



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

Muang Chonburi Police Station

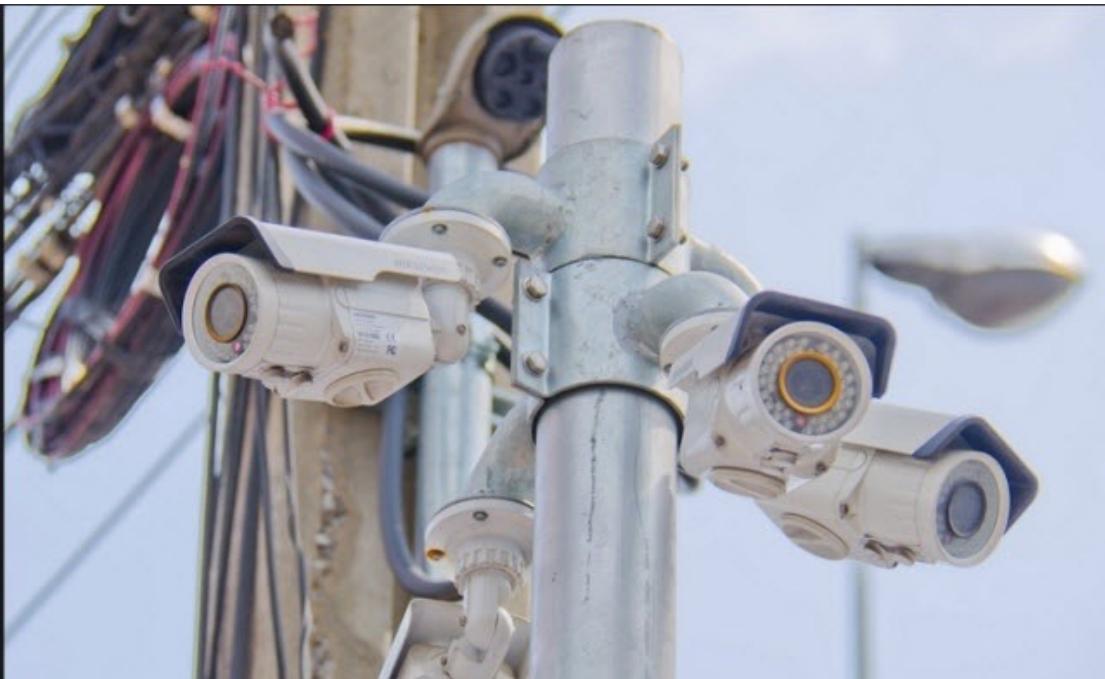
Dr.Thittaporn Ganokratanaa, KMUTT

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.”**

Problem Statement

Big Data Storage



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

Problem Statement

Welcome to Datacrime
<http://www.datacrime-cti.com/>



ระบบฐานข้อมูลบุคคลกลุ่มเสี่ยง ก.จ.จังหวัดชลบุรี

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



Problem Statement

Database of at-risk people

ค้นหาข้อมูลบุคคลกลุ่มเสี่ยง

ค้นหาด้วยคำสำคัญ (Keyword)

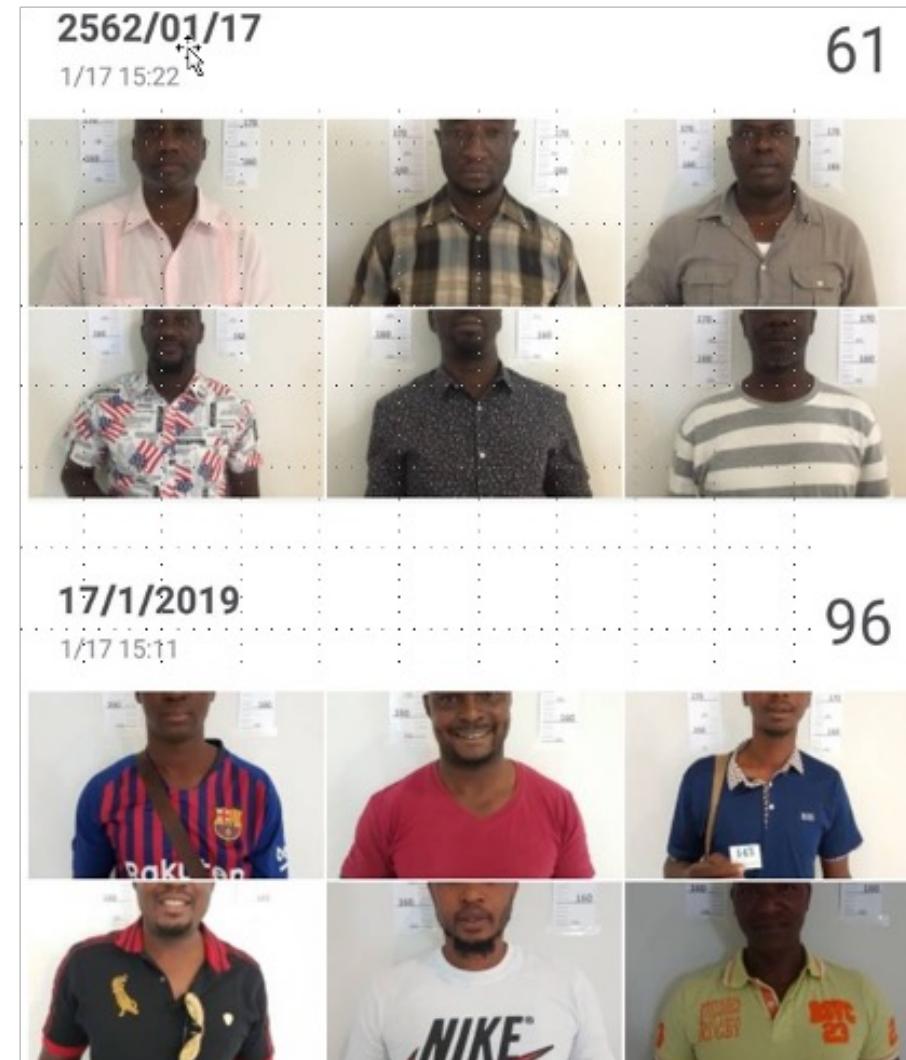
ประเภทข้อมูล 1:
 ชื่อ
 พิมพ์คำที่ต้องการค้นหา

ชนิดของการเชื่อมคำ 1:

ประเภทข้อมูล 2:
 นามสกุล
 พิมพ์คำที่ต้องการค้นหา

ก่อนหน้า ถัดไป เรียนร้อย

ชื่อ
 นามสกุล
 คำนำหน้าชื่อ
 ชื่อเล่น



Problem Statement

A database of offender-risk vehicles

ค้นหาข้อมูลบุคคลกลุ่มเสี่ยง

ค้นหาด้วยคำสำคัญ (Keyword)

ประมวลผล 1:

ชื่อ

พิมพ์คำที่ต้องการค้นหา

ชนิดของการเชื่อมคำ 1:

ประมวลผล 2:

ก่อนหน้า ถัดไป เรียบร้อย

ข้อหา/พฤติกรรมที่เกี่ยวข้อง

ประเภทยานพาหนะ

ยี่ห้อ รุ่น และสียานพาหนะ

ป้ายทะเบียน

2561/11/08 #1 N
2018/11/8



10

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



Problem Statement

Knowledge of Modern Investigations

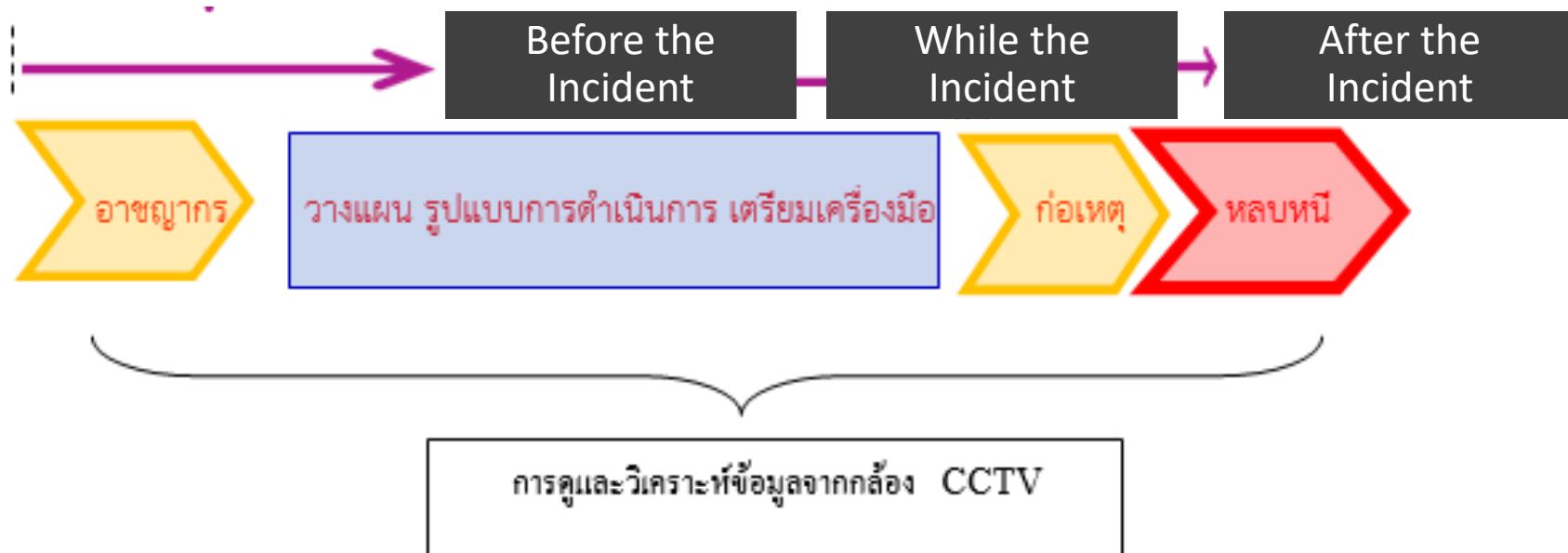
Currently, police officers use investigative knowledge to locate and apprehend criminals, forming the foundation for evidence collection and criminal pursuit. There are 4 elements:

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:



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

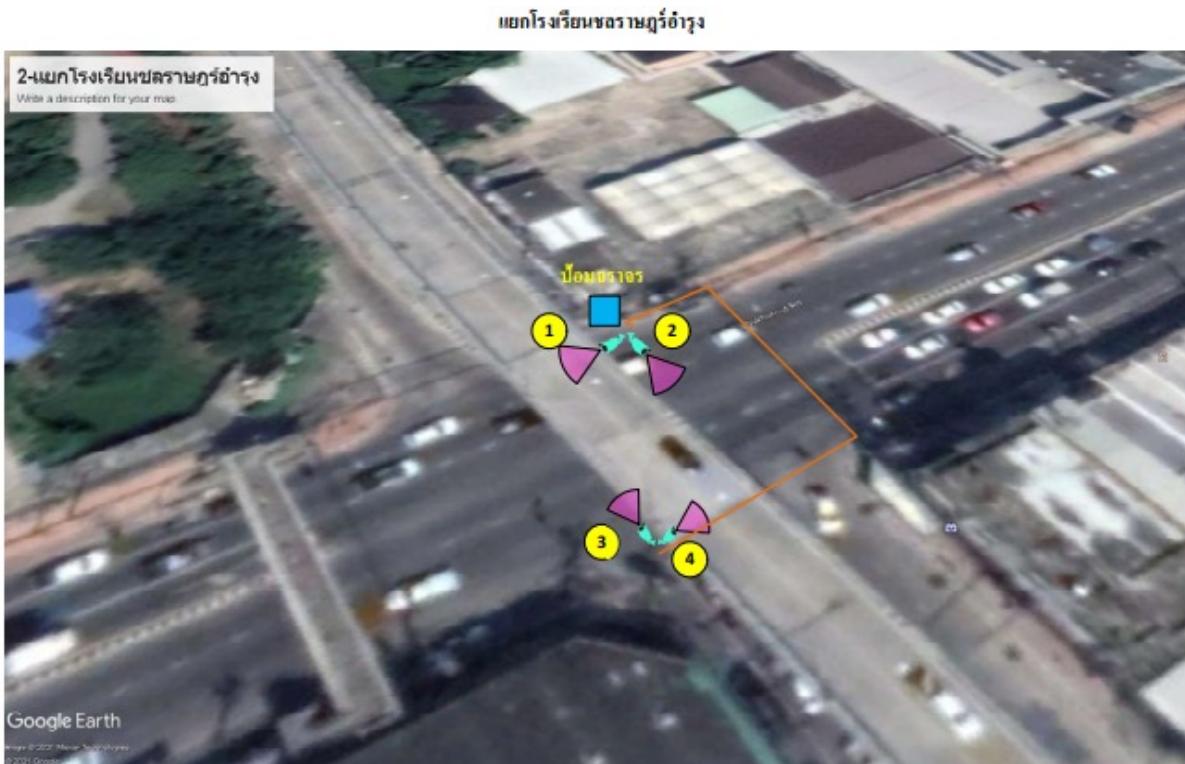
Camera Installation

2. Chalerm Thai intersection - 6 cameras.

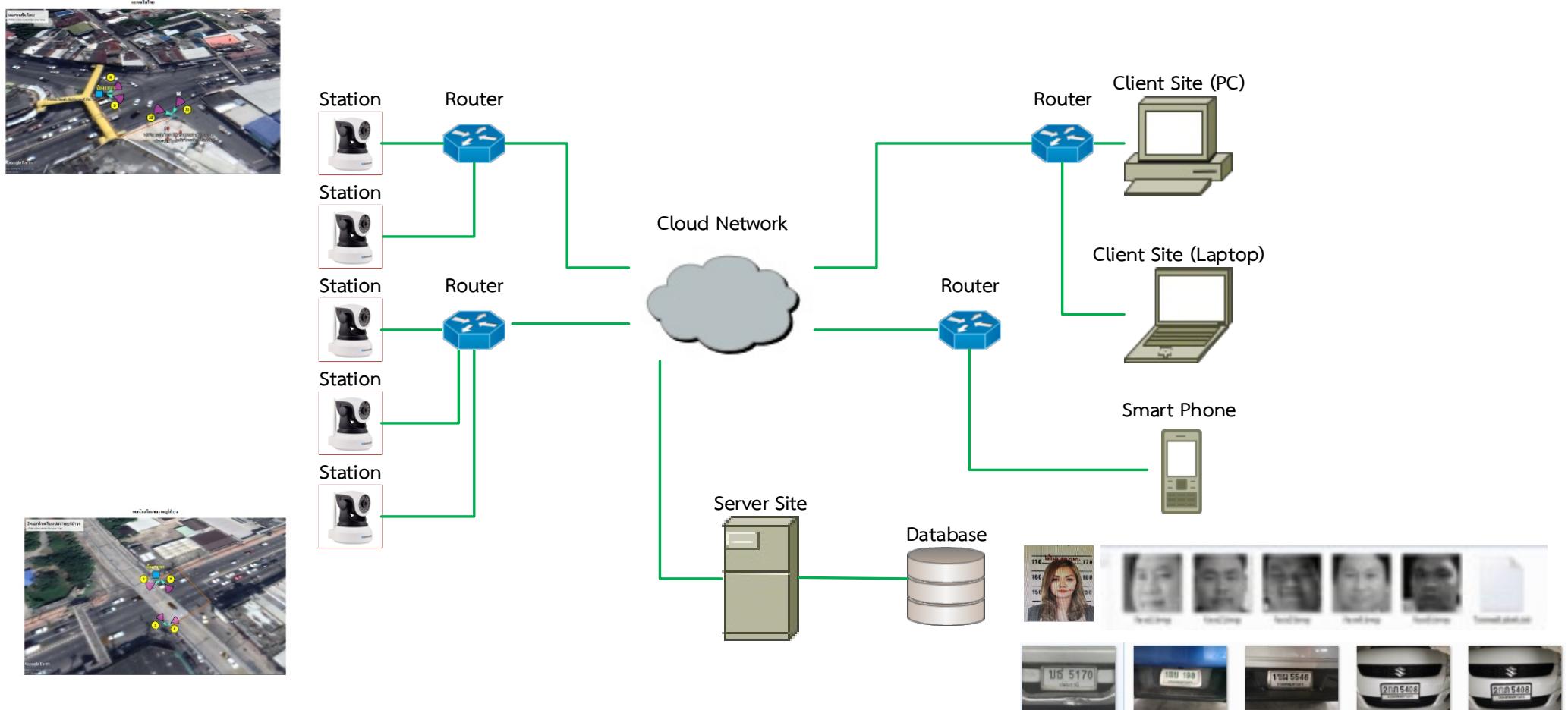


Environment Settings

Camera Installation Location



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

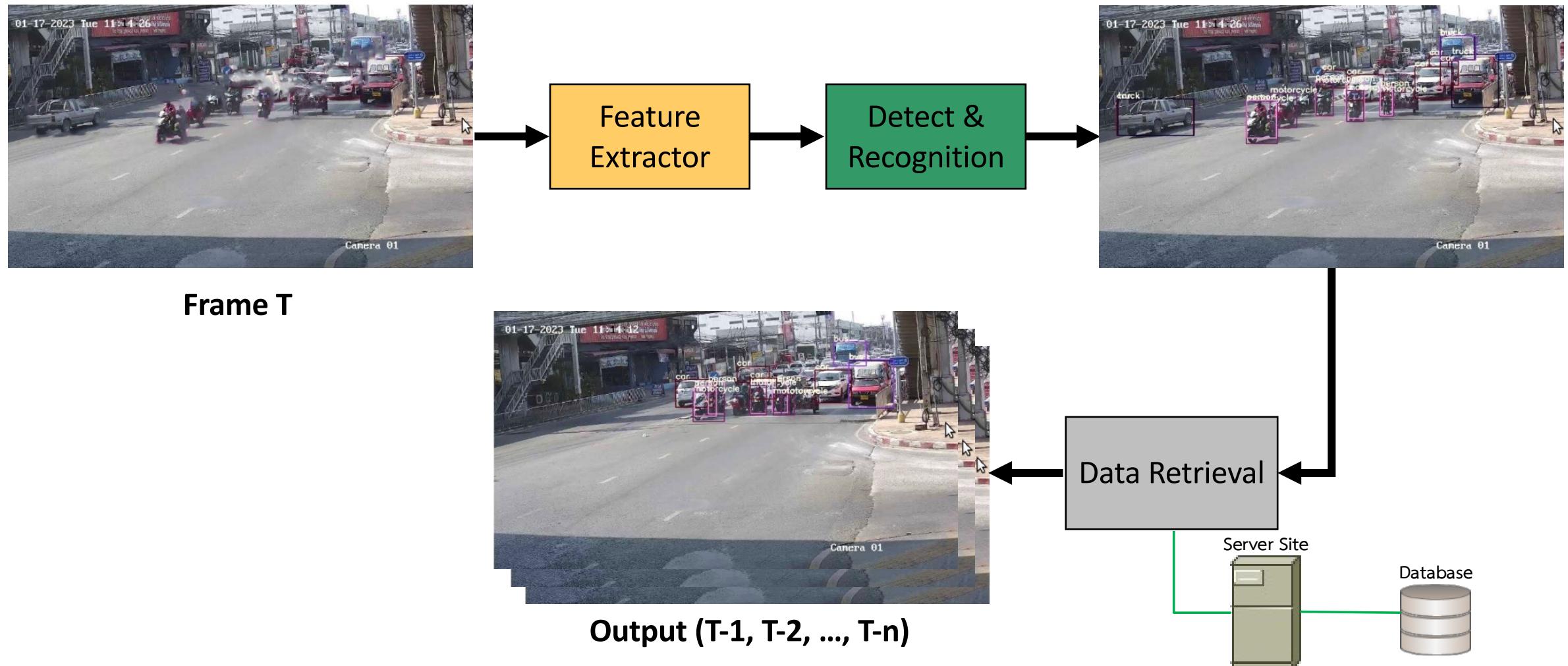


Illustration of the detection, tracking, and recognition procedure

System results

The visual results of system



Examples of results of system

System results

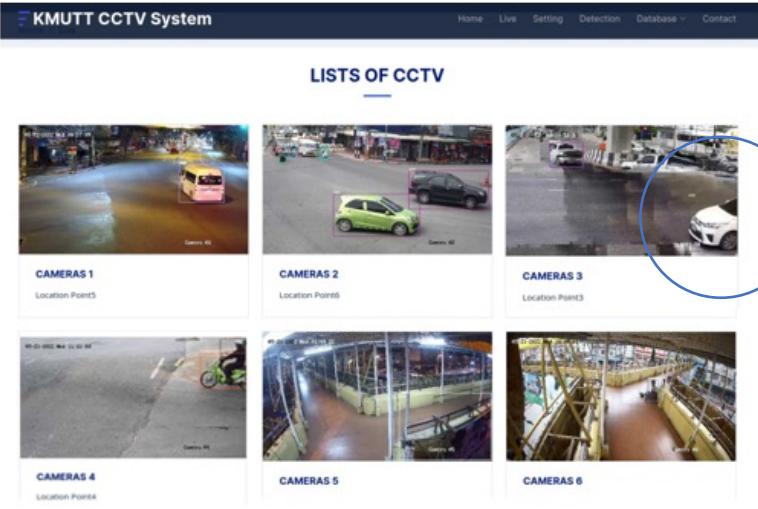
The visual results of system



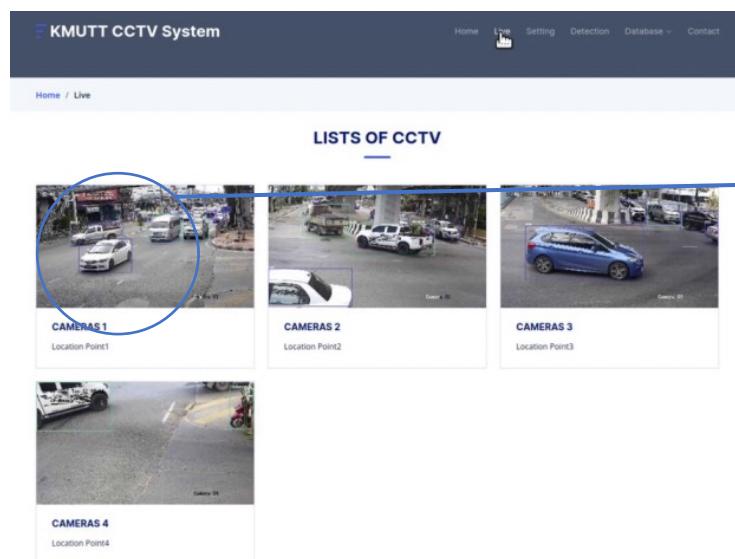
Examples of results of system

System outputs

Criminal Arrest Tracking System



2. แยกเฉลิมที่ไทย



1. แยกชลบุรีอัมรรุง



System outputs

System Operation: Add Face

KMUTT CCTV System

Home Live Setting Detection Database Contact

Home / Face

Add Face

Select a category
Select a category ...

Create New Category

Select a name
Select a name ...

Create New Name

National ID

Province

Image
Browse... No files selected.

Upload Face Go Back



System outputs

System Operation: Add Vehicle

Home / Face

Search

Faces Categories

ALL

- Citizen
- Criminal
- Civil Servant

Add Face



Category: Citizen Name: Sovann

Category: Criminal Name: Animal

Category: Civil Servant Name: Bird

KMUTT CCTV System

Home Live Setting Detection Database Contact

Home / Vehicle

Add Vehicle

Select a category

Select a category ...

Create New Category

Select a name

Select a name ...

Create New Name

Color

Year

License Plate

Image

Browse... No files selected.

Upload Vehicle Go Back

System outputs

System performance

The screenshot shows the KMUTT CCTV System interface. At the top, there's a navigation bar with links for Home, Live, Setting, Detection (which is highlighted), Database, and Contact. Below the navigation is a breadcrumb trail: Home / Detection. On the left, there's a video feed from 'Camera 01' showing a street scene with several cars. Overlays indicate detected vehicles with labels like 'car' and bounding boxes. A timestamp '12-06-2022 Tue' is visible in the top left of the video feed. To the right of the video are two sections: 'Face' and 'Vehicle'. The 'Face' section contains two video thumbnail icons with placeholder data for names, national IDs, and provinces. The 'Vehicle' section also has two video thumbnail icons and displays detailed information for a detected vehicle: a white Suzuki car from 2012 with license plate 5408, located at Chonradsadornnumrung.

System outputs

System performance

KMUTT CCTV System

Home Live Setting Detection Database Contact

Home / Detection

Select Cameras Position Confirm

12-06-2022 Tue 12:40:39

person person person

Face

Vehicle

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

Category:
Name:
National ID:
Province:

Category:
Name:
Color:
Year:
License
Location:

Category:
Name:
Color:
Year:
License
Location:

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

KMUTT CCTV System

Smart CCTV enables remote monitoring of a home or property, connecting to a device such as a smartphone or tablet even when away from the premises.

Contact Us

CCTV

System outputs

System performance

The screenshot shows the KMUTT CCTV System web interface. The header includes the logo and navigation links: Home, Live, Setting, Detection, Database, and Contact. Below the header, the breadcrumb navigation shows Home / Setting. The main content area is titled "Cameras Setting". It features two sections: "Add Camera" on the left with input fields for Username, Password, Ipaddress, Port, Channel, and Location, and "Camera Information" on the right, which is a table listing four camera entries with columns for ID, Location, Username, IP Address, Port, Channel, and Action (Edit and Delete buttons).

ID	Location	Username	IP Address	Port	Channel	Action
1	Point1	admin	192.168.100.100	554	3	<button>Edit</button> <button>Delete</button>
2	Point2	admin	192.168.100.101	554	3	<button>Edit</button> <button>Delete</button>
3	Point3	admin	192.168.100.102	554	3	<button>Edit</button> <button>Delete</button>
4	Point4	admin	192.168.100.103	554	3	<button>Edit</button> <button>Delete</button>

Add Camera

Username:

Password:

Ipaddress:

Port:

Channel:

Location:

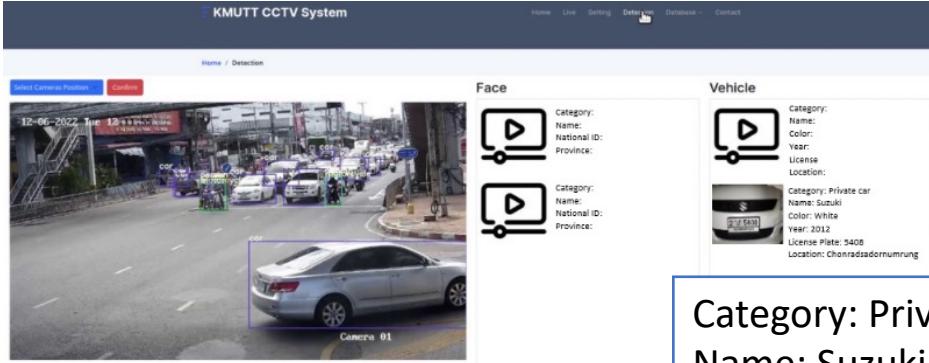
Add IPcamera

Camera Information

ID	Location	Username	IP Address	Port	Channel	Action
1	Point1	admin	192.168.100.100	554	3	<button>Edit</button> <button>Delete</button>
2	Point2	admin	192.168.100.101	554	3	<button>Edit</button> <button>Delete</button>
3	Point3	admin	192.168.100.102	554	3	<button>Edit</button> <button>Delete</button>
4	Point4	admin	192.168.100.103	554	3	<button>Edit</button> <button>Delete</button>

System impacts

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. ผลการทดสอบของระบบการจัดเก็บข้อมูลบุคคลกลุ่มเดี่ยว และ ยานพาหนะต้องส่งสัญผ่านโทรศัพท์ Smart phone	96
2. ผลการทดสอบของระบบแจ้งเตือนคำหนีรูปพรรณรถ และ หมายเลขทะเบียนรถ (License plate)	90
3. ผลการทดสอบของระบบแจ้งเตือนคำหนีรูปพรรณคนร้าย และ หมายเลขจีบ (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

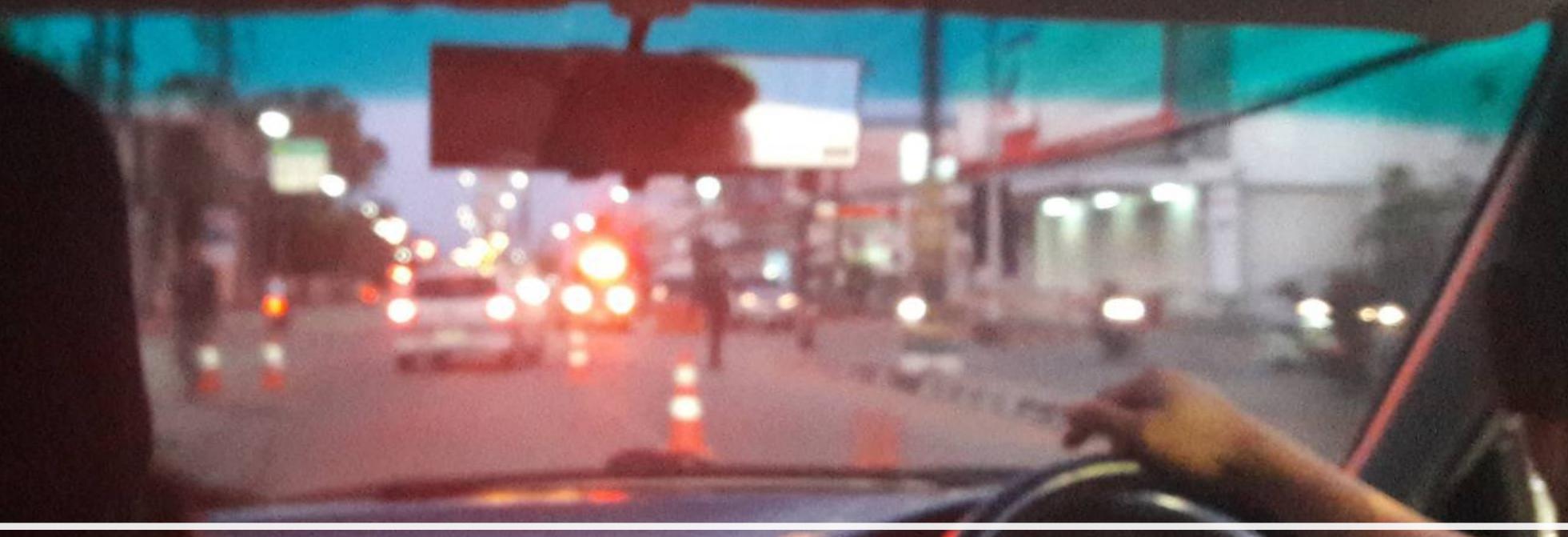


High-angle shot of Narathiwat Province





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.

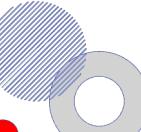
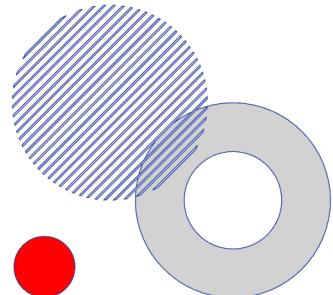
Q&A

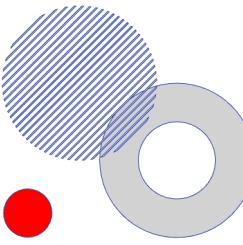
Thittaporn.gan@kmutt.ac.th



Real-Time Object Detection

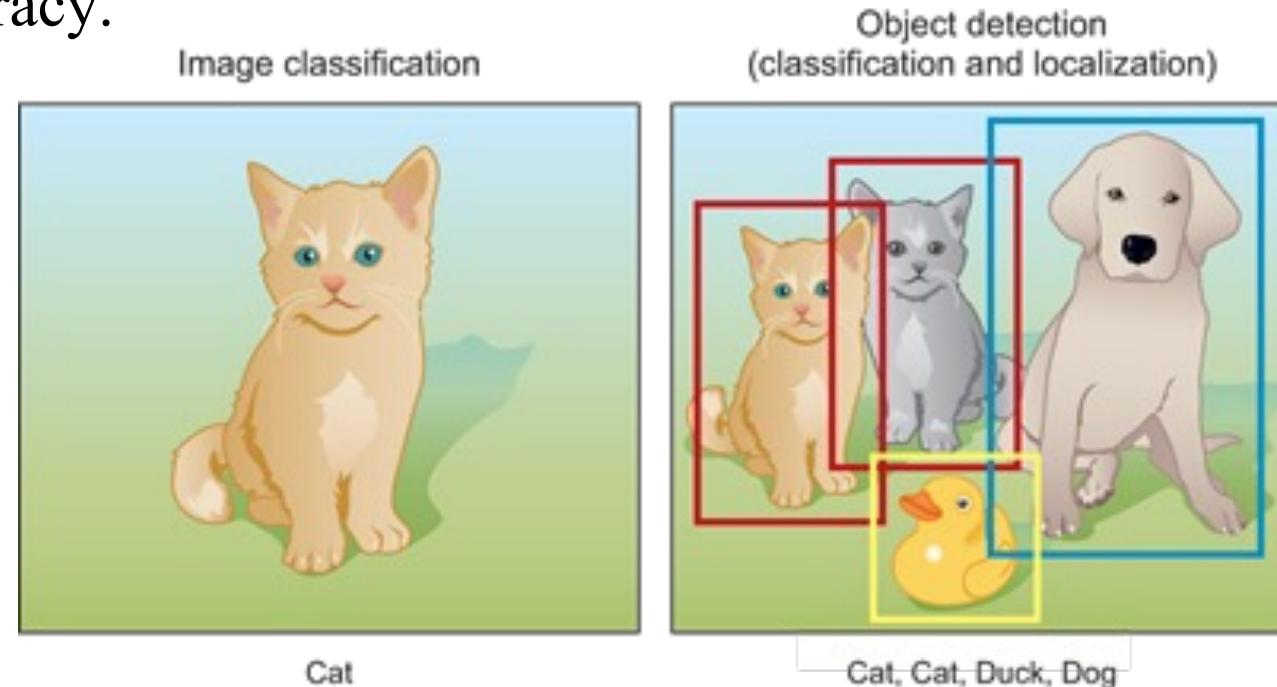
Lecturer: Dr. Thittaporn Ganokratanaa

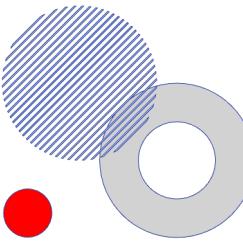




❖ Problem Addressed: Object Detection

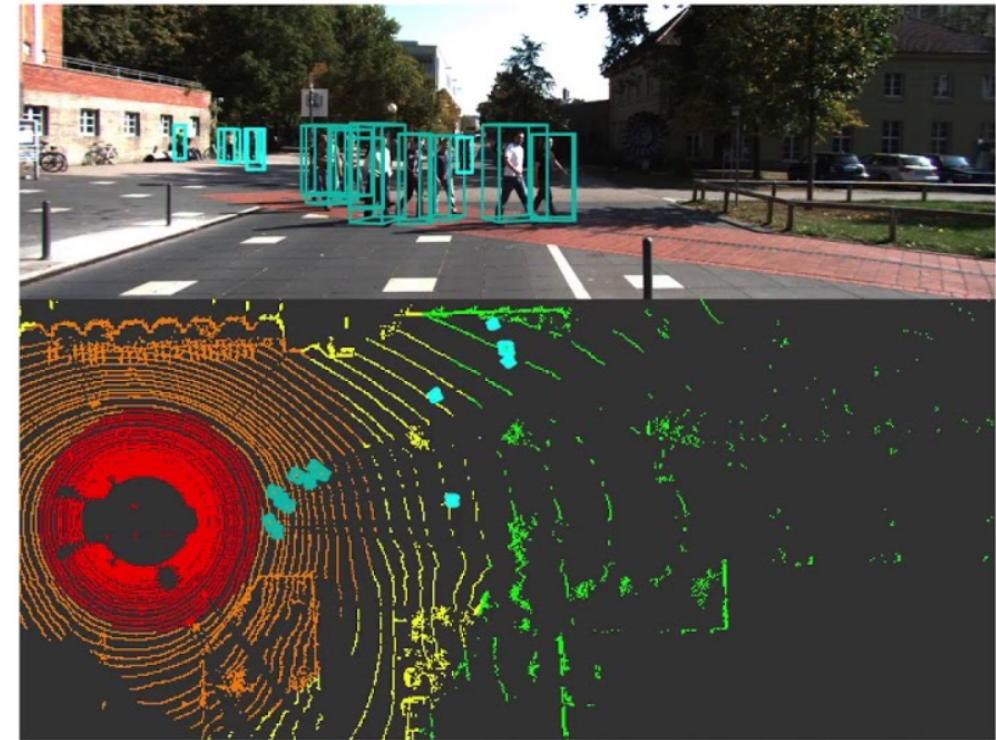
- Object detection is the problem of both locating AND classifying objects
- Goal of object detection algorithm is to do object detection both fast AND with high accuracy.

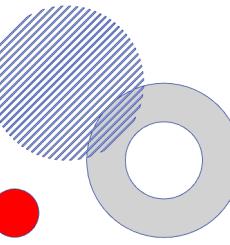




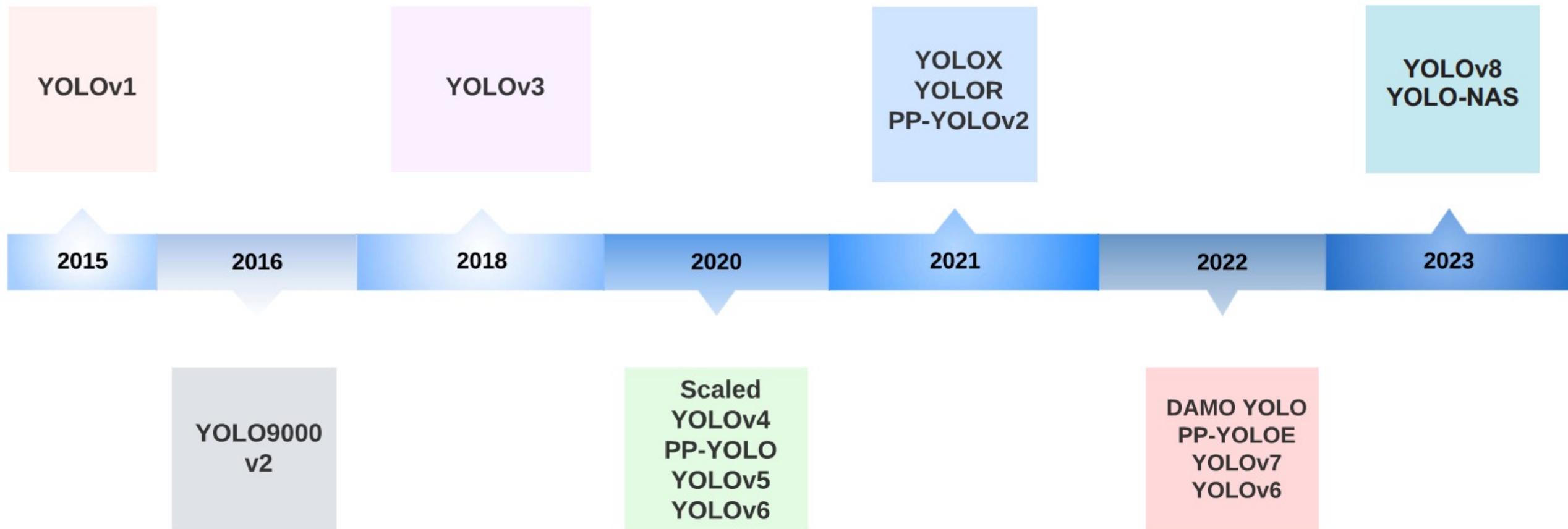
❖ Importance of Object Detection

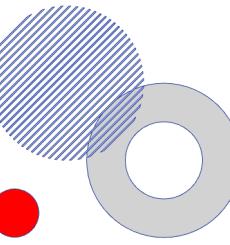
- Visual modality is very powerful
- Humans are able to detect objects and do perception using just this modality in real-time (not needing radar)
- If we want responsive robot systems that work real-time (without specialized sensors), almost real-time vision based object detection can help greatly.





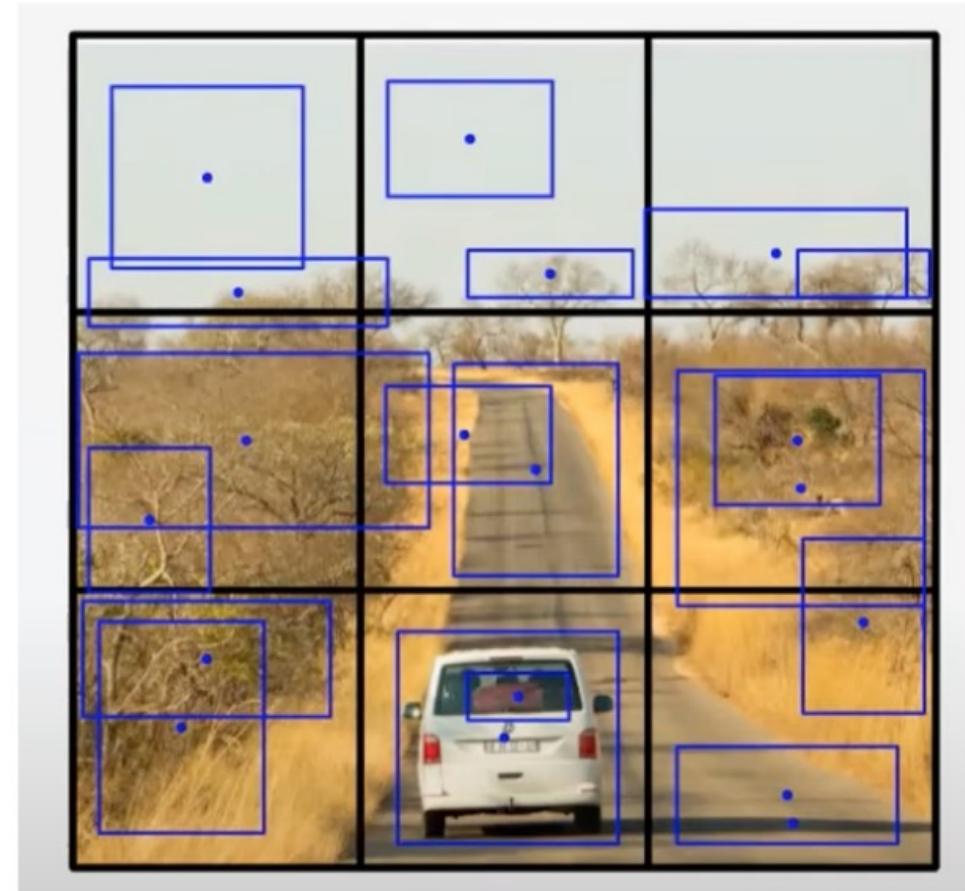
❖ A timeline of YOLO versions





❖ YOLO Overview

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

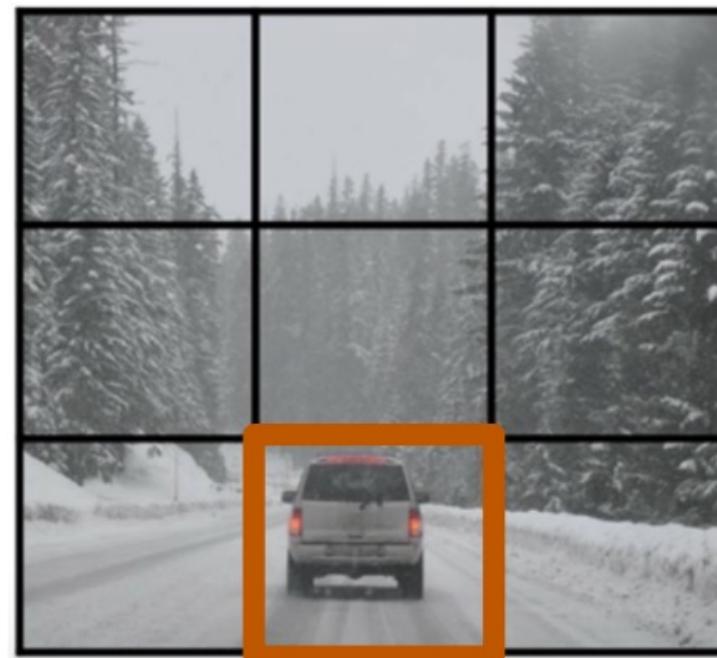


$$S = 3, B = 2$$

❖ 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

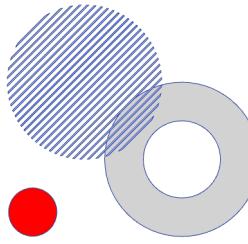
For each grid block, we have a vector like this. For this example B is 2 and C is 2



GT label
example:

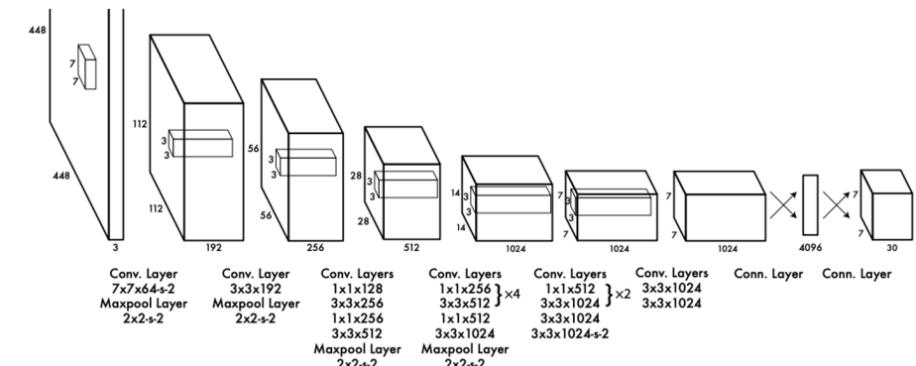
p_1
b_x_1
b_y_1
b_h_1
b_w_1
p_2
b_x_2
b_y_2
b_h_2
b_w_2
c_1
c_2

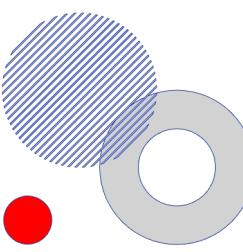
1
b_x_1
b_y_1
b_h_1
b_w_1
0
?
?
?
?
c_1 = 1
c_2 = 0



❖ YOLO Architecture

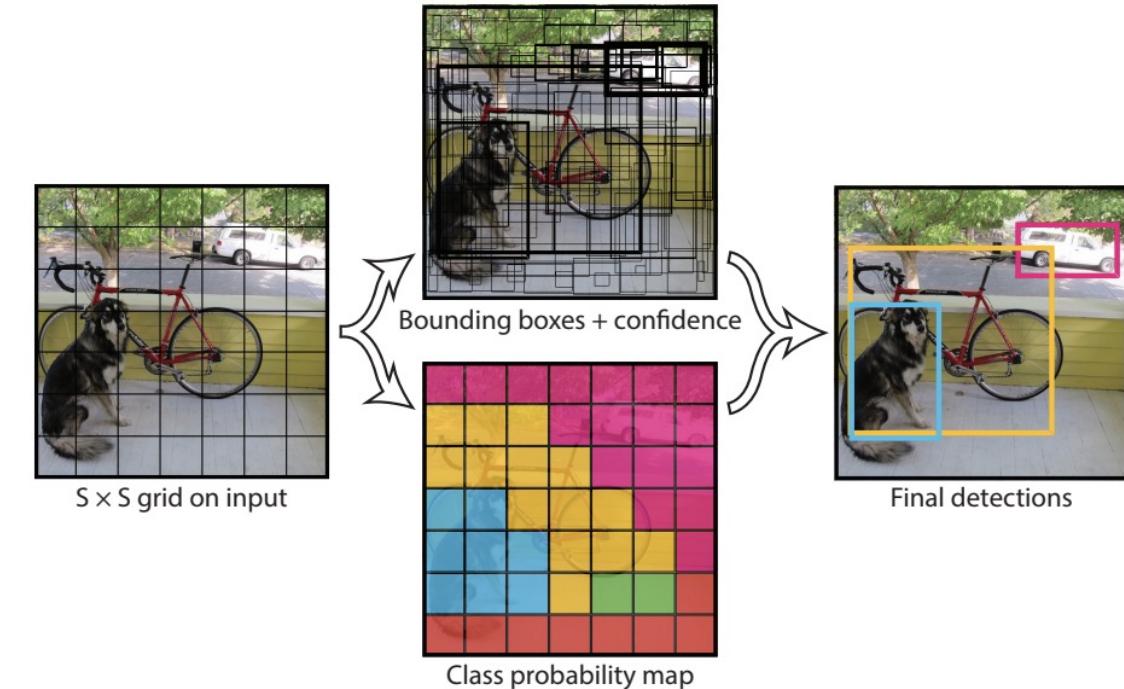
- Now that we know the input and output, we can discuss the model
- We are given 448 by 448 by 3 as our input.
- Implementation uses 7 convolution layers
- Paper parameters: S = 7, B = 2, C = 20
- Output is $S*S*(5B+C) = 7*7*(5*2+20) = 7*7*30$



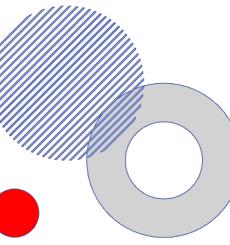


❖ Non-maximal suppression

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

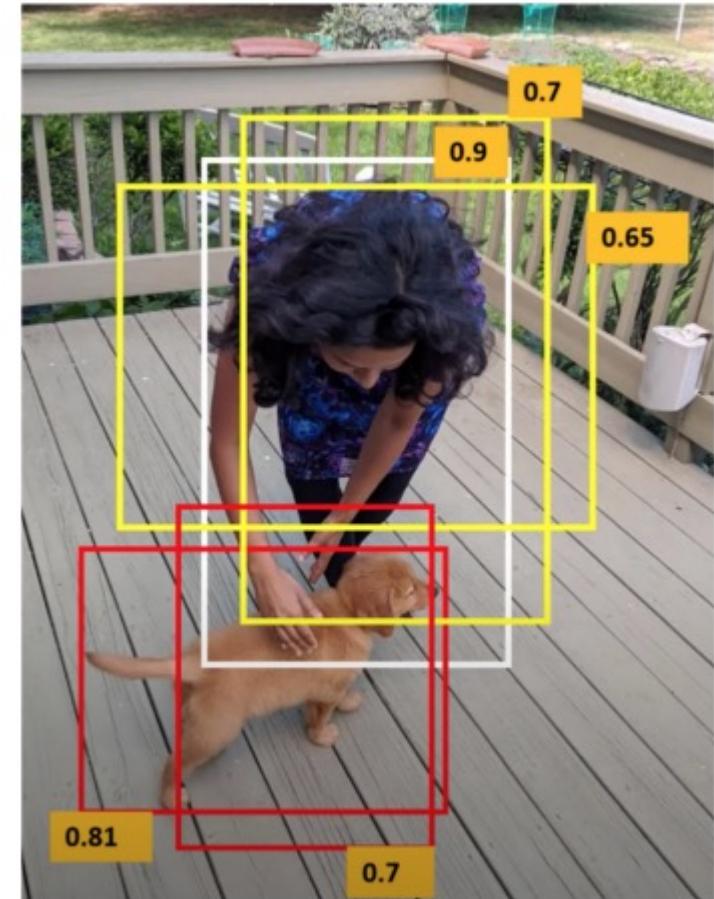


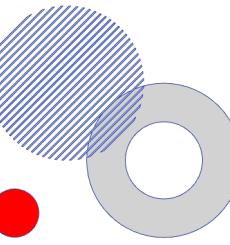
$$\Pr(\text{Class}_i|\text{Object}) * \Pr(\text{Object}) * \text{IOU}_{\text{pred}}^{\text{truth}} = \Pr(\text{Class}_i) * \text{IOU}_{\text{pred}}^{\text{truth}}$$



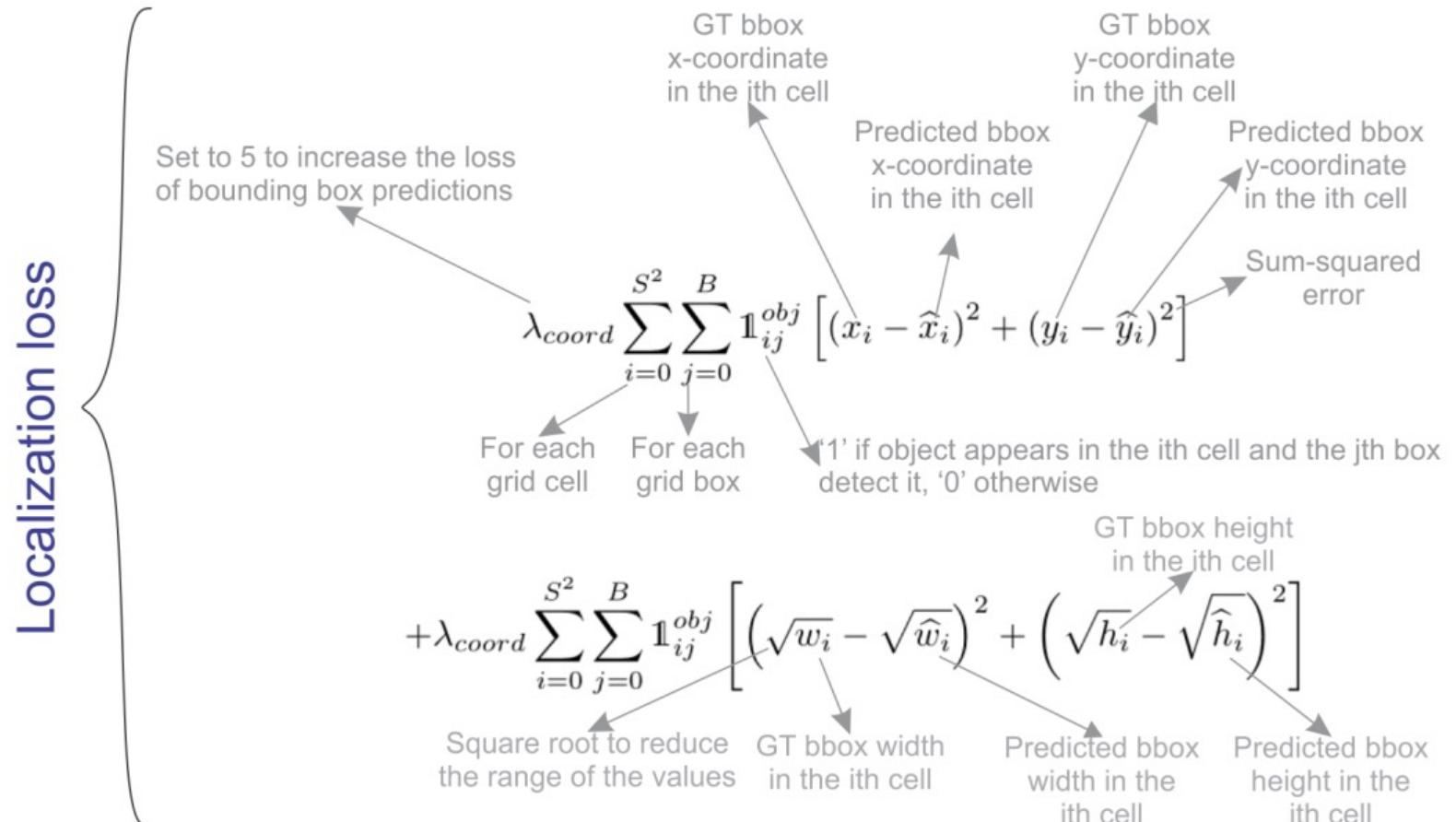
❖ YOLO Prediction

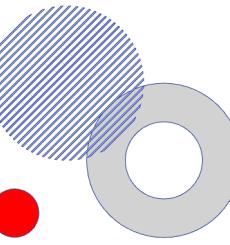
- Most of the time objects fall in one grid, however it is still possible to get redundant boxes (rare case as object must be close to multiple grid cells for this to happen)
- Discard bounding box with high overlap (keeping the bounding box with highest confidence)
- Adds 2-3% on final mAP score





❖ YOLO Objective Function





❖ YOLO Objective Function (Cont.)

Confidence loss

$$\begin{aligned}
 & + \sum_{i=0}^{S^2} \sum_{j=0}^B \mathbf{1}_{ij}^{obj} \left[(C_i - \hat{C}_i)^2 \right] \\
 & + \lambda_{noobj} \sum_{i=0}^{S^2} \sum_{j=0}^B \mathbf{1}_{ij}^{noobj} \left[(C_i - \hat{C}_i)^2 \right]
 \end{aligned}$$

Set to 0.5 to decrease the loss for empty boxes

'1' if there is no object in the ith cell, '0' otherwise

GT confidence score Predicted confidence score

Confidence error when an object is detected in the ith cell

Confidence error when an object not detected in the ith cell

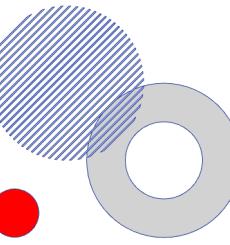
Classification loss

$$\begin{aligned}
 & + \sum_{i=0}^{S^2} \mathbf{1}_i^{obj} \sum_{c \in classes} \left[(p_i(c) - \hat{p}_i(c))^2 \right]
 \end{aligned}$$

For each grid cell For each class

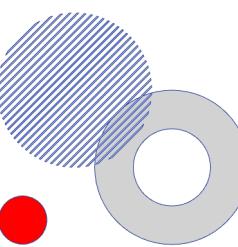
Predicted conditional probability of an object of class c appearing in the ith cell

GT conditional probability of class c appearing in the ith cell

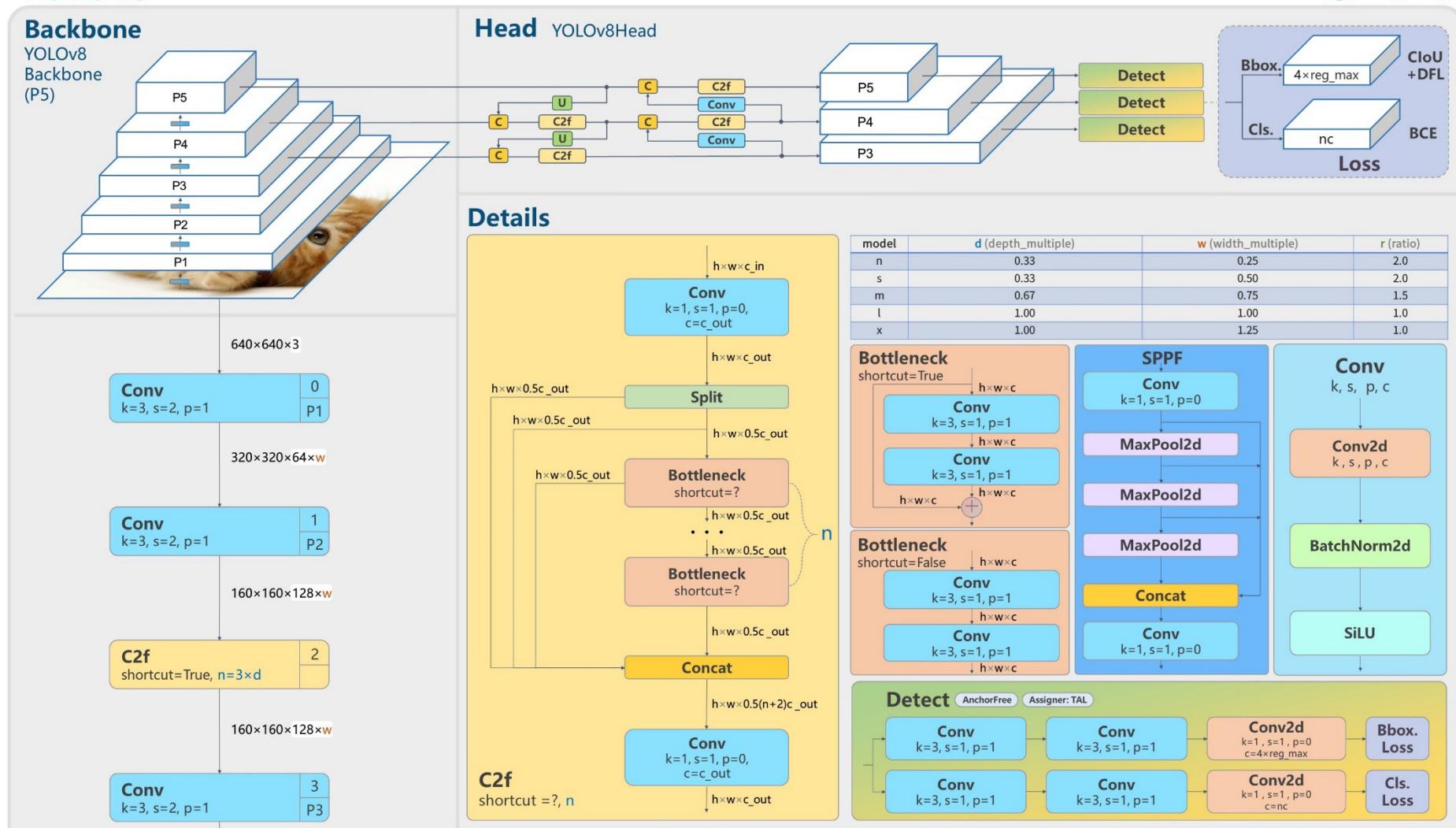


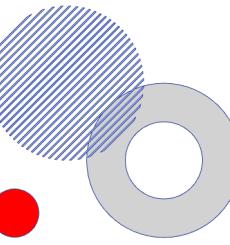
❖ YOLO V8

- 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

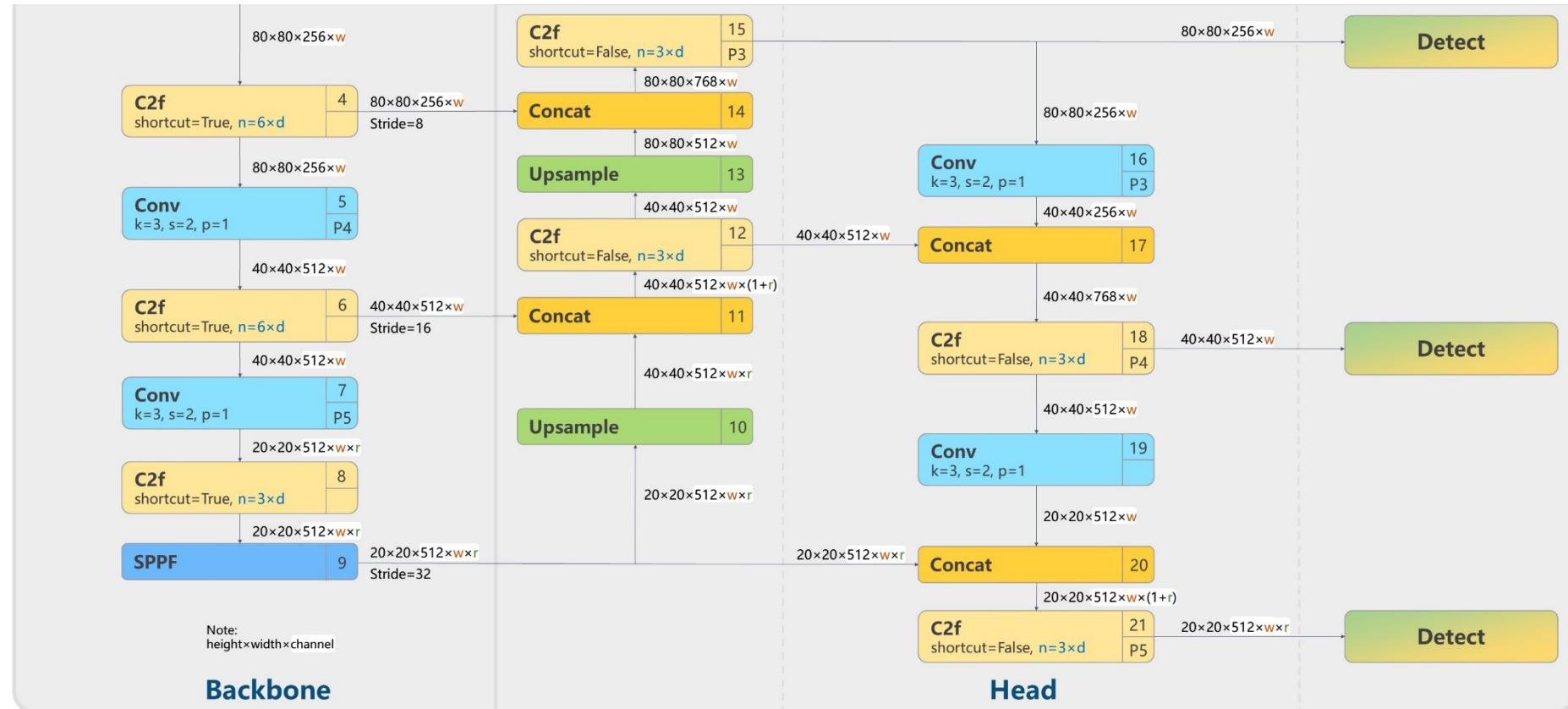


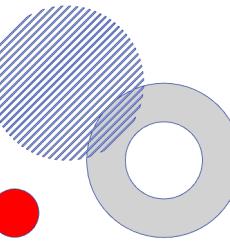
❖ YOLO V8 Architecture





❖ YOLO V8 Architecture (Cont.)





❖ YOLO V8 Experiment

➤ Using this Google Colab:

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

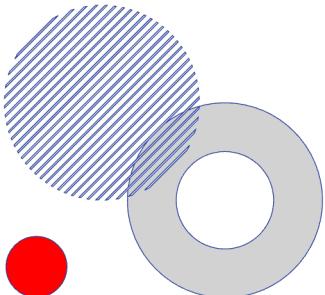
Exercise

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



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.



Q&A

