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PBL Presentation

Advanced Vehicle Authorization Management System Using Vehicle Number Plate Recognition (VNPR)

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Contents

Introduction

🚗**Importance of Authorized Vehicle Parking**

- In college campuses, universities, offices, and government institutions, managing authorized parking is essential for security and space efficiency.
- Traditional vehicle verification methods are slow, error-prone, and often allow unauthorized access.

⚠ **Problem Statement:** There is a need for an automated system that can quickly detect vehicles, recognize number plates, and verify authorization in real-time. To overcome these challenges, we propose an **Advanced Vehicle Access Management System using Vehicle Number Plate Recognition (VNPR).**

Objectives

1. To develop a system that automatically identifies vehicles and checks authorization using real-time video from gate cameras.
2. To ensure the system operates within a few seconds, providing accurate and reliable results to enhance security and convenience.
3. To utilize advanced image processing techniques to identify number plates and recognize characters accurately.
4. To integrate with an existing Excel database for matching recognized numbers with au thorized entries.
5. To improve safety and security by restricting unauthorized vehicles from entering the premises.
6. To facilitate better parking space utilization by ensuring only authorized vehicles gain access.

Tech-Stack

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Sr. No.	Tech Stack	Component	Task
1	OpenCV (cv2)	Video Processing	Read and filter frames from input video
2	YOLOv8 (Ultralytics)	Object Detection	Detect vehicles and license plates
3	EasyOCR	Character Recognition	Extract plate numbers from images
4	OpenCV, Matplotlib	Visualization	Show detection results
5	CSV	Data Storage	Store logs of recognized plates and checks authorization

Methodology

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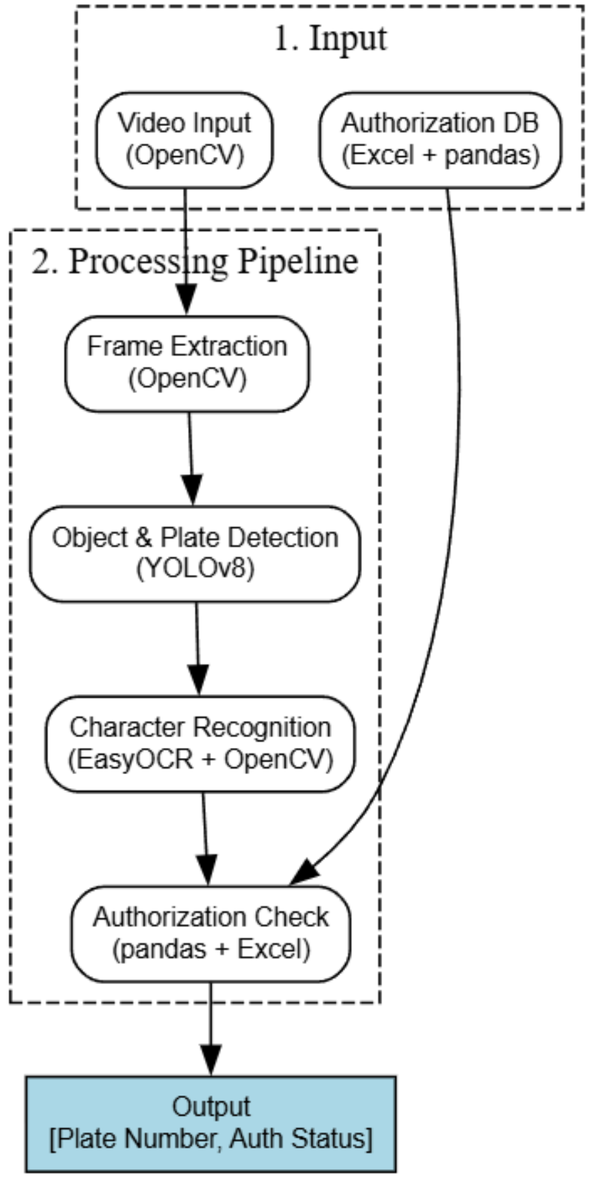
1. Video Processing & Object Detection

- **OpenCV (cv2) – Video Frame Processing**
  - Reads and breaks the real-time video into individual frames.
  - Filters out blurred or duplicate frames to ensure clarity.
  - Selects frames where the license plate is clearly visible.
- **YOLOv8 (You Only Look Once – Version 8) – Object Detection**
  - Real-time deep learning model for detecting objects in frames.
  - Identifies and locates vehicles and their license plates.
  - Draws bounding boxes around detected plates for further analysis.
- **EasyOCR – Optical Character Recognition**
  - Extracts alphanumeric characters from detected license plates.
  - Includes preprocessing steps:
    a. Grayscale conversion(optional).
    b. Thresholding to enhance contrast.
    c. Resizing for better character detection.
  - Converts processed license plate images into machine-readable text.



2. Visualization Techniques

- **OpenCV**
  - Draws bounding boxes around detected objects
  - Displays recognized text on image frames
- **Matplotlib**
  - Shows images with results for auditing and analysis

3. Dataset Management

- **Data Sources**
  - Public datasets (e.g., OpenALPR, MTMC)
  - In-house captured and synthetic datasets
- **Structure**
  - /images: Frame-wise images
  - /annotations: YOLO bounding box files
- **Future Upgrade**
  - Shift from Excel to NoSQL for scalability
- **Augmentation**
  - Rotation, brightness, noise added for robustness

Input Variables

- Real-time video frames from mounted cameras
- Excel database of authorized vehicle numbers

Output Variables

- Recognized vehicle number plates
- Authorization status (Authorized/Unauthorized)

Key Parameters

- Speed of detection & processing time
- OCR recognition accuracy
- Camera resolution & image clarity
- Database query performance

Existing Methods & Solutions

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- **Manual Verification:**
  - Done by security guards using entry tickets or stickers.
  - ⚠ Drawback: Error-prone, labor-intensive, and allows unauthorized access.
- **RFID-based Systems:**
  - Uses RFID tags and readers for contactless entry.
  - ⚠ Drawback: High initial setup and infrastructure costs.
- **Barcode Scanners:**
  - Vehicles have barcodes/QR codes that are manually scanned.
  - ⚠ Drawback: Slower and less efficient due to manual intervention.
- **Traditional LPR Systems:**
  - Uses edge detection and template matching for number plate recognition.
  - ⚠ Drawback: Accuracy drops in low light or with dirty/damaged plates.
- **FASTag Systems:**
  - RFID-based toll system with linked wallets for auto-payment.
  - ⚠ Drawback: Not widely adopted for general vehicle access control.

Comparison of Proposed and Existing Solutions

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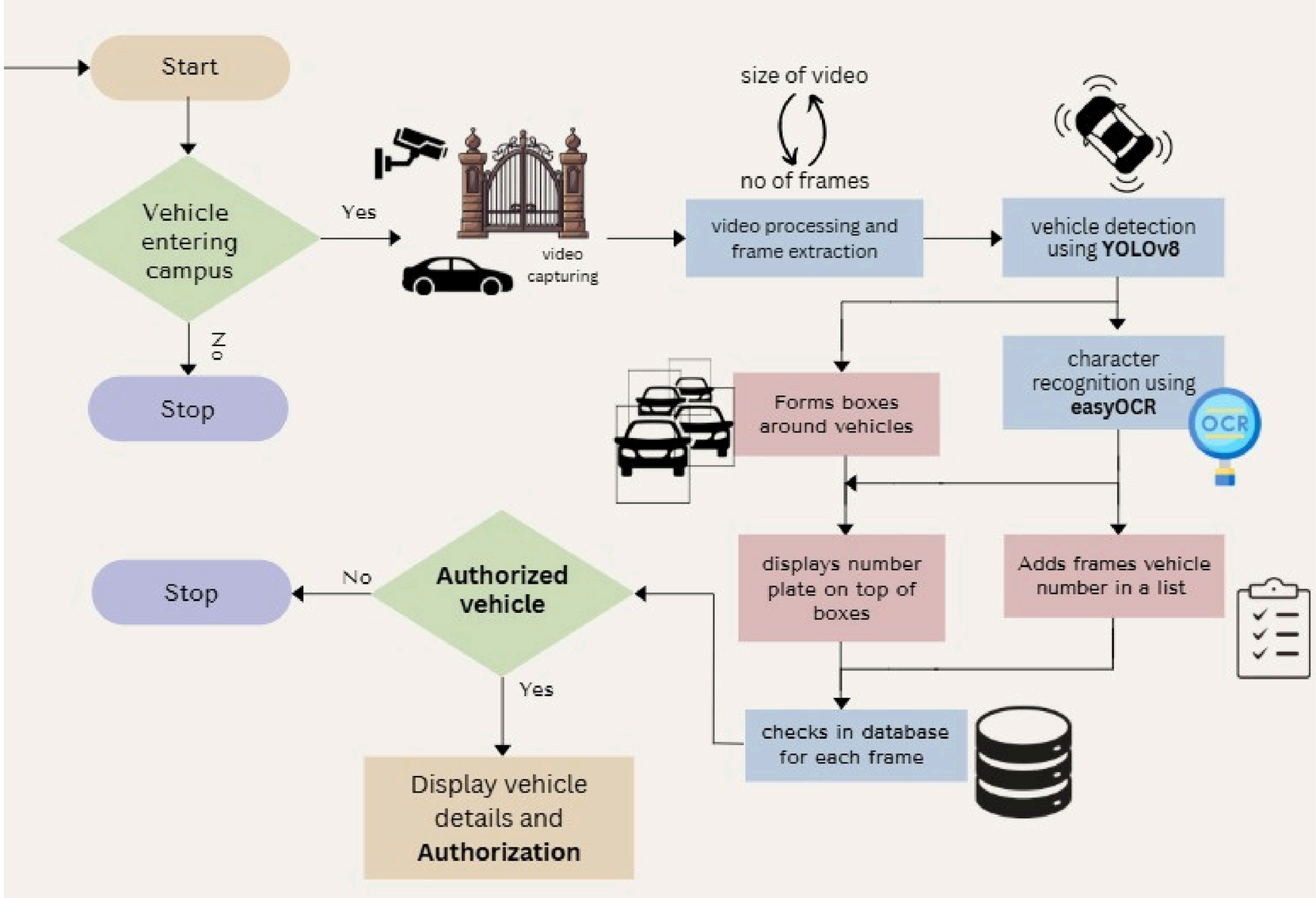
Criteria	Existing	YOLOv8 + OCR
Accuracy	Moderate	High (Advanced Detection + OCR)
Speed	Slow (Manual/Traditional)	Real-time (Fast Processing)
Authorization	Tags/Manual	Automated Recognition
Scalability	Limited	Highly Scalable
Security	Vulnerable (Fake Tags, Errors)	Enhanced & Accurate
Maintenance	Physical Tag Maintenance	Camera/System Maintenance
Cost	Low Setup, High Running Cost	High Setup, Low Running Cost

Model Architecture



1. Initializes the camera to **capture real-time video of incoming vehicles.**
2. **Extracts individual frames** from the video stream based on its duration.
3. For each frame:
   - Uses **YOLO to detect vehicles.**
   - For each detected vehicle, **retrieves the number plate region.**
   - **Applies EasyOCR** to extract characters from the number plate.
   - If recognized, **adds the vehicle number to a list and overlays it with a bounding box.**
4. For each number in the list:
   - Verifies against the authorized vehicle database.
   - **Labels as AUTHORIZED or UNAUTHORIZED** accordingly.
5. Displays frames with bounding boxes and **authorization status.**

Results and Analysis Summary

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High Detection Accuracy:

- Vehicle detection: >90% precision
- License plate detection: 85–95% accuracy
- OCR (EasyOCR): ~94% accuracy, robust even in night conditions

Plate Type Versatility:

- Supports Indian & foreign plates
- Handles both colored and monochrome plates effectively


```
Detected Number Plates from all frames:
Frame 1: 06CUE710
Frame 2: 006CUE710
Frame 3: 0(6CUE710
Frame 4: 0(06CUE710
Frame 5: 006CUE710
```

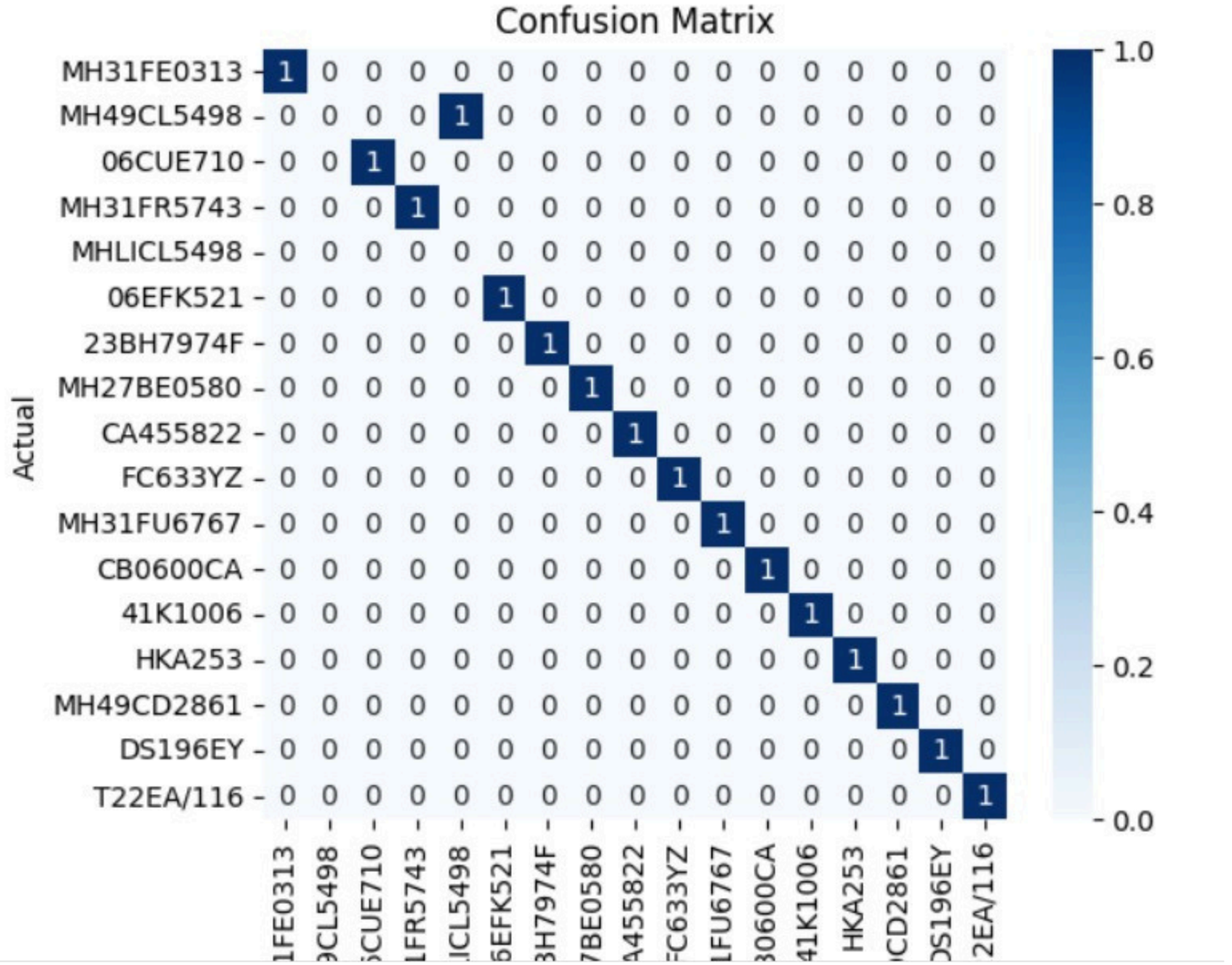
Confusion Matrix Insights:

- Accuracy: 94%
- Precision: 100%
- Recall: 94%
- F1 Score: 94%

Reliable for Real-World Use:

- Low false positives
- Effective for secure and automated vehicle access systems

```
Accuracy: 0.94
Precision: 1.00
Recall: 0.94
F1 Score: 0.94
```



Challenges, Advantages and Disadvantages

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Challenges Faced

- Camera Placement: Poor angles miss plates, especially two-wheelers
- Fast Objects: High-speed vehicles may blur or be missed
- Plate Variations: Fonts, damage, or dirt reduce accuracy
- Real-Time Lag: Heavy load slows down processing
- Database Issues: Needs regular updates to stay reliable

Advantages

- Automated: No manual checks, fewer errors
- Real-Time: Fast detection even in traffic
- Scalable: Works across multiple gates/databases
- Secure: Blocks unauthorized vehicles
- Trackable: Stores logs for monitoring and analysis

Disadvantages

- Camera Quality: Low-res or bad lighting affects results
- Heavy Processing: Needs strong hardware
- Plate Issues: Grime, wear affects OCR
- High Setup Cost: Cameras, servers, maintenance
- Privacy Risks: Constant surveillance concerns

Conclusion nd Future Work

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The **VNPR system** using **YOLOv8 and OCR** provides a **secure, accurate, and scalable** solution for automated vehicle identification in campuses and offices. It **improves parking management, boosts security, and outperforms traditional methods** like manual checks, RFID, and barcode readers.

Its easy Excel integration and real-time **video processing make it efficient and reliable**. Future upgrades may include cloud-based databases, better OCR for complex plates, and multi-camera support—**setting a new standard in vehicle access control.**

Future Improvements:

- **Cloud & NoSQL Integration:** Shift to real-time, scalable database systems.
- **Advanced OCR:** Improve recognition on distorted or non-standard plates.
- **Multi-Camera Support:** Enhance coverage across larger premises.
- **Edge Computing:** Reduce latency with on-device processing.

Thank You