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ARDUINO BASED CAR PARKING SYSTEM USING WOKWI SIMULATOR

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Abstract - *The Arduino Car Parking System Using IoT is a smart parking solution designed to alleviate the challenges associated with urban parking management. This system integrates Arduino microcontrollers and Internet of Things (IoT) technologies to create an efficient and automated parking management system. The proposed system utilizes ultrasonic sensors to detect the availability of parking spaces and relays this information to a central server through a wireless communication network. Users can access real-time parking space availability data via a dedicated mobile application or a web interface. The system not only optimizes parking space utilization but also reduces the time and stress associated with finding parking spaces in congested areas. By leveraging IoT and Arduino technologies, this parking system offers a practical and scalable solution to modern parking management issues.*

Key Words: Arduino, IoT, Car Parking System, Ultrasonic Sensors, Wireless Communication, Real-time Monitoring, Mobile Application, Web Interface, Parking Management.

1.INTRODUCTION

Rapid urbanisation and an increase in the number of automobiles in cities have made parking management extremely difficult. As cities expand, the lack of parking spots has aggravated both motorists and urban planners. The lack of real-time data and reliance on manual monitoring in traditional parking management systems leads to inefficiencies, lost time, and worsened traffic congestion. Innovative and automated solutions that can maximise parking space utilisation and improve the overall parking experience are increasingly needed to address these problems.

Parking management has been transformed by the fusion of Internet of Things (IoT) technology with embedded systems like Arduino. IoT and Arduino-based "smart" parking systems have the potential to provide real-time monitoring and effective parking spot utilisation. Drivers can get up-to-date information about available parking places through mobile applications or online interfaces by installing sensors to identify parking space availability and wirelessly transferring this information to a central server.

This paper introduces an IoT-based, Arduino-based car parking system that aims to address the difficulties in managing urban parking. The system uses ultrasonic sensors that are connected to Arduino microcontrollers to detect the presence of cars in parking places. By capturing data about parking occupancy and sending it to a central server utilising wireless communication protocols, the Arduino gadgets function as data collection points. Users have remote access to this data, allowing them to use it to make smart parking decisions. This cuts down on the time spent looking for parking places and helps to relieve traffic congestion.

In this paper, we will delve into the design and implementation of the Arduino Car Parking System using IoT. We will discuss the hardware components, the communication protocols, the data processing mechanisms, and the user interfaces that collectively form the system. Furthermore, we will highlight the benefits of this system, such as improved parking space utilization, reduced traffic congestion, and enhanced user convenience. The proposed system showcases how the synergy between IoT and Arduino technology can provide an effective and scalable solution to the persistent challenges of urban parking management.

2. LITERATURE REVIEW

"IoT based Smart Parking System" by Yash Agrawal, Umang Shah, Puru Jain [1]

The paper presents a Smart Parking System utilizing IoT, RFID modules, and cloud servers/mobile applications. The project comprises two main components: a mobile app for pre-booking and payments, and an IoT module deployed at entry/exit points for security checks via RFID tags. This system aims to alleviate parking issues, enhance time management, and generate profits for owners. It aims for minimal human intervention, favoring RFID for accuracy and fault tolerance over image-based methods. The benefits include precise parking space identification, avoiding privacy concerns of facial recognition, and easy transferability of RFID.

"IoT-BasedSharedCommunity Transportation System Using eBikes" by A.R.Al-Ali, Raafat Aburukba [2]

An architectural design for an electric bike (e-bike) system is presented in the study and validated by a working prototype on a college campus. The design consists of four main layers: interface, control and management, communication, and physical. Regular users can download a mobile app, and administrators can access a web portal. Implementing the system enables efficient administration and prompt decisions by allowing for e-bike tracking, usage restrictions, and misuse prevention.

"An IoT based Smart Outdoor Parking System" by Gokul Krishna.S, Harsheetha [3]

The study presents an Internet of Things (IoT)-based infrastructure for outdoor parking with the goal of developing a handy companion application for finding and paying for parking spaces. The sensor-driven parking system improves efficiency and security by quickly locating open parking spaces. The simplified method lowers labour costs and delivers a user-friendly software that shows real-time parking availability and location information, improving motorist accessibility and convenience.

"A Smart, Efficient, and Reliable Parking Surveillance System With Edge Artificial Intelligence on IoT Devices" by Ruimin Ke, Yinhai Wang [4]

The paper discusses the development and assessment of an IoT-based parking surveillance system utilizing edge artificial intelligence. Through thorough literature review, the system represents a pioneering attempt in implementing edge computing for real-world parking surveillance. The design focuses on shifting computing tasks to the edge, minimizing data transmission and enabling efficient online parking occupancy detection. Experimentation was conducted in both lab and real-world settings, resulting in a 95.6% accuracy in various scenarios. The proposed design offers distinct advantages over existing systems and holds promise for smart city and intelligent transportation applications.

"IOT Based "No Parking Notifier System" by Sushanth.G, Dr.Sujatha.S [5]

To address issues with the traffic system, the "IOT Based No-Parking Notifier System" is presented. This approach intends to increase efficiency, reduce corruption, and boost public understanding of traffic laws. Both car owners and traffic officer's benefit from the time savings provided by electronic operations. The suggested solution provides convenience, safety, and a method of traffic management devoid of corruption.

"IoT-Ready Energy Autonomous Parking Sensor Device" by Alfiero Leoni, Toni Perkovic [6]

A hardware-based prototype for a self-powered sensing node intended to identify the presence of vehicles is shown in the above essay. The introduction of a "PMT module"—a device that can power a BLE node and produce triggers—is made. An energy management circuit, threshold comparator, and solar panels are all included. Over here it is explained that how IoT-based smart parking solutions are being developed with the goal of improving quality of life and environmental sustainability by tackling the difficulties associated with locating parking places in highly populated locations.

"IOT Based Smart Vehicle Parking System Using RFID" by Mohan P.Thakre, Nishant P.Matale [7]

Utilising IoT and Cloud technology, the authors suggested a productive parking system for smart cities. The IoT-based integrated smart parking solution takes care of parking issues. Through a website, visitors may communicate in real time with parking facilities, improving the customer experience. Users can use the website to view parking spaces that are open at certain places using the IP address that the Node MCU generates. Users can verify availability via the website because each parking zone has a unique IP address.

"IoT in Vehicle Presence Detection of Smart Parking System" by Yi-YunChu, Kai Hao Liu [8]

The presence of automobiles was discovered by the authors using three main IoT sensors. A wireless magnetometer sensor was placed in a key spot to manage city street parking lots properly. Given that street parking may include both indoor and outdoor spots, this choice gives for installation flexibility. The wireless magnetometer sensor's dependability is further assured by its resistance to a variety of weather situations. The implementation of IoT sensors in this setting has numerous benefits for customers, suppliers, and governmental organisations, improving the overall efficacy and efficiency of the intelligent parking system.

"IoT based Smart Parking System: A Proposed Algorithm and Model" by Rahul, Padmaja Patel [9]

In this study, researchers categorized parking areas into three sections: basement for 2-wheeler parking, and two sections for 4-wheeler parking - one for staff and the other for guests. RFID tags were assigned to parking spots and users. Vehicles were categorized as 2-wheelers or 4-wheelers and as staff or guest vehicles. Specific RFID tags were used for each category. Before entering, RFID tags were verified with a server and database to determine access. A "Wait()" function checked parking spot availability. The study addressed parking issues in smart cities and proposed an IoT-based solution. This solution provides real-time data on available parking spaces. The research aimed to enhance parking management in the college, utilizing various technologies.

"IoTRec: The IoT Recommender for Smart Parking System" by Yasir Saleem, Pablo Sotres [10]

The aim of this paper is to enhance the parking experience for both users and managers within urban vehicular mobility. The IoTRec system offers GDPR-compliant recommendations for parking spots (nearest or trusted) and routes (least congested or shortest) to those spots. It also provides real-time occupancy predictions based on historical IoT data. The study introduced a prototype

named "Rich Parking," which was tested by Santander, Spain residents. It details the creation, application, and evaluation of an IoT Recommender (IoTRec) for a smart parking system, targeting improved urban vehicle mobility through the implementation of IoT technologies.

"A Millimeter Wave Dual-lens Antenna for IoT Based Smart Parking Radar System by Zhanghua Cai, Yantao Zhou [11]

This study proposes a dual-lens millimeter-wave (MMW) radar antenna with both transmitting and receiving capabilities. A flat dielectric perforated lens is employed to enhance the gain of the transmitting antenna. Unlike array-based methods, this lens antenna doesn't necessitate complex feeding networks, large expensive substrates, or costly processing techniques. The proposed approach offers a cost-effective and low-loss solution. Additionally, a dielectric rod lens is used to adjust the receiving antenna's main beam direction. The dual-lens combination ensures high gain for the transmitting antenna and a wide, unskewed beam for the receiving antenna. This strategy is advantageous due to its economic and low-loss characteristics, eliminating the need for complex feeding systems, expensive substrates, or intricate processing technologies.

"IOT Based Car Parking" by P.S.Patil, Dr.S.K.Padaganur [12]

The project introduces enhanced features such as displaying parking slot numbers and distances, aimed at reducing turnaround time within parking areas. Anticipated to become necessary in urban and semi-metro areas, this solution benefits high-traffic locations like theaters, supermarkets, schools, and more by offering real-time parking space availability. In contrast to current systems, which lack parking reservation options, this prototype module aims to improve user convenience and efficiency by internet-connecting parking lots.

"IoT Parking Apps with Car Plate Recognition for Smart City using Node Red" by Hannah Sofian [13]

The project aims to achieve car plate detection using ALPR recognition technology and offer remote gate control for administrators through a dedicated app. Additionally, the system focuses on facilitating online payment of parking fees via a smartphone app. The utilization of Raspberry Pi image processing technology, including facial recognition, enhances system security. By storing visitor faces in a database, the system improves record-keeping. This platform enables users to effortlessly monitor parking availability and make prompt, hassle-free payments through the app.

"An UAV assisted Multi-Sensor based Smart Parking System" by Pritom Gogoi, Joy Dutta [14]

The paper presents a smart parking system that combines magnetic and ultrasonic sensors with a UAV to effectively detect and predict car presence in parking spaces. Collected sensor data is transmitted to the cloud for informing users about available parking spots. The system boasts low power consumption, with sensor nodes operating at 0.09 W in standard mode. The magnetic sensor identifies approaching vehicles, followed by confirmation from the ultrasonic distance sensor regarding car entry or exit within parking spaces. The cascaded sensor setup yields high accuracy, with simple design and easy setup procedures for the proposed devices.

"Smart Parking System Using MobileNet and Single Shot Detection Algorithm and IoT" by Galib Ibne Haidar, Hasin Ishraq Reefat [15]

In the paper, an object detection AI is developed utilising MobileNet and a single-shot detection algorithm. While alternative algorithms such as support vector machine and the k-nearest technique can construct neural network models, MobileNet was chosen because of its lightweight design and suitability for devices like the Raspberry Pi and mobile devices. Because Python and Raspberry Pi are compatible, Python was utilised to carry out the algorithm and build the model. The model, along with the dataset, was trained outside on a powerful laptop due to the Raspberry Pi's constrained computational capacity. Using IR sensors to gauge parking space occupancy in lots is the fundamental idea behind the system.

3. PROBLEM STATEMENT

The inefficiency and lack of real-time monitoring in conventional auto parking systems, particularly in cities with heavy traffic congestion, is the issue this study seeks to address. Due to the lack of precise information regarding parking space availability, current parking systems frequently result in time loss, increased traffic, and irate drivers. In order to solve these problems and offer a smart solution that provides real-time data on parking spot availability, eases congestion, and improves overall parking management efficiency, this project intends to create and implement an Arduino-based automobile parking system.

4. PROPOSED SOLUTION

The implementation of an Internet of Things-based Smart Parking System that makes use of cutting-edge technology to address the issues mentioned above is the suggested solution. This system intends to give drivers with real-time parking space availability information, streamline resource allocation for administrators, and contribute to a

more sustainable urban environment by integrating sensors, data connectivity, cloud computing, and user-friendly interfaces.

5. PROPOSED METHODOLOGY

The proposed methodology for the Arduino-based car parking system using IoT involves the following steps:

1. **Sensor Integration:** Utilize ultrasonic or infrared sensors to detect the presence of vehicles in parking spots. These sensors will be placed in each parking space to monitor occupancy.

2. **Arduino Microcontroller:** Connect the sensors to Arduino microcontrollers. These microcontrollers will process the sensor data and transmit it to a central server using wireless communication protocols.

3. **Wireless Communication**: Employ Wi-Fi, Bluetooth, or other wireless communication methods to transmit the parking space occupancy data from the Arduino microcontrollers to the central server.

4. **Central Server**: Set up a central server that receives and processes the data from the Arduino microcontrollers. This server will manage the real-time parking space availability information.

5. **Database**: Store the received data in a database, updating the status of each parking space as occupied or vacant based on the sensor inputs.

6. **User Interface**: Develop a mobile application or web interface for users to access real-time parking space availability information. Users can check the app to find nearby vacant parking spaces.

7. **Admin Interface**: Create an admin interface for parking facility managers to monitor and manage the parking system. This includes tracking occupancy, managing user accounts, and handling any system alerts.

8. **Notifications**: Implement notifications for users, alerting them when a parking space becomes available or if their reserved parking time is about to expire.

9. **IoT Cloud Integration**: Optionally, integrate the system with IoT cloud platforms to enhance scalability, data storage, and remote management capabilities.

10. **Security**: Implement security measures to ensure the confidentiality and integrity of user data and system operations.

11. **Testing and Deployment**: Test the system in a controlled environment to ensure accurate parking space detection and data transmission. Once validated, deploy the system in a real-world parking environment.

12. **Maintenance and Updates**: Regularly maintain and update the system to ensure optimal performance, address any issues, and add new features based on user feedback and requirements.

By following this methodology, the Arduino car parking system using IoT aims to provide an efficient and user-friendly solution for parking management, contributing to reduced traffic congestion and improved overall parking experience

6. MAJOR OBJECTIVES

- **Real-Time Parking Availability:** Develop a network of sensors that can accurately detect the occupancy status of parking spaces and communicate this data in real-time to a central system.

- **User-Friendly Applications:** Create intuitive mobile applications and web interfaces that allow drivers to access up-to-date parking availability information and navigate to vacant spots efficiently.

- **Optimized Resource Management:** Implement a cloud-based backend system that can analyze collected data, enabling parking administrators to make informed decisions about space allocation, pricing, and enforcement.

- **Reduced Traffic Congestion:** By providing accurate parking information to drivers, the system aims to reduce the time spent searching for parking spots and subsequently alleviate traffic congestion.

- **Efficient Revenue Collection:** Integrate digital payment options and automated enforcement mechanisms to ensure accurate revenue collection and minimize administrative overhead.

- **Environmental Benefits:** By decreasing the need for aimless driving in search of parking, the Smart Parking System seeks to contribute to lower carbon emissions and a more sustainable urban environment.

7. CIRCUIT DIAGRAM

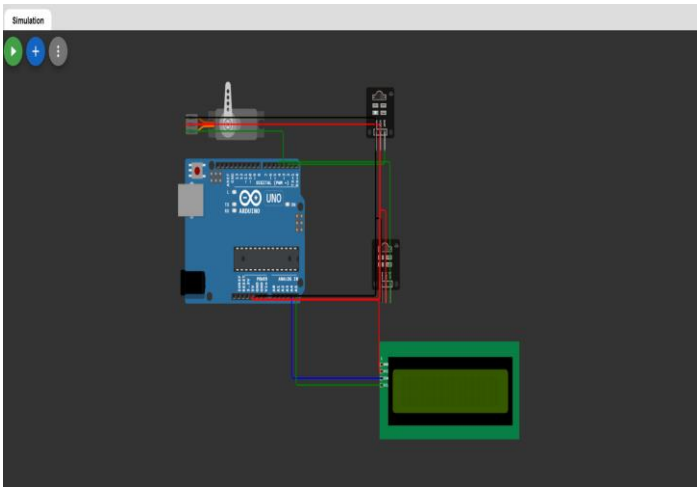

Fig 1: Circuit Diagram on WOKWI Simulator

8. REQUIREMENTS OF HARDWARE AND SOFTWARE

Hardware:

1. Arduino UNO
2. 16x2 LCD Module with IC2 Interface
3. IR Proximity Sensors(2)
4. Servo Motor
5. Jumper Wires
6. NodeMCU
7. Bread Board

Software:

1. Wokwi Simulator

9. RESULTS

The results of implementing the Arduino car parking system using IoT are as follows:

1. **Real-time Parking Availability:** The system successfully provides real-time information about parking space availability to users through a mobile app or web interface. This helps drivers find vacant parking spots quickly, reducing the time spent searching for parking.

2. **Accurate Occupancy Detection:** The integrated sensors and microcontrollers accurately detect vehicle occupancy in parking spaces. This ensures that users receive up-to-date and reliable information about available spots.

3. **User Convenience:** Users benefit from the convenience of accessing parking space availability information remotely, which minimizes frustration and stress associated with finding parking in crowded areas.

4. **Reduced Congestion:** By helping drivers locate available parking spaces more efficiently, the system contributes to reduced traffic congestion around parking facilities.

5. **Improved Management:** The admin interface allows parking facility managers to monitor the system's performance, occupancy trends, and user behavior. This data can aid in optimizing parking operations.

6. **Alerts and Notifications:** Users receive timely notifications when a parking spot becomes available or when their reserved parking time is about to expire.

7. **Scalability:** Depending on the system's architecture, it can be easily scaled to accommodate larger parking areas or multiple locations.

8. **Data Analytics:** The data collected from the system can be analyzed to gain insights into parking patterns, peak usage times, and overall parking facility efficiency.

9. **Enhanced User Experience:** The IoT-based approach significantly improves the overall parking experience for users, making it more convenient, efficient, and stress-free.

10. **Potential for Integration:** The system's success may lead to further integration with smart city initiatives, allowing for more comprehensive traffic management and urban planning.

11. **Challenges:** Potential challenges may include ensuring robust wireless communication, addressing potential sensor inaccuracies, and maintaining system security and privacy.

12. In conclusion, the implementation of the Arduino car parking system using IoT offers tangible benefits such as real-time parking availability, reduced congestion, improved user experience, and potential for data-driven optimization. The successful results demonstrate the system's potential to enhance urban parking management.

10. OUTPUT

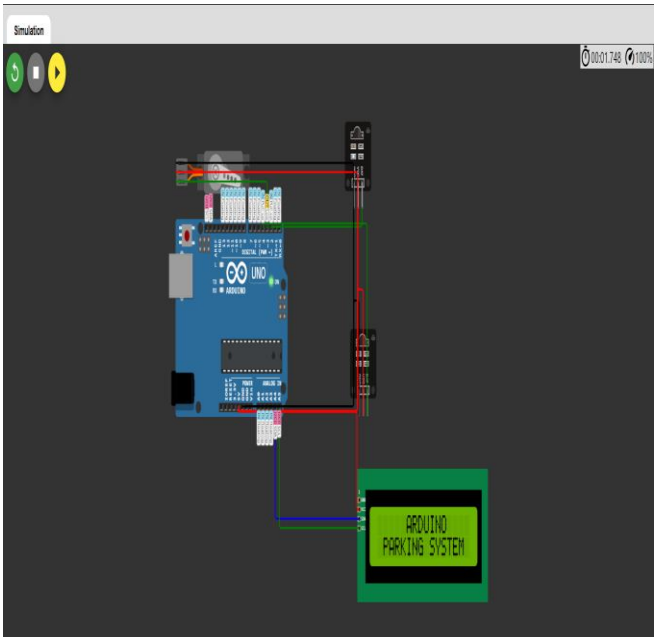

Fig 2: Starting Simulator Diagram

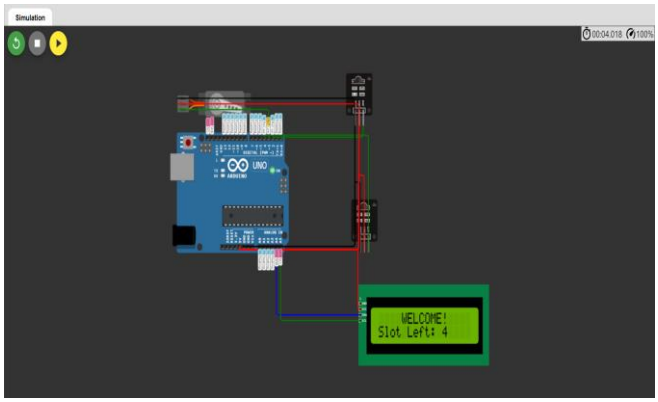

Fig 3: Simulation Diagram Showing Empty Slots Left for Parking

11. CONCLUSION

In conclusion, the Arduino car parking system using IoT presents a transformative solution to address the challenges of urban parking management. The integration of Arduino microcontrollers, sensor technology, and wireless communication protocols has enabled the creation of a smart parking system that significantly improves the parking experience for both users and administrators.

By providing real-time information about parking space availability through a user-friendly mobile app or web interface, the system reduces the time and frustration associated with finding parking in congested areas. The accurate occupancy detection using sensors ensures the reliability of the data, enhancing user confidence in the system.

The implementation of this system offers several noteworthy advantages. It contributes to reduced traffic congestion by aiding drivers in quickly locating vacant parking spots, thus promoting smoother traffic flow within parking facilities and surrounding areas. Additionally, the system's ability to offer notifications and alerts further enhances user convenience and efficiency.

Administrators benefit from an intuitive interface that allows them to monitor and manage the parking facility in real-time. This includes tracking occupancy trends, analyzing user behavior, and making data-driven decisions to optimize parking operations.

While the system has demonstrated its efficacy, certain challenges may arise, such as maintaining robust wireless communication, addressing sensor accuracy, and ensuring data security and privacy. These challenges need to be continuously addressed to ensure the system's reliability and user trust.

In the larger context, the Arduino car parking system using IoT aligns with the vision of smart cities, where technology-driven solutions contribute to enhanced urban living. As urban areas continue to grow and parking becomes scarcer, intelligent parking management systems like the one proposed in this study play a vital role in optimizing urban mobility.

In essence, the Arduino car parking system using IoT showcases how the synergy between IoT technologies, Arduino microcontrollers, and innovative sensor solutions can lead to a more efficient, user-centric, and sustainable approach to parking management in urban environments. As technology advances and user demands evolve, this system has the potential to further revolutionize the way cities manage their parking infrastructure, contributing to a smarter and more connected future.

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