Vision Based Parking Occupation Detection System with AI

Mrs. Sudha R, Associate Professor,

Department of Electronics and Communication Engineering,

Sri Shakthi Institute of Engineering and Technology, L&T Bypass, Coimbatore

r.sudha@siet.ac.in

Devapriyan S, Dheepak Prasath N, Manohar Kumar G, Nalin Kumar K

Department of Electronics and Communication Engineering,

Sri Shakthi Institute of Engineering and Technology, L&T Bypass, Coimbatore

Abstract - *An improvement in technology is linearly related to time and time-relevant problems. It has been seen that as time progresses, the number of problems humans face also increases. However, technology to resolve these problems tends to improve as well. One of the earliest existing problems which started with the invention of vehicles was parking. The ease of resolving this problem using technology has evolved over the years but the problem of parking still remains unsolved. The main reason behind this is that parking does not only involve one problem but it consists of a set of problems within itself. One of these problems is the occupancy detection of the parking slots in a distributed parking ecosystem. In a distributed system, users would find preferable parking spaces as opposed to random parking spaces. In this paper, we propose a web-based application as a solution for parking space detection in different parking spaces. The solution is based on Computer Vision (CV) and is built using the Django framework written in Python 3.0. The solution works to resolve the occupancy detection problem along with providing the user the option to determine the block based on availability and his preference. The evaluation results for our proposed system are promising and efficient. The proposed system can also be integrated with different systems and be used for solving other relevant parking problems.*

1. INTRODUCTION

A Vision-Based Parking Occupation Detection System with Artificial Intelligence (AI) uses computer vision and AI algorithms to automatically detect the availability of parking spaces. Cameras installed in parking areas capture real-time footage, which is then processed by AI models trained to identify whether a parking space is occupied or empty. By analyzing visual data, the system can overcome environmental challenges such as lighting changes, shadows, and vehicle types, ensuring accurate detection. This real-time monitoring helps reduce

the time spent searching for available spaces and provides users with instant parking availability information through mobile apps, websites, or dynamic signage.

The system offers significant benefits, including more efficient parking management, improved traffic flow, and reduced congestion in parking areas. By optimizing parking space usage, it enhances user experience and reduces the environmental impact of idle vehicles searching for parking. Additionally, it provides valuable data analytics for parking operators, helping them optimize operations and identify usage patterns. The integration of AI and computer vision makes this system a scalable, cost-effective solution, ideal for both small and large parking facilities in urban settings, shopping centers, airports, and more.

1.1. OBJECTIVES :

A **Vision-Based Parking Occupation Detection System with AI** aims to revolutionize parking management by leveraging computer vision and artificial intelligence to identify and monitor parking spaces in real-time. The primary objective is to provide accurate and timely information on parking availability, helping drivers locate free spaces quickly and efficiently. This reduces time spent searching for parking, minimizes traffic congestion, and lowers fuel consumption, contributing to a more eco-friendly urban environment. The system is designed to replace or complement traditional sensor-based approaches, offering a scalable and cost-effective solution adaptable to various parking lot sizes and conditions.

By utilizing advanced AI models, such as Convolutional Neural Networks (CNNs), the system ensures high accuracy in detecting vehicles, even under challenging lighting or weather conditions. It integrates seamlessly with smart city ecosystems, allowing real-time data to be shared through mobile applications, digital signage, or IoT platforms. Furthermore, the system supports data logging and analytics to monitor parking trends and optimize operations. Enhanced features like monitoring reserved parking spaces, identifying unauthorized usage, and offering improved security through surveillance capabilities further expand its scope. Overall, this solution aims to improve the user experience, enhance parking lot efficiency, and contribute to smarter urban infrastructure.

1.2. EFFECT OF AI :

The integration of Artificial Intelligence (AI) into Vision-Based Parking Occupation Detection Systems has significantly transformed traditional parking management by enhancing its efficiency, accuracy, and scalability. AI enables the system to utilize advanced computer vision techniques, such as Convolutional Neural Networks (CNNs), to accurately detect and classify vehicles and parking spaces in real-time, even in challenging conditions like poor lighting or adverse weather. This eliminates reliance on manual monitoring or expensive hardware, such as ground sensors, making the system cost-effective and easy to deploy. Furthermore, AI-powered systems provide real-time updates on parking availability, reducing the time drivers spend searching for spaces, which improves the user experience, reduces stress, and lowers fuel consumption.

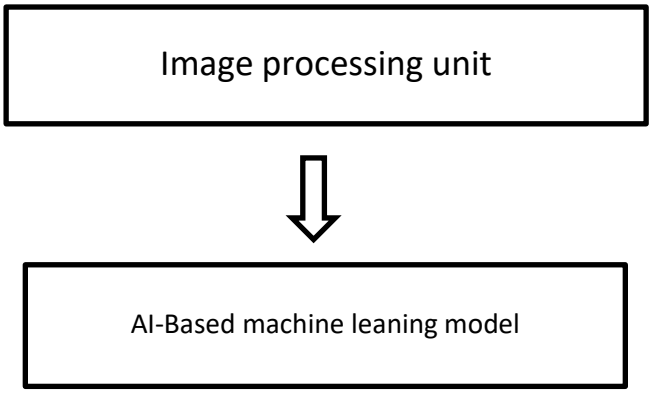
Additionally, AI facilitates seamless integration with smart city infrastructures, enabling real-time data sharing via mobile apps or digital signage to enhance urban mobility. By analyzing parking trends and usage patterns, AI generates valuable insights for operators, helping optimize parking layouts and operations. Over time, machine learning capabilities allow the system to adapt and improve, ensuring high accuracy and reliability. AI also strengthens parking lot security by detecting anomalies such as unauthorized parking or suspicious activities. Overall, the use of AI in parking detection systems contributes to smarter, more sustainable cities by improving efficiency, reducing environmental impact, and delivering a superior experience for users.

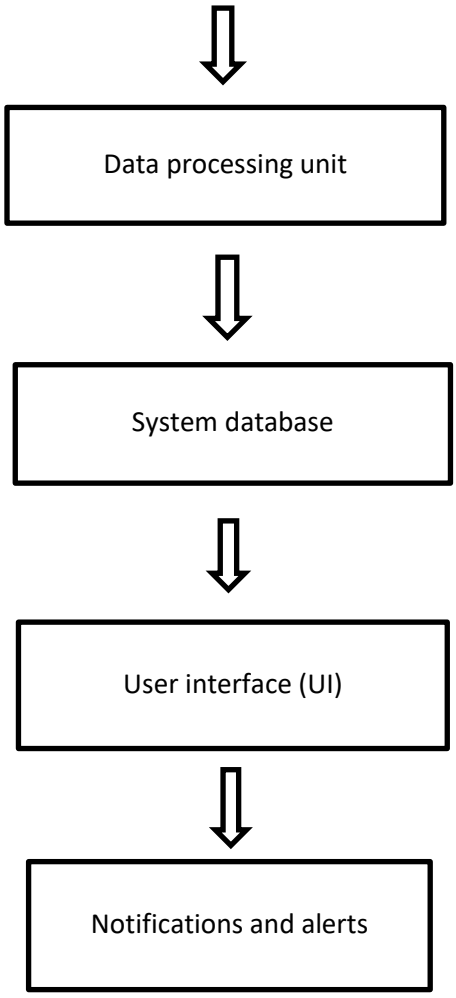
1.3 WHAT IS IMAGE PROCESSING USING AI :

Image processing using Artificial Intelligence (AI) has revolutionized how visual data is analyzed and utilized across various fields. AI, particularly through advanced techniques like deep learning and neural networks, enables the automation of complex image analysis tasks, such as object detection, image segmentation, and feature extraction. By leveraging models like Convolutional Neural Networks (CNNs), AI can process and interpret images with remarkable accuracy, even in scenarios involving noisy or incomplete data. This has made AI-driven image processing indispensable in areas like medical diagnostics, where it assists in identifying anomalies in X-rays or MRIs, and in autonomous vehicles, where it enables real-time object recognition for safe navigation.

AI also enhances traditional image processing by enabling systems to learn and adapt over time, improving performance with each interaction. Tasks such as facial recognition, image enhancement, and classification have become faster and more reliable due to AI's ability to handle large datasets and extract patterns effectively. Furthermore, AI-powered image processing is widely applied in agriculture for monitoring crop health, in security systems for surveillance and threat detection, and in entertainment for creating lifelike visual effects. By automating and enhancing visual data analysis, AI has opened new possibilities for innovation, transforming industries and improving efficiency in processes that rely on imagery.

2. BLOCK DIAGRAM





3. WORKING

Video capturing

- Cameras are installed in strategic locations to capture live images or video feeds of the parking lot.
- These cameras are positioned to ensure full visibility of parking spaces, minimizing blind spots.

Preprocessing

- Captured images are preprocessed to enhance quality by adjusting brightness, contrast, and removing noise caused by lighting variations, weather conditions, or obstructions.

AI-Based detection

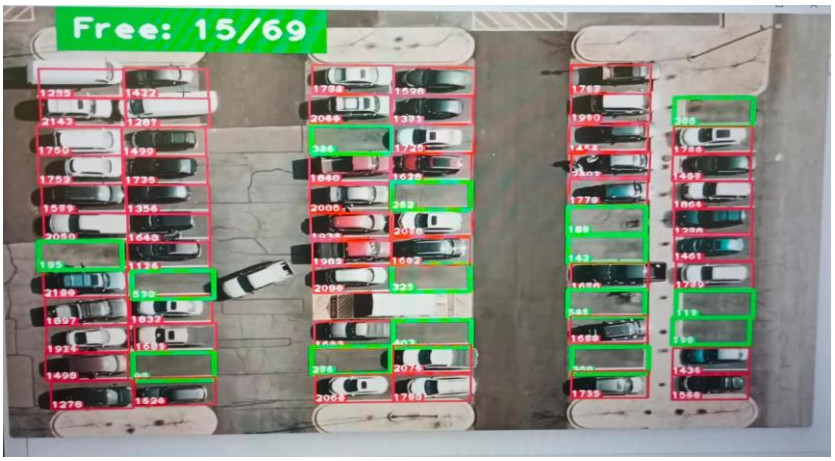
- AI models, typically using Convolutional Neural Networks (CNNs), analyze the preprocessed images to detect vehicles and identify parking spaces.
- Each parking spot is classified as either **occupied** or **vacant** based on the presence of a vehicle.

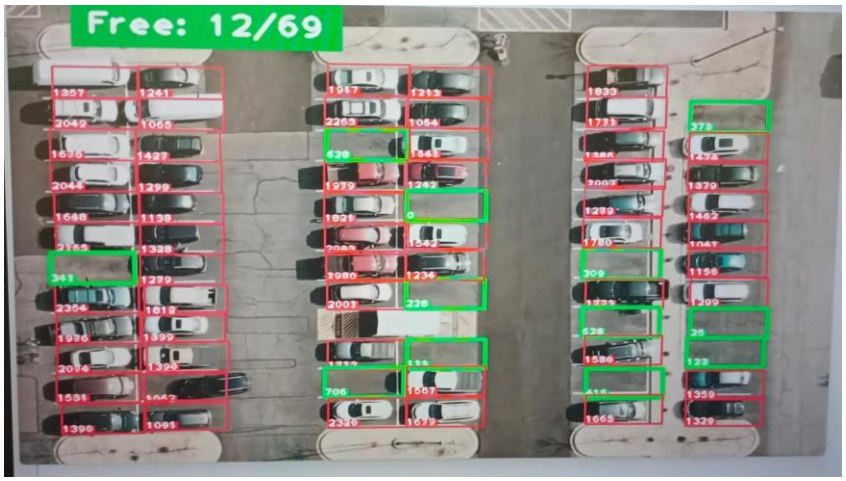
- Advanced algorithms can also recognize specific types of vehicles, such as cars, motorcycles, or larger vehicles, and detect reserved or special parking spots (e.g., for disabled individuals).

Real-Time data processing

- The processed data is transmitted to a computing framework, either on the cloud or on edge devices near the parking lot, to minimize latency.
- The system updates parking occupancy status in real time, ensuring users receive the most accurate information.

4. OUTPUT





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