WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

IoT enabled Smart Parking System

Bhargavi.S.R[1], Disha.A[2], Fida.K.S[3], Harshitha.B.K[4], Prof. Usha C.R[5]

[1] Dayananda Sagar Academy of Technology and Management bhargavisr2705@gmail.com
[2] Dayananda Sagar Academy of Technology and Management dishaashok1004@mail.com
[3] Dayananda Sagar Academy of Technology and Management ksfida29@gmail.com
[4] Dayananda Sagar Academy of Technology and Management harshithabk1425@gmail.com
[5] Dayananda Sagar Academy of Technology and Management usha-cse@dsatm.edu.in

ABSTRACT :

The Smart Parking Finder works by integrating IoT-based technology with real-time monitoring systems. Sensors are installed in each parking slot to detect whether the space is occupied or vacant. These sensors communicate with a centralized system that updates the parking status in real time. The drivers can use a mobile application to check for available spaces before entering the parking area, thereby reducing the hassle of aimlessly driving around to find a spot. The system not only helps drivers save time but also reduces traffic congestion within parking facilities, enhancing the overall user experience. The application is also designed to provide navigation to the nearest available parking space within the parking lot.

Additional features can include vehicle tracking, which also offers the feature of reservation. For example, users can reserve slots before the event and be ensured of their parking even at peak time. This is particularly helpful at times of events or festivity seasons, where a significant increase in demand occurs for parking. Additionally, this system can provide payment options so users can pay their parking through the application, thereby cutting down on manual intervention, which makes it more convenient. The Smart Parking Finder has broader implications for sustainability. It reduces the time spent searching for parking, which reduces fuel consumption and carbon emissions.

This is in line with the global efforts to combat climate change through eco-friendly solutions. As the system continues to evolve, it can expand to include more locations, including hospitals, airports, and business districts. Future developments could incorporate AI algorithms to predict parking availability based on historical and real-time data, further optimizing the user experience and contributing to smarter urban mobility solutions.

Introduction :

Urbanization and vehicle ownership increasing rapidly have added major impediments to the parking-management processes, including a poor optimization of parking places, rise in traffic congestions along with an increasing consumption of fuel in search for available ones. Traditional methods of tracking the parking rely on person-to-person inspection or traditional indicators, which do not offer live information that may enhance or optimize some processes. Such conditions cause user dissatisfaction, high consumption of 'greenhouse gases, and bad use of other resources involved. This demand for smart, automated solutions is a necessity to address these challenges and help the smart city grow.

This paper introduces an IoT-based Smart Parking System that leverages the latest technologies to provide real-time parking management and monitoring. The proposed system utilizes IR sensors, Arduino Uno, ESP8266 Wi-Fi modules, LED indicators, and the MQTT protocol to ensure a scalable, energy-efficient, and cost-effective solution. The primary objective is to automate the detection of occupancy in parking slots, transmit real-time data to a centralized dashboard, and enable remote gate control through a lightweight messaging architecture.

It works on a modular architecture in which infrared sensors at each parking space identify if the parking space contains any vehicles. These infrared sensors will be connected to an Arduino Uno that is the master microcontroller that takes data as input and then analyzes and interprets the output into processed information that the ESP8266 Wi-Fi module transfers wirelessly to the MQTT broker, and thus transfers to an accessible dashboard application. The dashboard allows for real-time updates regarding slot availability and allows users to control the parking gate remotely. The visual display is possible through the use of LED indicators, which indicate the occupancy status of slots in the parking facility. The Smart Parking System, which is IoT-driven, is a technically viable solution to the inefficiencies caused by parking. The system reduces search times, minimizes traffic congestion, and reduces environmental impacts by automating slot detection and providing real-time information. It brings about a great sense of dependability and scale improvement, hence suitable for implantation in parking facilities varying from size. Additionally, the system is in perfect terms with the goals of a smart city, as such; it promotes sustainable infrastructures
for urban development purposes, which incorporate IoT technologies improving quality of life.

This research sets the potential for IoT, MQTT, and the capability to revolutionize parking management using a foundation of future ideas in intelligent transportation systems, smart city applications.

Literature Survey :

IoT-Based Parking Occupancy Detection

The above research proposed ultrasonic sensors for monitoring the existence of cars within the parking lot. This highlights real-time data transfer, indicating that IoT may eliminate the need for human interaction within parking management. The system lacks the integration of a mobile application that allows users to interact.

Mobile Application for Parking Guidance

The authors developed a cloud-based architecture to process parking data and give real-time updates. Their system proved to be scalable and to have good data storage, but low- latency communication was difficult to achieve for time- sensitive operations.

Mobile Application for Parking Guidance

This research focuses on the integration of mobile applications with IoT systems, where users can check the availability of parking and reserve parking space remotely. The solution was effective but limited to a small geographic area and required significant investment in infrastructure.

Methodology :

The methodology followed involves the following key steps:

Architectural Design and Component Integration:

The system uses IR sensors in the parking slots to check whether there is a vehicle or not. There are connected to an Arduino Uno, which is the center processing unit that will process the data coming from all the sensors and send data to hardware components. This system makes use of LED indicators where green shows an empty parking slot, and red marks an occupied parking slot. An ESP8266 Wi-Fi module is incorporated to facilitate wireless communication between the Arduino and the MQTT broker. All components are connected via jumper wires to guarantee dependable power supply and data transmission.

Software Development and Data Communication:

The Arduino is programmed in embedded C to process signals coming from the IR sensors, control the LEDs, and send the status of the parking slot to the MQTT broker through the ESP8266 module. MQTT protocol is used for communication, and its lightweight publish-subscribe architecture is used for efficient communication.}}}he ESP8266 publishes the updates on the parking status in real time to the broker while subscribing to topics for the gate control commands.

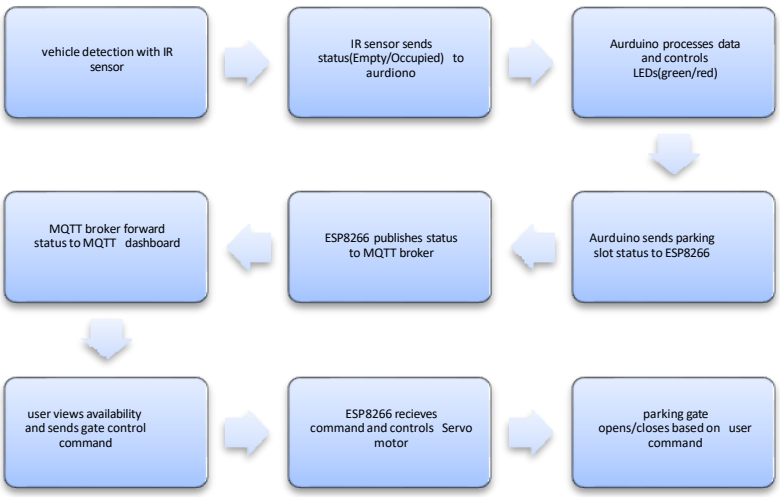
MQTT Dashboard Integration

An interface for users is built using a dashboard application supporting MQTT, such as the *MQTT Dashboard App* or similar, to provide users with instantaneous information about the availability of parking spaces. The dashboard shows the status of every parking slot and allows the user to control the parking gate from a distance. The protocol for controlling the gate is carried out through a servo motor or a similar device that is triggered by commands received by the MQTT broker.

Evaluation and Improvement:

The system is tested in a variety of scenarios to evaluate its effectiveness with respect to sensor accuracy, communication reliability, and latency in response. Modifications are made to improve power efficiency, increase real-time updates, and ensure seamless integration of hardware and software components. This methodology shows the practical use of IoT and MQTT technologies to develop an efficient and user- friendly smart parking system. It stresses modularity, scalability, and energy efficiency for a system that can be deployed in modern urban environments.

III.Implementation :



The flowchart represents the workflow of the IoT-based Smart Parking System, starting with vehicle detection using IR sensors that determine if a parking slot is occupied or empty. The sensor data is sent to the Arduino, which processes it and controls the LED indicators, turning them green or red based on slot availability. The Arduino then communicates the parking slot status to the ESP8266 module, which publishes this information to an MQTT broker. The broker forwards the data to the MQTT dashboard, allowing users to view real-time parking availability. Users can then send gate control commands via the dashboard, which the MQTT broker relays to the ESP8266. The ESP8266 processes these commands and triggers the servo motor to open or close the parking gate, ensuring seamless control of the parking system through the dashboard interface.

Algorithms:

Vehicle Detection Algorithm:

The Vehicle Detection Algorithm determines whether a parking slot is occupied or empty .This is achieved using IR sensors placed in each parking space. The algorithm reads data from the IR sensor and determines the parking status based on whether the sensor detects a vehicle. If a vehicle is detected, the parking slot is marked as Occupied and the corresponding LED indicator is turned red; otherwise, the slot is marked as "Empty," and the LED is set to green. The status is then transmitted to the ESP8266 module for further communication.

Data Transmission Algorithm:

The Data Transmission Algorithm deals with the communication between the system components using the MQTT protocol. Once the parking status is determined, the ESP8266 module will connect to the Wi-Fi network and establish a connection to the MQTT broker. The parking status is published to the MQTT broker and forwarded to the MQTT dashboard for real-time monitoring. The ESP8266 module also subscribes to the topics related to gate control commands. Whenever a status update occurs, the system transmits the data through the MQTT protocol, allowing users to access the latest information.

The Gate Control Algorithm:

The gate control algorithm is that which governs the operations of the parking gate. In case a user commands to open or close the gate through the MQTT dashboard, the system processes the message and causes the servo motor to open or close the gate. In this case, the gate will be opened if the command is "OPEN" and closed if the command is "CLOSE".

MQTT Message Handling Algorithm:

The MQTT Message Handling Algorithm shall process incoming MQTT messages related to parking status and gate control. In response to an incoming message that pertains to the status of a parking area or a control command for the gates, it executes the required action for example updating the dashboard, or in turn controls the gate.

Future Advancements :

Future enhancements of the Internet of Things-based Smart Parking System can make it scalable, efficient, and easier to integrate with other fast-emerging technologies. Most notably, scalability for multilots of parking may be developed, where multiple car parks across a city would be managed. This integration will require the addition of more sensors, ESP8266 modules, and MQTT brokers to handle the higher volume of data and real-time status updating across several locations. Another potential improvement is the integration with smart city infrastructure, where the system can work in tandem with traffic management systems to optimize vehicle flow, suggest alternative routes, or dynamically allocate parking spaces based on real-time data.

The system could also be improved in its mobile application, allowing users to reserve parking spots in advance, make digital payments, and receive real-time notifications on

parking availability. Artificial intelligence can be utilized for predicting the usage pattern of parking space, space allocation optimization, and dynamic pricing as per the demand. More over, emphasizing on energy efficient IoT devices, low power sensors and even energy harvesting methods such as solar power in large scale will make the system highly sustainable.

Security improvements are also necessary for the expansion of the system. It will be able to ensure the security of user data through end- to-end encryption, secure authentication protocols, and real-time anomaly detection. Lastly, the system could be modified for autonomous vehicle integration, enabling self-driving cars to park themselves in available parking spaces by interacting with the parking system, enhancing the overall user experience and contributing to smart city ecosystems.

Conclusion :

In conclusion, the IoT-based Smart Parking System utilizing the MQTT protocol offers an efficient solution to the challenges of urban parking management. By integrating IR sensors for vehicle detection, ESP8266 for wireless communication, and MQTT for real-time data transmission, the system provides accurate parking slot status updates and allows remote control of parking gates through a user-friendly dashboard. The implementation of this system enhances parking efficiency, reduces congestion, and provides users with a seamless s parking experience. Future advancements, including scalability for multiple parking lots, AI- based management, and integration with autonomous vehicles, can further improve the system's capabilities and its role in smart city infrastructures.

REFERENCES :

1. Sharma, V. K., Srivastava, S., Srivastava, S., & Goel, S. (2018). Smart Parking System Based on IoT Technology. Journal of Advanced Engineering Research, 5(2), 34-40.
2. Kumar, P., Mallick, B., & De, A. (2020). "IoT-Based Smart Parking System Using MQTT Protocol." *International Journal of Advanced Research in Computer and Communication Engineering*, 9(5), 123-129.
3. Ahmed, S., & Li, X. (2019). Cloud-Integrated Parking System Using IoT. International Journal of Smart Parking Systems, 4(1), 12-18.
4. Desai, S., & Patil, P. (2019). "Real-Time Parking Slot Monitoring Using Arduino and MQTT." *International Journal of Engineering Research and Technology (IJERT)*, 8(7), 78-84.
5. Chen, A., Li, B., Wang, Y., & Zhao, J. (2020). IoT-Enabled Parking System with Mobile App Support. Journal of Smart Parking Technology, 2(3), 25-32.