IRO Journal on Sustainable Wireless Systems (ISSN: 2582-3167)
www.irojournals.com/irosws/

# Automated Parking System using IR Sensor

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**Abstract**

As the population grows, people face more challenging parking issues that make city life more difficult. However, automated parking systems have become a ray of hope in modern society. Urban living is entering a transformational era with these innovative solutions. Automated parking systems reduce traffic and transform the urban environment by seamlessly incorporating advanced technology into parking management. Therefore, the proposed system utilizes Arduino boards and infrared (IR) sensors to develop an automated parking system (APS) that improves urban parking efficiency, reduces traffic jams, and minimizes environmental harm. The system integrates seamlessly with existing city infrastructure, providing a cost-effective and adaptable solution. The prototype of the APS is developed and tested to ensure its ease of installation and use in urban areas.

**Keywords:** Smart Parking System, Urban Mobility, Arduino Board, Infrared Sensors, Traffic Congestion, Environmental Sustainability, Real-time Communication, Parking Management, Sustainable Transportation.

## 1. Introduction

Rapid population growth has brought more critical challenges, one of which is parking management. The increasing number of vehicles on road in turn causes difficulties in finding a parking spot, leading to traffic jams, air pollution, and economic losses. Current parking management systems, which rely on manual labor and outdated technology, struggle to keep up with the demands of modern urban environments. IoT plays a vital role in embedded


*DOI: https://doi.org/10.36548/jsws.2024.3.002*
*Received: 12.06.2024, received in revised form: 04.07.2024, accepted: 20.07.2024, published: 01-08-2024*

systems; therefore, understanding all the components required for the application is essential. A smart parking system involves various IoT components to improve the understanding and implementation of the system [2].

To address parking challenges, the proposed work suggests a smart parking system that utilizes technology to improve parking efficiency and effectiveness. This system provides real-time parking availability information, guiding drivers to available vacant parking lots and reducing the search time. By optimizing parking utilization, smart parking systems aim to ease traffic congestion, lower carbon emissions, and improve the overall urban transportation experience.

The proposed APS uses Arduino boards and Infrared (IR) sensors to offer a better way to manage parking. It's a cheaper and scalable solution for urban parking problems. The system uses light strips on roads to intimate drivers about the vacant parking spaces in real time. This makes parking easier and reduces traffic.

The remainder of the manuscript is organized with the details on the design of the Automated Parking System (APS), the description of its components, and the results that support its effectiveness.

## 2. Related Works

### 2.1 RFID-based Parking Systems

The potential of RFID (Radio Frequency Identification) technology to revolutionize parking management is being intensively explored [1]. Cars that use RFID parking systems typically have tags on them. When a car enters or exits a parking lot, these tags enable immediate identification and verification of the vehicle. Using RFID-based parking systems can improve parking efficiency and lessen traffic congestion. This is due to the fact that they facilitate vehicles' entry and exit from parking lots more quickly and easily. Additionally, physical tickets and manual verification are eliminated by RFID-based technologies, giving drivers a more convenient and hassle-free parking experience [7].

### 2.2 Ultrasonic Sensor-based Parking Systems

Smart parking systems are also developed using ultrasonic sensors. These sensors are used by these systems to determine whether parking spots are filled [4]. This enables the users to have an idea about the amount of space occupied in the parking lot in real time and demonstrates the effectiveness of ultrasonic sensor systems in detecting the presence of a car. They are therefore suitable for various parking slots with different dimensions. It may be more difficult for these systems to be widely employed, because of a few disadvantages, namely their inability to be used on a big scale and susceptibility to external forces [ 5,6].

### 2.3 Computer Vision-based Parking Systems

Parking management has been completely transformed by computer vision technology, which interprets images through image processing. The research demonstrates how computer vision-based systems can use cameras to precisely identify empty parking spots. These technologies are incredibly accurate and dependable because they use machine learning and image recognition. The proper functioning of the system is ensured by providing accurate datasets [3].

### 2.4 Integration of IoT and Cloud Computing

The combination of Internet of Things (IoT) devices and cloud computing has led to the development of sophisticated smart parking systems that can gather and analyze data in real-time. These systems have the potential to improve the parking space usage and the user experience. By using wireless connectivity and cloud-based data processing, they provide in-depth information about available parking spaces and occupancy rates, making it possible to manage parking more effectively [8-12].

### 2.5 Hybrid Approaches

Combining different sensing technologies, like RFID, ultrasonic sensors, and computer vision, can improve parking management accuracy and reliability. The hybrid parking system uses RFID tags to identify vehicles, ultrasonic sensors to detect parking space occupancy, and computer vision to recognize license plates. This system combines the strengths of different technologies to address the drawbacks of each individual one, resulting in a better solution for urban parking challenges.

Smart parking systems are rapidly evolving, with different technologies and methods being explored. Each approach has its pros and cons, but they all aim to improve parking efficiency and reduce traffic congestion. Based on previous research, the proposed method utilizes IR sensors and Arduino to address traffic congestion by providing efficient parking management [13-15]

## 3. Proposed Work

Automated vehicle parking management systems are designed to address issues in cities, such as congestion and ineffective parking management, from the ground up. By making it easier to locate a parking spot, these solutions reduce traffic congestion and enhance parking management.

### 3.1 System Architecture

The Automated Parking System (APS) is a multi-level system made up of three main parts: sensors, data processors, and a user interface. Each parking space has sensors that can detect cars (Infrared or IR sensors). These sensors send data to Arduino boards, which act as data processors and handle data collection and processing. The Arduino boards communicate to a central control unit, which runs the whole system and communicate to the user interface. The Figure 1 shows the simple system architecture for the proposed, focusing on only few parking spots.

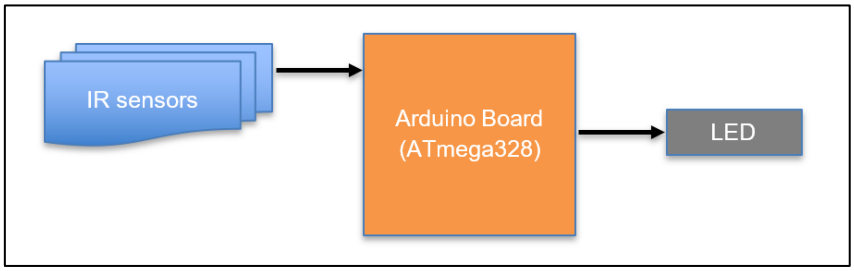


**Figure 1.** System Architecture

### 3.2 Sensing Mechanism

The Automated Parking System (APS) primarily focuses on accurately detecting vehicles parked in designated spaces. Infrared sensors are strategically placed in each space to continuously monitor the presence or the absence of the vehicles. As a vehicle enters a space,

it blocks the sensor's infrared beam, causing a change in the signal. This change is detected by the Arduino board, which recognizes it as a vehicle's presence and relays this information to the control unit for further processing. The Figure 2 shows the working of the IR sensor on detecting the vehicles.

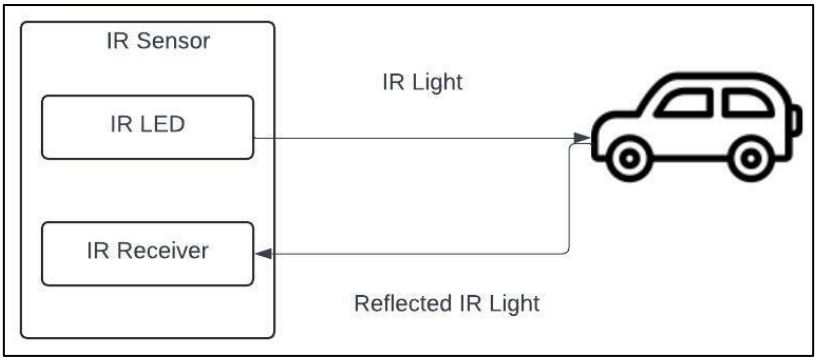


**Figure 2.** IR Sensor Working Principle [16]

### 3.3 Light Strip Indicators

The light strips on the road surface guides the drivers to the vacant parking spot. Each parking space is equipped with a corresponding light strip, which illuminates when the space is vacant and turns off when occupied. The activation of the light strips is controlled by the Arduino boards based on the sensor data collected, ensuring synchronized indication of parking availability throughout the parking facility.

### 3.4 Real-Time Communication

To offer live parking updates, the Automated Parking System (APS) in future with the Wi-Fi or Bluetooth would connect to the wireless user interface with the main control center. The user interface will display the details about the vacant and the occupied parking slot. As spaces become available or occupied, the user interface updates in real time, allowing drivers to make informed decisions about where to park. The Figure .3 below shows the flowchart of the proposed system.

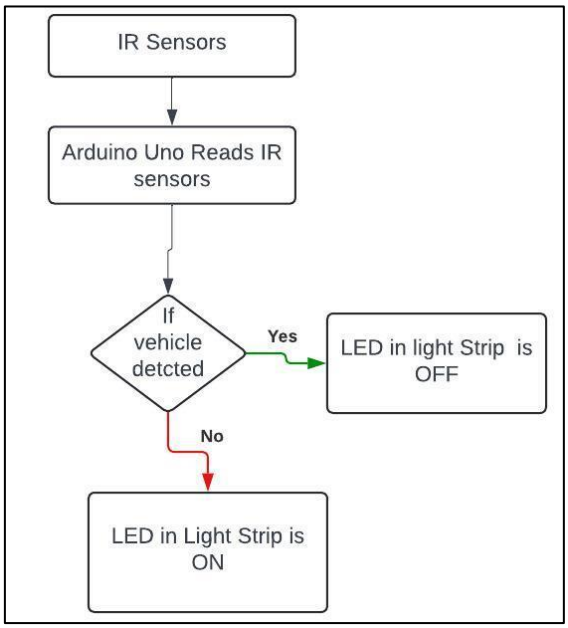


**Figure 3.** Flowchart

## 4. Results and Discussion

To test the smart parking system (SPS), a prototype of the parking lot was set up manually in a card board with the IR sensor to detect the vehicles and the Arduino board to control the process. The Figure .4 below shows the circuit diagram of the proposed system.

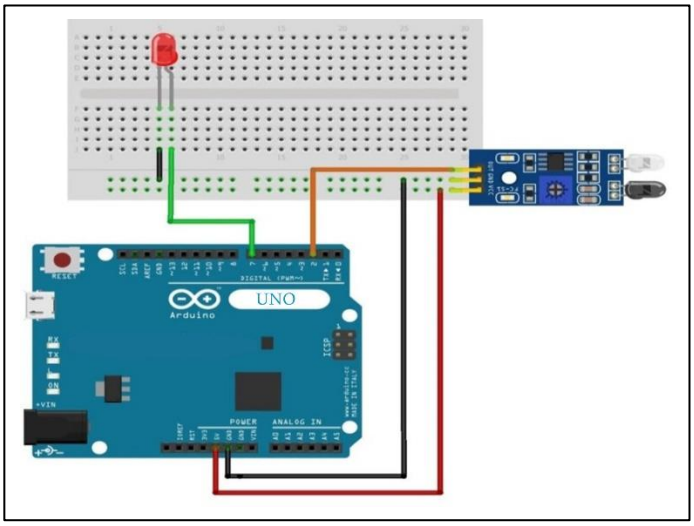


**Figure 4.** Circuit Diagram

The Figure 5 and 6 presents the prototype of the proposed work and the model of the parking lot developed in card board.

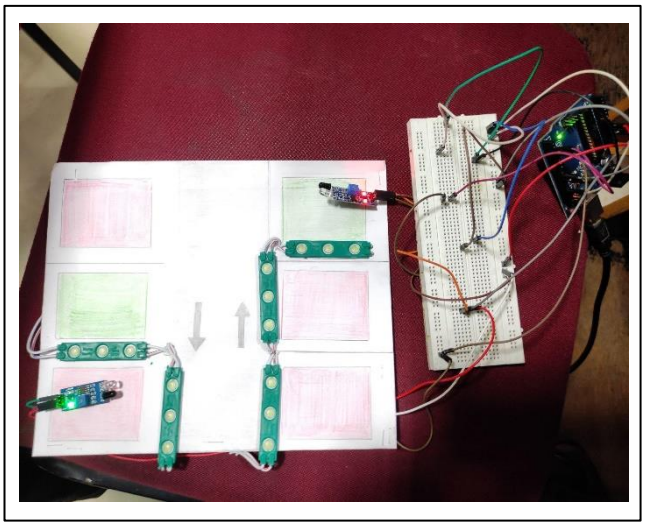

**Figure 5.** Prototype of the Proposed

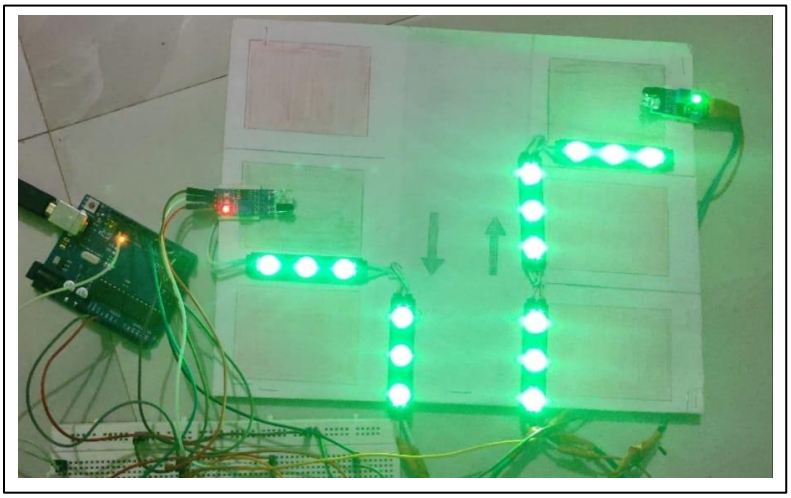

**Figure 6.** Parking Lot Output when there are No Vehicles

**Table 1.** Test Case

| Scenario | Test type | Outcome |
|---|---|---|
| When a car is detected | Sensor Test | LED strips goes off state |
| When car is not detected | Sensor Test | LED strips will be in on state |

The Table 1 presents the scenarios under which the proposed work was tested.

The scalability of the Automated Parking System (APS) architecture allows for the addition of additional sensors and Arduino boards without interfering with regular operation. It can be integrated seamlessly with the current city infrastructure by utilizing wireless communication protocols and compatible parts. The APS uses low-power components, such as IR sensors and Arduino boards, in addition power management strategies, such sleep modes and wake-up times can be used in future, to improve energy efficiency. Furthermore, the renewable energy sources like solar panel can be used to power up the system in future.

## 5. Conclusion

Automated parking systems have made great progress in solving urban parking management challenges. Researchers have used various technologies and methods, such as RFID-based systems, ultrasonic sensors, computer vision, and the Internet of Things (IoT), to develop efficient, reliable, and scalable solutions. Each technology has its strengths, addressing different parking lot challenges. Automated parking systems are gaining popularity in cities, optimizing parking space usage, reducing search times, and contributing to a more efficient and environmentally friendly transportation system. Combined with smart city initiatives, such as smart transportation systems and infrastructure management, these systems enhance urban resilience and sustainability, improving the overall quality of life. The proposed system, based on the existing literature, has developed a smart parking system using IR sensors and Arduino. Future work will focus on advanced sensors, such as improved infrared or LiDAR, and edge computing to enhance precision and decision-making in parking systems. Additionally, integrating machine learning for demand forecasting, dynamic pricing strategies, and interoperability, will further advance smart parking solutions.

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