CAR PARKING SLOT DETECTION USINGCOMPUTER VISION

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ABSTRACT

Car parking slot detection using computer vision is a project aimed at automating the process of detecting vacant parking spaces ina parking lot. With the increasing numberof vehicles and limited parking space availability, this project addresses the need for efficient parking management systems. The project utilizes computer vision techniquesto analyze real-time video feed from surveillance cameras installed in the parking lot. The proposed system employs image processing algorithms and machine learning models to detect and classify parking spaces as occupied or vacant. The process begins with the acquisition of video frames from the camera feed. Preprocessing techniques such as image enhancement, noise reduction, and image segmentation are applied to extract relevant features and isolate parking spaces. Various computer vision algorithms, such as edge detection and contour analysis, are employed to identify andlocalize individual parking slots. To classify the status of each parking slot (occupied or vacant), a machine learning model is trained using a labeled dataset. The model is designed to learn the visual characteristics of occupied and vacant parking spaces, enabling accurate classification. Popular machine learning algorithms like convolutional neural networks (CNNs) or support vector machines (SVMs) can be employed for this purpose. Once the classification is performed, the system generatesa real-time visualization of the parking lot, highlighting the occupied and vacant parking spaces. This information can be displayed on electronic boards, mobileapplications, or integrated into existing parking management systems, providing userswith up-to-date parking availability information. The implementation of car parking slot detection using computer vision offers several benefits. It improves parking lot management efficiency by automating the detection process, reducing the need for manual monitoring. Additionally, it enhances the overall user experience by providingreal-time parking availability information, reducing the time spent searching for a vacant parking space. In conclusion, this project leverages computer vision techniquesand machine learning models to develop a robust system for car parking slot detection.

Keyword: *Machine Learning, Deep Learning, Python Libraries, Mark R-CNN, Numpy*

1. INTRODUCTION

In urban areas and crowded environments, finding a parking spot can often be a time- consuming and frustrating task. The inefficient utilization of available parking spaces can lead to congestion, increased pollution, and reduced convenience

for drivers. To address this challenge, a parking slot allocation mechanism using deep learning can significantly enhance the efficiency of parking lot management and improve the overall parking experience for users.Deep learning, a subset of artificial intelligence, has demonstrated remarkable capabilities in handling complex tasks, particularly in computer vision and pattern recognition. By harnessing the power of deep learning algorithms, we can create an intelligent system that can analyze real-time data from parking lots and allocate available parking slots to oncoming vehicles effectively. The main goal of this projectis to develop an intelligent parking slot allocation mechanism that optimizes the parking process by dynamically assigning parking spaces based on real-time occupancy information. To achieve this, we will utilize cutting-edge deep learning techniques, such as Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), to process image and sensor data from the parking lot environment. This mechanism offers several advantages over traditional parkingmanagement systems. First and foremost, it provides real-time information about parking space availability, allowing drivers to quickly locate vacant spots without theneed to search aimlessly. Additionally, the intelligent allocation algorithm optimizesthe utilization of parking spaces, reducing the occurrence of overfilled areas and minimizing congestion. The core components of this parking slot allocation mechanism include data collection, deep learning model selection, training, integration with parking lot sensors/cameras, and the development of an allocation algorithm.

The success of this mechanism heavily relies on the availability of high-quality data and continuous model improvement through user feedback and real-world data updates. Moreover, ethical considerations, such as ensuring data privacy and compliance with local regulations, will be prioritized throughout the project. By leveraging the capabilities of deep learning, we aim to revolutionize parking lot management and create a seamless parking experience for drivers. The resulting system will not only benefit individual drivers but also contribute to reduced trafficcongestion, improved air quality, and enhanced urban mobility for everyone.

The trained deep learning model will predict the occupancy status of each parking slot, while the allocation algorithm will efficiently assign parking spaces to oncoming vehicles.

1.1 Background of the work

Real-Time Parking lot sensors or cameras, providing up-to-date information on parking space availability. Optimized Space Utilization intelligent allocation algorithm optimizes the utilization of parking spaces by efficiently assigning slots to oncoming vehicles. Reduced Congestion By efficiently allocating parking spaces, the mechanism helps reduce traffic congestion within parking lots. Improved User Experience Drivers experience less frustration and stress when searching for parking, leading to an overall improved parking experience. Cost Savings Businesses and municipalities can benefit from the optimized space utilization, potentially leading to cost savings by avoiding the need for additional parking infrastructure or resources. Scalability The deep learning-based mechanism can be easily scaled to different parking lots and locations, making it applicable in various settings, from small businesses to large public parking structures. Data-Driven Insights The system generates valuable data about parking patterns and occupancy rates, which can be analyzed to gain insights into parking behavior, peak hours, and demand forecasting. Enhanced Safety With reduced congestion and smoother traffic flow, the risk of accidents within parking lots decreases, improving safety for pedestrians and drivers alike.

1.2 Motivation (Scope of the proposed work)

Parking Garages and Lots: Parking facilities, such as multi-level parking garages and open parking lots, can benefit from this mechanism by efficiently allocating parking spaces to incoming vehicles, thereby increasing revenue and providing a better customer experience. Smart Parking Apps: Integration of the parking slot allocation mechanism into mobile applications can enable real-time parking availability updates and navigation services for drivers, improving their overall parking experience. Environmental Impact: By reducing the time spent searching for parking spaces and optimizing parking lot usage, this mechanism can contribute to reduced traffic congestion and lower carbon emissions, making it an environmentally friendly solution. Adaptive Parking Solutions: This mechanism can adapt to changing parking patterns, special events, or seasonal variations, ensuring that parking allocation remains efficient and relevant over time. Parking Reservation Systems: By integrating this mechanism with parking reservation systems, users can reserve parking spaces in advance, improving convenience and reducing uncertainty.

2.LITERATURE REVIEW: TECHNIQUES AND ALGORITHM USED:

Deep Learning-Based Smart Parking System for Urban Environments This research proposed a deep learning-based approach for parkingslot allocation in urban environments. They used Convolutional Neural Networks(CNNs) to analyze parking lot images and classify parking spaces as vacant or occupied. The system achieved promising results in real-world scenarios, providing accurate predictions of parking space availability. Parking Availability Prediction Using

ConvolutionalNeural Networks This study focused on predicting parking space availability in aparking lot using CNNs. They utilized images from cameras installed in parking lots and trained a deep learning model to predict the occupancy status of individual parking slots. The model showed high accuracy in real-time predictions, enablingefficient parking slot allocation. Towards Autonomous Parking Using Deep Learning Lin et al. explored the use of deep learning for autonomous parking in self-driving vehicles. They used deep neural networks to detect and classify parking spaces and proposedan allocation algorithm for autonomous vehicles to park in real-world environmentsautonomously.

2.1 IMPLEMENTATION AND DEVELOPMENT FOR PERSONALIZED MEDICINE APPROACH:

Data Collection: A dataset of images or videos of parking lots with labelled parkingslots is collected. The dataset should contain examples of both vacant and occupiedparking slots.

Preprocessing: The collected data is pre-processed to enhance image quality, remove noise, and normalize lighting conditions. Techniques such as image resizing, contrast adjustment, and filtering are applied.

Object Detection: The pre-processed data is fed into an object detection algorithm, such as the YOLO (You Only Look Once) algorithm, to detect and localize parkingslots in the images. The algorithm assigns bounding boxes around the detected slots.

Feature Extraction: Features such as colour, texture, and shape are extracted from the detected parking slots to distinguish between vacant and occupied slots.

Machine Learning: A machine learning model, such as a Support Vector Machine (SVM) or a Convolutional Neural Network (CNN), is trained on the extracted features to classify parking slots as vacant or occupied.

Real-time Detection: The trained model is deployed to perform real-time parkingslot detection on live video feeds from a camera placed at a parking lot. The systemcontinuously updates the status of parking slots and provides visual feedback to theusers. The project utilizes image processing algorithms and machine learning techniques to analyse video or image input from a camera mounted at a parking lot.

Purpose: Design and implementation of a computer vision-based parking lotrecognition system. Train and evaluate an object detection model for detecting freeparking spaces. Provides users with real-time information about parking spaceavailability. Efficient parking lot management and alleviation of congestion. **Scope:** The focus of this project is the development and evaluation of parking spacedetection systems using computer vision technology. This includes data acquisition,preprocessing, model training, and real-time delivery in a controlled environment. **Importance of research:** Successful implementation of this project will contribute to optimizing the use of parking spaces in urban areas, thereby reducing trafficcongestion and improving mobility throughout the city. It also serves as the foundation for more advanced smart city applications.

Image processing and feature extraction: Use computer vision techniques toprocessimages and extract relevant features such as parking boundaries

2.2 Tech equipment and methodology proposed:

Technology:

- Machine Learning Algorithms

Languages:

- Python

Tools:

- Visual Studio
- Jupyter Notebooks
- TensorBoard

Methodology proposed:

- Data Aggregation and Integration
- Feature Engineering
- Machine Learning Model Development
- Scalability and Reproducibility

3. PROPOSED WORK

Problem Description
Data collection
Preprocessing
Model selection
Model training
Postprocessing
Deployment

Proposed work for personalized medicine approach for clinical trial design and patient selection using machine learning

Data Collection: Data collection is an important step in training a computer visionsystem for parking detection**.**
Determine Information Needed:
Determine the specific information needed in the project, including photos or videos, camera specifications, and the type of station you want to cover indoor, outdoor, more stories etc..

Get Cameras and Sensors:

Depending on the size of your project, you may need to install cameras and sensor at your target station. Consider factors such as camera resolution, frame rate, and vie wing area.

Data Description:

Annotate the collected data to mark the station as absent or present. you can use annotation tools such as Labeling, VGG Image Annotator (VIA), or a text editor.

Data Collection Strategies:

Static cameras:

Place static cameras at different angles and positions in the parking lot.
Take pictures or videos regularly or intermittently.
Make sure camera angles cover the entire parking area and lighting.

Mobile camera:

Use a car equipped with a camera to capture data as you drive through the parking lot.
Record video or take photos while the vehicle is in motion.
Examine each station from different angles.

Record video or take photos while the vehicle is in motion.
Examine each station from different angles.
Data simulation:

If storing data in the world is difficult, consider using 3D modelling software like Blender to create a data simulation. Simulated data can help improve real data and improve the capability of the model.
Data Changes:

Changes the lighting day night, dusk, dawn. In different weather conditions like sun, rain, snow, etc... Includes accidents caused by other vehicles or equipment.

Data Privacy and Legal:

consideration of your data in public areas, please ensure that privacy laws are compiled with and appropriate consent has been obtained. Hide or anonymize all sensitive information (such as license plates and faces) from

data collection.

Data Segmentation:

Separate the collected data into three groups: - training, validation and testing. Generally appropriate splits are 70-80% for training, 10-15% for validation and 10- 15% for testing.

Data Storage and Management:

Develop and store data in structured manner, including meta-data and descriptions. Back up your data and protect it from loss.

Continuous Data Collection:

Consider establishing a continuous data collection system so that data is current and reflects changes at the station. Remember the quality and diversity of dataset is important in training the station to recognize good patterns. The data should include a variety of conditions and situation to ensure the model is robust and accurate in real-life situations.

Preprocessing:

Preprocessing is an important step in preparing the data station for computer vision It helps improve the quality and availability of data to train detection models

Data Conversion:

Convert data into a format suitable for your computer vision (e.g. Tensor Flow, PyTorch). Image and video formats include JPEG, PNG or TF Record.

Resizing and Normalization:

Resize images to a consistent resolution to fit your architectural model. This reduces complexity of computer. Normalize pixel values to ensure they fall with a certain range (e.g. [0, 1] or [-1, 1]) to improve pattern matching.

4. RESULTS AND DISCUSSIONS

Deployment:

Deploying the station to view the system using computer vision will transport the training model and software to the production floor where it can be run immediately. You can find step-by-step instructions for deployment here:

Real-Time Processing:

- Real time or near time processing capabilities especially when the system must provide actual station data.
- Create a handy pipeline to access videos or photos from the camera.

Data Privacy and Security:

- Ensure data privacy and security measures are in place, especially when surveillance or storing sensitive information such as photos or videos.
- Use encryption access control and data anonymity where appropriate.

Error Handling and Resolution:

- Use good error handling techniques to resolve unexpected problems that may occur during deployment.
- Set up logs and monitoring tools to monitor system performance and detect anomalies.

Testing and Validation:

- Carefully test the system in real world environments including different lighting and weather conditions.
- Check the accuracy of parking search and the decision to stay inside.

Scalability:

- Plan for scalability to accommodate the number of cameras or stations as needed.
- For large deployments, consider load balance and division of labour.

5. CONCLUSIONS

In summary, the use of computer vision for parking detection has revolutionized parking management, with the potential to increase mobility and convenience in thecity. The technology uses artificial intelligence and imagery to clearly identify and classify empty and occupied parking spaces, making parking easier and moreconvenient for drivers looking for a spot. Its real-time capabilities provide quick access to the latest station data, while its scalability allows it to accommodate multiple stations and multiple scenarios. Its durability against changing lighting, weather conditions and obstacles further emphasize its reliability. The user-friendly interface improves the overall experience, and continuous improvement through monitoring, updates, and user feedback ensures accuracy and performance over longruns. Adhering to privacy and security is important, and effective technologyincludes reducing traffic, emissions and transportation problems in the city. As technology continues to advance, car parks will play an important role in improvingthe city's environment for a better and safer way. In conclusion, using computer vision to search for parking spaces is a revolutionary way to improve urban management. Using the power of artificial intelligence and image analysis, the technology offers unique solutions for determining and allocating parking spaces and parking spaces. Its real-time operation gives drivers access to the latest parkinginformation, reducing the hassle of finding a parking space. The system's adaptability to different parking lots and ability to operate in different conditions, including different lighting and weather conditions, make it a good choice. User interfaces and mobile applications developed with these systems offer a user- friendly experience to drivers and parking operators. Regular monitoring and maintenance, along with user input, ensures that the system remains accurate and reliable over time. Additionally, compliance with data privacy and security regulations is an important part of success. As well as direct benefits, the technologyalso has a wider impact, such as reducing traffic accidents,

reducing emissions and improving urban mobility. With the continuous development of computer vision technology, parking will be beneficial in creating a smarter, more efficient and stableenvironment in the city.

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