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Empty Space Parking Slot Detection

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ABSTRACT: The "Empty Car Parking Slot Detection System" is an intelligent solution developed to address the growing parking challenges in urban areas. This project leverages computer vision techniques and machine learning models to detect and mark vacant parking slots in real time. By utilizing OpenCV for image processing and Keras for building a Convolutional Neural Network (CNN), the system processes video feeds or images from parking lot cameras to accurately identify empty spaces. The project provides an automated, cost-effective, and efficient method to manage parking areas, saving drivers time and reducing congestion caused by searching for available slots. The system is designed to be scalable, making it suitable for small parking areas as well as large commercial parking lots.

KEYWORDS: Smart Parking System, Convolutional Neural Networks (CNN), Deep Learning, OpenCV, Keras Image Processing, Real-Time Detection, Occupancy status, Automated Parking.

I. INTRODUCTION

The empty parking space detection system aims to solve the common problem of finding available parking spaces in crowded areas. By installing cameras in parking lots, the system automatically detects vacant parking spaces using image processing technology. The core of the system is based on machine learning, specifically convolutional neural networks (CNN), which have been trained to recognize and classify parking spaces based on real-time video data. This solution helps reduce the time spent searching for parking spaces, improves overall parking management, and enhances user convenience. The project combines the power of computer vision and deep learning to provide an intelligent and automated way of managing parking space usage. The system is designed to be adaptable to various types of parking layouts, including open lots and multi-level parking structures, ensuring scalability and wide applicability.Integration with GPS and mapping services can further guide drivers directly to the nearest available slot, improving route planning and traffic flow. The project also includes a data logging feature, which records parking activity patterns. This data can be used by parking authorities for decision-making, forecasting demand, and improving facility planning. Real-time alerts can be configured for specific scenarios, such as overstayed parking or unauthorized vehicle detection, enhancing security and compliance.

SCOPE

The scope of this project is to develop a system for real-time detection of empty parking spaces, utilizing computer vision and machine learning technologies. The project will focus on designing a model capable of analyzing video streams from cameras installed in parking lots to identify which parking spaces are available. The system is mainly applicable to open parking areas, such as shopping malls or office buildings, and will use images or videos captured by standard surveillance cameras. It does not take into account specific parking requirements, such as the detection of accessible parking spaces or very small parking spots.

Additionally, the system is designed to provide users with a simple interface to view real-time parking availability, reducing the time spent searching for empty spaces. This project will not address more complex aspects, such as vehicle identification or integration with parking management software, which could be considered for future enhancements.

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II. OBJECTIVES

Automatic Parking Space Detection:
Develop a system that can detect available parking spaces in real time using advanced computer vision and machine learning technologies. This will help reduce the time drivers spend looking for vacant parking spots.

Improvement of Parking Lot Efficiency:
By accurately identifying occupied and available parking spaces, optimize the utilization of parking spots. This can improve parking lot management and reduce congestion.

Real-Time Data Processing:
Implement a system that processes real-time video or images from cameras installed in parking lots. The system should rapidly analyze the data and provide real-time feedback on parking space availability.

User-friendly interface:
Design an intuitive and easy-to-use interface for users to access the system's discoveries. This ensures a seamless experience between parking lot operators and vehicle owners.

Scalability:
Ensure that the system can scale and be applied to various types of parking lots, including public places, commercial areas, and residential areas, to accommodate different sizes and needs.

III. PROBLEM STATEMENT

Finding available parking spaces in crowded areas is a common challenge faced by drivers. Traditional methods, such as physical signs or parking attendants, can be inefficient and time-consuming. This project aims to address this issue by developing a system that can automatically detect vacant parking spaces using computer vision and machine learning technologies. By utilizing a Convolutional Neural Network (CNN) model, the system can analyze images of parking lots and accurately identify empty spaces. This information can be displayed on a user-friendly web interface to help drivers quickly find available parking spots, reducing traffic congestion.

IV. DEMONSTRATION

The design of this system focuses on creating an efficient and robust parking space detection system using deep learning technology. The architecture is intended to handle real-time video inputs, detect empty parking spaces, and provide accurate predictions. The design integrates OpenCV for image processing and uses Keras to build the convolutional neural network model. The system is modular, making it easy for future updates or adjustments.

With the rapid growth of urban populations and the exponential increase in the number of vehicles, efficient parking management has become an urgent necessity for modern cities. Congested urban areas often lack parking spaces, causing drivers to waste a significant amount of time and fuel searching for available spots. This not only leads to frustration and traffic congestion but also increases carbon emissions and environmental pollution. To alleviate these issues, implementing intelligent and automated vacant parking space detection systems is timely and crucial.

The main goal of this system is to accurately identify and highlight available parking spaces in real-time using computer vision technology. By utilizing advancements in convolutional neural networks (CNN), OpenCV, and deep learning frameworks such as Keras, the system aims to analyze real-time camera footage or static images of parking lots to detect the availability status of each parking space.

Traditional parking systems mainly rely on hardware-intensive solutions, such as infrared sensors, RFID tags, or magnetic field detection. Although these methods are effective, the installation and maintenance costs are high. In contrast, vision-based systems are relatively cost-effective, scalable, and easy to deploy. They require minimal hardware—primarily cameras for visual input—and utilize intelligent software to interpret the captured visual information.

In our implementation, we use a dataset containing annotated images of parking spaces to train a CNN model. The trained model learns to distinguish between occupied and vacant slots based on the features extracted from the parking

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spaces. OpenCV is used for image preprocessing, including resizing, gray conversion, contour detection, and region of interest (ROI) extraction. Keras provides a high-level interface for building and training deep learning models.
The system workflow typically includes:

1. **Capturing real-time video or still image input** from overhead surveillance cameras in parking areas.
2. **Preprocessing the images** to isolate the parking space areas and enhance features.
3. Classifying each parking space using a trained CNN model, labeling them as "Occupied" or "Free."
4. **Overlaying detection results** on the original images or video streams to clearly indicate available parking spaces.

In practical deployment, this system can be integrated into smart parking management applications to:

• Guide drivers to find the nearest available parking spaces through mobile applications or digital signage.
• Collect statistics on parking usage patterns.
• Enable real-time monitoring and automatic alerts for security or rule violations.

V. RESULT EVALUATION

Fig: Output of slots Detection

VI. CONCLUSION

This project successfully combines computer vision with web development to detect vacant parking spaces in real-time. By using a trained convolutional neural network model, it accurately identifies whether the parking spaces are free or occupied. The backend is built with Flask, handling the video stream and updating the status on a user-friendly web interface. The interface is created using HTML, CSS, and JavaScript, displaying results in real-time, providing practical benefits for parking management in busy areas.

Although the project achieved its goals, the challenges faced include dealing with complex lighting conditions in video streams, optimizing the model for faster predictions, and ensuring the accuracy of slot detection in different environments. Despite these challenges, the system still demonstrates great potential to enhance parking efficiency and reduce traffic issues in urban areas. Further refinement and testing could make it more reliable and scalable for practical use.

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