Intelligent Parking System.

A report submitted in fulfilment of the requirements after completing the project during the course of the internship at GovTech, Bhutan.

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Car Number Plate Detection.

Introduction.

The global increase in vehicular traffic has necessitated the development of automated systems for effective vehicle management and monitoring. Traditional methods of manually recording car license plates are not only labor-intensive but also prone to human error. Automated License Plate Recognition (ALPR) systems have emerged as an efficient solution for applications such as traffic law enforcement, parking management, and toll collection (Anagnostopoulos et al., 2008). The integration of modern technologies like YOLO (You Only Look Once) and EasyOCR has made it possible to design systems capable of accurate license plate detection and recognition, even under challenging conditions. These advancements address the limitations of earlier approaches that struggled with poor lighting, motion blur, and complex backgrounds. Furthermore, with real-time processing capabilities, such systems offer an essential tool for modern traffic and parking solutions. By employing these state-of-the-art technologies, this project seeks to streamline the process of identifying and retrieving vehicle details, enhancing convenience and efficiency in scenarios where quick action is required, such as blocked parking spaces.

Background and Literature Review.

License plate recognition systems have been the focus of extensive research. Early approaches relied on traditional image processing techniques such as edge detection and template matching (Anagnostopoulos et al., 2008). While these methods performed well under controlled conditions, their accuracy dropped significantly in real-world scenarios with varying lighting, complex backgrounds, and motion blur.

Recent advancements in deep learning have revolutionized ALPR systems. YOLO, a state-of-the-art object detection framework, provides high accuracy and real-time performance, making it suitable for license plate detection (Redmon et al., 2016). EasyOCR, an optical character recognition tool, has been praised for its ability to recognize multilingual text and handle images with noise and distortions (Baek et al., 2019). These technologies, combined with regex-based text filtering, offer a comprehensive solution for real-world applications.

Studies have also explored enhancing detection and tracking techniques for various environments. For instance, improved methods for detecting objects in dynamic and noisy settings, such as fish tracking in farms, demonstrate the potential for adaptive algorithms in diverse use cases (Pham et al., 2021). These advancements provide a foundation for applying similar techniques to license plate detection.

Problem Statement.

Manual methods for identifying and recording vehicle license plates are inefficient, especially in high-traffic scenarios. Current automated systems often face challenges such as:

- Low detection accuracy due to poor image quality or complex backgrounds.
- Difficulty in extracting text from images with varying lighting conditions or font styles.
- Limited integration with databases for retrieving vehicle owner information.
- When other cars block a vehicle from moving out, obtaining their details can be tedious and time-consuming.

To address these issues, this project proposes an integrated system that utilizes advanced object detection and OCR tools for robust license plate detection and details retrieval. This application simplifies the process by providing quick access to relevant details, enabling effective communication to resolve the situation.

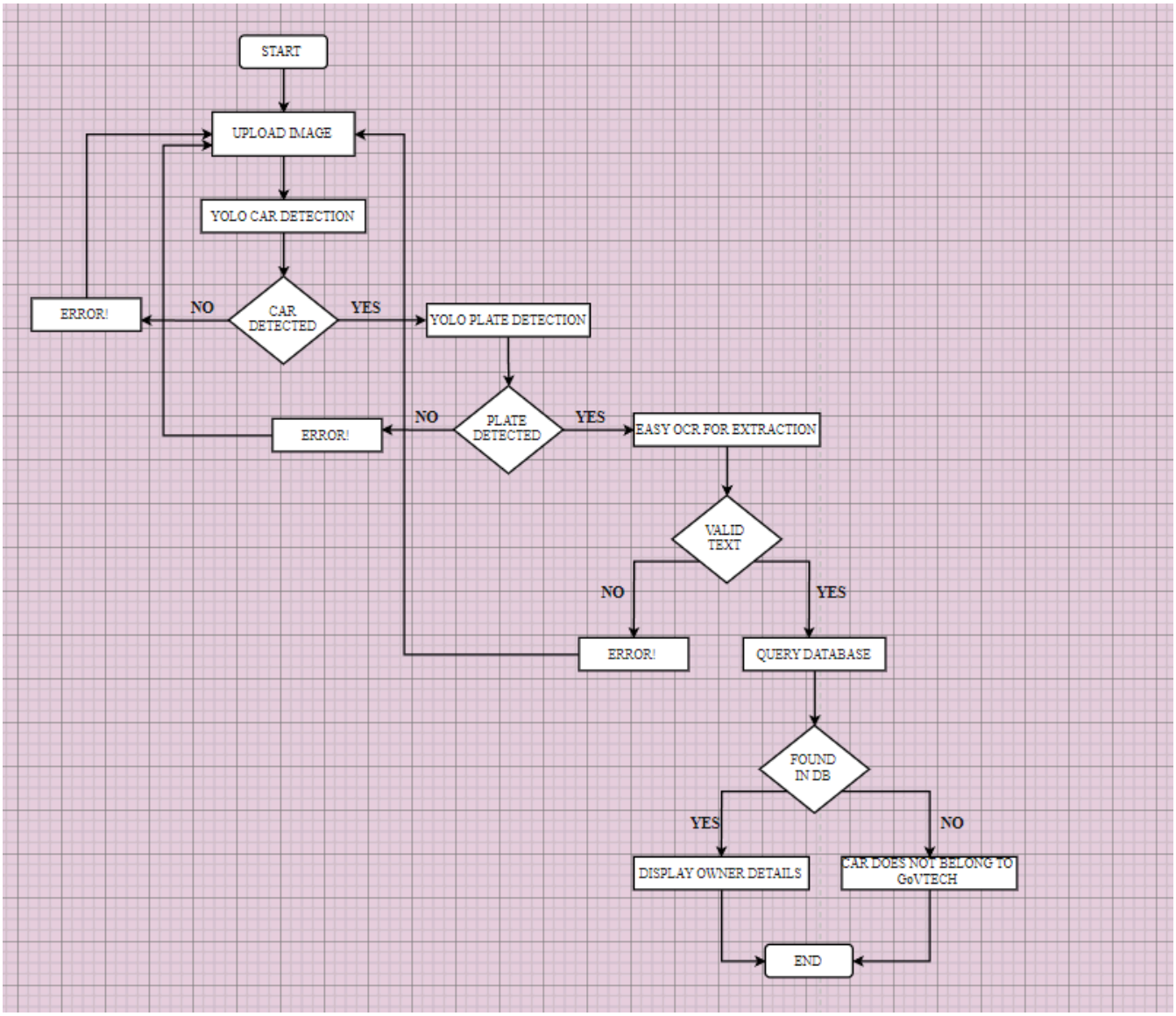
Aims.

To develop a robust system for detecting car license plates, recognizing the text using OCR, and retrieving corresponding owner details from a database.

Objectives.

1. Implement YOLO for detecting car license plates in uploaded images.
2. Utilize EasyOCR for extracting text from the detected license plates.
3. Design a regex-based filtering mechanism to validate and format the extracted text.
4. Integrate the system with a database to fetch and display car owner details.
5. Create a user-friendly interface using Streamlit for easy interaction with the system.

System Workflow.



1. Image Upload:

- Users upload an image of a car containing the license plate using a Streamlit-based web interface.
- Accepted formats: JPG, JPEG, PNG.

2. Number Plate Detection:

- The uploaded image is processed using YOLO, which identifies the bounding box of the license plate.
- The system crops the detected region and prepares it for text extraction.

3. Text Recognition:

- The cropped license plate image is converted to grayscale for enhanced OCR accuracy.
- EasyOCR extracts text from the image.
- Extracted text is validated and formatted using regex patterns to ensure it matches license plate conventions.

4. Database Query:

- The validated license plate number is used to query a database for car owner details.
- Retrieved details include the owner's name and contact information.

5. Result Display:

- The detected number plate and extracted text are displayed on the interface.
- If the license plate exists in the database, owner details are shown in a visually styled format.
- Errors or invalid results are appropriately handled with user feedback.

Smart Parking System.

Introduction.

Parking space detection is a computer vision-based solution that automates the monitoring and management of parking facilities. The system utilizes real-time video processing to determine the occupancy status of parking spaces, providing immediate feedback about space availability. This technology represents a significant advancement in smart parking management, offering improved efficiency and user experience in parking facilities.

Background.

Historical Context.

Traditional parking management systems relied on manual monitoring or simple sensor-based solutions. These methods were often:

- Labor-intensive
- Prone to human error
- Limited in scalability
- Costly to maintain

Technological Evolution.

Recent developments in computer vision and machine learning have enabled more sophisticated approaches:

- Image processing techniques for space detection
- Real-time video analysis
- Adaptive thresholding for varying lighting conditions
- Computer vision algorithms for occupancy detection

Current State of Technology.

Modern parking detection systems incorporate:

- IP camera networks
- Computer vision algorithms
- Real-time processing capabilities
- User interface systems

Problem Statement.

Parking management systems today face significant challenges that impact efficiency and user satisfaction. Inefficient space utilization, coupled with the time-consuming task of finding available spots, creates bottlenecks and unnecessary delays. Manual monitoring of parking areas adds to operational overheads while often leading to inaccuracies in occupancy tracking. This inefficiency not only frustrates users, especially in large parking facilities, but also contributes to broader issues such as increased traffic congestion, higher operational costs, and environmental harm from vehicles circling in search of spaces. Collectively, these problems degrade the user experience and highlight the need for smarter, more effective parking solutions.

Aims.

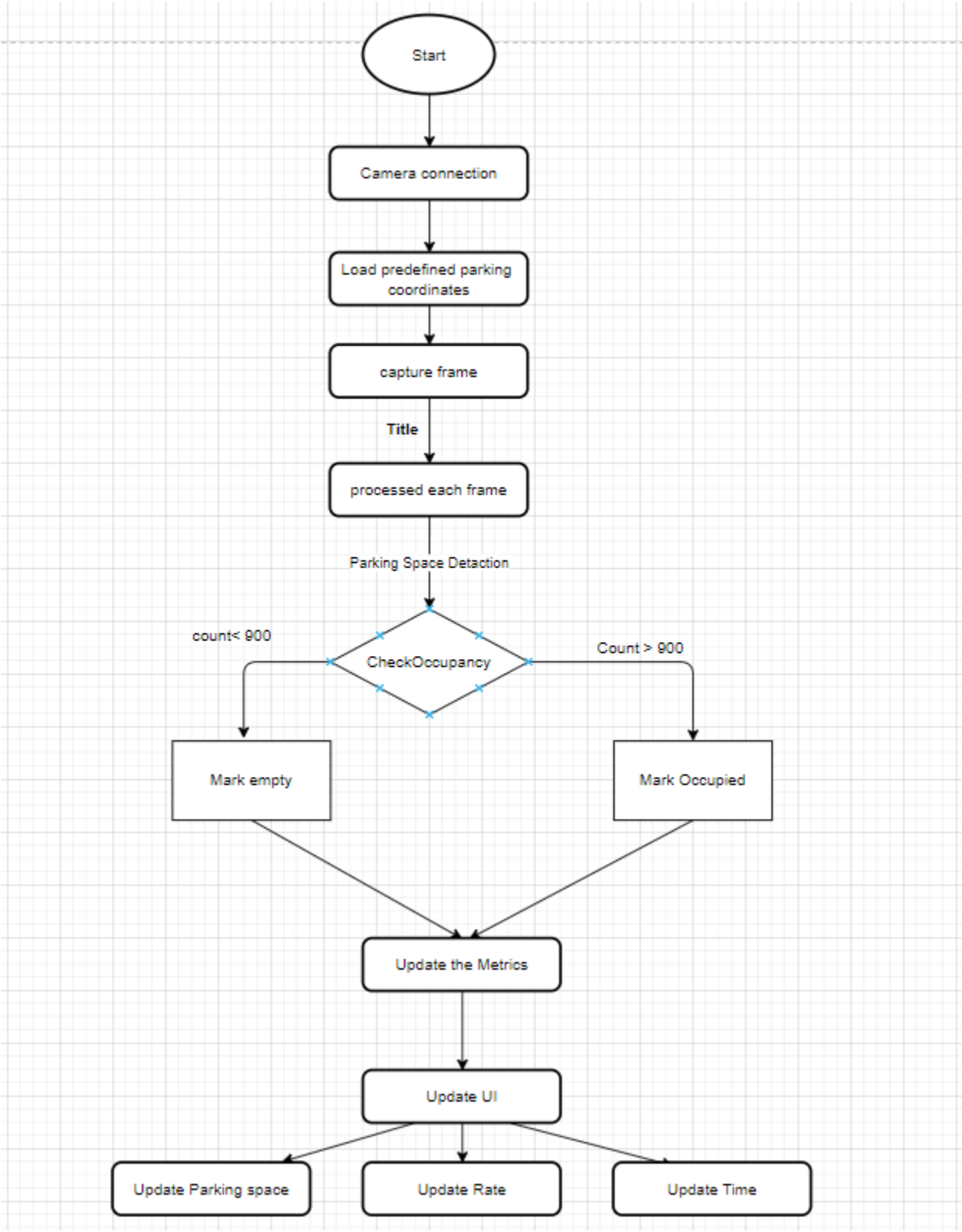
The primary aims of this parking space detection system are:

- To automate the monitoring of parking space availability
- To provide real-time occupancy information
- To improve parking facility efficiency
- To reduce the manual effort required for parking management
- To enhance the overall parking experience for users

Objectives.

1. Display real-time availability information
2. Provide clear visual indicators of space status
3. Update occupancy information within 0.1 seconds

System Workflow.



System Initialization.

- System starts
- Establishes camera connection
- Loads predefined parking coordinates

Frame Processing.

- Captures frame from camera feed
- Processes each frame through image processing pipeline
- Prepares frame for occupancy detection

Parking Space Detection.

- System enters the detection phase
- Analyzes each designated parking space
- Uses CheckOccupancy decision point:
    - If count < 900: Space marked as empty
    - If count > 900: Space marked as occupied

Status Updates.

- Marks spaces as empty or occupied based on detection
- Updates metrics including:
    - Available space count
    - Occupancy rates
    - Time stamps

UI Updates: The system simultaneously updates three key components:

- Update Parking Space: Refreshes individual space status
- Update Rate: Recalculates occupancy percentages
- Update Time: Updates current timestamp

Parking Space Monitoring

Available Spaces

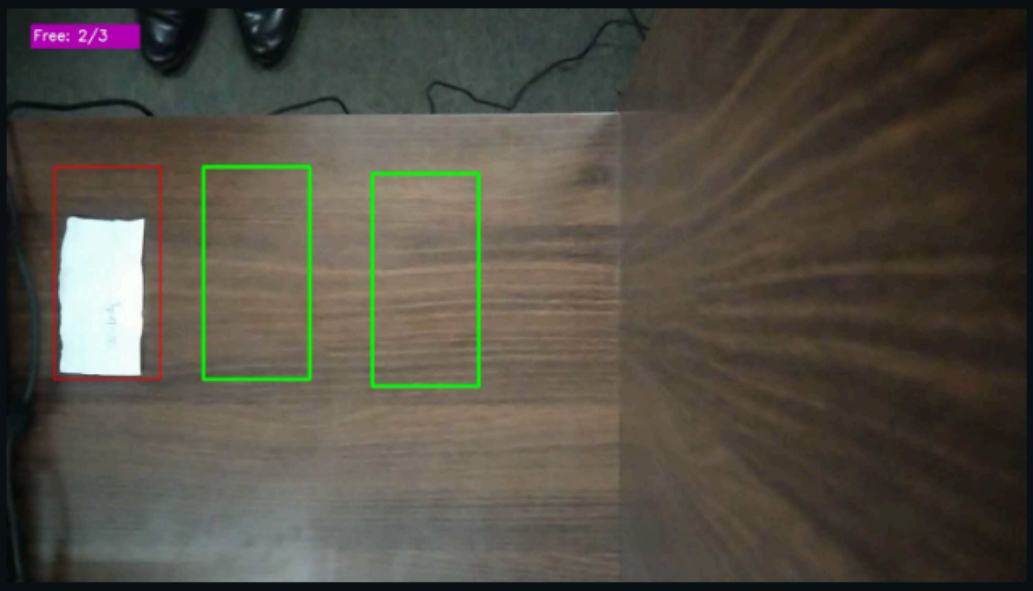
2/3

Occupancy Rate

33.3%

Current Time: 2025-01-06 10:04:51

Show Live Camera Feed



Live Parking Feed

	Parking Spot	Status	Time Parked
0	Spot 1	Car Parl	2025-01-06 10
1	Spot 2	Free	
2	Spot 3	Free	

Spot 1
Occupied
2025-01-06 10:02:26

Spot 2
Available

Spot 3
Available

Source Code.

Number Plate Detection & Smart Parking System.

Conclusion.

This project successfully demonstrates a system that automates car number plate detection, recognition, and details retrieval. By integrating advanced object detection and OCR techniques with a user-friendly interface, the system addresses common challenges in vehicle identification and monitoring.

Future enhancements could include support for video feeds, multilingual OCR, and integration with broader traffic management systems. Such developments align with recent research trends advocating for scalable and adaptive ALPR solutions (Pham et al., 2021).

The Smart Parking System is an innovative solution combining YOLO for vehicle detection, EasyOCR for license plate recognition, and Streamlit for an interactive user interface. It streamlines parking management by enabling real-time monitoring of parking spaces, quick identification of vehicles, and easy access to parking data. The system improves efficiency, reduces manual effort, and enhances user convenience with features like occupancy rate tracking and visually intuitive dashboards. Scalable and adaptable to various environments, it also supports sustainability by minimizing time spent searching for parking, thus lowering emissions. With potential for advanced integrations like predictive analytics and cloud-based data storage, this system is a step toward smarter, more efficient urban infrastructure.

References.

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