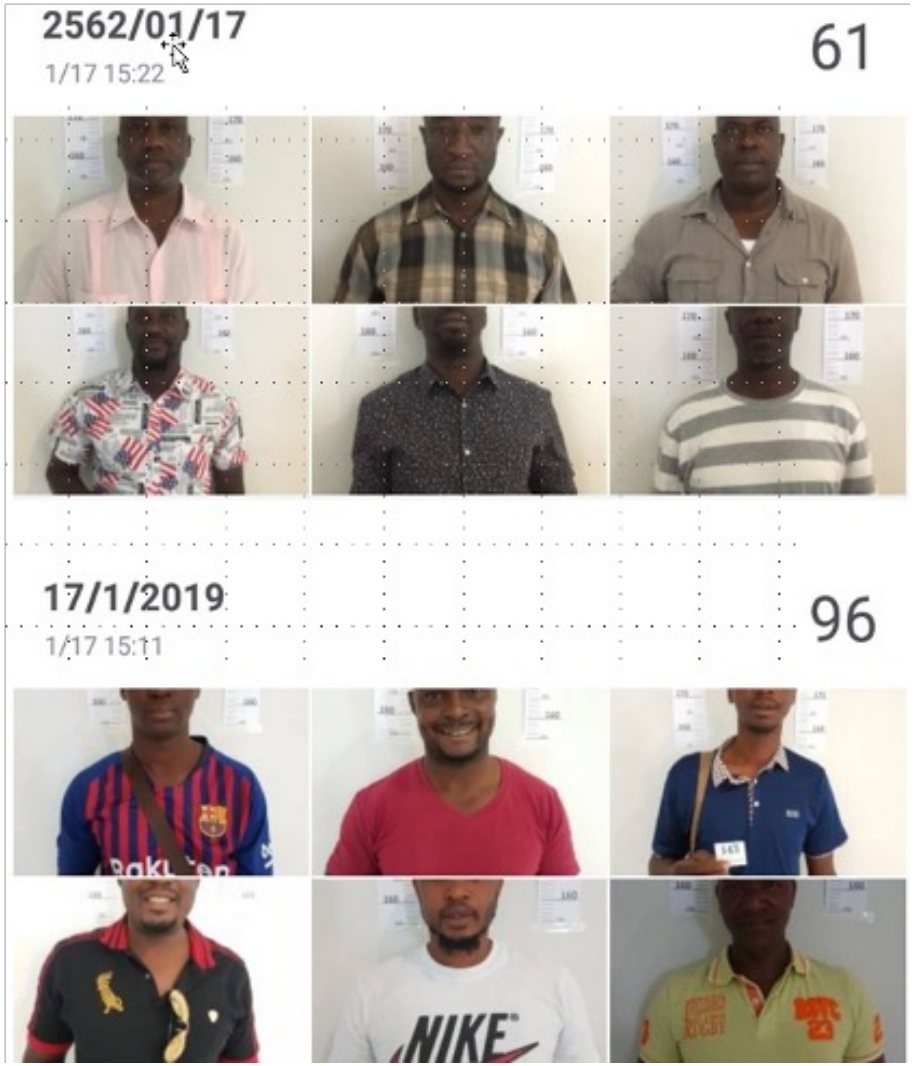
Problem Statement

Chanthaburi Police Database: Collecting data on target groups of people and vehicles

Problem Statement

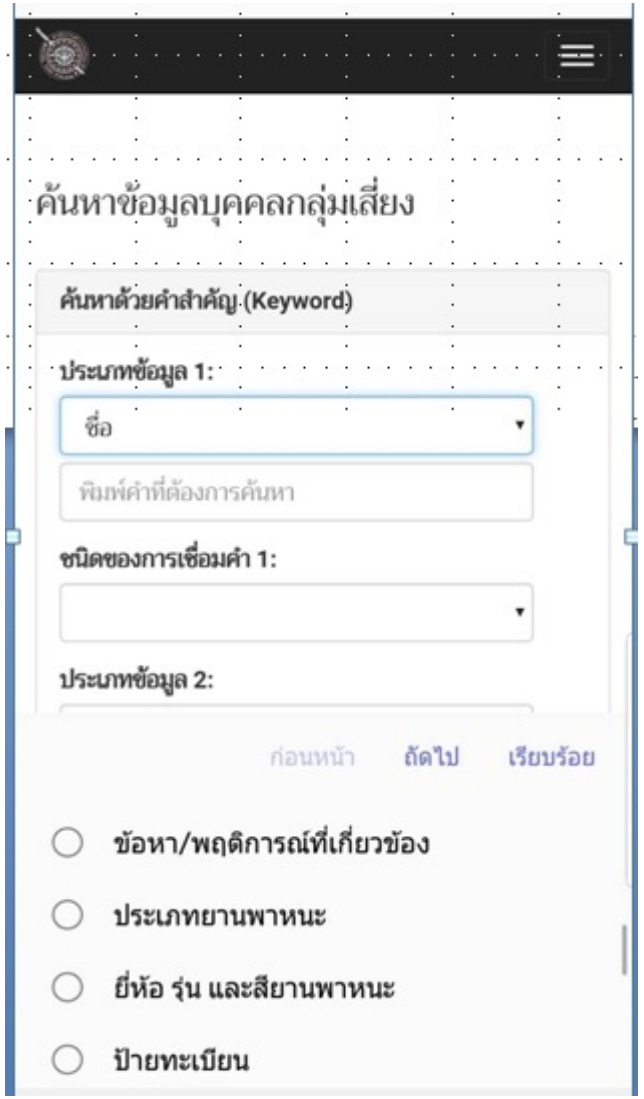
Database of at-risk people





Problem Statement

A database of offender-risk vehicles



Objectives

1. To enhance police officers' proficiency in using AI for crime data analysis in Thailand via smart phone, leveraging data collection and investigation of crime data process.

2. To boost public confidence in crime prevention through the systematic use of intelligent CCTV technology for crime monitoring and evidence recording.

3. To implement AI-driven technology to alert police of suspicious individuals or vehicles via mobile devices connected to a central server.

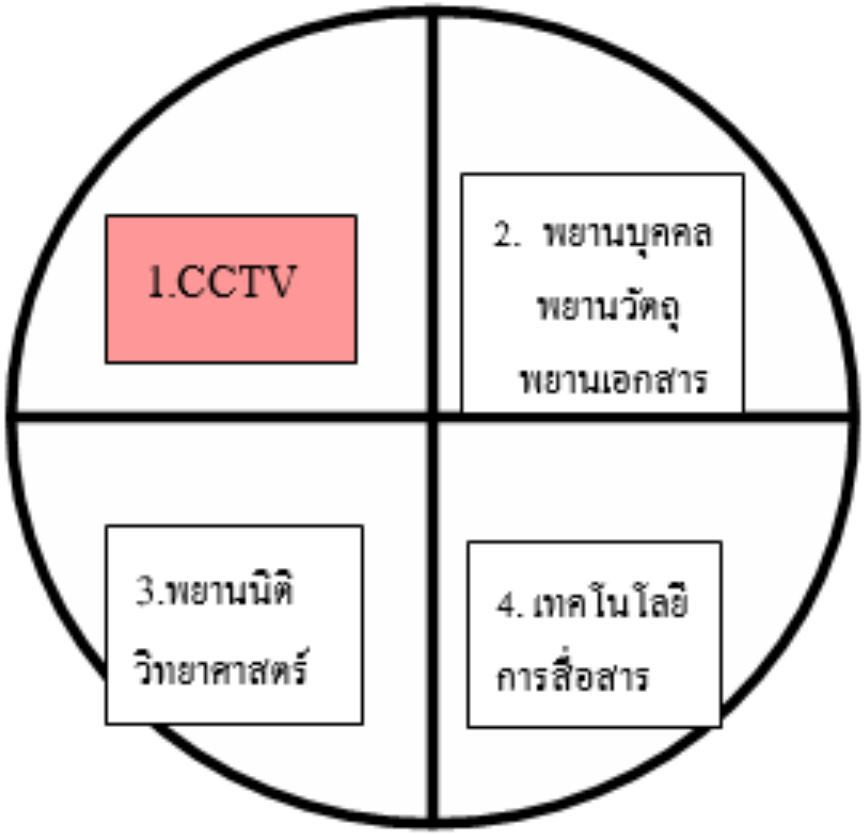
Problem Statement

A solution for system design of crime prevention

Knowledge of Modern Investigations

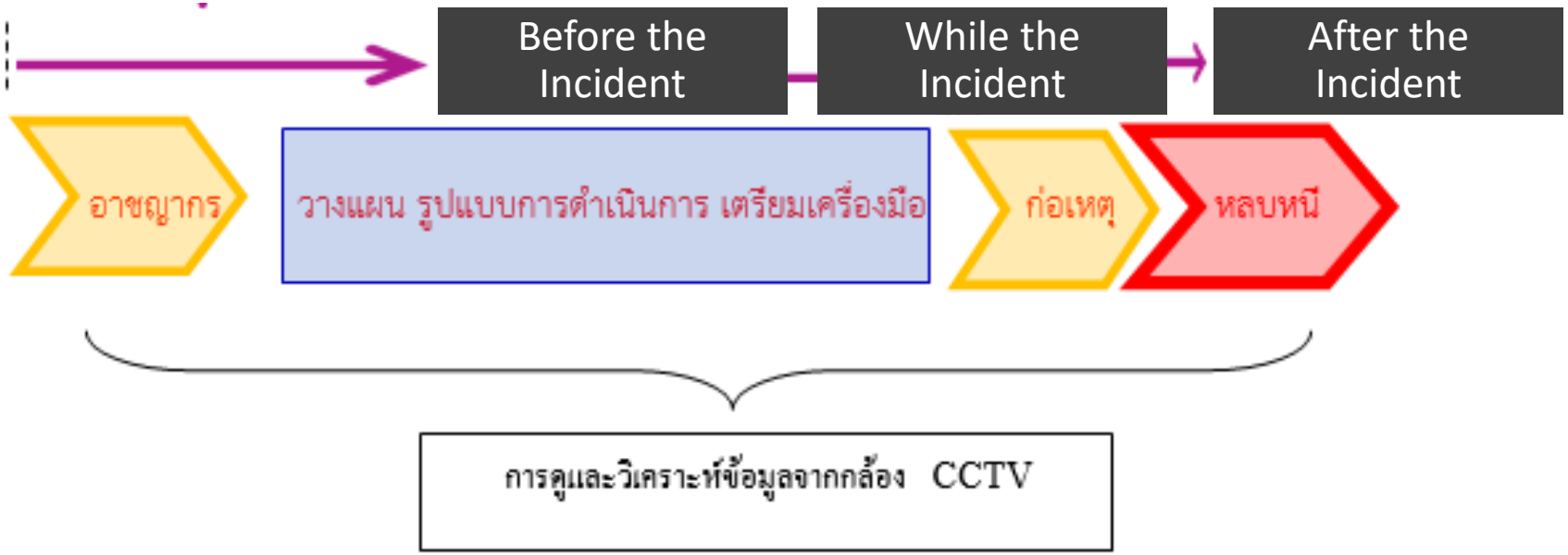
Currently, police officers use investigative knowledge to locate and apprehend criminals, forming the foundation for evidence collection and criminal pursuit. There are 4 elements:

1. CCTV ✓
2. Witnesses, Material Witnesses, Documentary Witnesses
3. Forensic Evidence
4. Communication Technology



Problem Statement

The sequence of events and attributes of criminals are:



Environment Settings

SMART CITY – Enhancing quality of life through innovative support.

CCTV camera locations in Chonburi city:

1. Chon Rat Amrung intersection - 4 cameras.
2. Chalerm Thai intersection - 6 cameras.

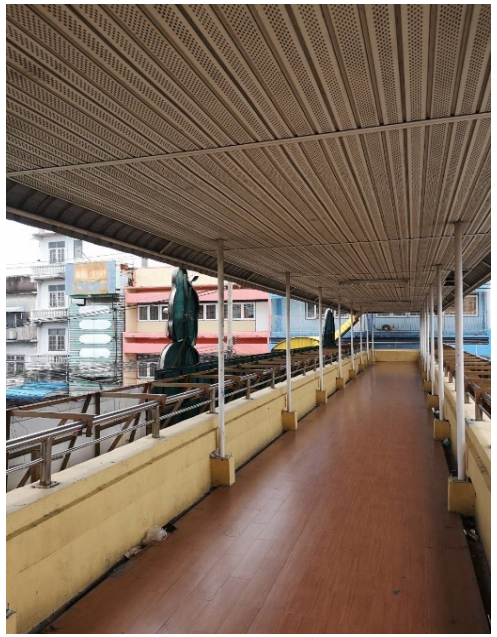
Environment Settings

Camera Installation

1. Chon Rat Amrung intersection - 4 cameras.

Environment Settings

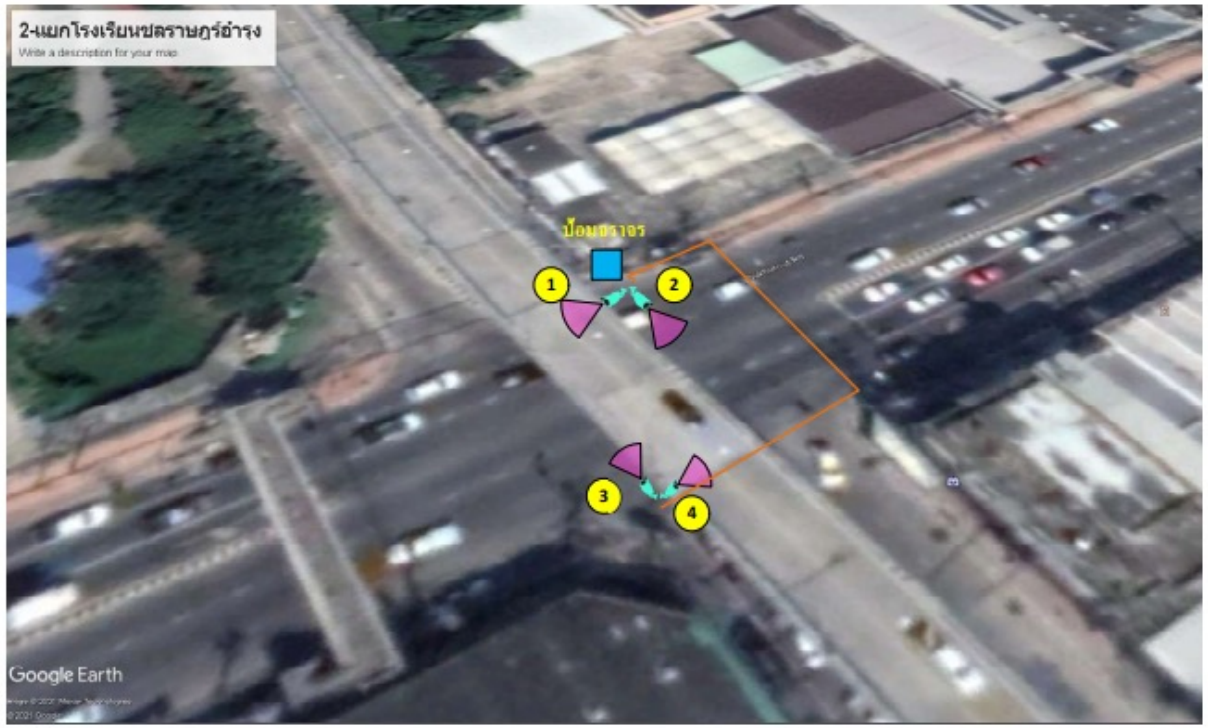
Camera Installation
2. Chalerm Thai intersection - 6 cameras.



Environment Settings

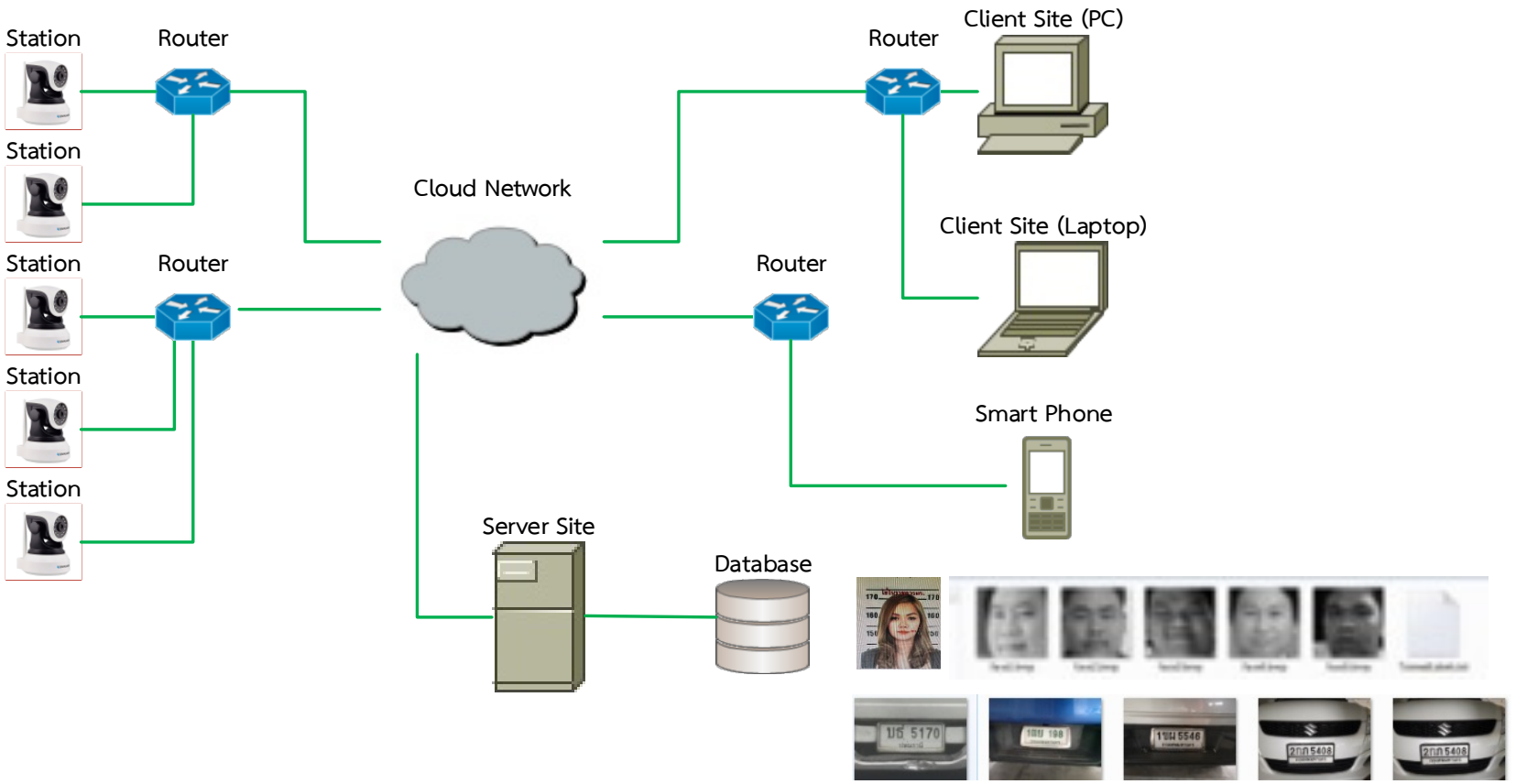
Camera Installation Location

แยกโรงเรียนชลราษฎร์อำรุง



แยกเฉลิมไทย

System Operation Overview



System Operation Overview Research and Development of Tracking and Arresting Criminal Systems Using Artificial Intelligence Technology

Methodology

The process of tracking by detection

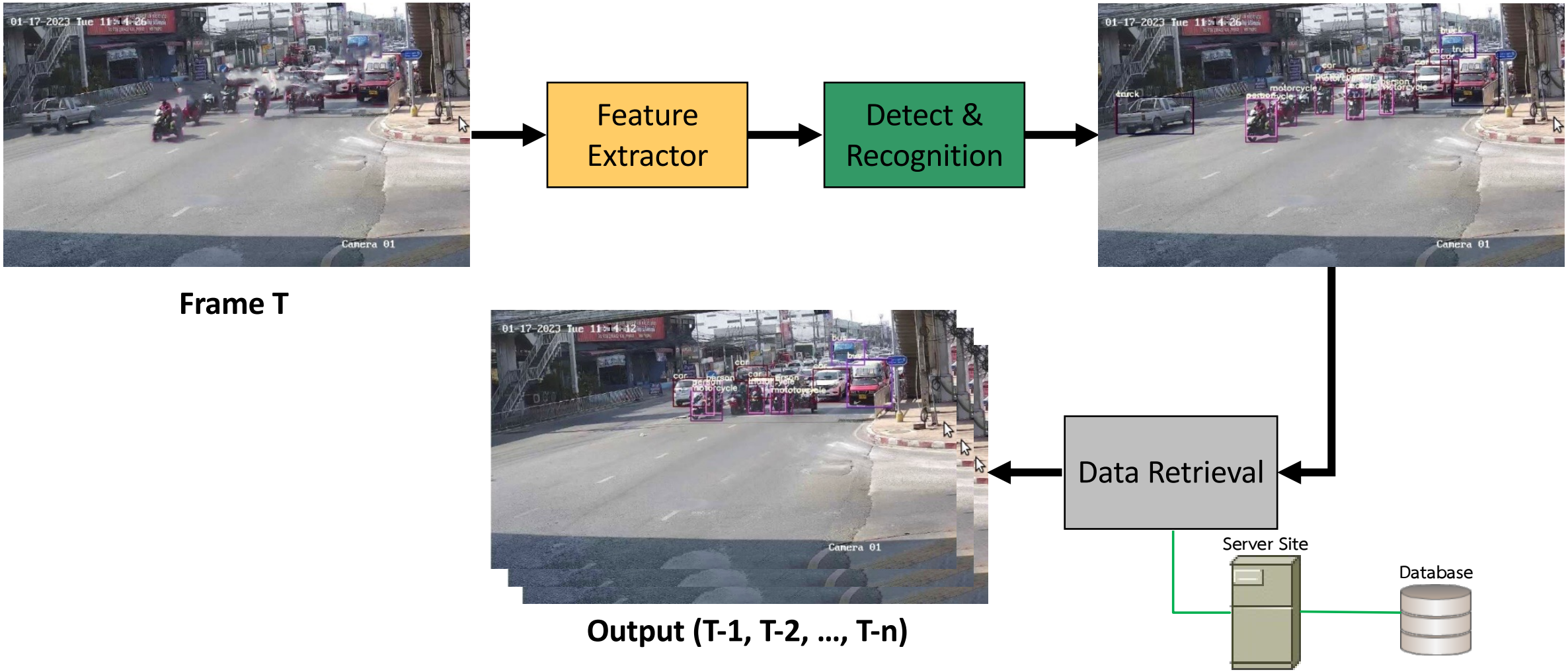


Illustration of the detection, tracking, and recognition procedure

System results

The visual results of system

Examples of results of system

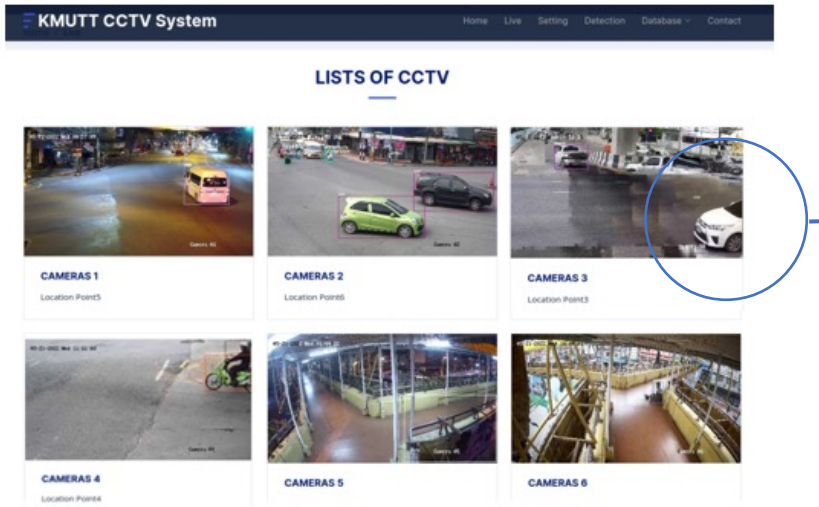
System results

The visual results of system

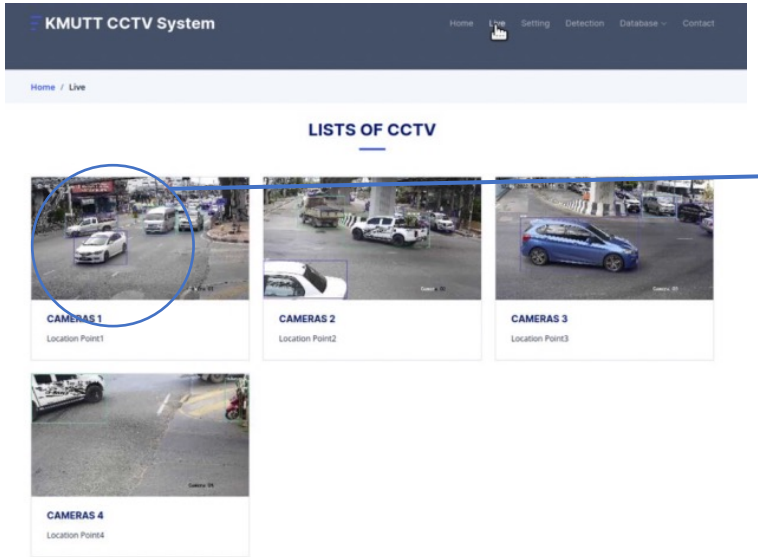
Examples of results of system

System outputs

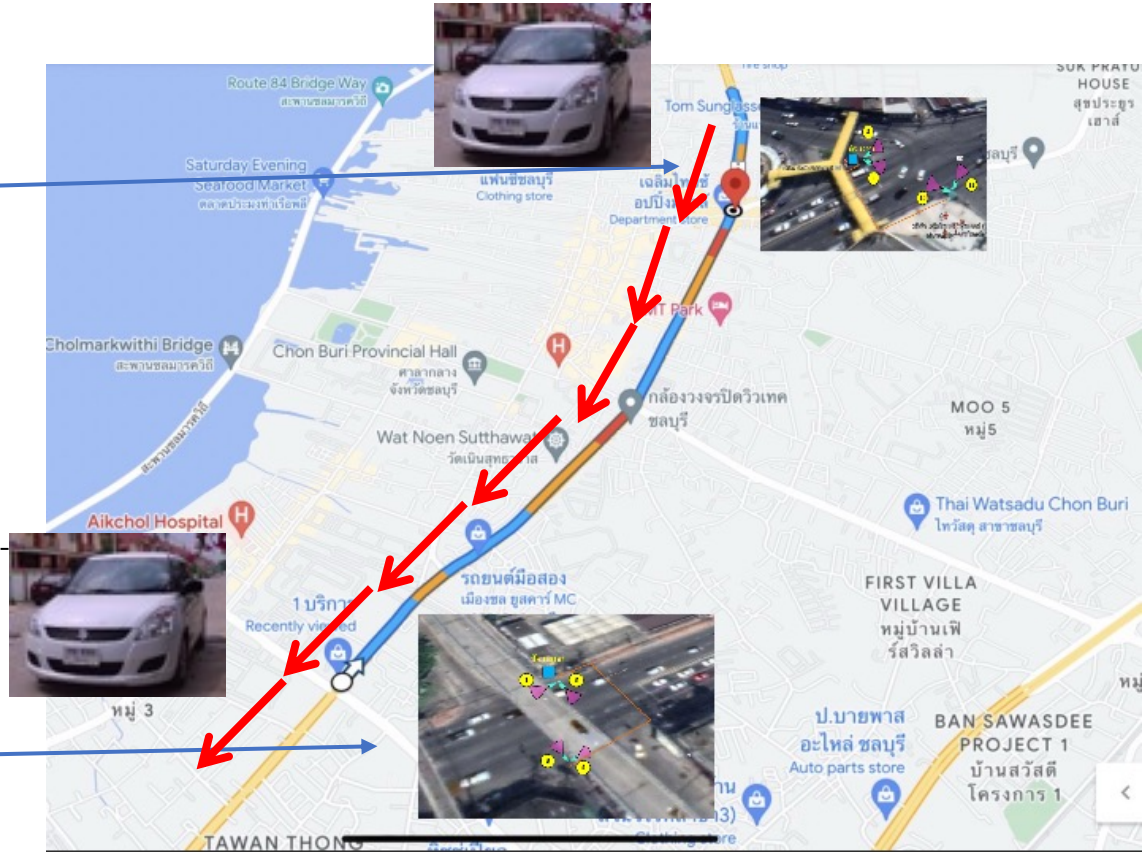
Criminal Arrest Tracking System



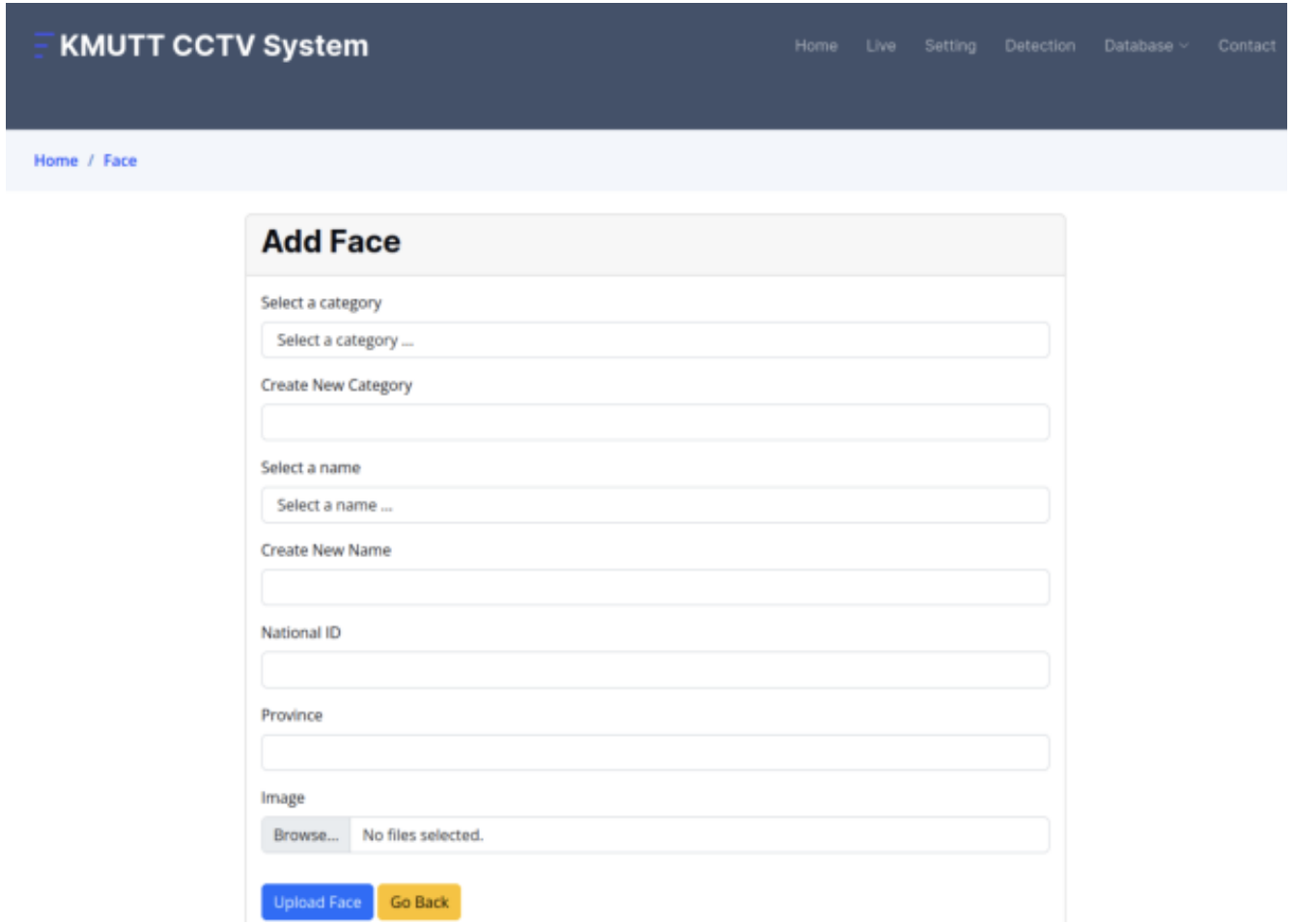
2. แยกเฉลิมไทย



1. แยกชลราษฎร์อำรุง

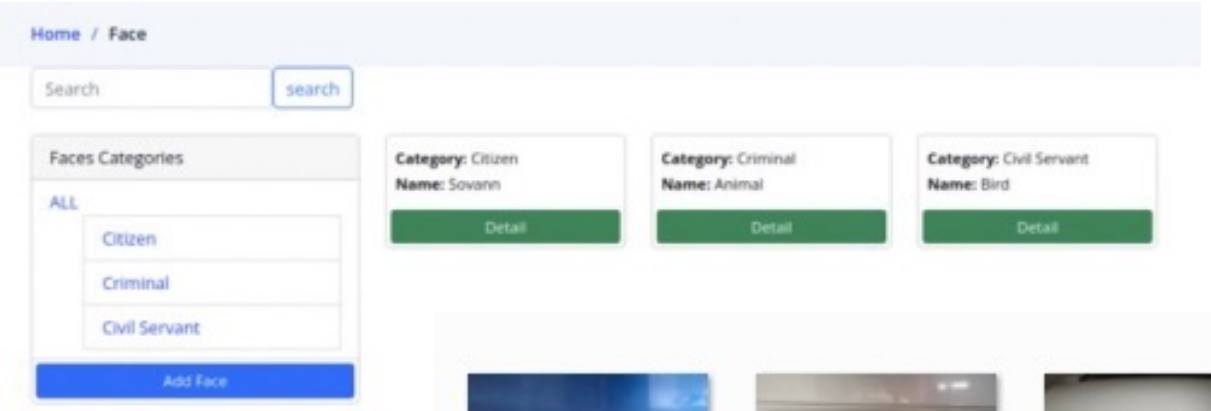


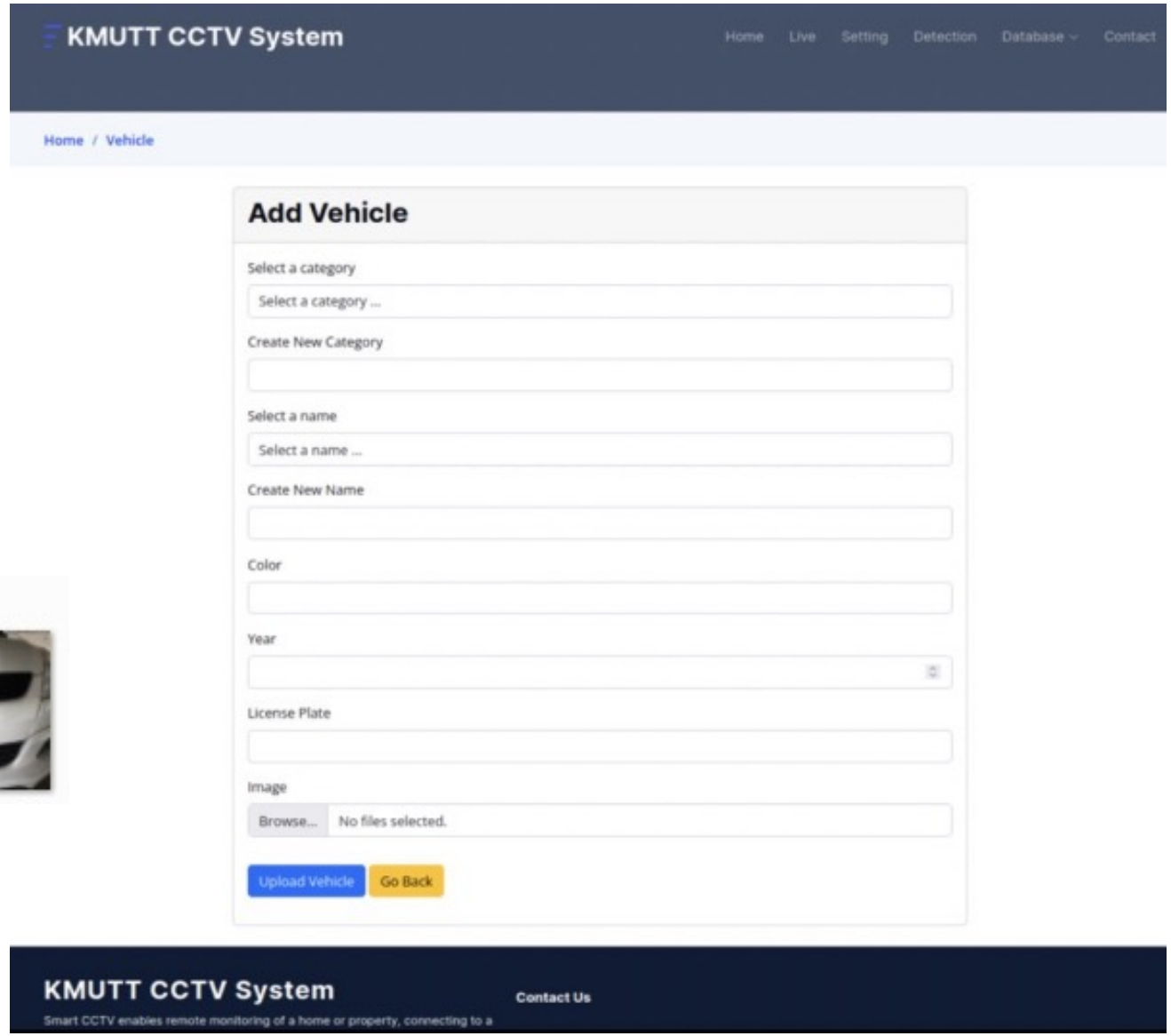
System Operation: Add Face



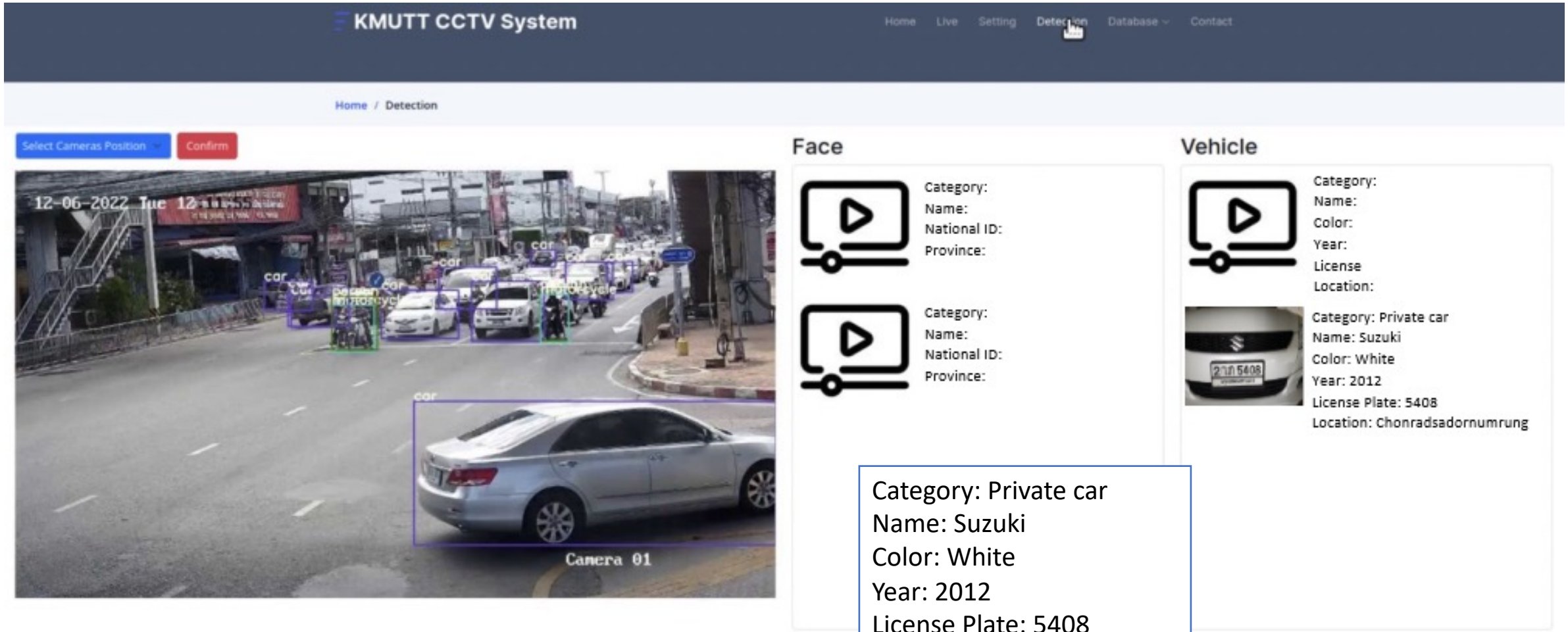
System outputs

System Operation: Add Vehicle





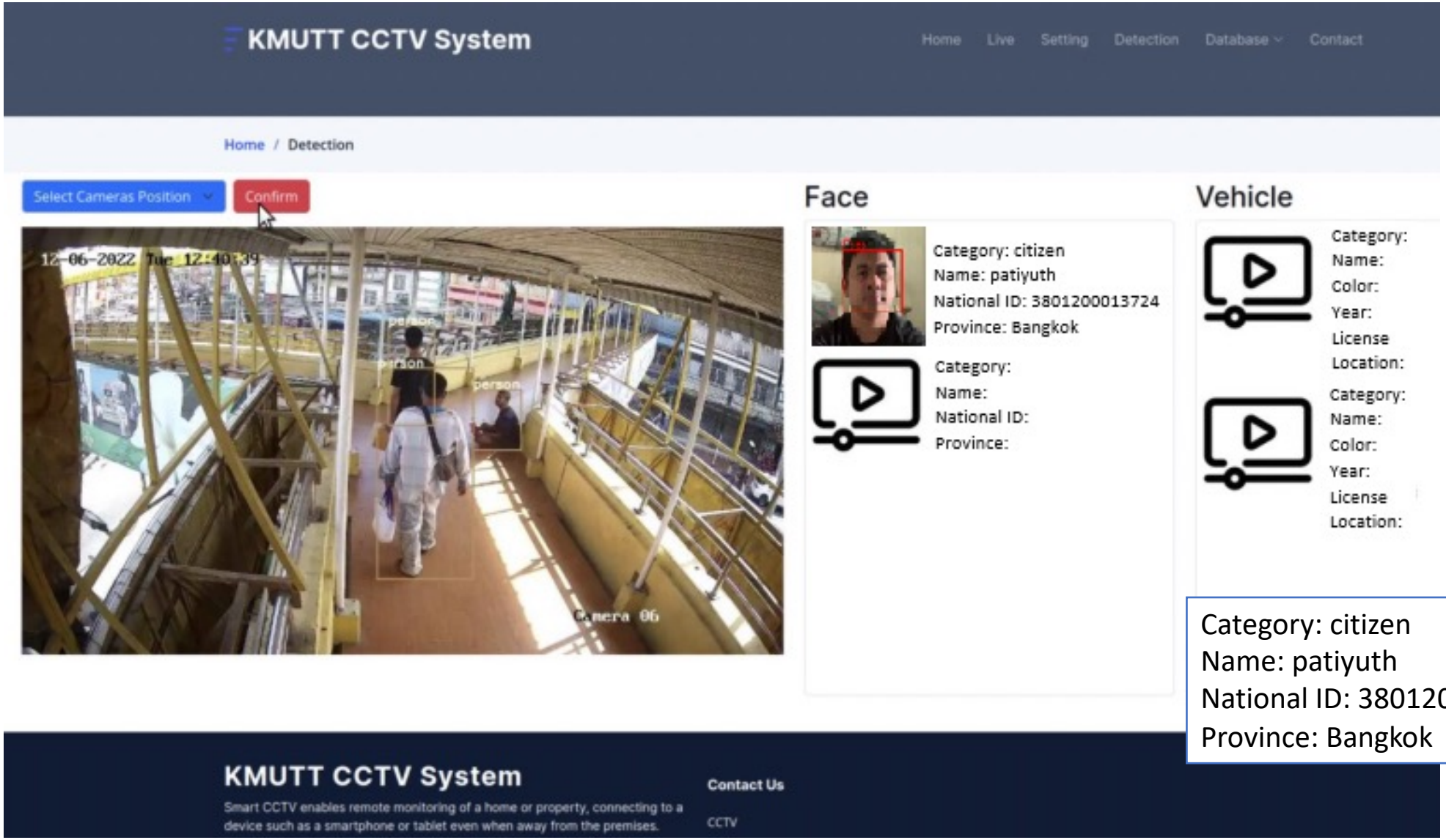
System performance



Category: Private car
Name: Suzuki
Color: White
Year: 2012
License Plate: 5408
Location: Chonradsadornumrung

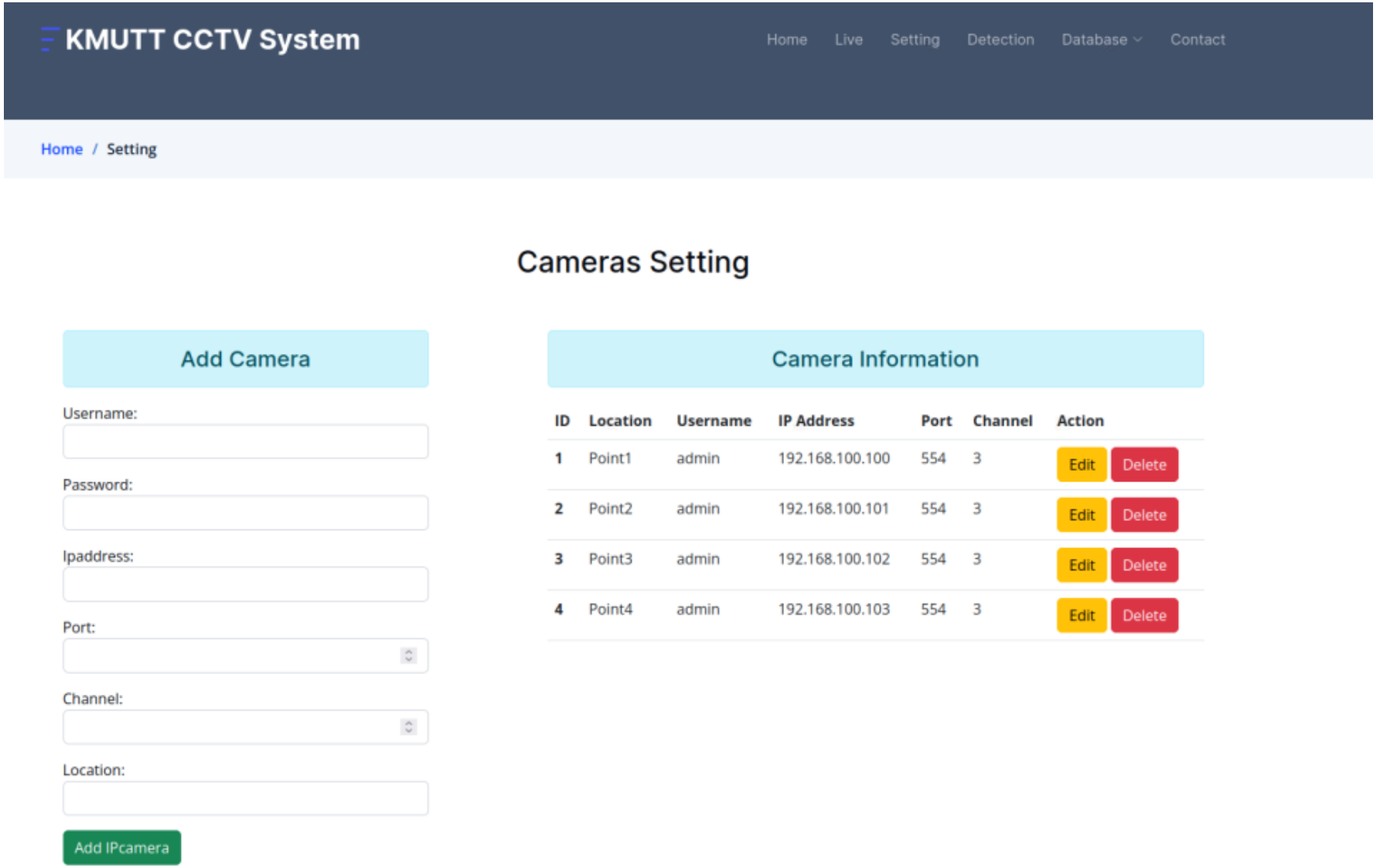
System outputs

System performance

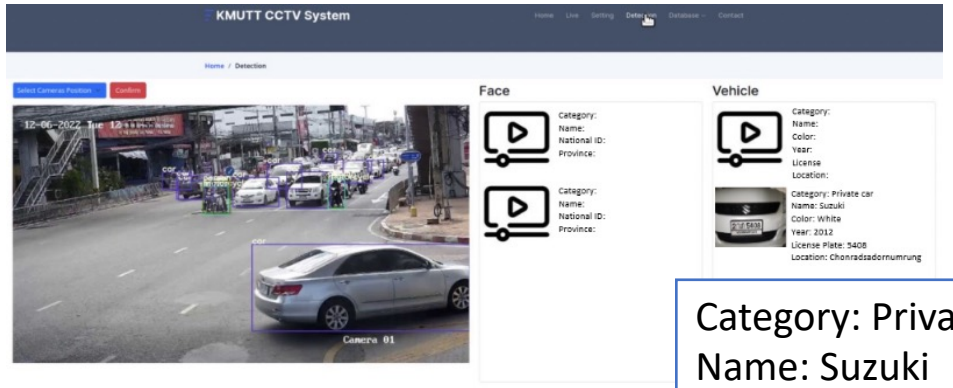


Category: citizen
Name: patiyuth
National ID: 3801200013724
Province: Bangkok

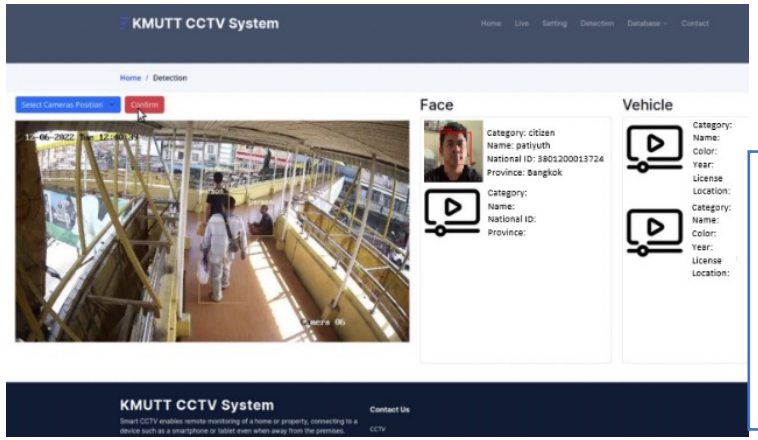
System performance



System performance



Category: Private car
Name: Suzuki
Color: White
Year: 2012
License Plate: 5408
Location: Chonradsadornumrung



Category: citizen
Name: patiyuth
National ID: 3801200013724
Province: Bangkok

ลักษณะในการทดสอบ	ผลการทดสอบคิดเป็นเปอร์เซ็นต์
1. ผลการทดลองระบบการจัดเก็บข้อมูลบุคคลกลุ่มเสี่ยง และยานพาหนะต้องสงสัยผ่านโทรศัพท์ Smart phone	96
2. ผลการทดลองระบบแจ้งเตือนตำหนิรูปพรรณรถ และหมายเลขทะเบียนรถ (License plate)	90
3. ผลการทดลองระบบแจ้งเตือนตำหนิรูปพรรณคนร้าย และหมายจับ (Face Recognition)	90

Extend the System

Extend the system - Thaworn Khao Kluea Checkpoint Border area Chanthaburi (Thailand - Cambodia)

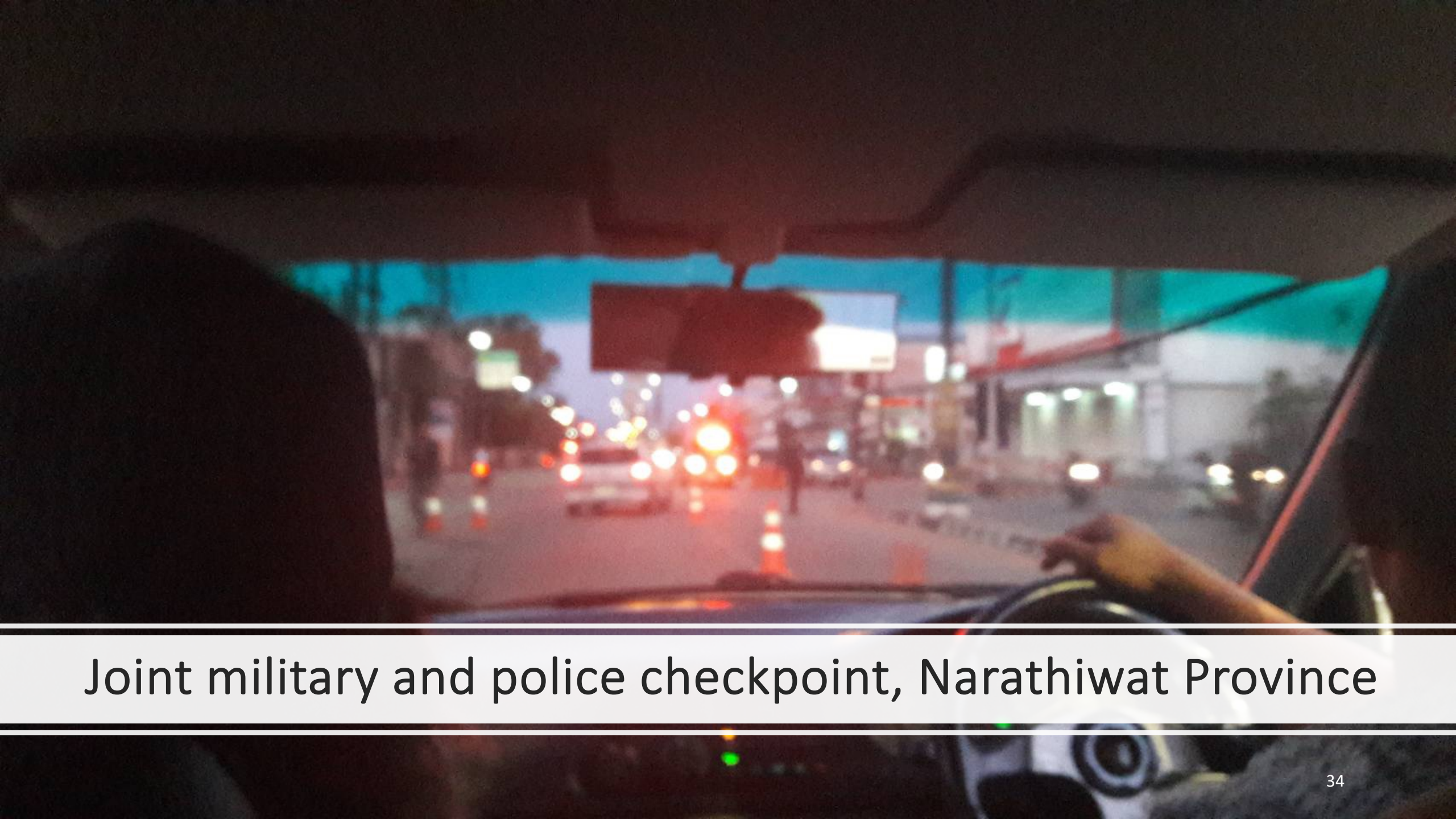
Using a mobile camera to detect the face of the suspected person

Collaborate with the navy – survey the air space of Narathiwat Province

Narathiwat Airport

High-angle shot of Narathiwat Province

Joint military and police checkpoint, Narathiwat Province



Joint military and police checkpoint, Narathiwat Province

Conclusion

- The research focused on utilizing AI technology to augment police efficiency in Thailand.
- The study aimed to enhance law enforcement capabilities and bolster public trust in crime prevention measures.
- By employing AI in crime data analysis through smartphones, leveraging intelligent CCTV technology for crime monitoring, and integrating real-time alerts for suspicious activities to police mobile devices.

Q&A

Thittaporn.gan@kmutt.ac.th

King Mongkut's University of Technology Thonburi

Real-Time Object Detection

Lecturer: Dr. Thittaporn Ganokratanaa

❖ Problem Addressed: Object Detection

- Object detection is the problem of both locating AND classifying objects
- Goal of object detection algorithm is to do object detection both fast AND with high accuracy.

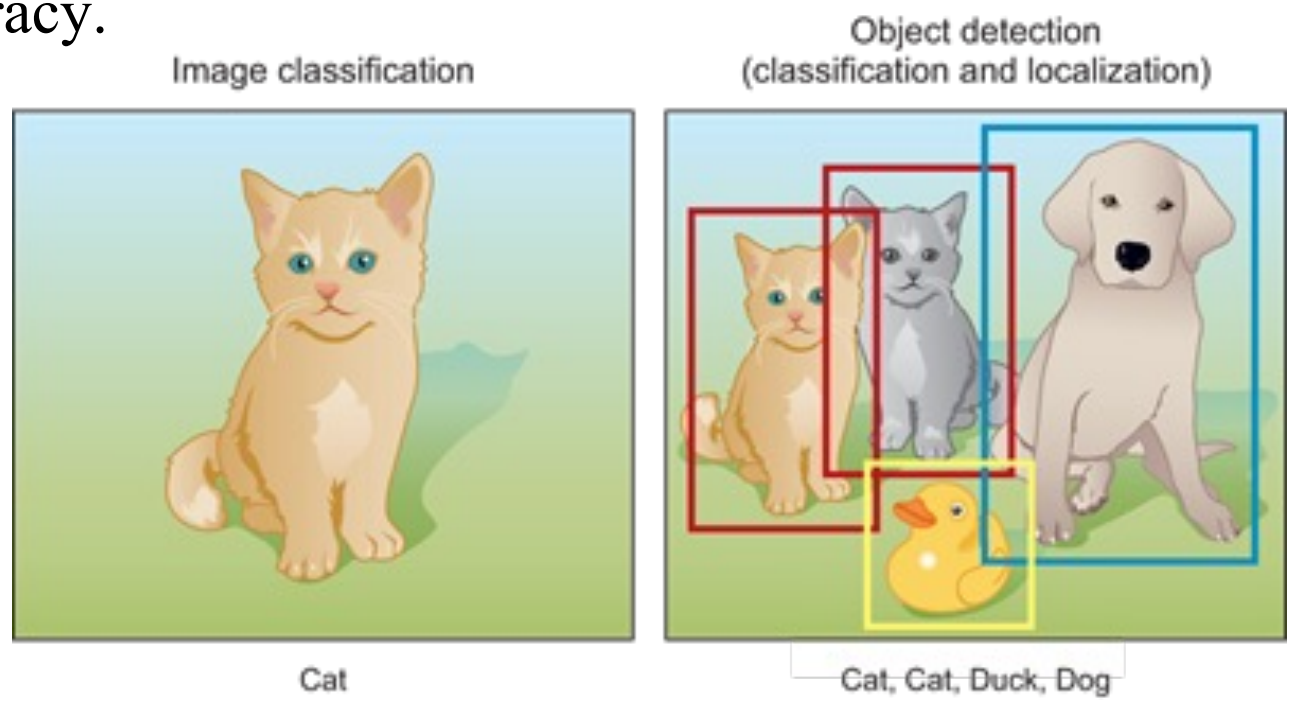


Image Source Object Detection

❖ Importance of Object Detection

- Visual modality is very powerful
- Humans are able to detect objects and do perception using just this modality in real-time (not needing radar)
- If we want responsive robot systems that work real-time (without specialized sensors), almost real-time vision based object detection can help greatly.

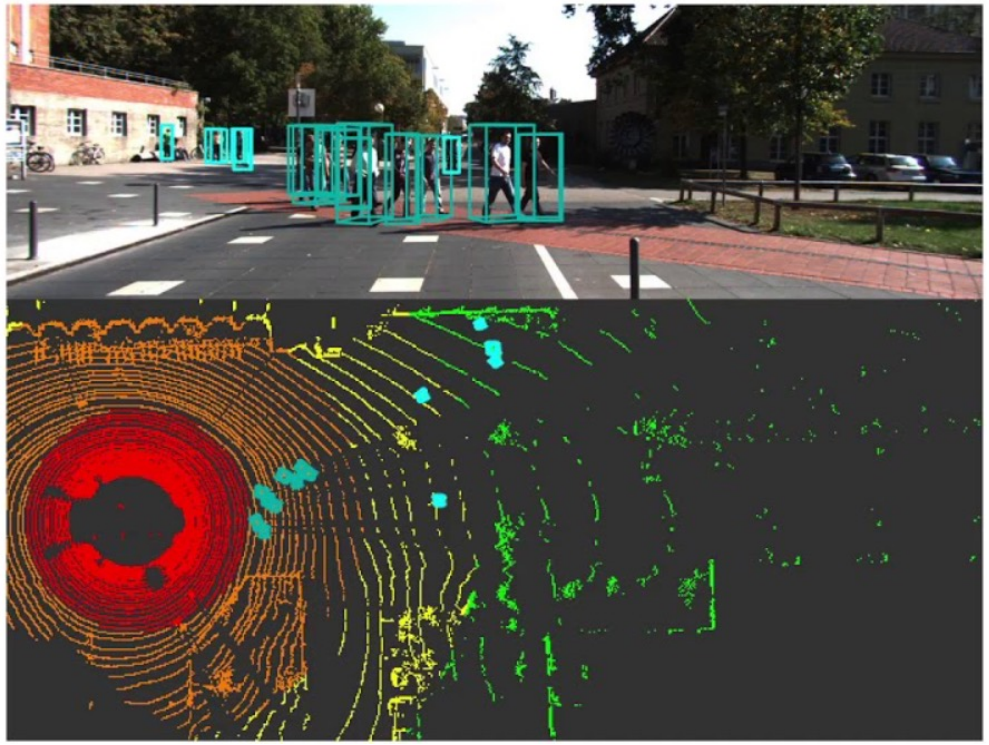
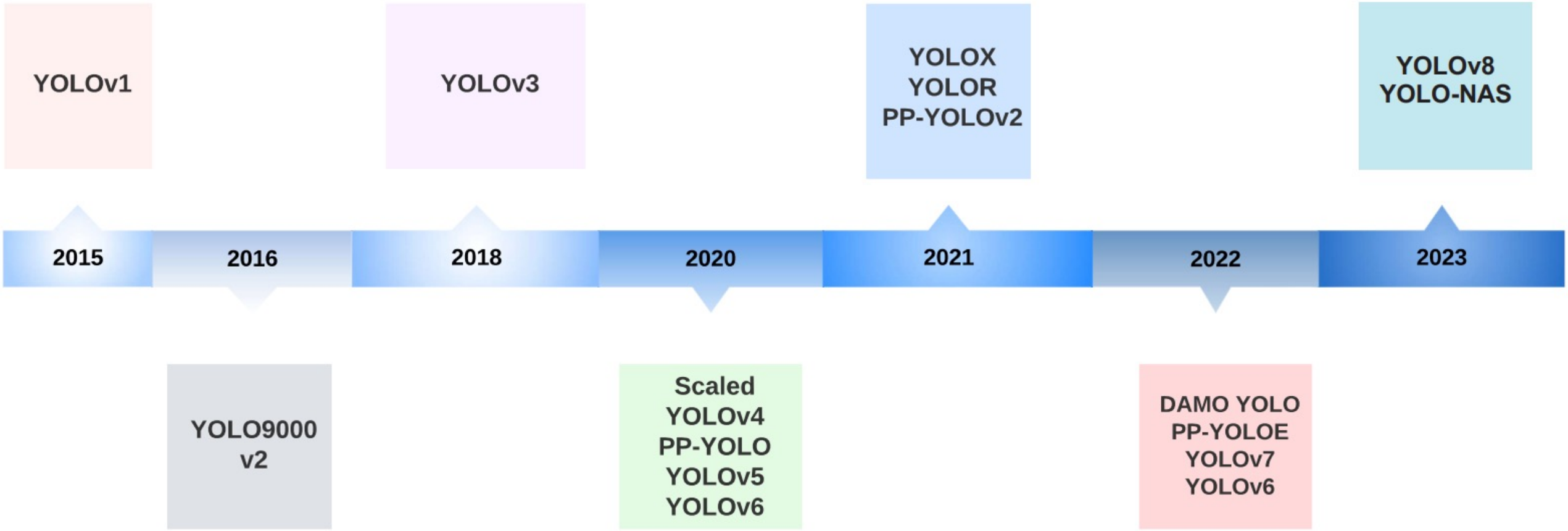


Image Source: Object Detection and Lidar

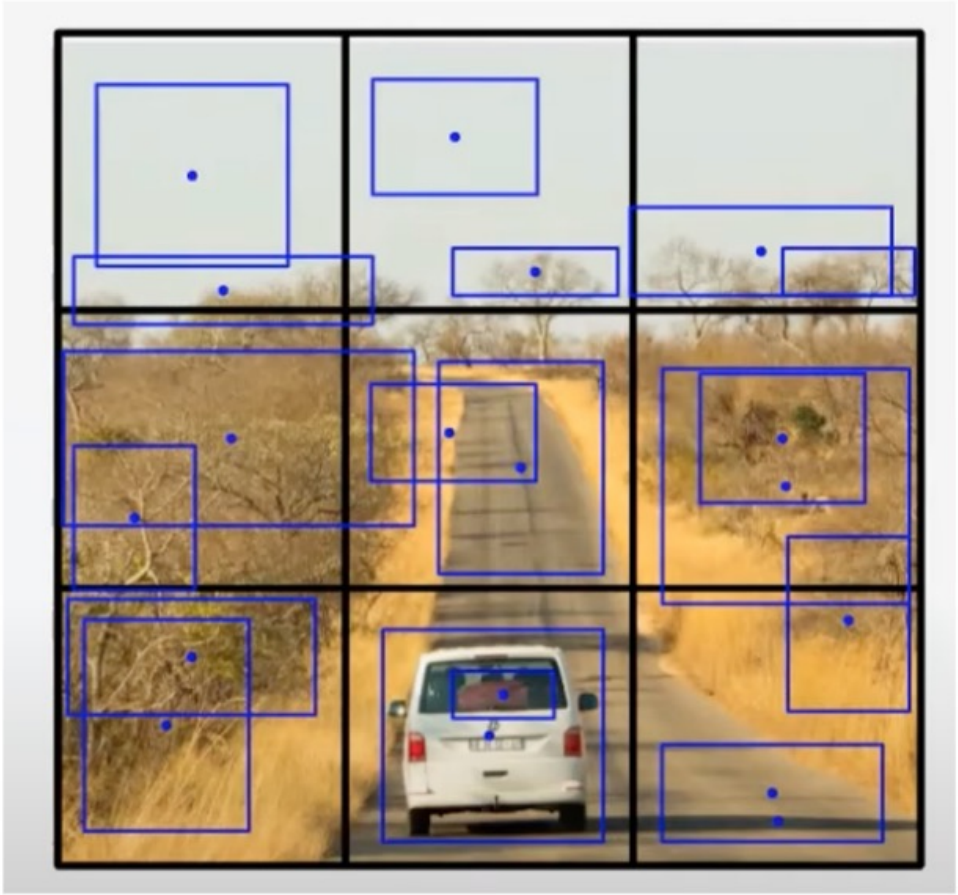
A timeline of YOLO versions



Source: YOLO

❖ YOLO Overview

- First, image is split into a S×S grid
- For each grid square, generate B bounding boxes
- For each bounding box, there are 5 predictions: x, y, w, h, confidence



S = 3, B = 2

Source: YOLO

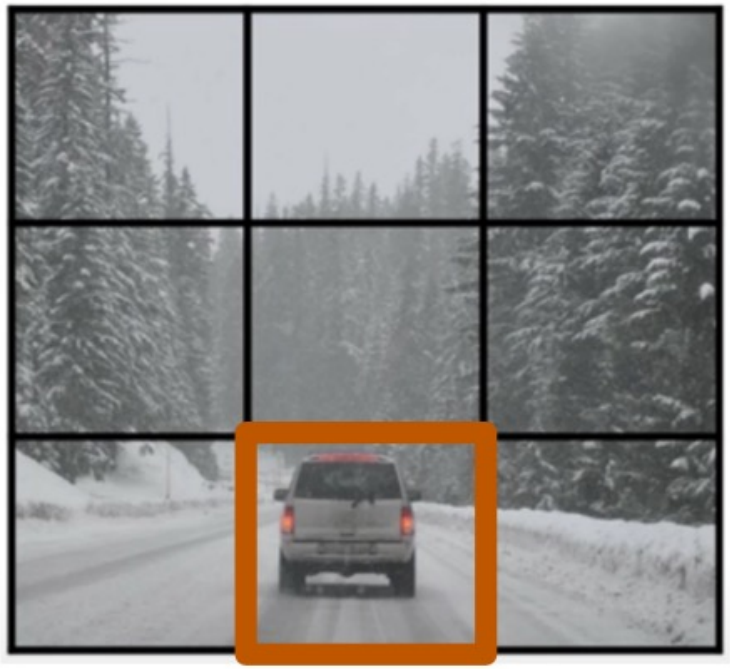
King Mongkut's University of Technology Thonburi

❖ YOLO Training

- YOLO is a regression algorithm. What is X? What is Y?
- X is simple, just an image width (in pixels) * height (in pixels) * RGB values
- Y is a tensor of size S * S * (B * 5 + C)
- B*5 + C term represents the predictions + class predicted distribution for a grid block

For each grid block, we have a vector like this. For this example B is 2 and C is 2

ρ_1
b_x_1
b_y_1
b_h_1
b_w_1
ρ_2
b_x_2
b_y_2
b_h_2
b_w_2
c_1
c_2



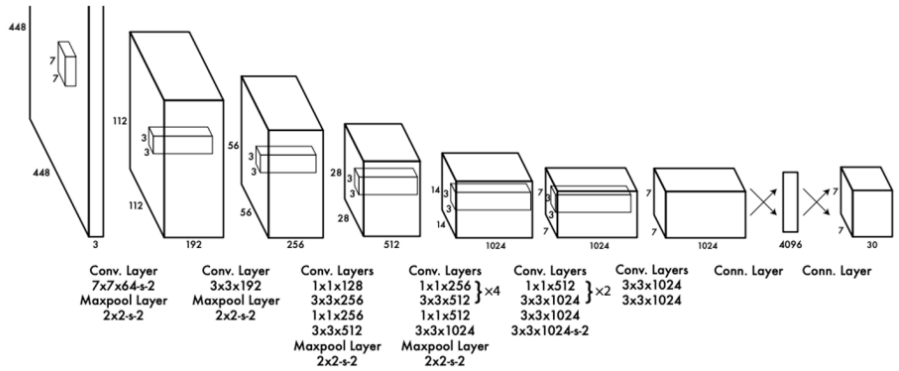
GT label example:

1
b_x_1
b_y_1
b_h_1
b_w_1
0
?
?
?
?
c_1 = 1
c_2 = 0

Source: YOLO

❖ YOLO Architecture

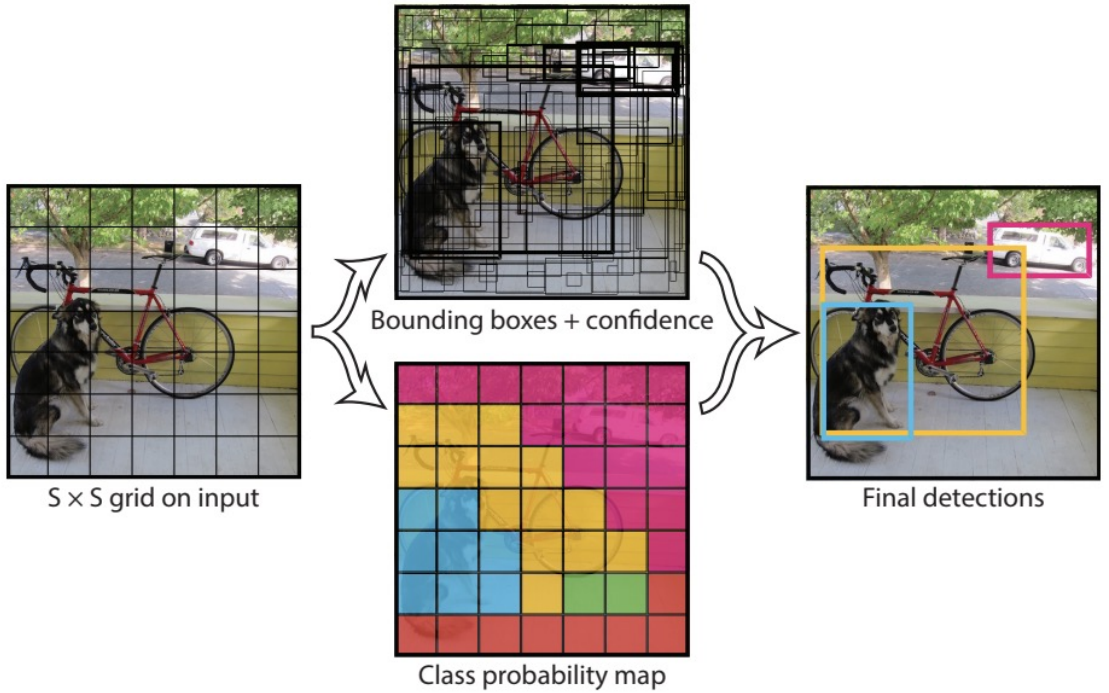
- Now that we know the input and output, we can discuss the model
- We are given 448 by 448 by 3 as our input.
- Implementation uses 7 convolution layers
- Paper parameters: S = 7, B = 2, C = 20
- Output is S*S*(5B+C) = 7*7*(5*2+20) = 7*7*30



Source: YOLO

❖ Non-maximal suppression

- We then use the output to make final detections
- Use a threshold to filter out bounding boxes with low P(Object)
- In order to know the class for the bounding box compute score take argmax over the distribution Pr(Class|Object) for the grid the bounding box's center is in

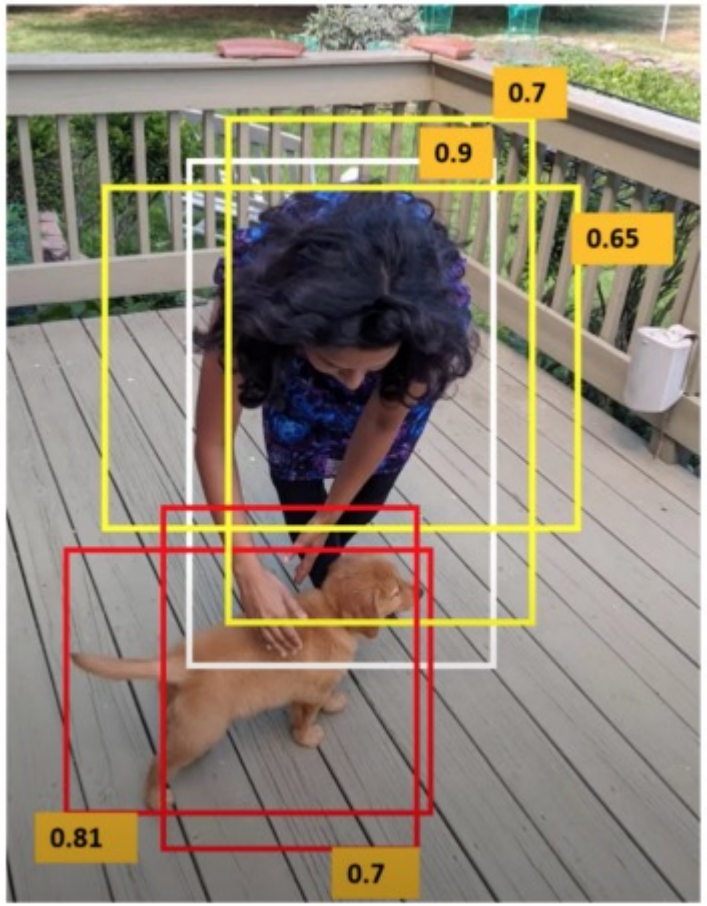


$$\Pr(\text{Class}_i|\text{Object}) * \Pr(\text{Object}) * \text{IOU}^{\text{truth}}_{\text{pred}} = \Pr(\text{Class}_i) * \text{IOU}^{\text{truth}}_{\text{pred}}$$

Source: YOLO

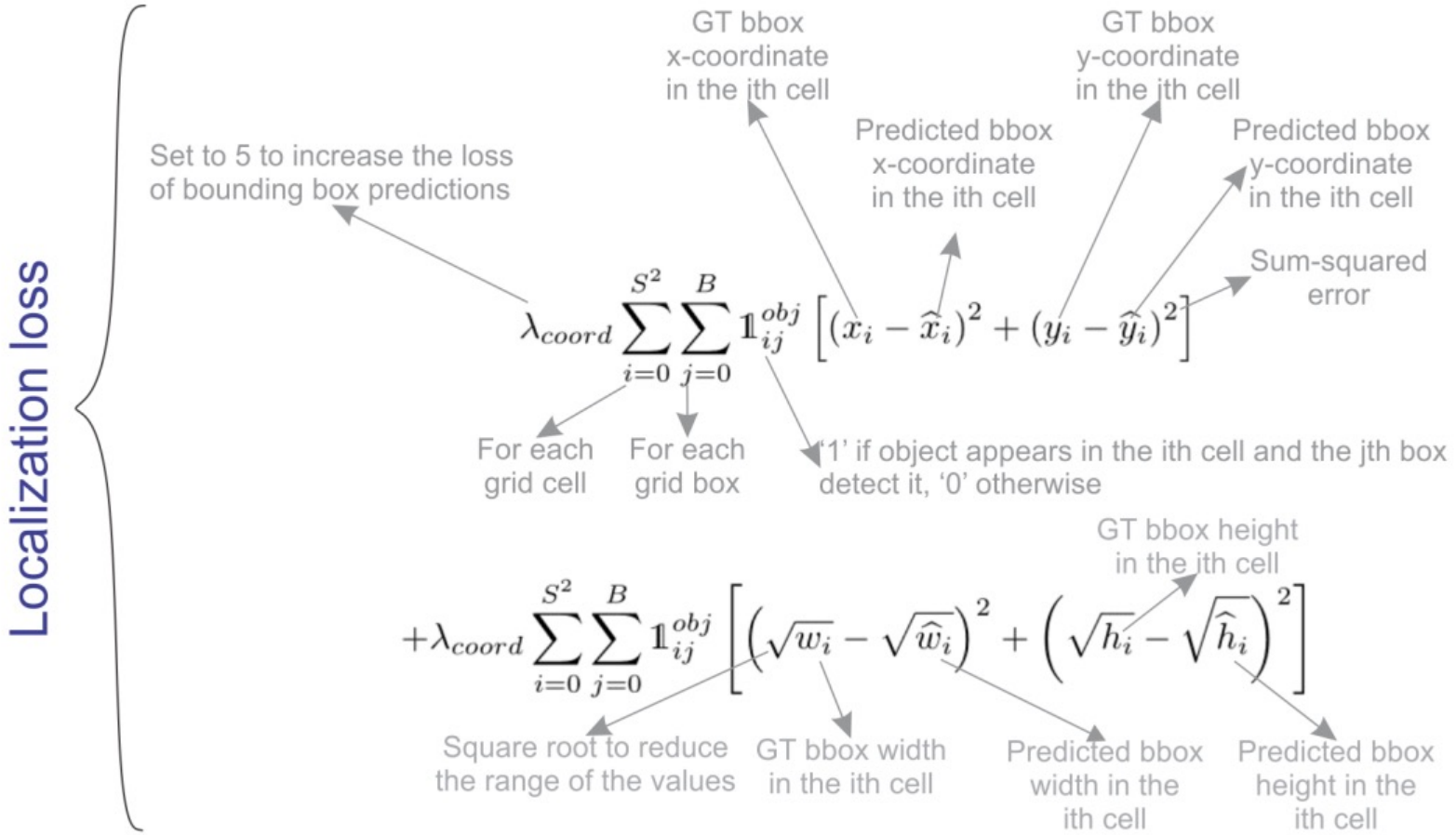
❖ YOLO Prediction

- Most of the time objects fall in one grid, however it is still possible to get redundant boxes (rare case as object must be close to multiple grid cells for this to happen)
- Discard bounding box with high overlap (keeping the bounding box with highest confidence)
- Adds 2-3% on final mAP score



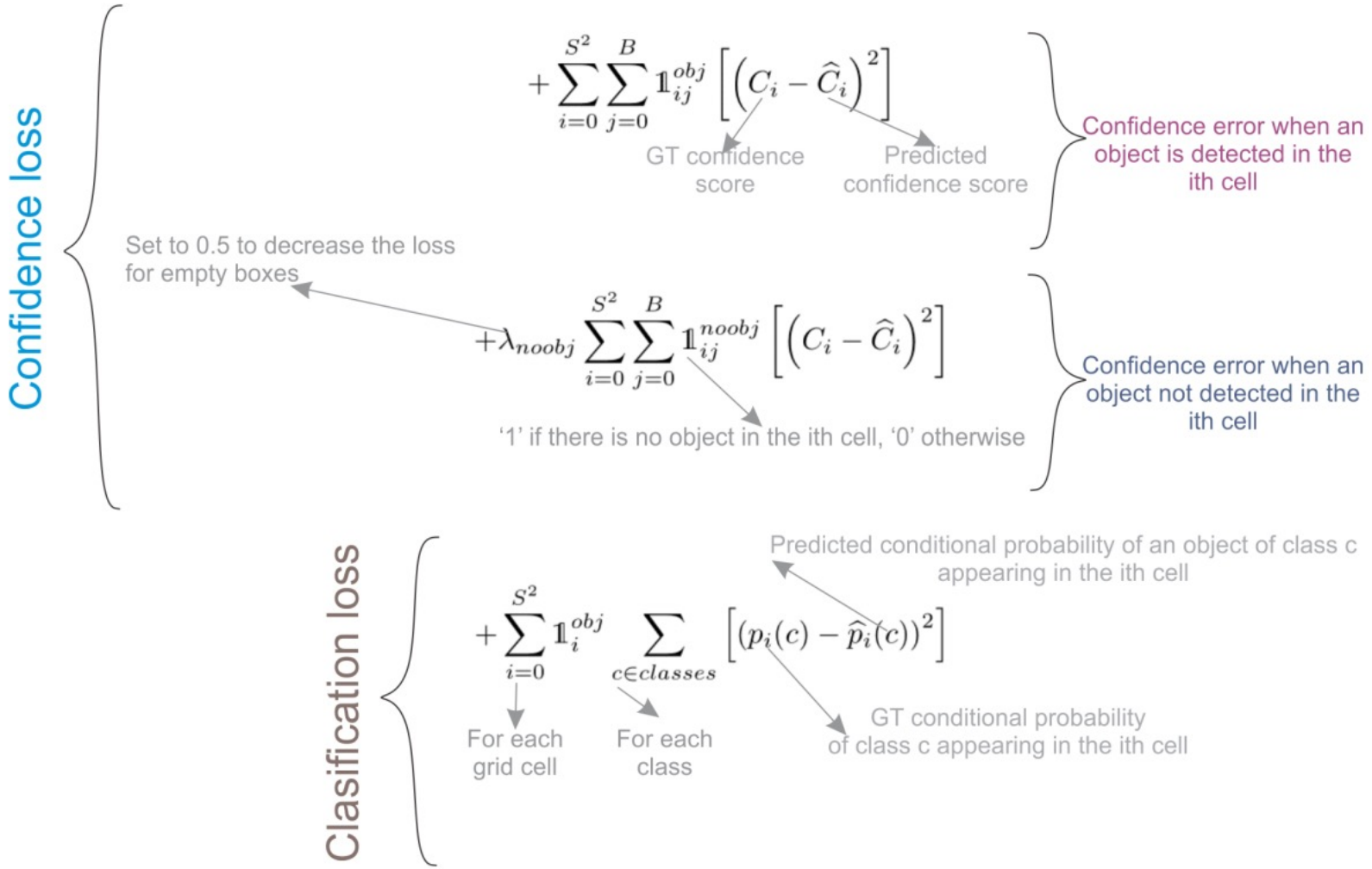
Source: YOLO

YOLO Objective Function



Source: YOLO

YOLO Objective Function (Cont.)



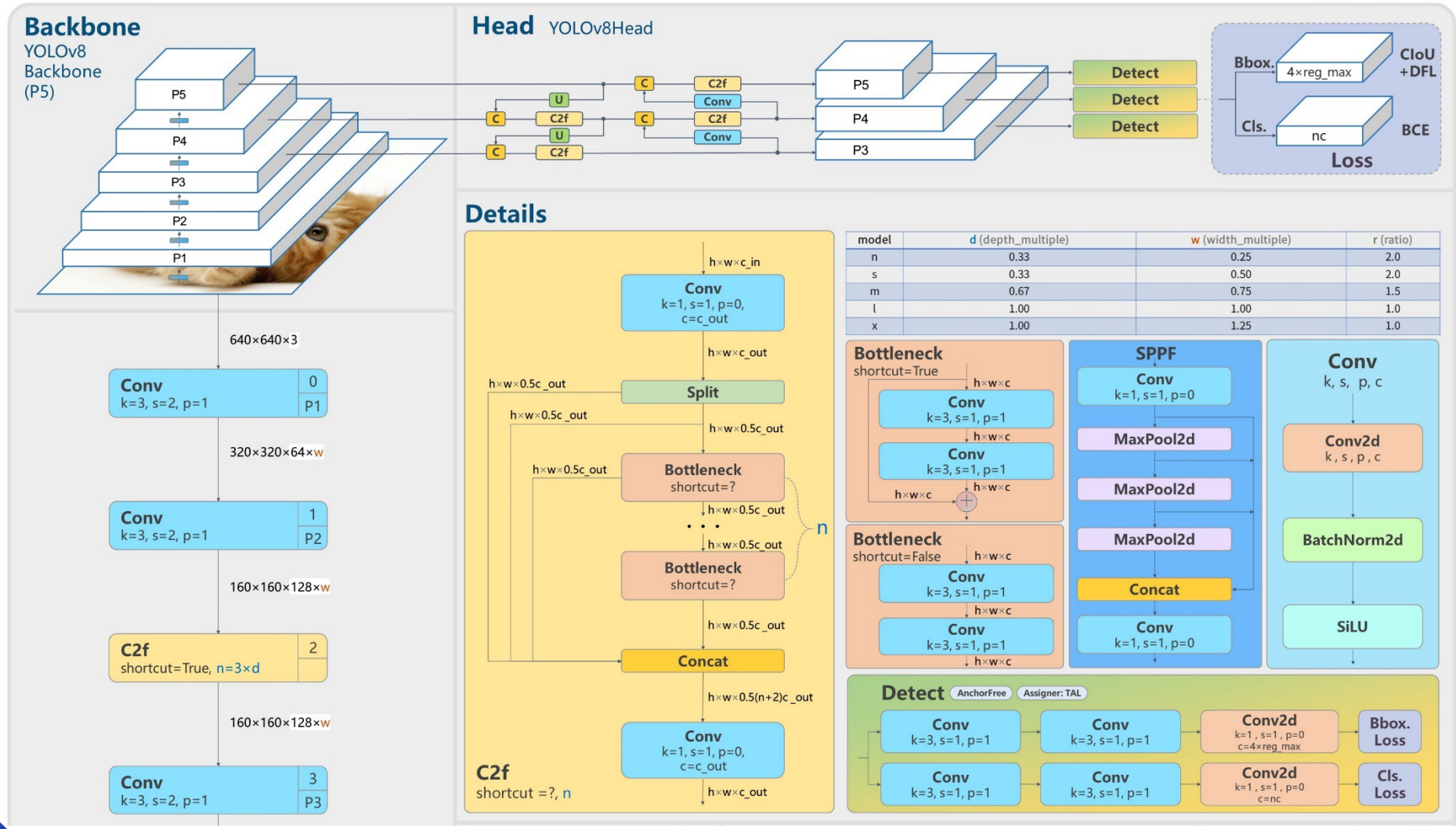
Source: YOLO

❖ YOLO V8

- YOLOv8 uses a similar backbone as YOLOv5 with some changes on the CSPLayer, now called the C2f module.
- The C2f module (cross-stage partial bottleneck with two convolutions) combines high-level features with contextual information to improve detection accuracy

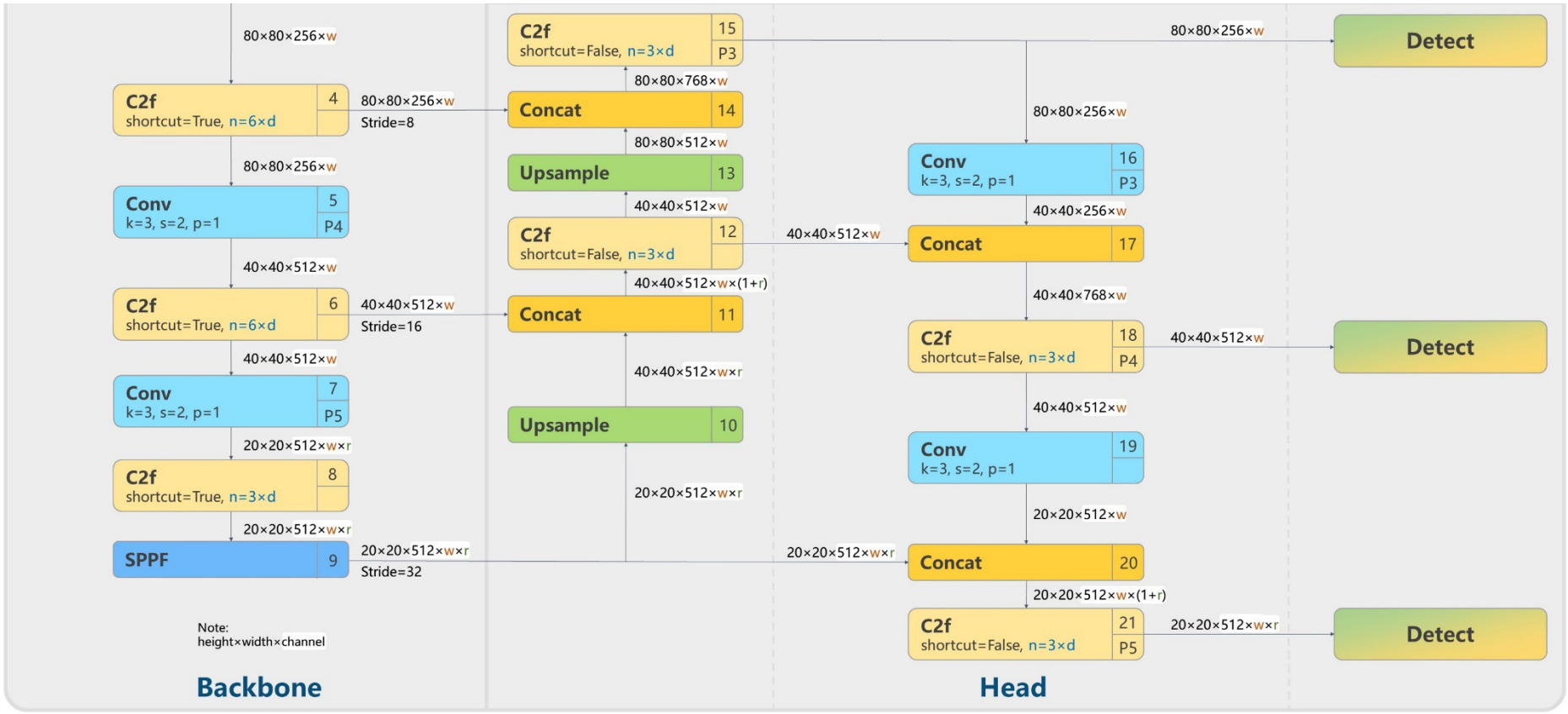
Source: YOLO

YOLO V8 Architecture



Source: YOLO

YOLO V8 Architecture (Cont.)



Source: YOLO

❖ YOLO V8 Experiment

➢ Using this Google Colab:

https://colab.research.google.com/drive/14x7_B44tBvAe8RzuETDVJ14cYWstnT2D?usp=sharing

King Mongkut's University of Technology Thonburi

Exercise

Extract this video into frame and label it into four classes (bus, taxi, car, and pedestrian), then generate the model to classify those four classes using yolov8

King Mongkut's University of Technology Thonburi

Conclusion

- The research focused on utilizing AI technology to augment police efficiency in Thailand.
- We aimed to enhance law enforcement capabilities and bolster public trust in crime prevention measures.
- By employing AI in crime data analysis, leveraging intelligent CCTV technology for crime monitoring, and integrating real-time alerts for suspicious activities to police.

King Mongkut's University of Technology Thonburi

Q&A