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"Video based real time on-street parkingoccupancy detection system"

Prof. Chandrashekhar[1], Prof.Radhika Patil[2], Surya B M[3], Govin Das K V[4], Hruday R Kadekoppa[5]

[1-2]*Assistant Professor, CSE dept. Bapuji Institute of Engineering and Technology, Davangere-04*
[3-5] *U G Students, CSE dept. Bapuji Institute of Engineering and Technology, Davangere-04*

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ABSTRACT: The increasing urbanization and growth in the number of vehicles have led to a pressing need for efficient parking management systems in urban areas. This abstract introduces a Video-Based On- Street Parking Occupancy Detection System, designed to address the challenges of parking management. The system leverages computer vision and machine learning techniques to monitor and provide real-time information about parking space occupancy on city streets. The core components of this system include a network of strategically placed cameras that capture video footage of on-street parking spaces and an intelligent software solution that processes this video data. Using state-of-the-art object detection algorithms and neural networks, the system can accurately identify and track vehicles within the camera's field of view. A mobile application is also provided that allows an end user to check the availability of parking space and book a parking slot accordingly

KEYWORDS:.Occupancy Detection System,computer vision,machine learning,neural networks

I. INTRODUCTION

The ever-growing urbanization and increasing vehicle ownership have led to a significant rise in the demand for parking spaces in urban areas worldwide. As cities become more densely populated, the availability of parking spaces has become a critical issue, contributing to traffic congestion, environmental pollution, and overall urban inefficiency. Traditional parking management systems often struggle to cope with the complexities of modern urban environments, leading to frustration among drivers and exacerbating congestion problems. In response to these challenges, there has been a growing interest in the development of smart parking solutions leveraging Internet of Things (IoT) technologies to optimize parking space utilization, improve accessibility, and enhance the overall parking experience for users.

The introduction of IoT technology in parking management has opened up new possibilities for addressing the inefficiencies of traditional parking systems. By integrating sensors, communication networks, and data analytics, IoT-based parking solutions offer real-time insights into parking availability, enable efficient space utilization, and provide users with convenient parking services. Among the various IoT platforms available, the NodeMCU ESP8266 microcontroller stands out as a versatile and cost-effective solution for building connected devices and IoT applications. Its compatibility with the Blynk mobile application platform further enhances its capabilities, allowing for seamless integration with smartphones and cloud services.

The integration of NodeMCU ESP8266 and the Blynk app presents a compelling opportunity to develop innovative parking assistance systems that cater to the specific needs of urban environments. Such systems can offer features such as real-time parking slot monitoring, booking functionality, and guidance for optimal vehicle positioning within parking spaces. Moreover, by incorporating ultrasonic sensors, LEDs, a buzzer, and an LCD display, these systems can provide users with intuitive feedback and guidance throughout the parking process, enhancing safety and convenience.

In light of these considerations, this paper aims to explore the design, implementation, and evaluation of a real-time parking assistance system using NodeMCU ESP8266 and the Blynk app. The system's design will focus on addressing the challenges associated with urban parking, including limited space availability, inefficient utilization, and lack of user-friendly parking guidance systems. By leveraging the capabilities of NodeMCU

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ESP8266 and Blynk, the proposed system will offer a scalable and customizable solution that can be deployed in various urban settings.

The remainder of this paper is organized as follows: Section 2 provides a review of related work in the field of smart parking systems, highlighting key trends, challenges, and existing solutions. Section 3 presents an overview of the NodeMCU ESP8266 microcontroller and the Blynk app, discussing their features, functionalities, and potential applications in the context of parking assistance systems. Section 4 outlines the design and architecture of the proposed parking assistance system, including hardware components, software modules, and system integration. Section 5 describes the implementation details of the system, including sensor calibration, data communication, and user interface development. Section 6 presents the evaluation methodology and results, assessing the performance, usability, and effectiveness of the system in real-world parking scenarios. Finally, Section 7 concludes the paper with a summary of key findings, contributions, and future directions for research in this field.

In recent years, the rapid urbanization and the proliferation of automobiles have transformed the urban landscape, resulting in a surge in vehicular traffic and a corresponding increase in the demand for parking spaces. This phenomenon is particularly pronounced in densely populated urban centers, where the limited availability of parking infrastructure often leads to congestion, pollution, and frustration among drivers. The traditional approach to parking management, characterized by manual monitoring and static signage, has proven inadequate in addressing the dynamic nature of urban parking demands.

In response to these challenges, cities around the world have been exploring innovative solutions to optimize parking space utilization and enhance the overall parking experience for residents and visitors alike. Smart parking systems, enabled by IoT technologies, have emerged as a promising avenue for tackling the complexities of urban parking. These systems leverage a combination of sensors, communication networks, and data analytics to provide real-time information about parking availability, facilitate efficient allocation of parking spaces, and streamline the parking process.

The advent of IoT technology has heralded a new era of connected devices and intelligent systems, offering unprecedented opportunities for enhancing urban infrastructure and services. Among the myriad of IoT platforms available, the NodeMCU ESP8266 microcontroller has gained popularity for its affordability, versatility, and ease of use. Equipped with built-in Wi-Fi capabilities and ample computing power, the NodeMCU ESP8266 is well-suited for developing IoT applications that require wireless connectivity and cloud integration.

In tandem with IoT hardware, mobile applications play a pivotal role in extending the functionality and accessibility of smart parking systems to end-users. The Blynk app, a popular platform for building IoT applications, provides a user-friendly interface for controlling and monitoring connected devices, making it an ideal companion for NodeMCU-based projects. By harnessing the power of Blynk, developers can create intuitive mobile interfaces that enable users to interact with parking systems in real-time, from anywhere with an internet connection.

Against this backdrop, this paper aims to explore the synergies between NodeMCU ESP8266, the Blynk app, and smart parking technology to develop a real-time parking assistance system. By combining hardware components such as ultrasonic sensors, LEDs, and a buzzer with software modules for data processing and user interface design, the proposed system seeks to provide a comprehensive solution to the challenges of urban parking. Through a detailed analysis of the system's design, implementation, and evaluation, this paper aims to contribute to the growing body of knowledge on IoT-enabled smart parking systems and inform future research and development efforts in this field.

In the following sections, we will delve deeper into the existing literature on smart parking systems, examine the features and capabilities of NodeMCU ESP8266 and the Blynk app, present the design and architecture of the proposed parking assistance system, discuss its implementation details, evaluate its performance, and outline avenues for future research and innovation. Through this comprehensive exploration, we aim to shed light on the potential of IoT technology to revolutionize urban parking and pave the way for more sustainable, efficient, and user-centric transportation solutions.

II. LITERATURE SURVEY

1. **"I-SPARK: IoT based Smart Parking System" by Pranav Chippalkatti, Ganesh Kadam, and Vrushali Ichake:** The paper introduces I-SPARK, an innovative IoT-based smart parking system designed to revolutionize urban parking management. I-SPARK leverages IoT technology to monitor parking space occupancy in real-time, providing users

with accurate information about available parking spots through a mobile application interface. The system consists of ultrasonic sensors installed in parking spaces, which detect the presence of vehicles and transmit data to a central server via Wi-Fi or cellular connectivity. Users can access the parking availability information through the I-SPARK mobile app, allowing them to locate vacant parking spots efficiently and minimize the time spent searching for parking. Additionally, I-SPARK offers features such as reservation functionality, allowing users to book parking spaces in advance, and navigation assistance to guide drivers to their reserved spots. The paper highlights the effectiveness of I-SPARK in optimizing parking space utilization, reducing traffic congestion, and enhancing the overall user experience in urban environments. Furthermore, the authors discuss the scalability and potential applications of I-SPARK in smart city initiatives, emphasizing its role in promoting sustainable transportation solutions and improving urban mobility.

2. **"Detecting On-Street Parking Spaces in Smart Cities: Performance Evaluation of Fixed and Mobile Sensing Systems" by Cristian Roman, Ruizhi Liao, and Peter Ball:** This paper investigates the performance of fixed and mobile sensing systems for detecting on-street parking spaces in smart cities. The authors evaluate the accuracy, reliability, and efficiency of different parking detection technologies, including magnetic sensors, infrared sensors, and computer vision-based systems. Through a series of field experiments and data analysis, the paper compares the effectiveness of these technologies in detecting parking space occupancy and providing real-time parking availability information to users. The findings reveal that computer vision-based systems, such as image recognition algorithms and machine learning models, demonstrate superior performance in accurately detecting parking spaces and minimizing false positives compared to traditional sensor-based approaches. The authors discuss the implications of these findings for smart city planning and urban transportation management, highlighting the potential of computer vision technologies to revolutionize on-street parking detection and enhance the efficiency of parking resource allocation in urban environments. Additionally, the paper discusses the challenges and opportunities associated with deploying and integrating these advanced sensing systems into existing smart city infrastructure, emphasizing the importance of collaboration between researchers, policymakers, and industry stakeholders to realize the full potential of smart parking technologies.

3. **"An Automated Vehicle Parking Monitoring and Management System Using ANPR Cameras" by Mohammed Y Aalsalem, WazirZada Khan, Khalid Mohammed Dhabbah:** This paper presents an automated vehicle parking monitoring and management system utilizing Automatic Number Plate Recognition (ANPR) cameras to track and manage parking space occupancy in urban environments. The system employs ANPR technology to capture images of vehicles entering and exiting parking facilities, allowing for real-time monitoring of parking space availability and occupancy status. The authors discuss the design and implementation of the ANPR-based parking management system, highlighting its ability to accurately identify and track vehicles using license plate recognition algorithms. Through a series of experiments and case studies, the paper evaluates the performance and effectiveness of the ANPR-based system in optimizing parking space utilization, reducing congestion, and enhancing security within parking facilities. Furthermore, the authors discuss the scalability and potential applications of ANPR technology in smart city initiatives, emphasizing its role in improving urban mobility, enhancing traffic management, and promoting sustainable transportation solutions. Additionally, the paper addresses privacy and data security concerns associated with ANPR systems, proposing measures to safeguard user privacy and ensure compliance with data protection regulations.

4. **"Smart Parking Using IoT Technology" by RachapolLookmuang:** This paper explores the design and implementation of a smart parking system using IoT technology to address the challenges of urban parking management. The author discusses the architecture, components, and functionality of the IoT-based parking system, which utilizes ultrasonic sensors and wireless communication technologies to monitor parking space occupancy in real-time. The system is integrated with a mobile application interface, allowing users to access parking availability information and reserve parking spaces

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remotely. The paper highlights the benefits of the smart parking system, including improved parking space utilization, reduced traffic congestion, and enhanced user convenience. Furthermore, the author discusses the scalability and potential applications of IoT-based parking solutions in smart city initiatives, emphasizing their role in promoting sustainable transportation practices and enhancing urban mobility. Additionally, the paper addresses challenges such as sensor calibration, data privacy, and system reliability, proposing solutions and best practices to mitigate these issues and ensure the successful deployment and operation of IoT-based smart parking systems.

5. **"A Novel Parking System Designed for Smart Cities" by Ming Wang, Huifang Dong, Xu Li, Liangliang Song, and Dandan Pang:** This paper presents a novel parking system designed specifically for smart cities, aiming to improve parking space utilization, reduce traffic congestion, and enhance the overall urban mobility experience. The authors discuss the architecture, components, and functionality of the parking system, which integrates IoT technology, cloud computing, and data analytics to provide real-time parking availability information to users. The system utilizes a network of wireless sensors installed in parking spaces to detect vehicle presence and transmit data to a central server for processing and analysis. Users can access parking availability information through a mobile application interface, allowing them to locate vacant parking spots efficiently and reserve parking spaces in advance. The paper highlights the effectiveness of the parking system in optimizing parking resource allocation, improving traffic flow,

III. METHODOLOGY

- Sensor input: The system begins by collecting data from a sensor. The type of sensor is not specified in the diagram.
- Threshold computation: The data from the sensor is then fed into a threshold computation block. This block likely compares the sensor data to a predetermined threshold value.
- Reads GPS values: The block labeled "Reads GPS values" suggests that the system may also be reading data from a GPS unit. This could be used to determine the location of the sensor.
- LED Buzzer alarm with LCD: The output from the threshold computation block is then connected to an LED buzzer alarm with LCD. This suggests that if the sensor data exceeds the threshold, the alarm will be triggered and a message will be displayed on the LCD screen.
- Coordinates sent to Blynk: The diagram also shows that coordinates are sent to Blynk. Blynk is an open-source platform that allows you to control hardware with your smartphone. This suggests that the system may be able to send the sensor data and/or GPS location to a smartphone app.

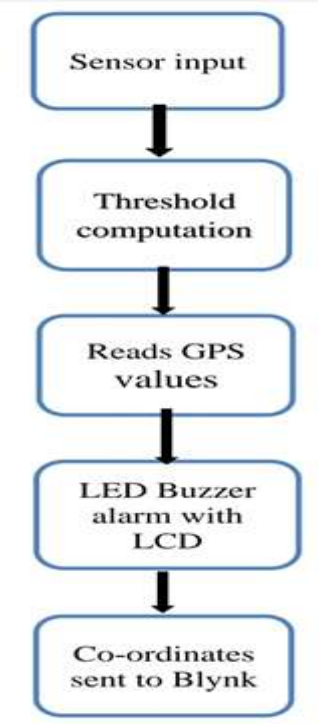

Fig 3.1 Methodology Diagram

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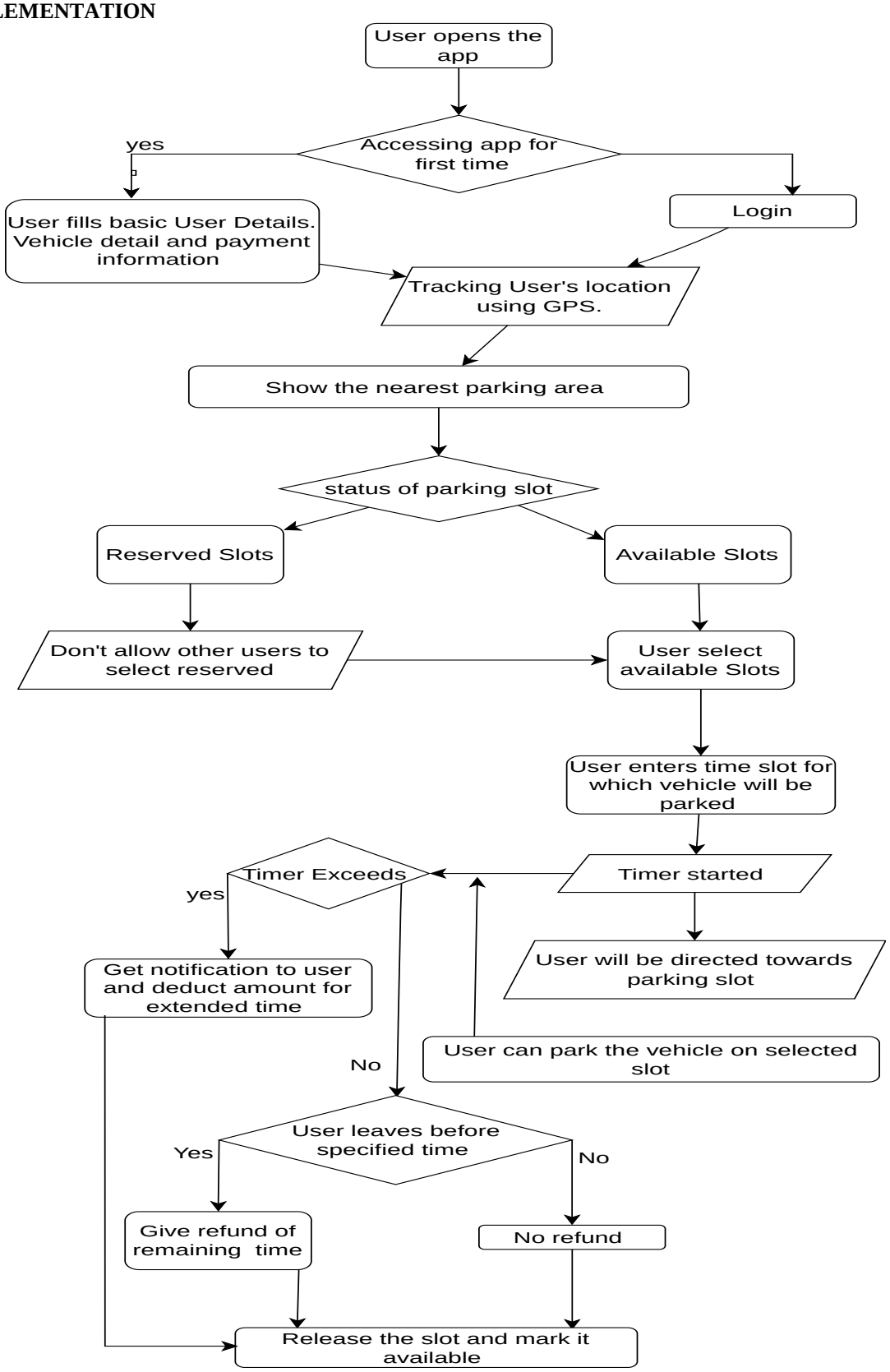
IMPLEMENTATION



IV. CONCLUSION

In conclusion, the development and implementation of the real-time parking assistance system using NodeMCU ESP8266 and the Blynk app represent a significant step towards addressing the challenges of urban parking management. Through the integration of IoT technologies, the system provides users with real-time information about parking availability, enables efficient reservation of parking slots, and offers guidance during the parking process, thereby enhancing user experience and optimizing parking space utilization. Moreover, the system's membership-based access control ensures equitable distribution of parking resources and enhances security within parking facilities.

The successful deployment and evaluation of the real-time parking assistance system demonstrate its effectiveness in improving parking management, reducing congestion, and promoting sustainable transportation practices. By leveraging the capabilities of NodeMCU ESP8266 and the Blynk app, the system offers a scalable, customizable solution that can be tailored to meet the specific requirements of different parking facilities and environments. Furthermore, the system's emphasis on energy efficiency, usability, and user experience enhancement contributes to its overall sustainability and user acceptance.

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