An IoT-Based Intelligent System for Realtime Parking Monitoring

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ABSTRACT

Abstract— Parking space is becoming harder to obtain as the number of vehicles on the road grows by the day. Looking for parking space is a major problem, especially in large cities or areas where sporting or artistic events are scheduled, and finding a parking site can be a frustrating experience. To combat this issue, some parking lots have installed sensors that detect when a car enters or exits a parking lot, allowing them to track capacity and alert drivers if it is full. This is a partial solution that allows drivers to determine whether a parking lot has available parking spaces, but not the exact location of those spaces. The Smart Parking Sensor Network project aims to create a low-cost sensor-based parking system for mapping parking area usage. This system consists of sensor nodes that can detect parking space occupancy; relay nodes that communicate between sensor nodes and the server; a server application that receives data from the relay nodes and sends it to a web application; and a web application that displays parking areas and occupancy on a dashboard. The vehicle detection sensor node was created using sensors and components that were low in cost and power. A proximity sensor is used to detect the vehicle's presence, and the distance sensor confirms it. Web applications are developed using HTML, CSS, JavaScript, Bootstrap and Google firebase is used as a centralized database.

Keywords— Smart Parking, Internet of Things, MQTT, Proximity sensor, Firebase.

1. INTRODUCTION

An IoT-based real-time parking monitoring system is an innovative solution that utilizes advanced technologies such as ESP8266, Firebase, and a web application to efficiently manage parking spaces. This system aims to address the common problem of finding available parking spots in crowded urban areas. By leveraging IoT connectivity, data collection, and cloud-based storage, it provides real-time updates on parking availability, enabling drivers to locate vacant spaces easily and minimize the time spent searching for parking. At the heart of this system is the ESP8266, a powerful Wi-Fi microcontroller that serves as a communication module between the physical parking spaces and the digital infrastructure. Each parking space is equipped with an ESP8266 module, which monitors and relays information regarding its occupancy status. The module communicates with a central server through the internet, ensuring seamless connectivity and data transmission.

Firebase, a cloud-based real-time database, and backend platform is employed to store and manage the parking data collected from the ESP8266 modules. It provides a scalable and reliable solution for storing and synchronizing real-time parking information across multiple devices and platforms. The data includes the availability status of each parking space, timestamps, and other relevant details. To provide a user-friendly interface and enable easy access to parking information, a web application is developed. The web application fetches the data from the Firebase database and displays it to the users in real-time. It allows drivers to view the availability of parking spaces, reserve spots if available, and navigate to the selected parking area efficiently. Additionally, the application can send notifications or alerts to users when parking spaces become available or when their reservation time is about to expire.

The IoT-based real-time parking monitoring system utilizing ESP8266, Firebase, and a web application revolutionizes the way parking is managed. By leveraging the power of IoT connectivity, data storage, and cloud-based applications, this system offers an efficient and user-friendly solution for both drivers and parking space operators. It enhances the overall parking experience, reduces traffic congestion, and optimizes the utilization of available parking spaces in urban areas.

2. LITERATURE SURVEY

In this work [1], authors proposed an idea to book a parking spot through the app and generate a receipt for the user and reflect the vacancies in real time on the app as well as the website operated by the admin at the parking lot. With such a system the parking authorities can easily manage their parking spaces efficiently.

The research [2] focuses on incorporating IoT technology into smart packaging to monitor the freshness of food products. Sensors embedded in the packaging detect temperature, moisture, and gas levels and transmit the data to a cloud-based platform. The system provides consumers with real-time information about the quality and freshness of packaged food.

Authors [3] proposed an approach based on GCNN and an LSTM model to forecast real-time future parking availability by capturing both the temporal occupancy patterns and the geospatial interactions in traffic flow. Different model configurations were evaluated by varying the information fed to the model (e.g., weather forecast, parking violations), the extent of historical data used, and the forecasting period. Experimental evaluation over historical parking data of the city of Tandil in Argentina showed that the proposed approach was able to outperform other state-of-the-art models significantly.

This system [4] elaborates on pilot research on improving truck parking facilities cooperated with the Washington State Department of Transportation (WSDOT), building and testing the advanced Truck Parking Information and Management System (TPIMS) with the real-time user visualization and prediction function empowered by artificial intelligence. Furthermore, by analyzing the activities of truck drivers, the researchers aggregated the regularity of truck parking patterns by a customized sequential similarity methodology. A Truck Parking Occupancy Prediction (TPOP) neural network for time-variant occupancy prediction by deep learning and attributes embedding is proposed and integrated into the TPIMS.

3. SYSTEM ARCHITECTURE AND METHODOLOGY

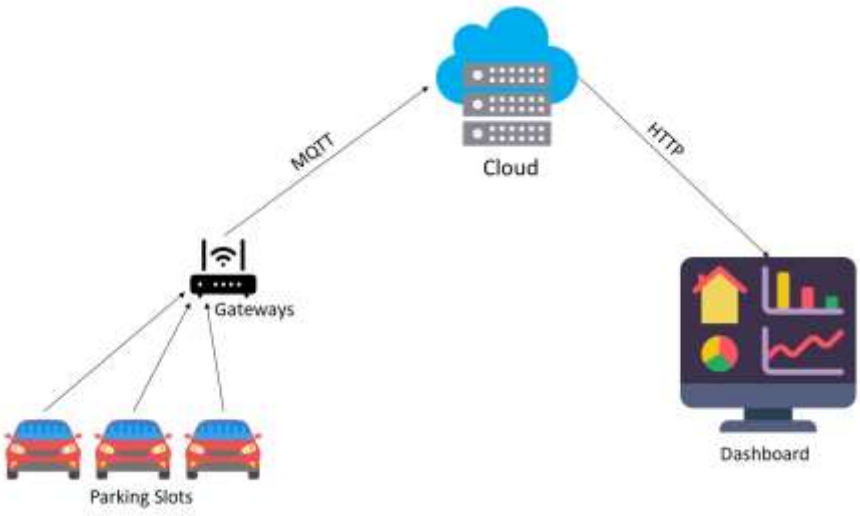

Fig -1: System Architecture

The system architecture of the solution is given in Fig. 1. This architecture consists of three main sections: a sensor network, a server, and a mobile application. The sensor network consists of vehicle detection sensor nodes and relay

nodes. Sensor nodes connect to relay nodes through a wireless communication medium (Wi-Fi/MQTT). Relay nodes connect to the server through a wireless communication medium (Wi-Fi). Sensor nodes do not connect to the server through the outer network because these nodes are designed to be low cost with limited communication capabilities. The relay nodes are more powerful and will transfer data using the MQTT (Message Queuing Telemetry Transport) protocol. The server application will be on the Internet and will send data about the occupancy of parking areas when requests come from the mobile application.

4. RESULT

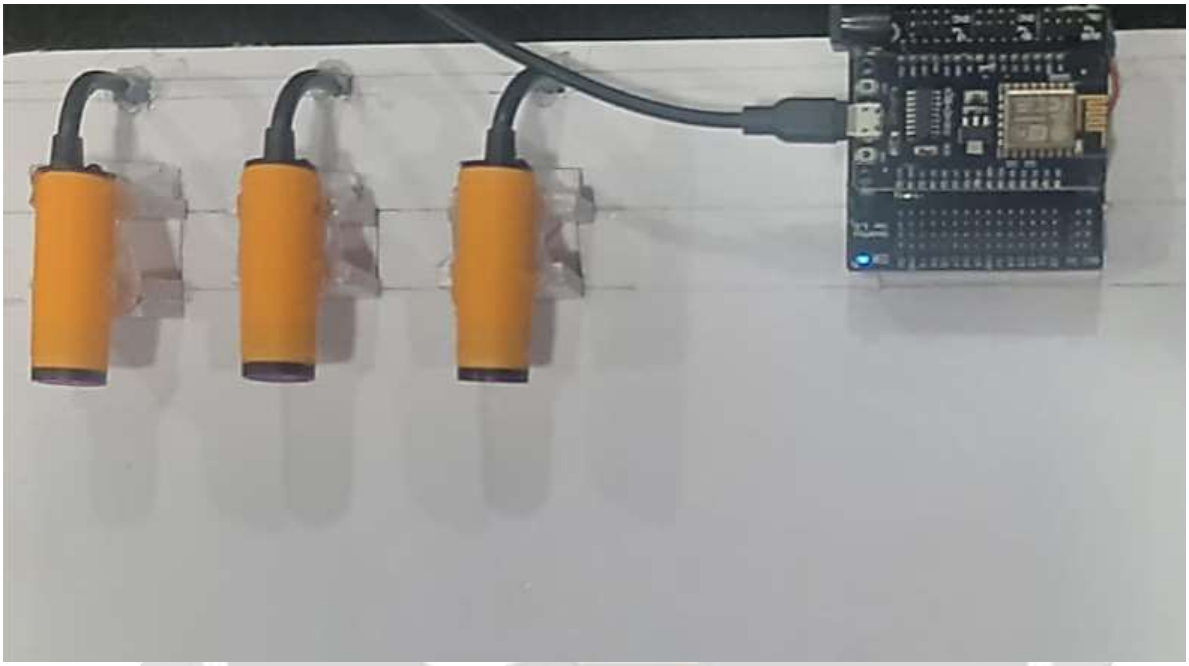

Figure 1 - Hardware Setup

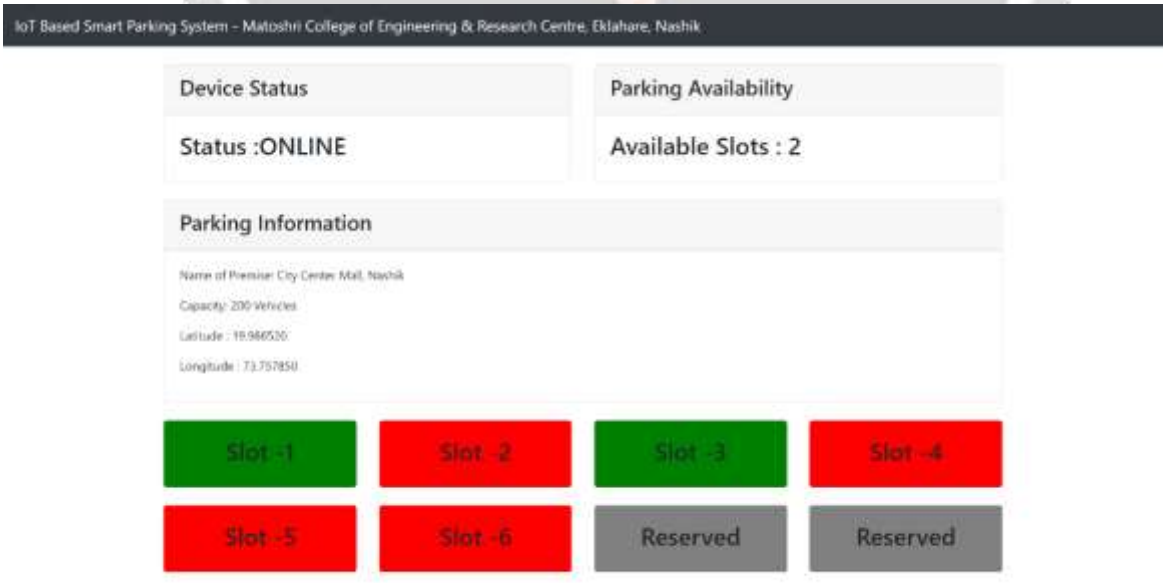

Figure 2 - Dashboard

5. CONCLUSIONS

In this proposed system, an inexpensive solution is proposed to design and develop a smart parking sensor network with a mobile application, server application, a relay node and magnetic and distance sensor-based vehicle detection node. Mobile and server applications are also introduced. Vehicle detection nodes were designed along with the vehicle detection algorithm. The cost of these nodes is around 1200 INR. Continuation of this project can be done as the next phase by conducting more test scenarios and adding low-power consumption methods in the vehicle detection sensor nodes.

The future of IoT-based smart parking holds immense potential for urban environments. With advanced analytics and machine learning algorithms, these systems can provide valuable insights into parking patterns, enabling city planners and transportation authorities to make informed decisions regarding parking infrastructure and policies. By analyzing historical data, the system can predict peak parking hours and demand, allowing for proactive management of parking resources. This can help optimize parking space utilization, reduce traffic congestion, and minimize carbon emissions caused by vehicles circling around in search of parking. Furthermore, IoT-based smart parking can be seamlessly integrated with other smart city initiatives, such as traffic management systems and electric vehicle charging stations, creating a holistic urban environment that promotes sustainability, efficiency, and improved quality of life for residents and visitors alike.

6. REFERENCES

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