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Automatic Number Plate Recognition (ANPR) Based Parking Management System Using Machine Learning Algorithms

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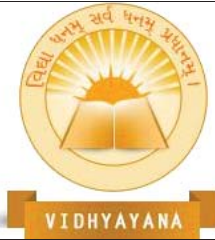vg36200@gmail.com

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Abstract:

The increasing number of personal vehicles has led to an insufficiency of parking spaces throughout the globe. Traditional parking management systems lack security and cannot track pilferage. This also leads to traffic jams which ultimately reduce the flow of traffic significantly. Therefore, there is a need for a smart parking management solution that can optimize the use of parking spaces, reduce traffic congestion, and enhance the overall parking experience

This paper proposes a smart parking management solution that is based on an application of Computer Vision – ANPR: Automatic Number Plate Recognition or ALPR: Automatic Licence Plate Recognition. This system makes use of cameras and an ANPR engine that runs on ML algorithms.

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The proposed solution was evaluated through a series of simulations and tests in a real-world environment. The results showed that the proposed system was able to optimize parking space utilization, reduce traffic congestion, and enhance the overall parking experience for users. The proposed system can be deployed in various parking environments such as shopping malls, airports, and public parking areas.

In conclusion, the proposed smart parking management solution based on ANPR technology can effectively address the challenges of traditional parking management methods and enhance the overall parking experience for users. The proposed system can be further improved through future research and development.

Keywords: Smart Parking, Machine Learning, Artificial Intelligence, Traffic Management solution, Smart City solution, Parking Space Optimization, ANPR technology, Computer Vision, Pilferage Detection.

Introduction

The increasing number of vehicles in cities has led to a growing demand for parking spaces, resulting in traffic congestion and frustration among drivers. Smart parking management solutions have emerged as a promising technology to tackle this issue. Automatic Number Plate Recognition (ANPR) technology is one such solution that has gained popularity due to its accuracy and efficiency in managing parking spaces.

This research paper aims to explore the benefits and drawbacks of a smart parking management solution based on ANPR technology. The paper discusses how the ANPR technology works and the benefits of using it for parking management. The research also analyses the challenges that may arise during the implementation of such a system, such as privacy concerns and costs.

The paper provides insights into how ANPR technology can contribute to reducing traffic congestion, improving parking efficiency, and providing a better user experience for drivers. The research also highlights the need for integrating ANPR technology with other smart city initiatives to achieve more comprehensive and efficient parking management.
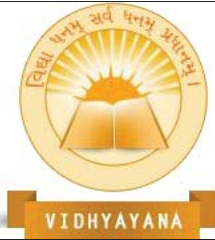
Overall, this research paper presents a comprehensive analysis of ANPR technology as a smart parking management solution and its potential to improve the urban mobility landscape.

Literature review:

The AI-enabled Smart Parking Management System runs densely on the following:

1. Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are designed to perform tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation. AI involves the development of algorithms that can learn from data, identify patterns, and make predictions or decisions based on that data. [1]

2. Machine learning (ML) is a subfield of AI that involves the development of algorithms and statistical models that enable computers to learn from data without being explicitly programmed. ML algorithms can identify patterns in data, make predictions, and optimize performance based on feedback. Examples of machine learning applications include image recognition, natural language processing, and recommendation systems.[2]

3. Computer vision is a subfield of AI that focuses on enabling computers to interpret and understand visual data from the world around them. Computer vision involves the development of algorithms and techniques that can identify and classify objects, track motion, and analyse patterns in images and videos. Applications of computer vision include autonomous vehicles, surveillance systems, and medical imaging.[3]

4. Automatic Number Plate Recognition (ANPR), also known as Automatic License Plate Recognition (ALPR), is a technology that uses optical character recognition (OCR) to automatically read and capture license plate information from images or videos. ANPR/ALPR is commonly used for law enforcement and security purposes, such as identifying stolen or wanted vehicles, enforcing parking regulations, and monitoring traffic.[4]

5. Pilferage detection refers to the use of technology, such as sensors and machine learning algorithms, to detect and prevent theft or loss of inventory in retail stores and warehouses. Pilferage detection systems can track inventory movement, identify anomalies or

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discrepancies in stock levels, and alert personnel to potential theft or losses. By preventing pilferage, businesses can reduce losses and improve their bottom line. [5]
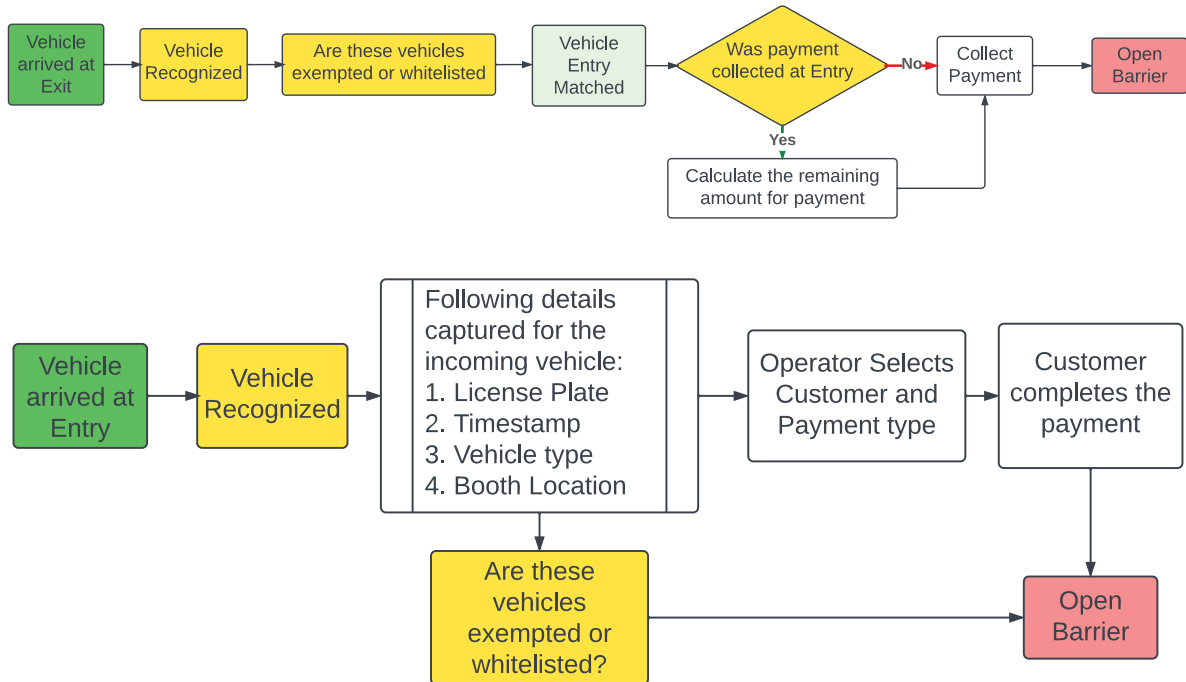
Methodology

Requirements:

To implement a smart parking system based on ANPR technology, you would need the following:

1. ANPR/ALPR cameras: These cameras capture license plate information from images or videos and send it to the ANPR engine for processing.

2. ANPR engine: This is the software that processes the license plate information captured by the ANPR cameras. The ANPR engine uses machine learning algorithms to identify license plate numbers and match them with the registered vehicles in the database.

3. Database: The database stores the registered vehicles' information, including their license plate numbers, owners' details, and parking preferences.

4. Payment system: The payment system allows users to pay for parking using various payment methods such as credit/debit cards, mobile wallets, or pre-paid parking cards.

5. Parking guidance system: A parking guidance system guides drivers to the available parking spots using real-time data from the ANPR cameras and sensors installed in the parking lot.

6. Mobile application: A mobile application allows users to book parking spaces in advance, navigate to the parking lot, and pay for parking.

7. Security system: The security system ensures the safety of vehicles parked in the lot, monitors for theft and pilferage, and alerts the authorities in case of any suspicious activity.

8. Analytics and reporting system: The analytics and reporting system provides insights into parking space utilization, revenue generation, and customer behaviour.

Overall, the smart parking system requires a combination of hardware and software components to function efficiently and optimize the use of parking spaces.

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The Flow diagram for the proposed system is as follows:

Algorithm:

1. START

2. A vehicle enters the parking space

3. The mounted cameras identify the vehicle using the ANPR engine

4. The ANPR engine identifies the numberplate and the characters in it

5. The system puts together a string that matches the numberplate in the image

6. The system displays the following data on the screen

   a) Vehicle image

   b) Vehicle type

   c) Numberplate string

7. The Operator in the parking lot verifies the system generated information and makes changes if necessary.

8. The system checks with the database and applies an appropriate charging scheme when the vehicle type is identified: ₹50 for 4 wheelers and ₹20 for 2 wheelers
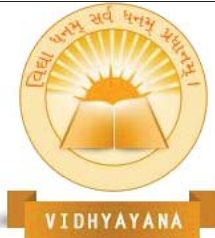
9. The operator collects the fare and then a start time is allotted to that vehicle to be dealt with during exit.

10. When the vehicle arrives at the exit, the camera captures the same data like the entry camera.

11. The system then compares the timestamps and displays the following information:

   a) Vehicle image

   b) Vehicle type

   c) Vehicle numberplate string

   d) Selected customer type

   e) Parking duration

12. The operator again verifies the system generated information.

13. The system displays a fare that is calculated based on the charges for the specific vehicle type.

14. The operator collects the charges and logs the exit.

15. The system actuates the barrier and logs the vehicle as exited.

16. END

Results and discussions:

After surveying several parking lots following observations were made:

1. There are 3 broad categories of parking lots

   - Manual Ticket based

   - Printed ticket based

   - RFID based

2. All types of parking lots charge the vehicle on either of the following charging schemes:

   - Flat charge: A flat charge is levied at the time of entry which allows the user to park the vehicle for the day.

   - Duration-based: Charges to be levied are calculated based on the number of hours the vehicle spends in the parking lot and the amount is calculated and collected at the exit.

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- Time-based: This is a hybrid charging scheme where the user pays a part of the charge at entry and then spends a certain time inside the parking lot. The initial payment validates the users' parking for some time. At the exit, the value is calculated based on the extra hours the vehicle spends in the parking lot. The operator can spike the charges based on the peak hours.

3. Compared to current parking systems, an ANPR solution cuts down operation time making transaction time the only time the vehicle has to stop.
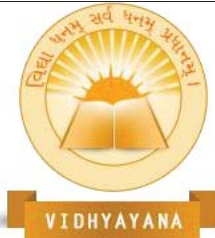
The following figures shows the result.

Entry Dashboard

Exit Dashboard

Conclusion:

As cities continue to experience an influx of vehicles, the need for parking spaces has increased, leading to traffic congestion and driver frustration. Smart parking management solutions have been identified as a promising technology to tackle this problem. Among them, the Automatic Number Plate Recognition (ANPR) technology has gained popularity due to its accuracy and efficiency in managing parking spaces.

This research paper provides a thorough examination of the advantages and disadvantages of using ANPR technology as a smart parking management solution. It explains the workings of ANPR technology and outlines its benefits in parking management. Moreover, the research analyses potential challenges that could arise during the implementation of such a system, including concerns over privacy and expenses.

The research also delves into how ANPR technology can help reduce traffic congestion, enhance parking efficiency, and improve the driver experience. The study emphasizes the importance of integrating ANPR technology with other smart city initiatives to achieve a more comprehensive and efficient parking management system.

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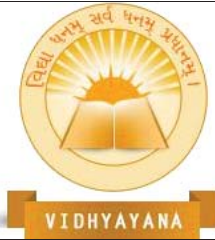
In conclusion, ANPR technology is a viable option for improving the urban mobility landscape by mitigating traffic congestion, enhancing parking efficiency, and providing a better user experience for drivers. However, careful consideration should be given to the challenges that may arise during implementation, such as privacy concerns and costs. This research paper presents a detailed analysis of ANPR technology as a smart parking management solution, providing valuable insights for policymakers and stakeholders involved in the development of smart cities.

Limitations and future scope

After trying out various iterations to improve the accuracy of number plates and vehicle types, it was observed that ANPR requires significantly less time in comparison with its predecessor. Although comes with the following drawbacks which can be improved in future scope:

1. The system requires an internet connection at all times.

2. The accuracy of detection may vary depending on the following factors:

   1. Camera angle

   2. Number plate condition

   3. Language for plate used

   4. Lighting conditions

Complex OTS (One-Time Setup)

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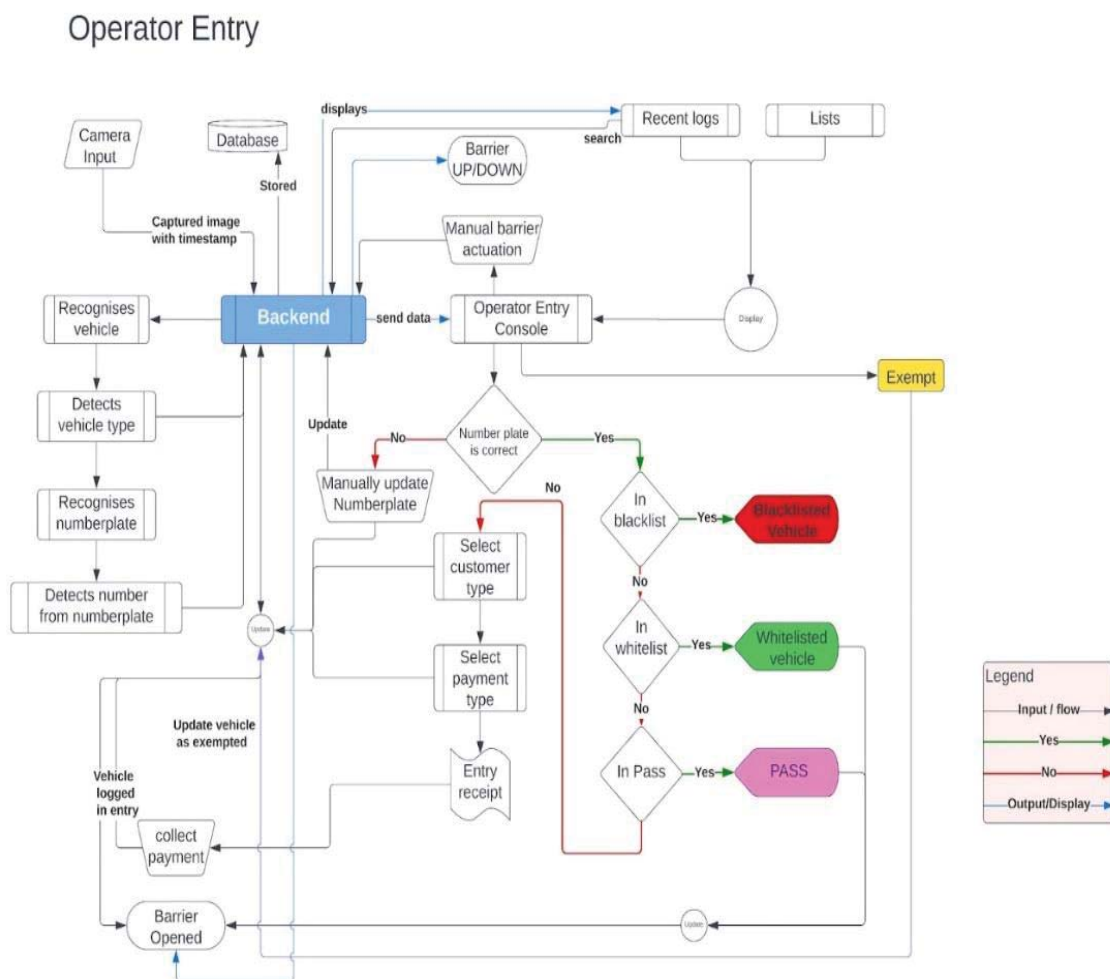
Appendices:

Flowcharts

Figure 1

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Figure 2