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Real Time Parking Occupancy Detection using OpenCV

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***Abstract*—This research proposes a real-time parking occupancy detection system using Python and OpenCV. The system dynamically updates parking availability. This enhances parking management and promotes safer environments. The proposed system employs a combination of image processing and machine Learning algorithms to monitor parking spaces continuously. A camera network Is strategically placed to capture live video feeds of the parking area. The video Frames are processed using OpenCV, leveraging object detection algorithms to Identify and track vehicles in real-time. The parking occupancy status is then Dynamically updated, providing users with up-to-the-minute information on Available parking spaces.**

I. INTRODUCTION

Real-time parking occupancy detection has emerged as a pivotal technology, offering a dynamic approach to optimize parking utilization. This research focuses on the development and implementation of a real-time parking occupancy detection system using Python and OpenCV, enriched with helmet detection capabilities for enhanced safety within parking areas.Urbanization has led to an unprecedented surge in the number of vehicles, exacerbating the strain on available parking resources. Conventional parking management systems often fall short in providing timely and accurate information regarding parking space availability, leading to frustration among drivers and exacerbating traffic congestion. Addressing these challenges requires a sophisticated and intelligent system capable of monitoring parking spaces in real-time and providing actionable insights to both drivers and parking administrators.The integration of computer vision, particularly leveraging the OpenCV library, with Python programming, offers a powerful and flexible platform for developing such intelligent parking solutions. Real-time object detection and tracking algorithms enable the system to continuously analyze video feeds from strategically positioned cameras, dynamically updating the status of parking spaces. This not only optimizes the parking experience for users but also aids in efficient parking management.

II. OBJECTIVES

1. Real-Time Parking Occupancy Detection: Develop an efficient and Accurate system for real-time parking occupancy detection using Python And OpenCV. Implement object detection and tracking algorithms to Continuously monitor parking spaces and update the occupancy status in Real-time.

2. Integration of Helmet Detection: Integrate a deep learning-based helmet Detection model into the system to identify individuals wearing helmets Within the parking area. This feature aims to enhance safety compliance And contribute to accident prevention in parking premises.

3. Python and OpenCV Implementation: Utilize the Python programming Language and OpenCV library to create a scalable and easily deployab neele Solution. Ensure that the system is modular and adaptable for different Parking environments, allowing for straightforward integration and Customization.

4. User-Friendly Interface: Develop a user-friendly interface accessible Through web or mobile applications. The interface should provide Intuitive and real-time information on parking space availability and Safety compliance, enhancing the overall user experience.

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5. Efficient Resource Utilization: Optimize the system for resource Efficiency to ensure that it can operate in real-time without significant Computational overhead. Implement algorithms and techniques that Balance accuracy with computational speed to achieve practical viability.

III. MODULE BREAKDOWN

The proposed real-time parking occupancy detection system with helmet Detection comprises several key modules, each playing a crucial role in the Overall functionality of the system. Here is a detailed description of the main Modules:

1. Video Input Module:
- Functionality: This module is responsible for capturing live videoFeeds from strategically positioned cameras within the parking Area. It serves as the primary source of input for the system.

- Implementation: Utilizes OpenCV's VideoCapture functionality to Access and stream video frames from the cameras in real-time.

2. Object Detection Module:
- Functionality: Implements advanced object detection algorithms, Such as YOLO (You Only Look Once) or SSD (Single Shot Multibox Detector), to identify and track vehicles within the video Frames.
- Implementation: Utilizes pre-trained deep learning models for Object detection, which have been trained on large datasets to Accurately recognize vehicles. The OpenCV library is employed for Integrating and applying these models to the video stream.

3. Parking Occupancy Tracking Module:
- Functionality: Dynamically updates the parking occupancy status Based on the output from the Object Detection Module. Keeps Track of the number of occupied and vacant parking spaces in real-Time.
- Implementation: Employs algorithms to process object detection results and maintain a dynamic count of parking spaces. The information is then made available for display through the user interface.

4. User Interface Module:
- Functionality: Provides a user-friendly interface accessible Through web or mobile applications, presenting real-time Information on parking space occupancy and safety compliance.Enables users to visualize parking availability and safety status.
- Implementation: Developed using web technologies (HTML, CSS, JavaScript) or mobile app frameworks. Integrates with the Backend to retrieve and display real-time parking information.

IV. ONGOING CONFIGURATION

1. Manual Parking Monitoring: Many parking facilities still rely on Manual monitoring methods, where parking attendants manually count And record the number of occupied and vacant parking spaces. This Approach is time-consuming, prone to human error, and provides only Periodic snapshots of parking availability, making it inadequate for Addressing real-time demands.

2. Static Signage and Displays:Traditional static signs and displays are Commonly used to convey parking availability information to drivers. However, these signs lack real-time updates and are unable to adapt to
Dynamic changes in parking occupancy. Drivers may be misled by Outdated information, leading to frustration and inefficiencies.

3. Manual Ticketing Systems: Traditional ticketing systems, where users Collect a paper ticket upon entry and pay at a booth upon exit, are still Prevalent. These systems are labor-intensive, susceptible to errors, andcan lead to congestion during peak hours.

4. Limited Surveillance Cameras: Some parking areas use surveillancen Cameras, but these are often limited in functionality. Basic camera setups Lack the sophisticated computer vision capabilities needed for accurate And real-time parking occupancy detection.

5. Lack of Safety Features: Many existing systems primarily focus on Parking space management and overlook safety features. There is a lack Of integration with advanced safety measures, such as helmet detection,Which is crucial for preventing accidents and ensuring compliance with Safety regulations.

V. PROPOSED SYSTEM

The proposed real Time parking occupancy detection system aims to Overcome these limitations by leveraging advanced computer vision and Machine learning techniques.

1. Computer Vision and Object Detection: The system utilizes computer Vision techniques, particularly object detection algorithms, to analyze live Video feeds from strategically placed cameras. By employing state-of-the-Art object detection models, such as those based on deep learning Architectures the system can accurately identify and Track vehicles in real-time.
2. User-Friendly Interface: The proposed system includes a user-friendly Interface accessible through web or mobile applications. This interface Provides an intuitive and visually appealing display of real-time parking Occupancy status, contributing to a positive user experience.
3. Real-Time Updates and Dynamic Information: Unlike traditional Methods that provide periodic snapshots of parking occupancy, the Proposed system offers real-time updates. Users can access dynamic information on parking space availability through a user-friendly interface, which significantly improves the efficiency of parking space utilization.

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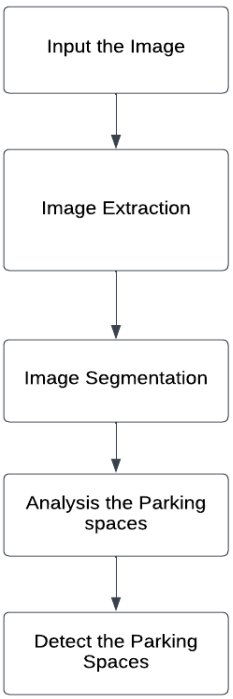
VI. DATA FLOW DIAGRAM

Data Flow Diagram (DFD) is a graphical tool for picturing how data flows through a business information system. They also show the mechanisms by which data moves from outsource to storing and subsequently producing reports. The two types of DFD are known as logical and physical. It is related data flow diagramals are a physical data flow diagram that outlines how the logical data flow has been implemented. This differentiation allows the system designers to focus on system's functional requirements without worrying about the system's implementation intricacies.

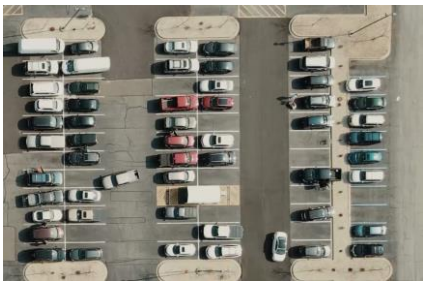
Data Flow Diagrams (DFDs) are visual depiction of those functions and processes that hold, manipulate, store, and distribute data between system parts as well as between the system and the outside world. Such a graphical depiction is a convenient means of communication between the system designer and user. Using DFDs, system designers are then able to express the complexity of system functionalities clearly and universally to be understood by all stakeholders as to what the system is required to do and behave. DFD's primary purpose is to define the scope and boundary of the system and addresses the details as to what the operations of the system are, what data storage locations, and what interactions it carries with the environment.

DIAGRAM :



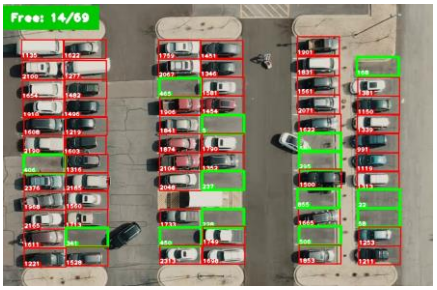
VII. SOURCE IMAGE

- Top down view of a parking area captured for feature extraction and space classification in occupancy deduction.



VIII. RESULT IMAGE

- Final detection frame with bounding boxes indicating available and filled parking slots as determined by the open CV model



IX. CONCLUSION

1. In conclusion, the proposed real-time parking occupancy detection system with Helmet detection stands as a transformative solution that addresses and the limitations of conventional parking management systems. By Seamlessly integrating cutting-edge technologies like computer vision, deep Learning, and Python programming with the OpenCV library, this system offers A comprehensive approach to enhance both efficiency and safety within Contemporary urban environments.
2. The key modules designed for various functionalities work in concert to create a Sophisticated yet user-friendly solution. The video input module serves as the System's eyes, capturing live video feeds from strategically positioned cameras.
3. Leveraging OpenCV's VideoCapture functionality, it establishes the primary Source of real-time input for the entire system, setting the stage for advanced Processing.

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