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Automated Smart Parking and Number Plate Recognition System

P. Girish[1], M. Prashanth Naidu[2], Dr. DNS. Ravi Kumar[3]

[1,2,3]Department of ECE Sathyabama Institute of Science and Technology

Abstract

This study presents an Automated Smart Parking and Number Plate Recognition System designed to enhance parking efficiency in urban environments. The system integrates IR sensors, Arduino Uno, an LCD display, and Python-based OCR (Optical Character Recognition) to automate vehicle entry tracking and parking slot availability detection. IR sensors monitor vacant spaces, while an Arduino processes this data and updates real-time slot availability on an LCD screen. A camera captures vehicle number plates upon entry, and Python OCR extracts and registers the license plate information into a database for tracking. This reduces human intervention and ensures a faster, more efficient parking process. The proposed system is cost-effective, scalable, and adaptable, making it suitable for smart city applications. Additionally, automation in parking management helps reduce congestion, minimize waiting times, and enhance security through digital record-keeping. Future improvements may include RFID-based vehicle authentication, cloud storage for centralized parking data, and mobile application integration for a seamless user experience. By leveraging hardware-software integration, this system contributes to modernizing traditional parking infrastructure and improving urban mobility.

Index terms: Automated Parking System, Smart Parking, Number Plate Recognition, Optical Character Recognition (OCR), Arduino Uno, IR Sensors, LCD Display, Python-based OCR, Vehicle Tracking, Parking Slot Detection, Smart City Infrastructure, Digital Record-Keeping, RFID Authentication, Cloud-Based Parking Management, Urban Mobility, Intelligent Transportation Systems.

INTRODUCTION

Parking congestion has become a critical issue in urban areas due to the rapid increase in vehicle ownership and limited parking space availability. Conventional parking systems rely heavily on manual operations, leading to inefficiencies such as mismanagement of parking slots, long waiting times, and unnecessary fuel wastage. The lack of real-time parking status updates further contributes to increased traffic congestion, environmental pollution, and driver frustration. To mitigate these challenges, modern urban infrastructures require intelligent, automated parking solutions that optimize space utilization and enhance user convenience.

With advancements in embedded systems and artificial intelligence, automated parking management has emerged as an efficient alternative to traditional methods. This project introduces an IR-based Smart Parking System that integrates Arduino, IR sensors, and Python-based Optical Character Recognition (OCR) for seamless vehicle entry and exit management. The system employs a network of IR sensors to monitor parking slot occupancy in real-time, reducing human intervention and ensuring efficient space allocation. The incorporation of an LCD display provides instant feedback to drivers regarding available slots, minimizing search time and traffic congestion. A motorized gate mechanism, controlled by the

system, ensures authorized vehicle access while maintaining security and smooth traffic flow.
A key feature of this system is the automatic number plate recognition module, which uses a camera module to capture vehicle registration details at entry points. Python-based OCR technology processes the captured image, extracting alphanumeric data and cross-verifying it against a central database. If the vehicle is registered, the system grants entry; otherwise, it prompts an alert for unauthorized access. The database maintains a record of all vehicle entries and exits, enabling better security monitoring and data analysis.

EXISTING MODEL

The working of full NPR system can be divided in to two broad sections which are the hardware part and the software part. The working mechanism of all the parts is described in details below.
The first and the most important part in this process is the software model. The software model uses the image processing technology. The algorithm is divided into following parts: Capture image, Pre-processing, Plate region extraction, Segmentation of character in the extracted number plate, Character recognition, Comparison with database and Indicate result. The flow chart of license plate recognition system implementation in this work is shown in the following figure. There are various steps in this approach and these are implementation in Python Programming.

PROPOSED MODEL

The proposed system introduces a fully automated smart parking and vehicle identification solution that leverages modern sensor technology, microcontrollers, and image processing techniques to address urban parking challenges. Traditional parking systems often face inefficiencies due to manual supervision, space mismanagement, and lack of real-time updates, leading to traffic congestion and unnecessary fuel consumption. To overcome these limitations, this project employs IR sensors to detect vehicle presence, an Arduino microcontroller to process the collected data, and an LCD screen to display real-time parking slot availability.
This ensures that drivers are informed about vacant slots, reducing search time and optimizing space utilization. A key feature of the proposed system is the integration of a number plate recognition module using a camera and Python-based Optical Character Recognition (OCR). When a vehicle approaches the parking facility, its number plate is captured, processed, and compared against a central database for authentication. If the vehicle is registered, the system automatically grants access by opening a motorized barrier; otherwise, entry is restricted. This automated authentication eliminates the need for manual verification, reducing human errors and security risks. The system also maintains a comprehensive log of all incoming and outgoing vehicles, providing valuable data for parking management and security analysis.
Additionally, the proposed solution includes a structured data management approach, where each vehicle's entry and exit time are recorded, enabling better monitoring of parking duration and availability. The system can be further enhanced with cloud integration, allowing real-time remote monitoring through a mobile application. Features such as online slot reservation and automated payment processing can be incorporated to enhance user convenience. Moreover, RFID tags could be introduced as an alternative vehicle authentication method to enable contactless entry, further reducing waiting time.
Energy efficiency and cost-effectiveness are also considered in the design of this smart parking system. By utilizing low-power IR sensors and an optimized algorithm for OCR processing, the system ensures

minimal power consumption while maintaining high accuracy. Compared to conventional parking solutions, this system significantly reduces operational costs by minimizing manpower requirements and optimizing space utilization.

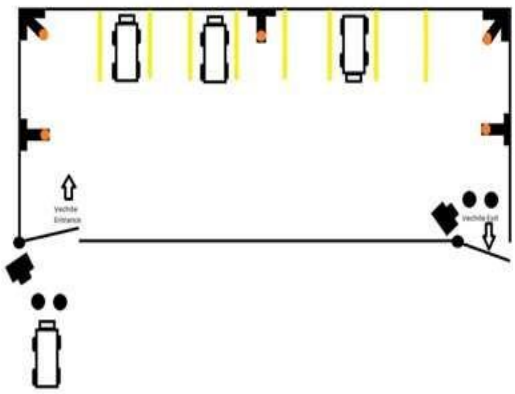

Fig. 3.1: Parking Floor Plan

Future extensions of the project may include AI-driven analytics to predict parking demand based on historical data, integration with smart city infrastructures, and IoT-enabled communication for seamless data exchange between vehicles and parking management systems. These improvements will make the system more scalable, adaptable, and efficient in managing urban parking spaces, ultimately leading to a smarter and more sustainable city environment.

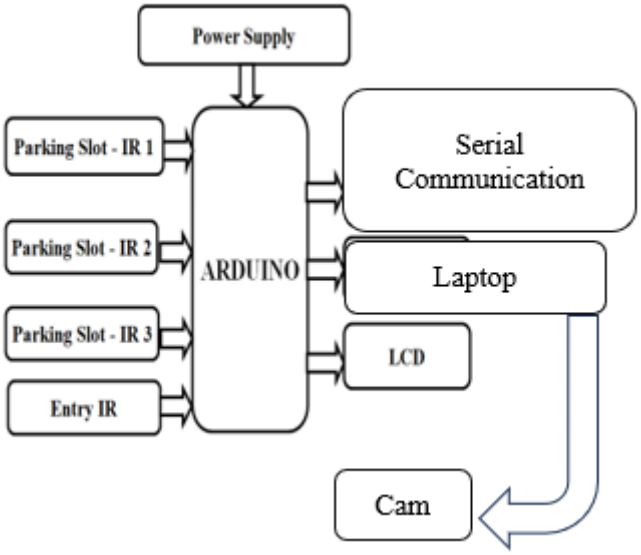

Fig 3.2: Block Diagram

The block diagram illustrates an Arduino-based smart parking system designed to automate vehicle entry detection and parking slot monitoring. The system is powered by a dedicated power supply, ensuring a stable voltage for all components. Infrared (IR) sensors are strategically placed at different parking slots and the entry point to detect the presence of vehicles. These sensors continuously transmit data to the Arduino microcontroller, which processes the information to determine parking slot availability. The

detected information is displayed in real-time on an LCD screen, providing a clear indication of available and occupied slots.

A camera module is integrated into the system for automatic number plate recognition, capturing images of vehicles entering the parking area. The captured image is processed using Optical Character Recognition (OCR) technology on a laptop connected via serial communication. The extracted vehicle number is compared with a database to verify authorization, allowing automated access control. If the vehicle is registered, the system grants entry by triggering a gate mechanism; otherwise, access is denied. The entire setup ensures a seamless parking experience by reducing human intervention, enhancing security, and improving efficiency.

PROPOSED ALGORITHM

Algorithm for Smart Parking System Using Arduino and OCR

1. **Start the System**
   - Power on the Arduino and initialize all connected components, including IR sensors, LCD, camera, and serial communication.
2. **Monitor Parking Slots**
   - Continuously check the status of parking slot IR sensors (IR1, IR2, IR3).
   - If a sensor detects a vehicle, mark the corresponding slot as occupied.
   - Update the LCD display to show real-time parking availability.
3. **Detect Vehicle Entry**
   - Monitor the entry IR sensor.
   - If a vehicle is detected at the entrance, trigger the camera module.
4. **Capture and Process Vehicle Number Plate**
   - Capture an image of the number plate using the camera module.
   - Send the image to the connected laptop via serial communication.
   - Use OCR (Optical Character Recognition) to extract the number plate details.
5. **Verify Vehicle Authorization**
   - Compare the extracted vehicle number with the database.
   - If the number is registered, grant access by opening the parking barrier.
   - If the number is not found in the database, deny entry.
6. **Log Entry and Update Parking Status**
   - If access is granted, log the vehicle entry time into the database.
   - Update the available parking slots on the LCD.
7. **Monitor Vehicle Exit**
   - Detect when a vehicle leaves a parking slot using IR sensors.
   - Update the database and LCD display accordingly.
8. **Repeat Process**
   - Continuously monitor entry, parking slots, and exits for real-time operation.
9. **End System**
   - Shut down components safely when the system is turned off.

ALGORITHM FOR OCR

Algorithm for Number Plate Recognition Using OCR

1. **Capture Image**
- Capture the image of the vehicle's number plate using a camera.
- Store the captured image for processing.
2. **Pre-Processing**
- Convert the image to grayscale to remove color-related noise.
- Apply image filtering techniques such as Gaussian blur to smoothen the image.
- Enhance contrast using histogram equalization to improve character visibility.
3. **Plate Recognition Extraction**
- Detect the region of interest (ROI) containing the number plate.
- Apply edge detection techniques (such as Canny edge detection) to highlight the plate's boundary.
- Use contour detection or morphological operations to isolate the plate from the background.
4. **Character Segmentation**
- Extract individual characters from the recognized plate region.
- Use thresholding techniques (e.g., Otsu's method) to convert the plate into a binary image.
- Identify and segment each character based on connected components analysis.
5. **Character Recognition**
- Apply Optical Character Recognition (OCR) to identify characters from the segmented image.
- Use machine learning or deep learning-based OCR models (e.g., Tesseract OCR) for accurate recognition.
6. **Display Recognized Characters**
- Convert the extracted characters into text format.
- Display the recognized number plate characters on an LCD or user interface.
- Store the recognized plate number in a database for further processing (e.g., vehicle authentication, parking access control).

REFERENCES

1. Mukesh Kumar," A Real-Time Vehicle License Plate Recognition (LPR) System", A thesis report submitted for the completion of Master degree in Electronics Instrumentation and control engineering, July 2009.
2. Automated parking system- Research Report by Arbind Kumar Mishra.
3. Nepal Traffic Police, License Plate Information cited from http://traffic.nepalpolice.gov.np/other-notices/number-plate1.html
4. An article on Tesser act based Nepali OCR - Research Report published on http://nepalinux.org/index.php?option=com_content &task=view&id=46&Itemid=53
5. Ashok Kumar Pant, Sanjeeb Prasad Panday and Prof. Dr. Shashidhar Ram Joshi, "Off-line Nepali Handwritten Character Recognition Using Multilayer Perception and Radial Basis Function Neural Networks".
6. Love Shankar Shrestha, Promisha Mishra, Ravi Bhagat, Tanka Bahadur Pun, "Final Report on Vehicle Number Plate Recognition System ", 2013.
7. Ahmed, M., Khan, S., & Rehman, U. (2021). "IoT-based Smart Parking System Using Image

Processing and Machine Learning." International Journal CO.
8. Alotaibi, B., & Mehmood, R. (2019). "Smart City Architecture for Smart Parking: Machine Learning-Based License Plate Recognition System." Future Internet, 11(2), 46.
9. Badrinarayanan, V., Kendall, A., & Cipolla, R. (2017). "SegNet: A Deep Convolutional Encoder-Decoder Architecture for Image Segmentation." IEEE Transactions on Pattern Analysis and Machine Intelligence, 39(12), 2481- 2495.
10. Basu, A., & Ghosh, S. (2020). "Real-Time Automatic Number Plate Recognition Using Deep Learning and OCR." Proceedings of the IEEE International Conference on Computer Vision, 2020, 34-40.
11. . Chen, C., Zhang, Y., & Liu, Y. (2022). "An Edge AI Approach for Automated Parking System with License Plate Recognition." Sensors, 22(6), 3157.
12. Ghosh, S. K., et al. (2012). "Smart Parking Management System using IoT and Cloud Computing." IEEE Xplore.
13. . Gupta, P., Sharma, A., & Singh, R. (2021). "Deep Learning-based Smart Parking Management System Using ANPR Technology." Neural Computing and Applications, 33(4), 1123-1137.
14. Hannan, M. A., et al. (2020). "Advancements in Intelligent Parking Systems." Elsevier, Transportation Research.