ASIAN COLLEGE OF HIGHER STUDIES

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Proposal Report

On

"ParkIn: AI Driven Parking Management System"

In partial fulfillment of the requirements for the Bachelor's in Computer Science and Information Technology

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1. Introduction

In today's fast-paced urban environments, efficient and intelligent parking management has become a growing necessity. With the rapid increase in the number of vehicles, limited parking spaces, and rising traffic congestion, traditional parking systems that rely on manual supervision are no longer sustainable. These conventional methods often lead to longer waiting times, mismanagement of available parking slots, lack of transparency in billing, and insufficient security monitoring. With a continuous rise in the number of vehicles in the valley, it is becoming increasingly difficult for the capital valley, a densely populated and unsystematically developed city, to manage road traffic and other issues efficiently [1]. As a result, there is a critical need for a smart solution that can automate and optimize parking operations.

To address these challenges, we propose the development of a project titled "Vehicle Number Plate Recognition for Automatic Parking Management System". This project aims to design and implement a smart, automated parking system that leverages modern technologies such as computer vision, machine learning, and web development. The goal is to minimize manual effort while maximizing efficiency, accuracy, and security.

At the core of this system is real-time vehicle number plate recognition and tracking using camera input. As a vehicle approaches the parking area, a camera captures frames that are processed using YOLO for detecting vehicles and number plates. The detected plates are then passed through OCR tools to extract the registration number. To accurately track each vehicle across multiple frames and avoid duplication, the system uses SORT (Simple Object Realtime Tracking), which assigns a unique ID to each moving vehicle. The extracted information—vehicle number, time of entry or exit, and tracking ID—is stored in a centralized database to maintain digital logs, manage parking slot availability, and generate electronic bills.

This system is designed to be fully web-based, allowing administrators to manage parking activity through a responsive web interface. Features will include real-time monitoring of parking status, vehicle tracking, space allocation, and the generation of electronic bills based on the duration of stay.

The solution can be effectively implemented in locations such as shopping malls, hospitals, office complexes, airports, and public parking areas. It not only reduces the

dependency on human operators but also enhances user convenience and improves overall traffic flow within the parking facility. Moreover, the collected data can later be analyzed for usage patterns and predictive management.

By combining emerging technologies in artificial intelligence and web-based systems, this project serves as both an innovative technical solution and a step forward toward developing smarter cities and automated infrastructure.

2. Problem Statement

With the rapid increase in vehicle ownership in urban areas of Nepal, managing parking efficiently has become a serious challenge. Despite the availability of parking spaces, poor management practices, especially manual entry and exit tracking often result in traffic, time delays, and user frustration. The current system, which depends on security personnel to manually record vehicle number plates, is time-consuming, error-prone, and inefficient. Additionally, drivers frequently waste time searching for available parking due to the lack of real-time slot monitoring. These issues highlight the urgent need for an automated, accurate, and reliable parking management system that can reduce human dependency and improve overall parking efficiency.

3. Objectives

The main objectives of this project are:

- Create a web-based application to automate parking management procedures.
- Use Computer Vision to detect and read vehicle number plates automatically.
- Automatically log vehicle entry in the database and assign parking space base on real-time availability.
- Make the system digitally managed and semi-paperless, improving efficiency for both customers and management.

4. Scope and Limitations

4.1 Scope

The scope of the project are as follows:

- Allow user registration, login, and profile management.
- Display real-time parking spot availability.
- Enable online parking spot reservations.
- Implement vehicle check-in and check-out tracking.
- Automatically calculate parking duration and fees.

4.2 Limitations

The limitations of the projects are:

- The proposed system only detects embossed license plates.
- Being web-based application, the system requires a stable internet connection to function properly.

5. Methodology

In order to build the website, we use the Waterfall model. In this method, the project is broken down into a series of sequential phases, such as requirements gathering, design, development, testing, deployment and maintenance. Each phase must be completed before moving on to the next, which ensures a clear structure and well-defined deliverables. The Waterfall model suits our project because it provides a systematic and disciplined approach, making it easier to manage and document progress. It is ideal when the project requirements are well understood from the start, and it allows us to plan thoroughly and reduce uncertainty. This model aligns well with our goal to deliver a stable, fully functional system with minimal changes during the development process.

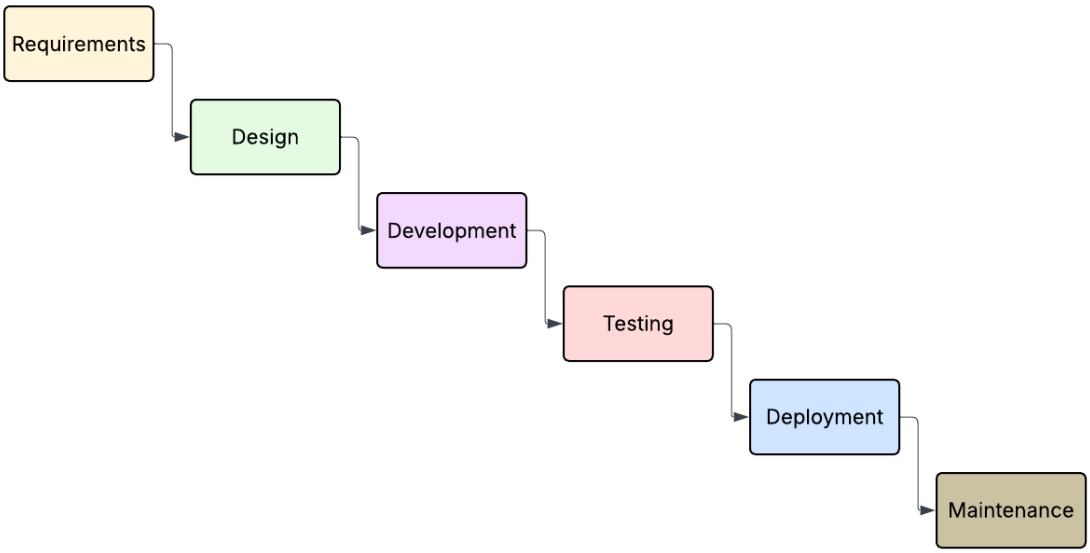

Figure 5. 1 Waterfall Model

5.1 Requirements Specification

5.1.1 Study of the existing system

The study of an existing system in the context of a Parking Management System involves analyzing and understanding the current methods and technologies used for managing vehicle parking operations. This includes examining how vehicles are admitted, how parking slots are allocated, how fees are collected, and how data is tracked. The goal of studying these systems is to identify inefficiencies, understand user experiences, and uncover opportunities to implement smart technologies that

can improve operational efficiency, reduce human involvement, enhance security, and provide better services to users.

There are some parking management systems like Sajilo Parking and IMS Parking Management System which are currently in use, offering features such as digital ticketing, real-time vehicle tracking, automated billing, and integration with mobile apps. Sajilo Parking focuses on user-friendly interfaces and smart solutions for urban parking, while IMS is known for handling large-scale parking operations with features like space monitoring and reporting tools [2]. Despite these advancements, many parking areas still rely on manual processes or semi-automated setups, which limits efficiency, transparency, and scalability.

Fully automated systems featuring Automatic Number Plate Recognition (ANPR), real-time slot detection, digital payments, and mobile app integration are still rare in Nepal but are common in developed countries.

5.1.2 Literature review

In the context of Nepal's rapidly urbanizing cities like Kathmandu and Pokhara, the challenges of managing increasing vehicular traffic and limited parking spaces have become pronounced. While Nepal has yet to fully implement large-scale smart parking systems, initiatives like the "Sajilo Parking System" have emerged as pioneering efforts. This system utilizes mobile applications to facilitate digital payments and real-time parking slot reservations, aiming to alleviate urban parking issues. However, it currently lacks integration with advanced technologies such as Automatic Number Plate Recognition (ANPR) and real-time vehicle tracking, which are essential for comprehensive automation and security.

In Nepal, research on Automatic Number Plate Recognition (ANPR) systems is still emerging[3]. Their system employed image processing techniques to detect and segment license plates, followed by character recognition using Support Vector Machines (SVM) with Histogram of Oriented Gradients (HOG) features. Tested on a self-created dataset of Nepali number plates, the system achieved an average precision of 87.59% and a recall of 98.66%. However, the study highlighted challenges such as varying plate sizes, fonts, and illumination conditions, which affected the overall accuracy.

In neighboring India, several smart parking solutions have been developed and deployed, offering valuable insights[4]. This system employs cameras at parking entrances to capture vehicle images, processes them using Optical Character Recognition (OCR) for license plate identification, and updates parking availability in real-time through a cloud-based platform accessible via a mobile application.

Further advancements are seen in systems integrating deep learning models for enhanced accuracy. The system utilizes YOLOv8n for real-time object detection and Tesseract OCR for character recognition, achieving high accuracy in diverse environmental conditions [5].

5.1.3 Requirement Analysis

a. Functional Requirements:

- **Reservation Booking:** User should be able to book or reserve the parking spots in advance. The reservation system should quickly confirm bookings and give users the details of their reservation, like where it is and how long they can park.
- **Real-Time Parking Availability:** Users must be able to view up-to-date information on available parking spaces. The system should refresh the status of parking slots immediately as cars come in or go out, allowing users to make smart choices and prevent wasting time looking for a parking spot.
- **User-friendly interface:** The app needs to have a neat and easy-to-understand design that anyone, no matter their tech skills, can use without trouble. Having clear menus, simple booking steps, and an easy payment process helps make the user experience better, which can lead to more people using it and fewer mistakes or frustrations for users..
- **Automated Billing Calculation**: The system shall calculate parking fees based on entry and exit times linked to the recognized license plate.

b. Non-functional requirements:

- **Real-Time Processing:** The system must process license plate recognition, parking slot allocation, and billing calculations in real time to enable seamless vehicle flow.

- **Automatic vehicle identification:** Users expect the system to automatically capture and recognize vehicle license plates at entry and exit points without manual intervention, ensuring a smooth and quick parking process
- **Performance**: The system shall process license plate recognition and grant entry/exit within 3 seconds to prevent vehicle queues.
- **Reliability**: The system shall operate continuously with 99.9% uptime, ensuring minimal downtime or service interruptions.
- **Maintainability**: The system shall be designed to allow easy updates, bug fixes, and addition of new features with minimal disruption.
- **Backup and Recovery**: The system shall implement regular data backups and support fast recovery in case of hardware failure or data corruption.

5.2 Feasibility Study

5.2.1 Technical feasibility

Implementing a Vehicle Number Plate Recognition (ANPR) system for automatic parking management in Nepal is totally possible with the technology we have today. High-quality cameras and advanced image processing software can effectively capture and identify Nepalese vehicle number plates, even with the different weather and lighting conditions that are typical in the area. The necessary equipment, like cameras, servers, and gate control systems, is easily available and can be combined with the current parking setups. Moreover, software that uses Optical Character Recognition (OCR) and machine learning can be tailored to fit local number plate styles. With the growing use of mobile networks and digital payment options in Nepal, it's also possible to integrate real-time data processing and secure transactions. In summary, with the right planning and investment, launching an ANPR-based parking management system can significantly boost efficiency, minimize human mistakes, and improve user convenience in parking facilities across Nepal.

5.2.2 Operational feasibility

The Vehicle Number Plate Recognition system for automatic parking management is practical in Nepal because it fits well with the country’s expanding urban infrastructure and the increasing use of technology. Parking areas in major cities like Kathmandu, Pokhara, and others are facing more issues with vehicle overcrowding and the inefficiencies of manual management. This system can be easily added to

current parking lots, allowing staff to automate the tracking of vehicle entries and exits, which reduces human mistakes and speeds up the process. The technology needs very little training for users, and parking attendants can effectively handle exceptions, like unclear plates, by entering information manually. Additionally, people in Nepal are getting more used to digital solutions, which makes the switch easier. The system's capability to provide accurate billing and real-time monitoring will improve overall parking management, making it a useful and advantageous solution for local operators and customers as well.

5.2.3 Economic feasibility

The setup of a Vehicle Number Plate Recognition system for managing parking automatically is cost-effective, providing long-term savings and better revenue collection. Although the initial costs for equipment like cameras, servers, and software development can be high, this system cuts down on the need for manual work and reduces billing mistakes, which can boost profits. Automated tracking and payment methods help stop revenue loss by making sure all parked cars are charged correctly. Moreover, quicker vehicle turnover and better space management can raise parking capacity without needing to physically expand, which further increases earnings. In the long run, lower operational costs and happier customers are likely to surpass the initial costs, making this system a financially smart choice for parking operators.

5.2.4 Schedule feasibility

This Gantt chart represents the project schedule of our project starting from 22 April 2025 and the end date 3 July 2025.

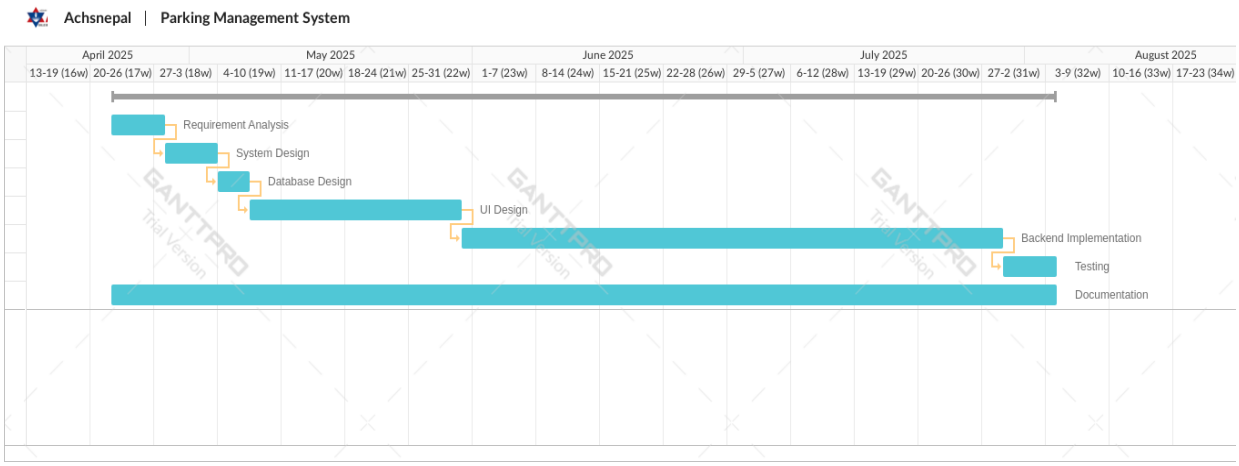

Figure 5. 2 Gantt Chart

The estimated time required for the completion of the project is approximately 90 days, starting from March 22 and expected to be completed by July 3. The first step of the project is requirement analysis, which will be completed within 5 days. The next step is designing, which is expected to take around 5 days. Database design follows, with an estimated duration of 3 days. The next phase is the UI design, which is expected to be completed within 20 days. Following that, the backend implementation phase will take approximately 50 days. Next, testing is estimated to take 5 days. Finally, project documentation will be carried out alongside each phase of the project.

5.3 High Level Design of System

5.3.1 Flowchart

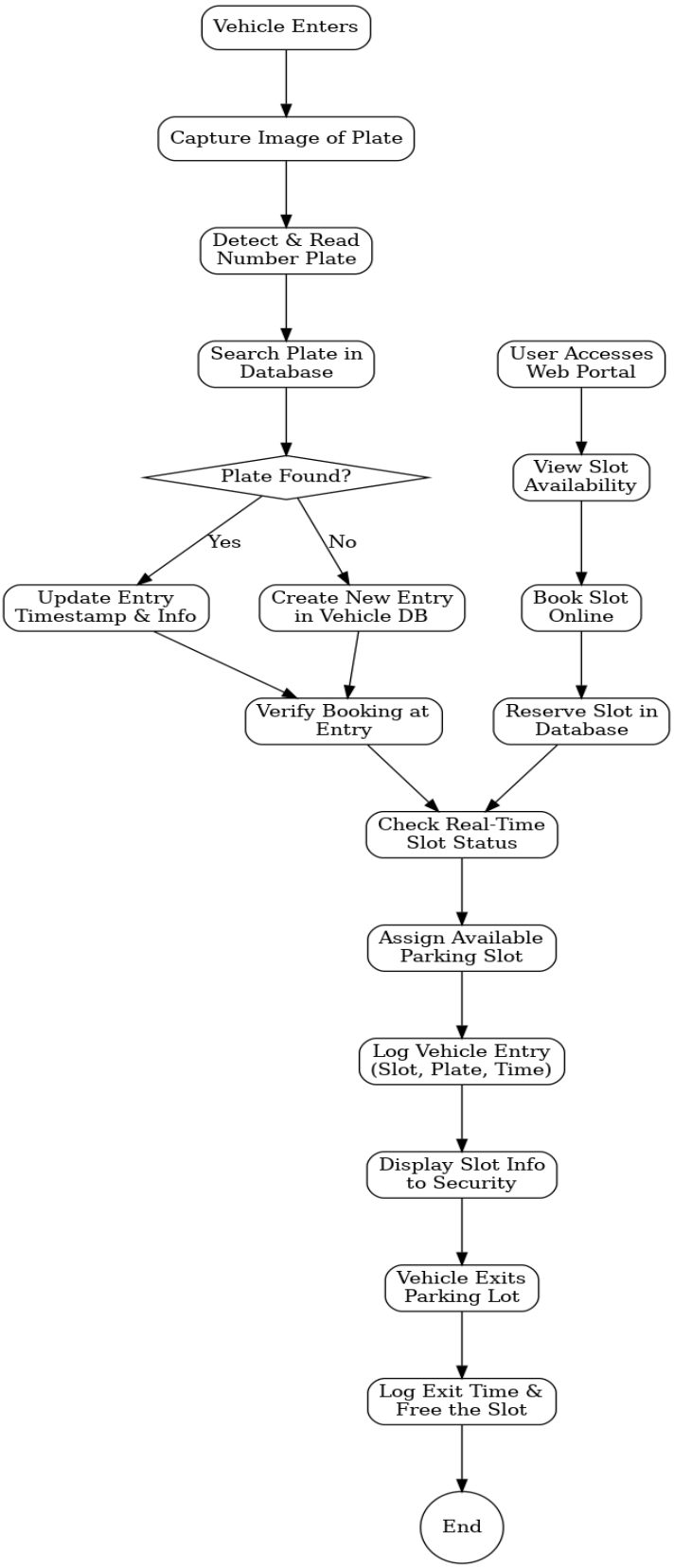

Figure 5. 3 Flowchart of the system

The process begins when a vehicle enters the parking area. At the entry point, a camera captures an image of the vehicle's number plate. This image is processed to detect and read the license plate number, which is then checked against the existing vehicle database. If the number is already registered, the system updates the timestamp and vehicle information; if not, a new entry is created in the database. The system then verifies if a parking slot was booked online by the same vehicle. Based on real-time slot availability, it either confirms the reserved slot or assigns a new available one. All relevant information, including the vehicle number, assigned slot, and entry time, is logged in the database. The slot information is then displayed to the security personnel for smooth guidance. Meanwhile, users can also interact with the system through an online portal to check availability and pre-book parking slots. Upon exiting, the system logs the exit time and frees up the assigned slot, updating the availability in real time. This streamlined process ensures automated tracking, efficient slot utilization, and reduced manual effort.

5.3.2 Context Diagram

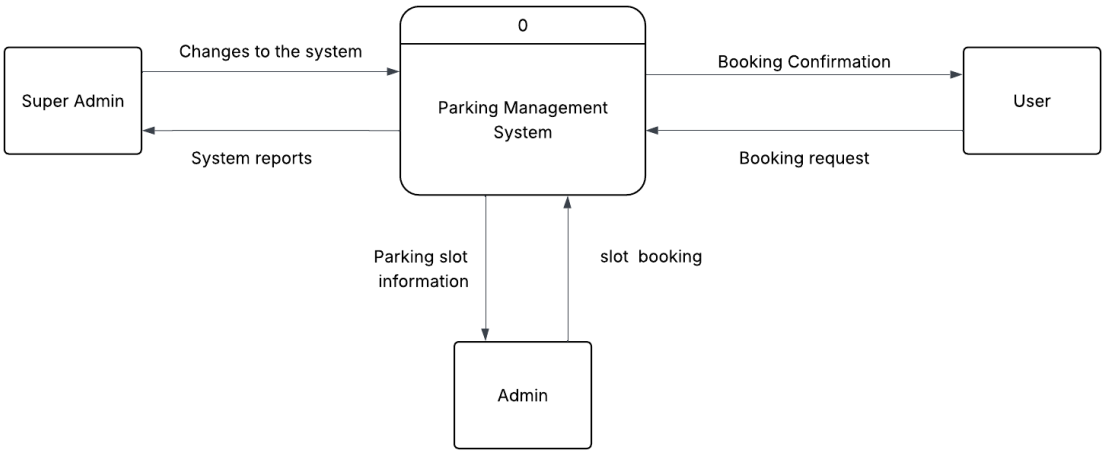

Figure 5. 4 Level 0 DFD

5.3.3 Use Case Diagram

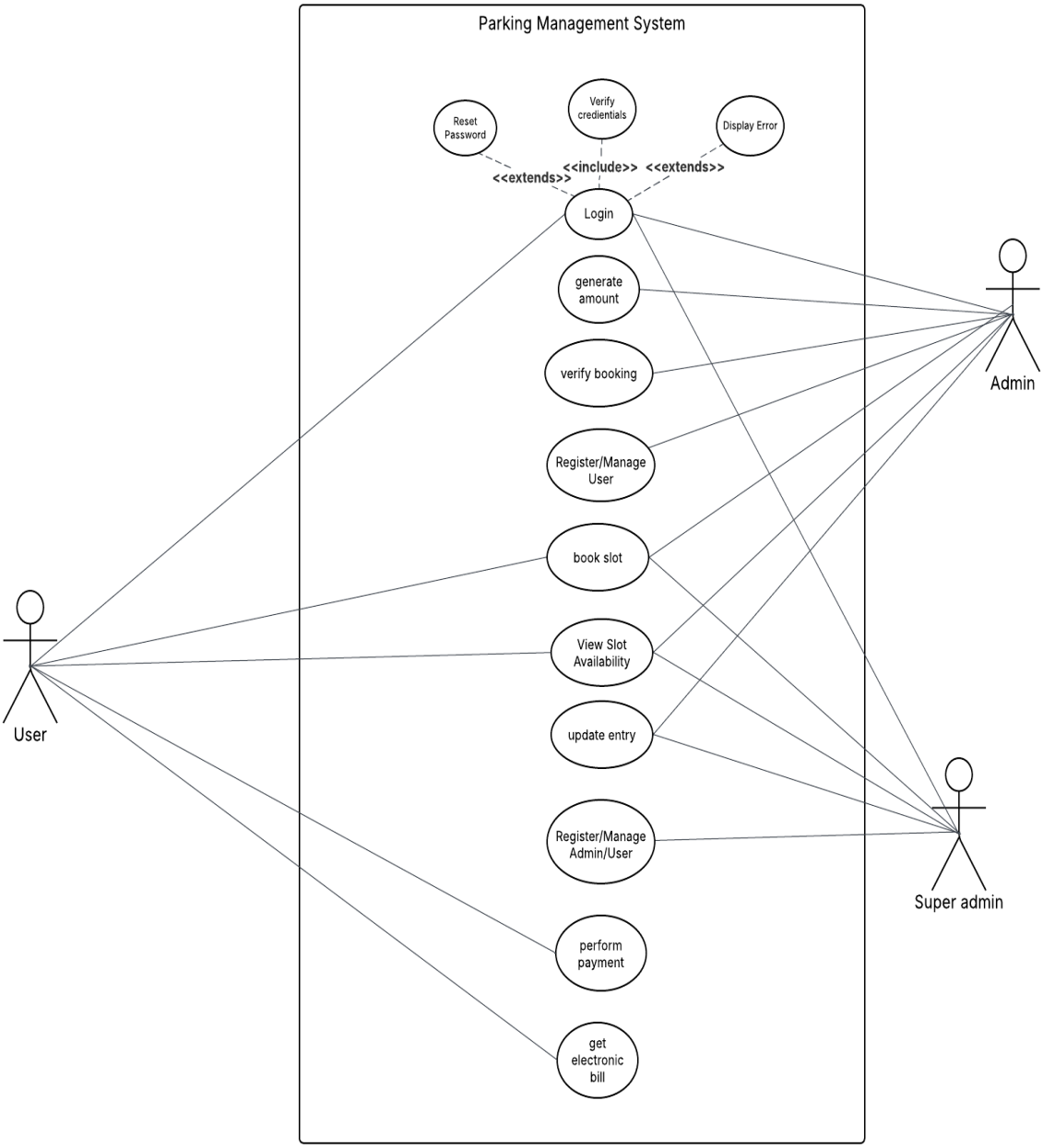

Figure 5. 5 Use Case Diagram

5.3.4 Description of Algorithms

a. Availability checking algorithm

It determines parking slot availability for a vehicle. Uses data structures like availability calendars or database to quickly update parking slot availability based on current reservation.

b. You Only Look Once (YOLO) algorithm

It is used for real-time object detection. It quickly and accurately identifies vehicles and their license plates in each video frame, enabling the system to know where cars are before SORT tracks their movement across frames. Together, YOLO detects vehicles, and SORT tracks them efficiently.

c. Optical Character Recognition algorithm

It is used to read and extract text from images, in this case license plates. This helps identify and record vehicle details automatically, enabling tasks like automated entry, exit logging, or billing based on the detected license plates.

6. Expected Outcome

The expected outcome of the project is a smart parking management system that automatically detects and reads vehicle number plates, logs vehicle entries in real-time, and assigns parking spaces efficiently. It features a user-friendly web application allowing customers to book parking spots online and manage vehicle and parking data with full CRUD capabilities. This system streamlines parking operations, reduces paperwork, and enhances convenience and efficiency for both customers and management.

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