ASIAN INSTITUTE OF TECHNOLOGY

Department of Industrial System Engineering

Proposal Presentation on

LICENSE PLATE RECOGNITION IN LOW LIGHTING USING CLAHE-ENHANCED TWO-STAGE YOLOv8 PIPELINE

Presenter:
Rabin Karki (st125993)

1.Introduction

- VLPR is critical for traffic management, toll collection and securing big organizations and campuses.
- Manual Monitoring of vehicles is inefficient.
- Need for an automated vehicle registration recognition system using computer vision.

2. Problem Statement

- Number Plates are hard to detect at low light.
- System struggles to detect plates when two vehicles arrive together.
- Vehicles moving quickly through the gate reduce the clarity of the captured frame.

Secondary Challenges

- Thai License Plate complex Layout for standard OCR extractors.
- Distinction between similar characters like “8” vs “0” or “B” vs “8”.

3. Objective

Main Objective

- To recognize the vehicle registration number of Thai license plate using CLAHE-Enhanced Two Stage YOLOv8 pipeline

Specific Objective

- To implement CLAHE to improve visibility in nighttime images.

- To replace standard OCR with a Two-Stage YOLOv8 Pipeline (Detection + Recognition) to eliminate classification errors.

4. Literature Review

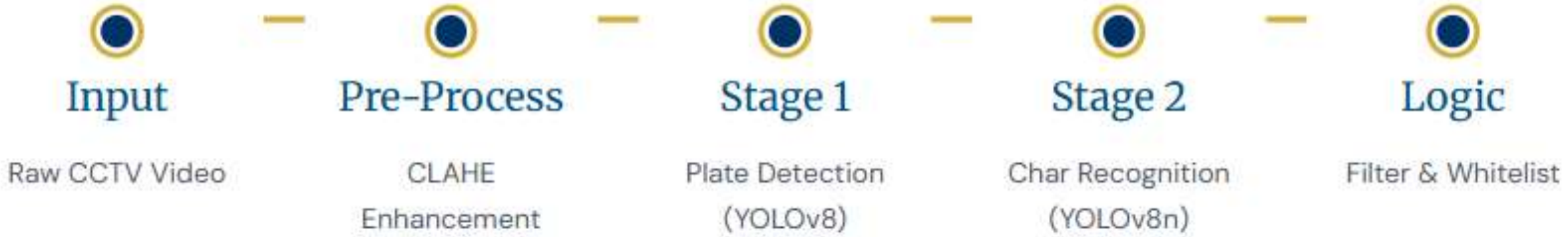
- Number Plate recognition system often faces challenges in low-light environments.
  (*PMC, 2021*)

- Input images have different types of illumination, mainly due to environmental lighting and vehicle headlights.
  (*IEEE Transactions on circuits and systems for video technology, 2013*)

- Recognizing multiple vehicles becomes more challenging as some plates will have a smaller size or low resolution, and different background colors.
  (*EURASIP Journal on Image and Video Processing, 2021*)

- The Histogram equalization (Contrast Limited adaptive Histogram Equalization) was most effective for enhancing the license plates, improving the edge sharpness and revealing the plates hidden in shadows.
  (*Romanian Journal of Information Technology and Automatic Control*)

5. Methodology: System Architecture




```
PROVINCE_CLASSES_TO_IGNORE = [
    'BKK', 'CRI', 'CBT', 'CPM', 'KBI', 'KPT', 'KSN', 'LEI',
    'LPG', 'LPN', 'NAN', 'NBI', 'NBP', 'NKI', 'NPT', 'NSN',
    'PBI', 'PCT', 'PKN', 'PLG', 'PLK', 'PNA', 'PMB', 'PRE',
    'PTE', 'PTN', 'PWO', 'RBR', 'RET', 'ACR', 'AYA'
]
```

```
DIGIT_CLASSES = ['0', '1', '2', '3', '4', '5', '6', '7', '8', '9', '|']
```

6. System Configuration & Runtime Settings

```
# Main settings
frame_skip = 3
confidence_threshold = 0.3
enable_display = True

# Low Light Enhancement Settings
enable_low_light_enhance = True
clahe_clip_limit = 2.0          # CLAHE contrast limit
clahe_tile_size = (8, 8)        # CLAHE tile grid size
display_size = (480, 360)       # Frame display size
```

- **Frame Skip(3):** Process every 3rd frame to optimize real-time performance without missing slow-moving vehicles.

- **Confidence Threshold (0.3):** Balanced to maximize Recall (detecting dirty/dim plates) while relying on Stage 2 logic to filter false positives.

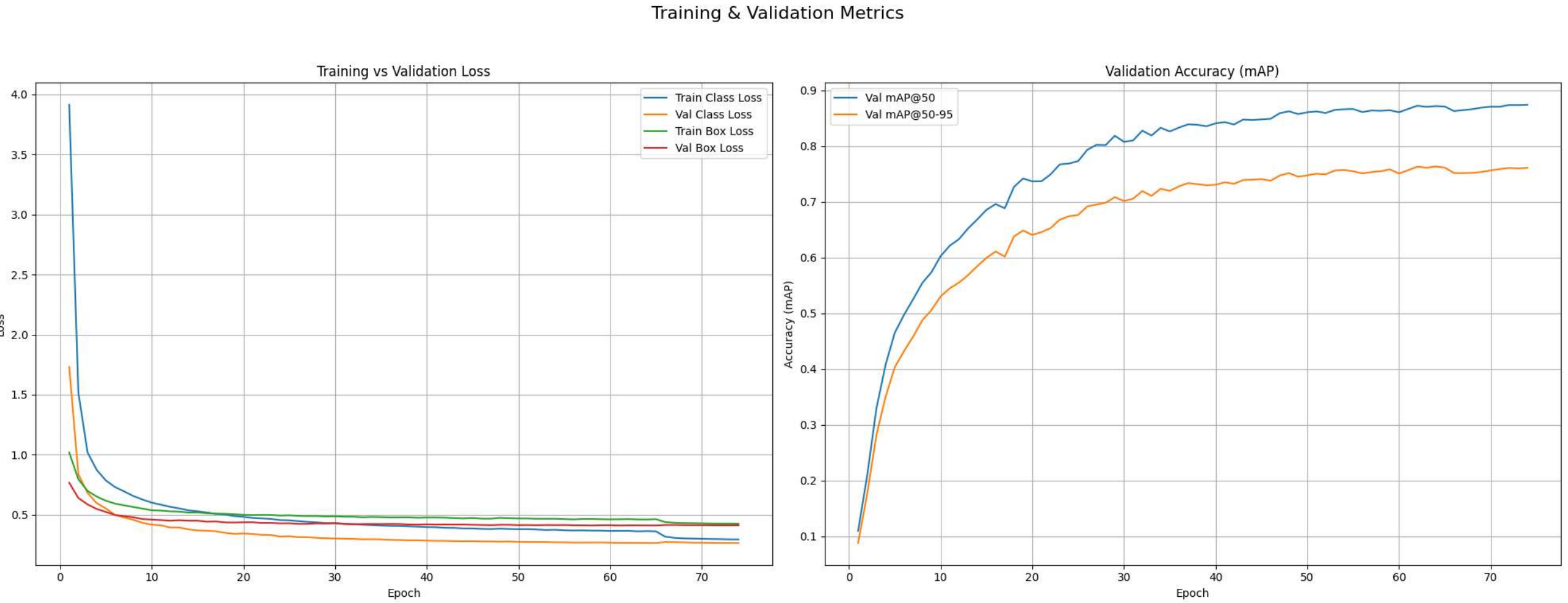
- **CLAHE Clip Limit (2.0):** Prevents the histogram equalization from over-amplifying background noise in extremely dark scenes.

7. Experimental Setup

- **Training Configuration**

- Model: YOLOv8n (Nano)
- Hardware: Google Colab T4-GPU
- Training Data: 7260 images (Roboflow)
- Testing Data: 138 CCTV Video Frames
- Epochs: 75 (SGD Optimizer)

8. Experimental Results

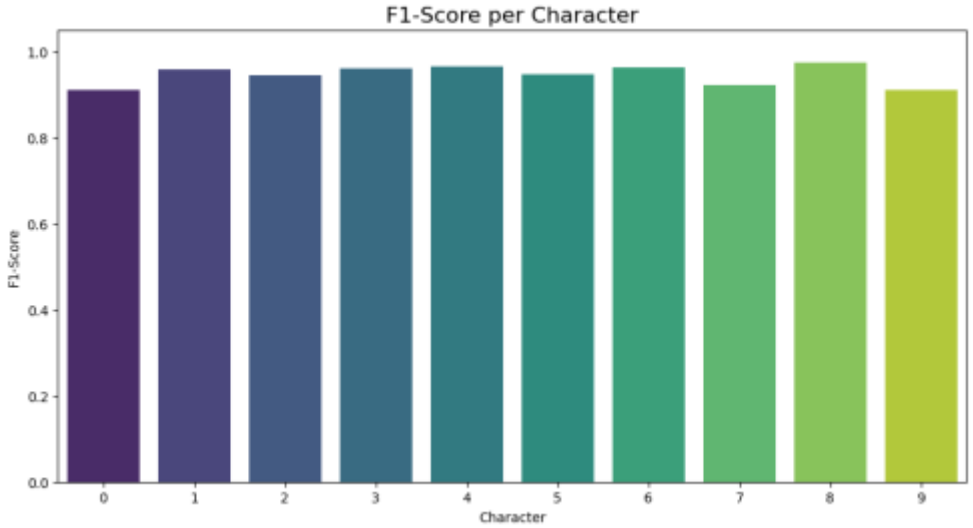


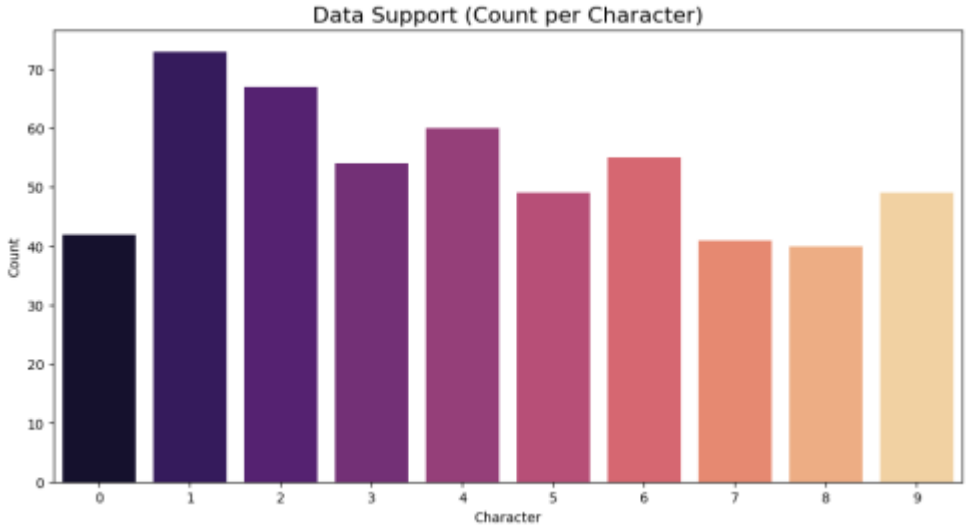
8. Quantitative Results

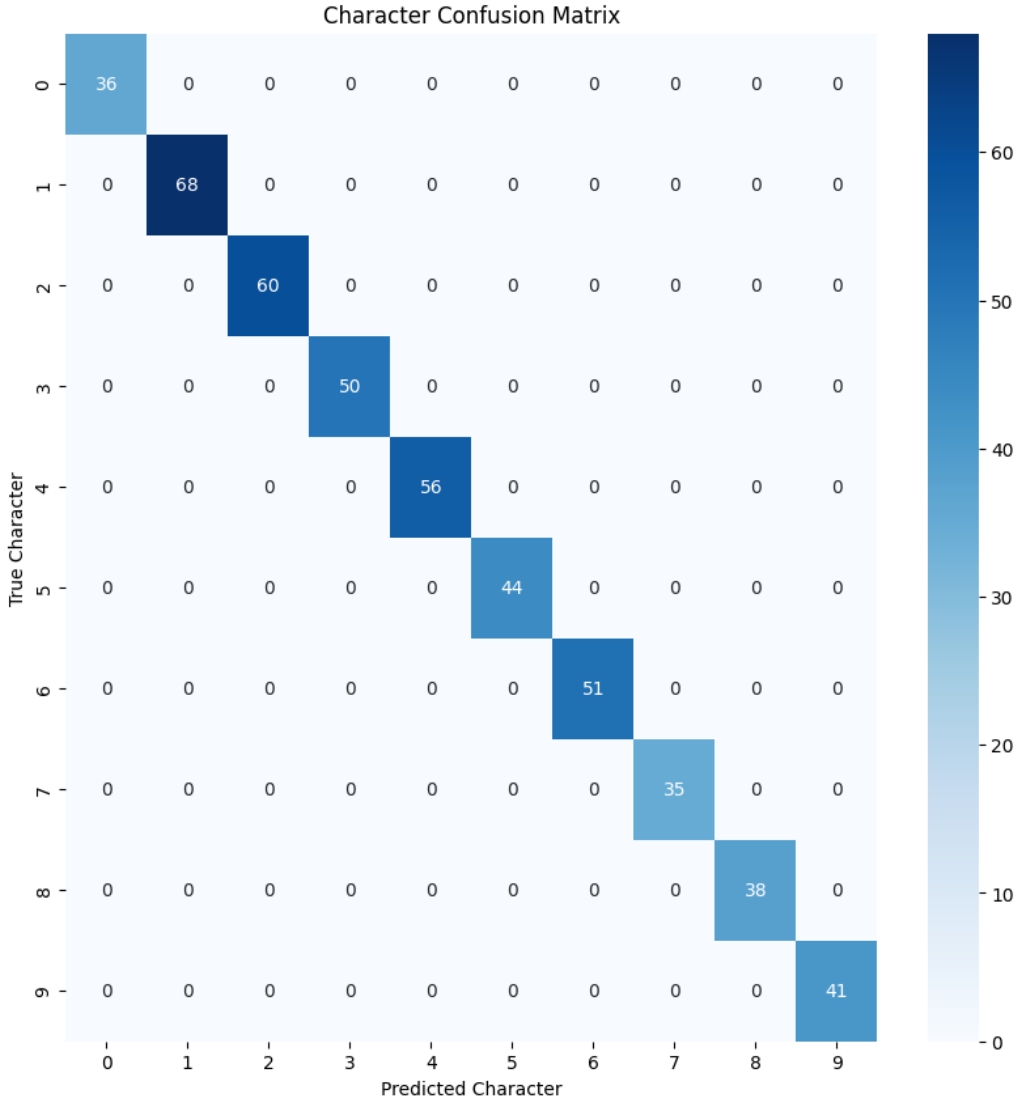
- The model achieved a **Weighted Average Precision of 1.00** on the test set of 530 characters.

Class	Precision	Recall	F1-Score	Support
0	0.97	0.86	0.91	42
1	0.99	0.93	0.96	73
2	1.00	0.90	0.94	67
3	1.00	0.93	0.96	54
4	1.00	0.93	0.97	60
5	1.00	0.90	0.95	49
6	1.00	0.93	0.96	55
7	1.00	0.85	0.92	41
8	1.00	0.95	0.97	40
9	1.00	0.84	0.91	49
Micro Average	1.00	0.90	0.95	530
Macro Average	1.00	0.90	0.95	530
Weighted Average	1.00	0.90	0.95	53

9. Visual Results





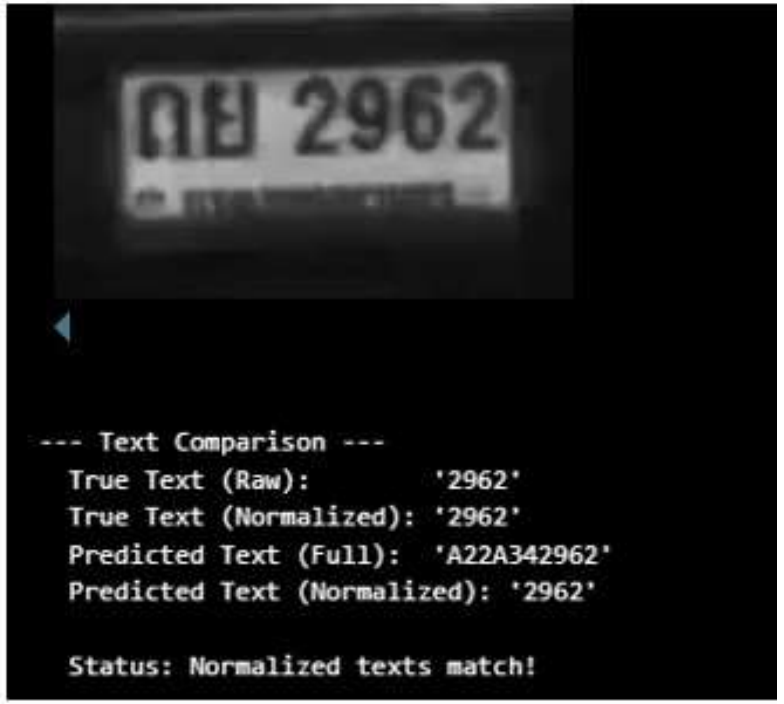


10. Ablation Study

Configuration	Result / Observation
YOLOv8 + Raw Image	Fails in dark; no plate detected.
YOLOv8 + CLAHE	Plate detected; characters unclear.
CLAHE + Easy OCR	Incorrect characters; 8/9 confusion.
CLAHE + Custom YOLOv8	Accurate but includes province text.
CLAHE + Custom YOLO + Logic	**Best accuracy; clean numeric output.**

11. Visual Analysis

- The system logic successfully filters out noise (Thai characters) and normalizes the prediction to digits only.



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THANK YOU