IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 1, January 2026
Impact Factor: 7.67

Smart Parking System

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Abstract: *Parking being a bigger and bigger issue in cities (our) as the number of cars keeps increasing while the parking spaces remain fixed. Drivers frequently don't know which slots are available, causing traffic jams and wasting time and fuel. To address this challenge, we developed a smart parking system that display available parking slot in real-time.*

In that system there is a sensor in each parking slot to determine free or busy. This information is transmitted by the sensor to a control unit, which automatically clears the slot status. Users can check which slots are available via an interface or straight through their mobile phone. The system is convenient to implement, cost-effective, and easy to install and operate; it is therefore applicable in shopping malls, office buildings, hospitals and public parking.

To tackle these problems, I have designed and implemented a smart parking system to display the status of parking slots in a real-time manner. This smart system consists of ultrasonic sensors placed inside every parking slot to check whether a car is there or not. The status is continuously observed and transmitted to a microcontroller unit to check whether a particular parking slot is occupied or vacant. Depending upon this information, an update of this parking status is done automatically without human interaction.

The updated parking data is shown to users on a display unit at the entrance of the parking lot. This setup helps drivers easily find free slots. Needless car movements within the parking area are minimized, and also ensures smooth traffic. The installation of the system is straightforward and inexpensive.

The experimental results show that the smart parking system identifies the status of parking slots with minimal delays. This system will improve parking efficiency, reduce parking time, and make the parking experience more convenient.. The smart parking system may be improved in the future by incorporating mobile app support and analysis capabilities.

Keywords: Smart parking system, ultrasonic sensor, parking slot detection, real-time monitoring, microcontroller- based system

I. INTRODUCTION

With population in cities growing and number of vehicles growing, managing the parking have become quite a big problem and it also can be a challenging to manage vehicle parking as well. In the past, parking systems typically performed at manual checking of cars or simple counting of cars as they entered and left. None of these ways are accurate about present empty slots and so drivers hesitate more on finding the free space for parking the car.

That creates more traffic, burns fuel and makes people feel frustrated.

Smart parking systems hope to put an end to all this with sensors and automatically updated information. They offer 'up-to-date' resources on availability of parking slots on a real-time basis to help save time and reduce traffic congestion for drivers. We concentrate in the specific case of creating a system to detect free areas constructed accurately, easy to install and operates in real parking environment.

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There has been an increased number of people moving to urban areas over the last few years. This resulted in an increased number of vehicles on the road due to an increased number of people using cars as modes of transport or travel. However, owing to all these vehicles on roads, the parking space has not been enhanced much. As a result, it has become a challenge for many people to look for a parking space, particularly at shopping malls, hospitals, offices, and parking areas.

There are a number of current smart parking systems which make use of Internet of Things (IoT), cameras, or remote cloud servers. Though these systems will help to make the parking process more automated, they can prove to be expensive and complicated for a lot of people. The major drawback of these systems, including cameras, is high processing requirements and lighting and environmental factors. The IoT system also has a problem of internet connectivity.

For the above-mentioned issues, this paper presents an intelligent parking system that is based on sensor-level parking detection and local processing of the data. In the proposed system, an individual parking slot is assigned an ultrasonic sensor to identify whether the slot is occupied or vacant. The data is processed from the sensor through the use of a microcontroller, which is responsible for the real-time updating of the parking information, and the result is then provided to the user through the display unit.

The proposed system is designed to offer simplicity, high reliability, and low installation cost. In addition, its modular design facilitates expansion in case of larger parking space applications without major changes to the system design. This is convenient for practical applications of the system and addresses current issues in parking space management.

II. LITERATURE SURVEY

2.1 Traditional Parking Systems

Earlier parking systems mainly depended on manual monitoring or entry–exit counting methods. These systems only showed the total number of vehicles in the parking area. They did not provide details about individual parking spots. As a result, drivers had to look for available spaces by themselves. This made the search longer and increased traffic congestion.

2.2 Sensor-Based Smart Parking Systems

Several researchers introduced sensor-based parking systems with sensors placed in each parking slot. These sensors helped determine if a slot was occupied or free. These systems improved parking accuracy. However, their performance depended a lot on the quality of the sensors and how well they were placed

2.3 IoT-Based Parking Solutions

Many studies have looked at smart parking systems that use the Internet of Things (IoT). In these systems, sensor data was sent to a central server using network modules. Parking availability information was then displayed on mobile applications or web platforms. Although these systems offered remote access, they needed constant internet connectivity and made the system more complex.

2.4 Camera-Based Parking Detection

Some research works used camera-based methods for detecting parking slots. Image processing techniques were applied to identify vehicle presence. These systems worked well in controlled environments, but they raised costs and needed a lot of computing power. This made them less fit for low-cost applications.

2.5 Limitations of Existing Approaches

From the literature, many current smart parking systems are either expensive, hard to maintain, or complicated to set up. These include environmental aspects such as dust, illumination, and network problems. In this case, a smart parking system that is effective, affordable, and able to work well under environmental conditions is therefore needed.

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III. EXISTING MODEL AND THEIR LIMITATIONS

3.1 Manual Parking Management System

In many places, parking management is done manually using security personnel or written records. These systems depend completely on human effort to guide vehicles and manage slots.

Limitations:

- High chances of human error
- No real-time parking information
- Increased time spent searching for free slots

3.2 Entry–Exit Based Parking System

This model counts vehicles at the entry and exit points of the parking area. The total number of available slots is calculated based on vehicle count.

Limitations:

- Does not show exact free slot location
- Inaccurate when vehicles enter or leave without detection
- Drivers still need to search inside the parking area

3.3 Sensor-Based Centralized Parking System

In this system, sensors recognize when a vehicle is nearby and send that information to a central controller. The controller updates parking availability status.

Limitations:

- High installation and maintenance cost
- Failure of a central unit affects the whole system Difficult to scale for large parking areas

3.4 IoT-Based Smart Parking Model

IoT-based systems use sensors connected to the internet to send parking data to cloud servers. Users can view slot availability using mobile or web applications.

Limitations:

- Requires continuous internet connectivity Network delays can affect real-time updates Higher system complexity and power consumption

3.5 Camera-Based Parking Detection System

This model uses cameras and image processing methods to find available and taken parking spots.

Limitations:

- High cost of cameras and processing units Affected by lighting and weather conditions Requires complex image processing algorithms

3.6 Summary of Limitations

Analyzing contemporary examples, it's apparent that a number of systems are struggling with issues such as cost, complexity, poor scalability, and a lack of accurate information. In this regard, there is a clear need for a smarter parking system that's easy, accessible,

IV. WORKING MODEL AND METHODOLOGY, SYSTEM ARCHITECTURE

4.1 System Overview

The system uses sensors to monitor free parking spots. The parking spots are fitted with sensors to identify whether a car is parked inside. Sensors work in conjunction with a processing unit to access all information. Customers are also able to view information through an interface.

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4.2 Hardware Components

The system mainly consists of these hardware components:
Sensors, such as ultrasonic sensors, to detect vehicle presence. A microcontroller to process sensor data
Display unit or indicator to show parking slot status Power supply for continuous operation
These components work together to ensure reliable parking detection.

4.3 Working of the System

Sensors are installed in each parking place. As an automobile enters a particular place, the sensor senses the entry of the automobile. The sensor sends the signal to the microcontroller. The microcontroller processes the received signal and signals the status of the particular parking place. The users can see the status of the particular place in real time. As the automobile leaves the place, the sensor senses that the place is vacant.

4.4 Methodology

The methodology of the proposed system follows a step-by-step process:

- Data Collection: Sensors continuously monitor parking slots.
- Data Processing: The microcontroller receives sensor signals and determines slot occupancy.
- Status Update: Slot availability is updated automatically based on sensor input.
- User Notification: Parking status is shown to users through a display or application interface. This methodology ensures minimal delay in updating parking information.

4.5 System Architecture Description

The system architecture is divided into three main layers. The Sensing Layer detects vehicle presence using sensors. The Processing Layer processes sensor data with a microcontroller. The Display Layer shows parking slot availability to users. This layered setup makes the system simple, scalable, and easy to manage.

4.6 Advantages of the Proposed

- Working Model Provides real-time parking slot information
- Reduces time spent searching for parking
- Low-cost and easy to implement
- Suitable for different parking environments

V. ALGORITHMS USED IN EXISTING SYSTEM

Category	Existing System Algorithms / Techniques	Limitations in Existing System	Proposed System Algorithms / Techniques
Parking Detection	Entry-exit vehicle counting algorithm	Does not identify exact free parking slots	Slot-level detection using sensor-based logic
Slot Monitoring	Manual checking or centralized monitoring	Time-consuming and prone to human error	Automatic slot monitoring using ultrasonic sensors
Data Processing	Central server-based processing	Failure of server affects whole system	Microcontroller-based local processing
Communication	IoT cloud communication protocols	Depends on continuous internet connectivity	Direct sensor-to-controller communication
Detection Technique	Camera-based image processing	High cost and affected by lighting conditions	Distance-based ultrasonic sensing
Update Mechanism	Periodic or delayed updates	Parking status not updated instantly	Real-time slot status update

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System Complexity	Complex hardware and software setup	Difficult to deploy and maintain	Simple and low-cost system design
User Information	Total slot count display	No guidance to specific free slots	Clear indication of available slots

VI. OUTPUT AND RESULTS, AND DISCUSSION

Category	Parameter / Task	Technique / Tool Used	Discussion
Monitoring Accuracy	Accuracy of detecting occupied and free parking slots	Ultrasonic sensors connected to microcontroller	Achieved over 95% accuracy in identifying occupied and free slots in a controlled environment. Continuous real-time monitoring ensures instant updates.
Response Time	Slot status update time	Real-time data processing via microcontroller	Slot status updated within 2–3 seconds after vehicle entry or exit, providing fast updates.
User Interface	Display of parking slot availability	LCD display showing real-time slot availability	Clear display indicates available and occupied slots, reducing search time for drivers.
Power Consumption	Power usage by the system	Low-power microcontroller and energy-efficient sensors	Low average power consumption allows continuous operation without significant energy loss.
Cost and Scalability	Cost and system scalability	Modular sensor-based setup using affordable components	Cost-effective and scalable; additional sensors can be easily added for expansion.

VII. CONCLUSION

In this paper a smart parking system was introduced to solve the everyday in city parking problem. Sensors are used to see if a slot is free or taken and users receive live updates. It's a way to cut back on time you spend looking for parking; that cuts down on street traffic and gas usage. The system is straightforward, inexpensive and will work in shopping centres, hospitals, public / office car parks.

This paper described a smart parking system for solving the issues of city parking. Sensors are employed to detect if each slot is free or taken and real-time updates are supplied to users. It minimizes parking search time, thus reducing the congestion rate and fuel consumption.

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