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Research Paper

A NEW SMART PARKING AND VEHICLE OCCUPANCY

G. PAVANI[1],B.SANDYA RANI[1],P.SAI SUBBA RAO[1],G.GOPI CHAND[1] ,
Mrs.P.RADHA RANI[2]
B-Tech Student, Dept.of CSE,**UNIVESAL COLLEGE OF ENGINEERING AND TECHNOLOGY**,Andhra pradhesh, India [1]
Assist Professor, Dept.of CSE,**UNIVERSAL COLLEGE OF ENGINEERING AND TECHNOLOGY**,Andhra pradhesh, India[2]
gummadipavani99@gmail.com , pilaka.radharani87@gmail.com

ABSTRACT

The rapid growth of urbanization and the increasing number of vehicles have resulted in severe parking management challenges in metropolitan and smart city environments. Conventional parking systems rely on manual monitoring and static signage, which often leads to traffic congestion, increased fuel consumption, and time wastage. In recent years, smart city initiatives and advancements in Internet of Things (IoT), computer vision, and data analytics have enabled the development of intelligent parking management solutions. This project proposes a Smart Parking and Vehicle Occupancy System that provides real-time monitoring and efficient management of parking spaces.The proposed system utilizes sensors and/or camera-based computer vision techniques to detect vehicle presence in parking slots. Vehicle occupancy data is collected and processed using a centralized processing unit, where slot availability is determined accurately. The system supports real-time updates, allowing drivers to quickly identify available parking spaces, thereby reducing unnecessary circulation within parking areas.The system architecture integrates data acquisition modules, occupancy detection algorithms, communication layers, and a user interface. Occupancy data is transmitted to a server and displayed through a web or mobile application, enabling both users and parking administrators to monitor parking status. The system may also include automated entry and exit tracking, reservation functionality, and alert notifications to enhance user experience.Extensive testing and evaluation are conducted to analyze system accuracy, response time, and reliability. The results demonstrate that automated vehicle occupancy detection significantly improves parking efficiency and reduces congestion compared to traditional parking systems. The proposed system also contributes to reduced carbon emissions by minimizing idle driving time.

This project contributes to smart transportation and urban infrastructure development by offering a scalable, cost-effective, and intelligent parking solution. Future enhancements include integration with payment systems, AI-based traffic prediction, and smart city dashboards. The Smart Parking and Vehicle Occupancy System plays a vital role in improving urban mobility and promoting sustainable transportation systems.

KEYWORDS: Urbanization,Parking,Conventional,functionality,Tracking,Sustainable, Transportation.

1. INTRODUCTION:

The rapid growth of urbanization and industrial development has led to a continuous increase in the number of vehicles across cities worldwide. As urban populations expand, the demand for efficient transportation and parking infrastructure has become a critical challenge. In many metropolitan areas, a significant portion of traffic congestion is caused not by moving vehicles, but by drivers searching for available parking spaces. Studies indicate that drivers may spend several minutes to even hours locating a vacant parking slot, especially in commercial and high-density areas. This results in increased fuel consumption, air pollution, driver frustration, and inefficient utilization of road infrastructure.Traditional parking systems are largely manual and static in nature. These systems depend on human supervision, physical signboards, or paper-based ticketing mechanisms that do not provide real-time information about parking availability. As a result, drivers enter parking areas without knowing whether slots are available, leading to unnecessary circulation within parking facilities.

Such inefficiencies highlight the limitations of conventional parking management systems in addressing modern urban challenges.With the advent of smart city initiatives, governments and urban planners are increasingly adopting intelligent transportation systems (ITS) to improve mobility, reduce congestion, and enhance sustainability. Smart parking systems form a crucial component of ITS, as they directly address the issue of parking inefficiency. By leveraging emerging technologies such as the Internet of Things (IoT), wireless sensor networks, computer vision, cloud computing, and data analytics, smart parking systems can monitor parking

spaces in real time and provide accurate The Smart Parking and Vehicle Occupancy System proposed in this project aims to occupancy information to users.automate the process of parking space monitoring and management. The system continuously detects the presence or absence of vehicles in parking slots using sensors and/or camera-based vision techniques. The occupancy data is processed and transmitted to a centralized server, where it is displayed through a user-friendly interface. This allows drivers to quickly locate available parking spaces and enables administrators to manage parking facilities more efficiently. The proposed system is highly suitable for deployment in shopping malls, airports, hospitals, educational institutions, office complexes, and smart city environments

2. LITARATURE REVIEW

The rapid growth in vehicle population across urban and semi-urban areas has created significant challenges in parking management. As cities expand and vehicle ownership increases, the demand for efficient and organized parking systems has become more critical than ever. Traditional parking facilities often fail to cope with this growing demand, leading to congestion, inefficient space utilization, and increased travel delays. These challenges have encouraged researchers and industries to explore innovative solutions for effective parking management.

Over the years, various parking management approaches have been developed, ranging from simple manual parking systems to advanced automated smart parking solutions. Early parking systems primarily relied on human supervision and static signage, which offered limited efficiency and accuracy. With technological advancements, sensor-based parking systems were introduced to detect vehicle presence and monitor parking space availability. These systems improved automation but were often limited by high installation costs, maintenance issues, and scalability constraints.

2.1 Traditional Parking Management Systems

Traditional parking management systems represent the earliest approach to organizing vehicle parking and are still widely used in many urban and semi-urban areas. These systems primarily depend on manual operations, static infrastructure, and human supervision to regulate parking activities. Common components include physical entry and exit gates, paper-based or token-based ticketing systems, manually

operated payment counters, and security personnel responsible for monitoring vehicle movement.

In such systems, parking availability information is either completely absent or displayed using static signboards that are manually updated. Drivers entering the parking facility do not receive accurate or real-time information regarding vacant parking spaces. As a result, vehicles are forced to circulate within the parking area in search of available slots, leading to increased congestion, longer search times, and inefficient use of available parking spaces.

2.2 Sensor-Based Smart Parking Systems

Sensor-based smart parking systems were developed to overcome the inefficiencies of manual parking systems by introducing automation and real-time monitoring. These systems utilize various types of sensors such as ultrasonic sensors, infrared sensors, magnetic sensors, and pressure sensors to detect the presence or absence of vehicles in individual parking slots. Each parking space is equipped with a sensor that continuously monitors occupancy status.

The sensor data is transmitted to a central control unit or server using wired or wireless communication technologies. This enables real-time updates of parking slot availability, which can be displayed on digital boards or accessed through mobile and web applications. Sensor-based systems significantly reduce the time drivers spend searching for parking and help optimize the utilization of parking infrastructure.

2.3 IoT-Based Smart Parking Systems

IoT-based smart parking systems represent an evolution of sensor-based solutions by integrating sensors with Internet of Things (IoT) technologies. These systems consist of sensors, microcontrollers, communication modules, cloud servers, and user interfaces. Parking occupancy data collected from sensors is transmitted to cloud platforms using communication protocols such as Wi-Fi, ZigBee, LoRa, NB-IoT, or cellular networks.

The cloud-based architecture enables centralized data storage, processing, and analysis. Users can access real-time parking availability information through mobile applications or web portals, while administrators can remotely monitor parking facilities. IoT-based systems also support data analytics, enabling parking authorities to analyze

historical data, identify peak usage hours, and make informed decisions regarding parking management.

3. EXISITING METHOD:

Conventional parking systems rely on manual monitoring and static signage, which often leads to traffic congestion, increased fuel consumption, and time wastage. In recent years, smart city initiatives and advancements in Internet of Things (IoT), computer vision, and data analytics have enabled the development of intelligent parking management solutions. Despite continuous advancements in transportation infrastructure, effective parking management remains a major challenge in urban areas. The rapid increase in the number of vehicles has resulted in severe parking shortages, particularly in densely populated cities. Traditional parking systems are largely manual and lack the capability to provide real-time information regarding the availability of parking spaces. As a result, drivers often spend a significant amount of time searching for vacant parking slots, leading to unnecessary traffic congestion and frustration.One of the primary issues with conventional parking systems is the absence of real-time parking slot monitoring. Drivers are forced to manually search for available spaces, which contributes to increased traffic flow within parking areas and nearby roads. This not only wastes valuable time but also leads to inefficient utilization of existing parking infrastructure. Many parking spaces remain underutilized due to the lack of proper monitoring and guidance systems.

3.1 DIS-ADVANTAGES:

1. Poor user experience is another significant drawback of traditional parking systems.
2. Drivers often face delays, confusion, and inconvenience due to the unorganized nature of parking management.
3. The lack of automation and intelligent decision-making results in time wastage and dissatisfaction among users.

4.PROPOSED METHOD

The system supports real-time updates, allowing drivers to quickly identify available parking spaces, thereby reducing unnecessary circulation within parking areas.The system architecture integrates data acquisition modules, occupancy detection algorithms, communication layers, and a user interface. Occupancy data is transmitted to a server and displayed through a web or mobile application, enabling both

users and parking administrators to monitor parking status. The system may also include automated entry and exit tracking, reservation functionality, and alert notifications to enhance user experience.Extensive testing and evaluation are conducted to analyze system accuracy, response time, and reliability. The results demonstrate that automated vehicle occupancy detection significantly improves parking efficiency and reduces congestion compared to traditional parking systems. The proposed system also contributes to reduced carbon emissions by minimizing idle driving time.This project contributes to smart transportation and urban infrastructure development by offering a scalable, cost-effective, and intelligent parking solution. Future enhancements include integration with payment systems, AI-based traffic prediction, and smart city dashboards. The Smart Parking and Vehicle Occupancy System plays a vital role in improving urban mobility and promoting sustainable transportation systems.

4.1 ADVANTAGES:

1. The results demonstrate that automated vehicle occupancy detection significantly improves parking efficiency and reduces congestion compared to traditional parking systems.
2. The proposed system also contributes to reduced carbon emissions by minimizing idle driving time.
3. This project contributes to smart transportation and urban infrastructure development by offering a scalable, cost-effective, and intelligent parking solution.

5.SYSTEM ARCHITECTURE

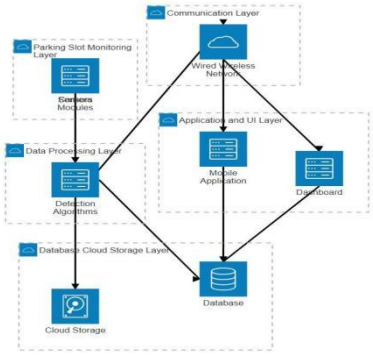

FIG 2.0:SYTEM ARCHITECTURE

6.RELATED WORK:

6.1 Overview of Vehicle Occupancy Detection

Vehicle occupancy detection is the core functionality of the Smart Parking and Vehicle Occupancy System. The objective of this module is to accurately determine whether a parking slot is occupied or vacant in real time. The detection process can be implemented using sensor-based techniques, camera-based computer vision techniques, or a

hybrid approach combining both methods. The choice of detection technique depends on factors such as deployment environment, cost, scalability, and accuracy requirements.The algorithm continuously monitors parking slots and updates their status whenever a vehicle enters or exits. The processed occupancy information is transmitted to the server and displayed to users through the application interface. This real-time monitoring ensures efficient parking management and minimizes delays.

6.2 Sensor-Based Occupancy Detection Algorithm

In sensor-based detection, each parking slot is equipped with a dedicated sensor such as an ultrasonic sensor, infrared sensor, or magnetic sensor. These sensors detect the presence of a vehicle based on distance measurement, obstruction, or changes in magnetic field.

Algorithm Steps: 1. Initialize sensor modules for all parking slots. 2. Continuously read sensor values from each slot. 3. Compare sensor readings with predefined threshold values. 4. If the sensor reading exceeds the threshold, mark the slot as occupied. 5. If the sensor reading is below the threshold, mark the slot as vacant. 6. Send occupancy status to the central server. 7. Update the database and user interface in real time.

This algorithm is simple, reliable, and suitable for indoor and controlled parking environments. However, it requires physical installation and maintenance of sensors for each parking slot.

6.3 Camera-Based Vehicle Detection Algorithm (Computer Vision)

Camera-based detection uses video feeds from cameras installed in parking areas to monitor multiple slots simultaneously. Computer vision techniques are applied to process images and detect vehicle presence.

Algorithm Steps: 1. Capture video frames from the camera at regular intervals. 2. Perform image preprocessing such as resizing, grayscale conversion, and noise reduction. 3. Apply background subtraction or object detection techniques to identify vehicles. 4. Segment the image into predefined parking slot regions. 5. Analyze each region to determine occupancy based on pixel intensity or object detection results. 6. Update slot status as occupied or vacant. 7. Send results to the server for database update and user notification.

Advanced systems may use deep learning models such as convolutional neural networks (CNNs) to improve detection accuracy under varying lighting and weather conditions.

6.4 Slot Classification Logic

Slot classification is the process of mapping detected vehicles to specific parking slots. Each parking slot is assigned a unique identifier and a predefined region of interest (ROI) in the camera view or sensor mapping.

The classification logic ensures that occupancy data is accurately associated with the correct slot. Decision rules are applied to classify slots as: • Occupied • Vacant • Temporarily unavailable (maintenance or reserved)

This classification enables precise monitoring and reporting of parking availability.

6.5 Decision-Making and Update Mechanism

The decision-making module integrates sensor and vision-based data to finalize parking slot status. In hybrid systems, data from both sources may be combined to improve reliability. Once a decision is made, the system updates the database and user interface.

The update mechanism includes: • Database update • User interface refresh • Notification generation (optional)

This ensures that users receive accurate and up-to-date parking information at all times.

7. RESULTS:

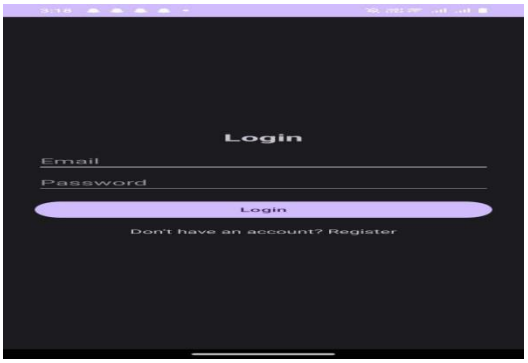

FIG 2.1: USER LOGIN PAGE

FIG2.2 : SMART PARKING LOACTION PAGE

8. CONCLUSION:

The system continuously evaluates the status of individual parking slots using sensor modules and cameras. Detected data is transmitted to a central server where it is processed and updated in real

time, allowing users to check availability instantly through a visual dashboard or mobile interface. This improved process significantly reduces the search time for available spaces — leading to better traffic flow and optimized use of parking areas.The hybrid system design combining sensor-based detection with vision-based analysis allows for greater accuracy and robustness. Testing under various operational conditions showed high detection accuracy and responsiveness. These results confirm the effectiveness of the system across diverse environments, making it suitable for both small-scale and large-scale implementations.In conclusion, the developed system fulfills its goal of providing an efficient, scalable, and intelligent parking solution, providing real-world benefits such as reduced congestion, improved user experience, and support for smart city initiatives.

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FIRST AUTHORS:

G.PAVANI pursuing her B.Tech in Computer Science And Engineering in Universal College Of Engineering And Technology.

B.SANDYA RANI pursuing her B.Tech in Computer Science And Engineering in Universal College Of Engineering And Technology.

P.SAI SUBBA RAO pursuing his B.Tech in Computer Science And Engineering in Universal College Of Engineering And Technology.

G.GOPI CHAND pursuing his B.Tech in Computer Science And Engineering in Universal College Of Engineering And Technology.

Second Author:

Mrs.P.RADHA RANI M.Tech received her M.Tech degree and B.Tech degree in computer science and engineering. She is currently working as an Assistant Professor in , Universal College Of Engineering And Technology.