SMART PARKING SYSTEM USING INDUCTION LOOP DETECTOR

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***Abstract*—Parking management in the urban areas has become a rising concern for many. Improper management of the space allotted for vehicle parking has always led to reduced availability of parking lots of vehicles. In addition to this, huge parking spaces such as multi-storeyed parking facilities may face difficulty in keeping track of the available parking slots. To combat the challenging issue at hand, this project aims to propose an innovative way to utilize the technology of the Internet of Things (IoT) and build a smart system that can track parking space occupancy and minimize the search time of parking lots for drivers and improve the overall parking experience. We propose an induction loop vehicle detector system that consists of an induction loop made out of copper enameled wires, a resistor, a capacitor, a diode, and an LED. In addition to this, we have used a database to keep a record of the parking slots and their availability. A front end is designed for the user to view the currently available parking slot. The admin can view all the parking slots and their current status (i.e. available or occupied).**

***Index Terms*—Induction Loop, Arduino, MySQL, SpringBoot, parking**

I. Introduction

Traditional methods of parking detection, such as manually allotting the available space are often inaccurate and unreliable, leading to misdirection of drivers and an increase in the time spent to search for a parking space. Another huge problem is that without a proper system to manage the real-time occupancy data drivers may occupy a space that's not meant for parking due to a misdirection through many obstructions such as means of human error or more. The current parking experience is often frustrating and time-consuming, due to the lack of real-time guidance and efficient parking allocation. To address these challenges the project proposes an innovative approach using an induction loop sensor as the base and combining the IoT technology to improve the overall parking experience.

Previous attempts to build such a system were mostly based on either of camera, IR sensor or magnetic sensor as the detecting sensors. However, these come with their own drawbacks. Magnetic sensors, which identify metallic objects by disturbing the Earth's magnetic field, face challenges in detecting stationary vehicles and have constraints in terms of detection zones. Surveillance video cameras encounter accuracy problems, particularly in congested conditions, where they may have difficulty distinguishing smaller vehicles obscured by larger ones. Likewise, infrared (IR) sensors are prone to reflections from sunlight, interference from atmospheric particles, and sensitivity to water presence in fog, haze, rain, and snow. They are also impacted by obstructive elements like smoke and dust. In essence, the smart parking system using an induction loop detector not only addresses the immediate need for efficient parking management but also lays the groundwork for future developments in intelligent transportation systems.

Therefore, we aim to build a smart parking system using induction loops that can be installed in the parking slots and detect the presence or absence of a car. A database containing the record of the parking slot availability has also been created that will be used to display the current available slot to the driver. The admin can view all the parking slots and their current status (i.e. available or occupied).

II. Literature Survey

The system proposed by [1] prioritizes parking slot allocation based on user preferences, employing automation depicted. The article emphasizes the significance of Erlangian distribution in implementing a priority queuing technique for optimized results. The operational model employs ultrasonic sensors to detect all available vacant parking slots. This data facilitates the analysis of priority selection based on the First Come First Serve (FCFS) scheduling model. The study involves the examination of approximately 180 unique scenarios for parking allocations to various users, particularly during peak festive times. User information gathered during booking priorities is compared with the availability of empty slots, giving preference to end users in accordance with the FCFS model in the automated booking system. The smart parking system operates on a real case study using a prototype model, considering user demands to prioritize parking slot bookings. Future

research could extend the study to different booking locations to coordinate among multiple parking systems. The article by [2] outlines the development of a system for detecting and counting vehicles, employing inductive loop technology. The system primarily consists of three components: the inductive loop section, the electronic vehicle detector section, and the counter section. The inductive loop relies on electromagnetic communication to induce an electric current in a nearby wire. As a vehicle passes over the loop, the inductance of the loop experiences an increase. Design and testing occurred within Proteus simulation software, evaluating each system section before holistic testing. Commands issued and counter-displayed values affirmed the system's impeccable design and functionality. The thorough testing process corroborated the system's efficiency and reliability in accurately detecting and counting vehicles, asserting its practical effectiveness in traffic signal systems. The work proposed by [3] addresses parking system challenges by introducing an Internet of Things (IoT)-enabled mechanism for parking space allocation. Smart parking is achieved through the utilization of ultrasonic sensors, Arduino Uno, and a cloud server. The system is accessible via an Android application, allowing users to monitor the availability of vacant slots in the parking area. This establishes a communication link between the smart parking system and the user. The proposed implementation focuses on a reservation-based parking system, where each user is assigned a unique OTP (One-Time Password) to occupy their reserved parking slot. Additionally, precautions have been implemented to prevent any malfunction or unauthorized entry of a vehicle into an allocated parking slot. This is achieved by assigning a unique OTP to each individual, ensuring that the same person who received the OTP parks their vehicle in the designated slot.

Authors of the work [4] have introduced a sophisticated parking system based on the Internet of Things (IoT) with control facilitated through a Smartphone Device. The system aims to provide a comprehensive parking solution for both commuters and vehicle owners. Its functionalities include reserving parking spaces, validating reserved users, identifying nearby vacant spaces based on vehicle length, and generating daily, weekly, and monthly usage reports. Infrared (IR) sensors are employed to determine the availability of free parking spots. Using Wi-Fi module technology, a microcontroller, and wireless communication, information about the location of a free parking space is transmitted to the server and retrieved through a mobile application. An RFID tag affixed to a vehicle is utilized for authenticating individuals occupying regular, daily, weekly, or monthly parking spots. A mapping algorithm is employed to identify the nearest available space based on the size of the vehicle. The parking space owner can analyze data such as the number of free spaces at a given time, occupancy rates on weekdays and weekends, and earnings for a specified period. This information can be utilized to adjust variable parking fees. The Mobile App is designed to provide a user-friendly experience.

The study conducted by [5] introduces an innovative and straightforward inductive loop sensor design aimed at accurately detecting the presence of a vehicle without errors. The paper outlines the specifics of the new inductive loop structure, including circuit design, methodology, operational principles, experimental setup, and the results obtained from field trials. To ensure the circuit operates smoothly, a meticulous coding technique is employed. Additionally, the implementation of a well-designed oscillator with minimal noise contributes to reducing disturbances in the detector. The versatility of this loop detector extends beyond vehicle presence detection; it can be applied in various scenarios such as speed detection and vehicle type identification. Once installed, the detector is easy to maintain and exhibits a characteristic of not being affected by environmental changes.

III. Methodology

A. Vehicle Detection

Induction loops embedded in the pavement detect the presence or absence of vehicles in parking spaces. When a vehicle enters a parking space, the electromagnetic field generated by the induction loop is disrupted. This disruption is detected by the induction loop sensor, which sends a signal to the Arduino Uno. The Arduino Uno then determines whether the parking space is occupied or vacant based on the signal received from the sensor and the threshold limit set for vehicle detection.

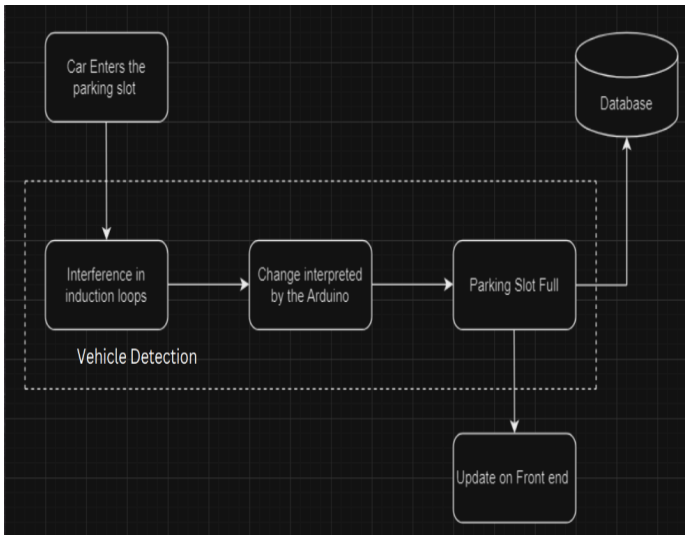

Fig. 1. Flowchart of proposed work.

B. Data Collection

Whenever a vehicle comes inside the parking slot area, a change in the charge on the capacitor of the LCR circuit is observed. This change is captured and used in the Arduino code in order to detect the presence or absence of a vehicle with the help of threshold limits set beforehand.

In order to collect readings from the hardware circuit, Arduino IDE is used. This IDE is used to handle programming on the Arduino Uno-based circuit. This is done in the following steps :-

1) Defining pins of the Arduino board.
2) Setting up the pin mode for each pin.
3) Read the charge on the capacitor for 150ms.
4) Find the average charge to avoid spikes in the readings.
5) If the average charge is greater than the threshold value, prompt the LED to glow signaling a vehicle has entered the parking slot.

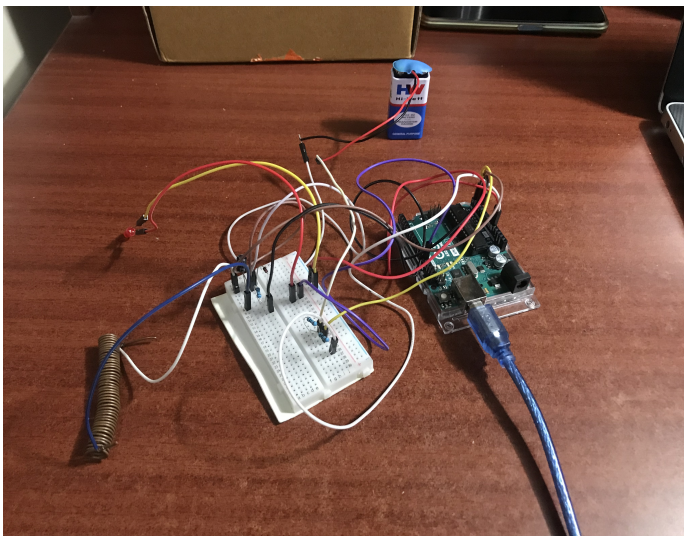

Fig. 2. Circuit setup.

C. Database Management

The database stores and manages the parking occupancy data, maintaining a historical record of parking availability. It utilises the MySQL platform to write scripts to administer the database and retrieve information from it.

1) Create a database for storing the record of the parking slot availability in the parking space.
2) Create a table inside the database with three columns – an autoincrement integer ID, a parking slot number, and, boolean availability, where 1 represents that the parking slot is available and 0 represents that it is occupied.
3) View the table contents to ensure successful creation.

D. Web Application

SpringBoot is used to create a controller class that constantly reads from the COM5 port of the Arduino for the vehicle detection readings and consequently updates the database. The first available slot is displayed to the vehicle entering the parking space by reading from the current database state. The parking administration will access to a distinct webpage that shows the current occupancy of the whole parking space. The procedure consists of the below mentioned steps:

1) Download a Maven Spring project template from Spring Initializr and include necessary dependencies.
2) Open *application.properties* file of the project and mention the database port, username and password to allow access to the database.
3) Create four packages named *model*, *controller*, *repository* and *services*.
4) Create a class inside model package having data members same as the columns of the table in the database. Include getters and setters to access and manipulate data.
5) Create a repository interface inside repository package and extend *CrudRepository* to include functions to be utilized for database manipulation.
6) Define all functionalities using built-in functions defined in JPA-based repositories.
7) Create a controller class inside the controller module that will comprise of three functions being rendered at three different URLs respectively upon launch of the application.
   - *list*: displays data from the database to the administration webpage that shows the currently occupied slots in red colour and the available slots in green colour.
   - *slot* : assigns the first available slot to the car that enters the parking space.
   - *readArduino* : utilizes *fazecast.jSerialComm.SerialPort* package to read COM5 port of the device. All data printed to the serial monitor of the Arduino IDE is read in this function. If the data value is greater than the set threshold, the corresponding parking slot availability status is updated.
8) All webpages are designed and styled using HTML and CSS.

IV. Results

As soon as a metal is brought near the inductor coil, the inductance of the coil changes. Thus, a metal is detected and the LED starts to glow.

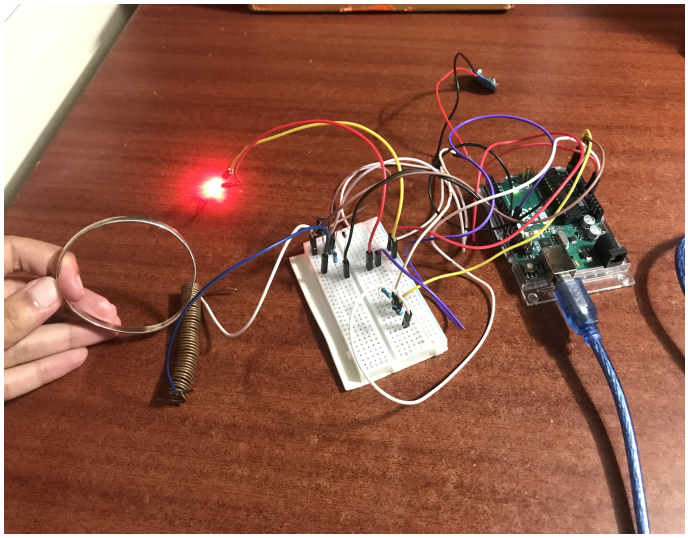

Fig. 3. Metal detected.

The readings showing the charge in the capacitor were displayed on the Serial Monitor of the Arduino IDE.

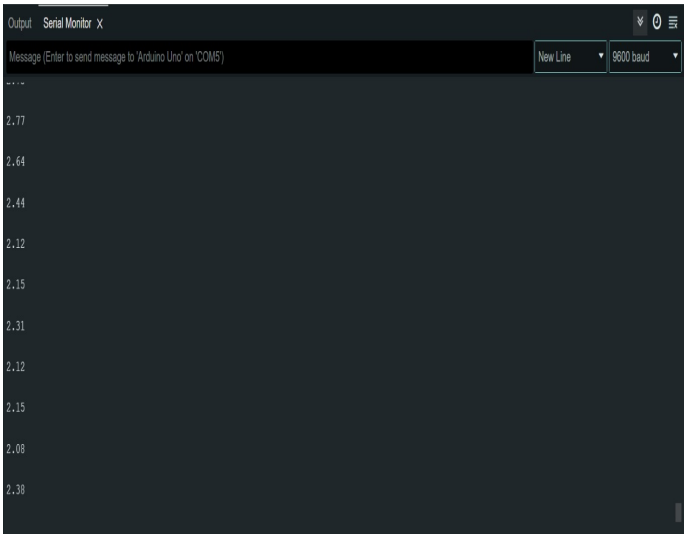

Fig. 4. Serial Monitor.

The user side of the web application shows the current available parking slot as shown in the figure below.

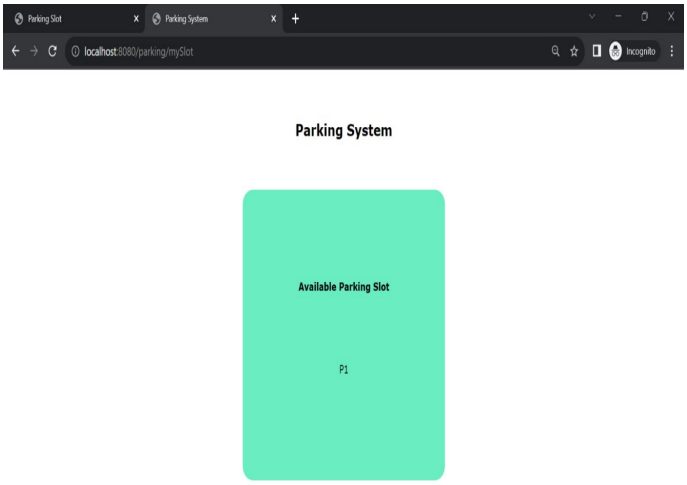

Fig. 5. First available slot allotted.

The admin side of the web application will show all the parking slots and their current availability status. The red colour shows that the slot is occupied or not available, while the green colour shows that the parking slot is available.

The database will also be simultaneously updated as a car occupies or leaves the parking slot.

V. Conclusion

In conclusion, the development and implementation of a smart parking system using an induction loop detector represent a significant leap forward in addressing modern parking challenges. The project successfully demonstrated the feasibility and effectiveness of utilizing this technology to create a more efficient and user-friendly parking environment. The

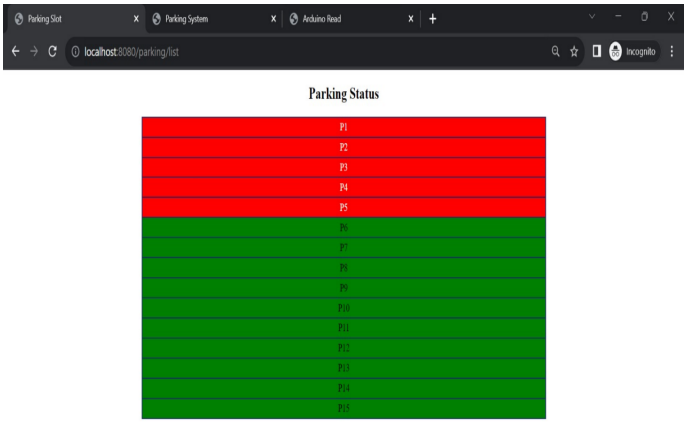

Fig. 6. Admin Page.

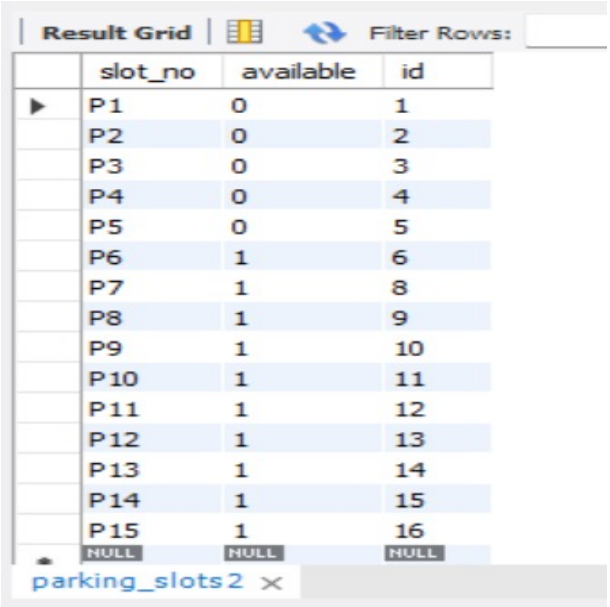

Fig. 7. Final database state.

circuit can be modified to meet the specific requirements of the project for future development as well. For example, multiple induction loop sensors can be connected to the Arduino Uno to monitor multiple parking spaces. Additionally, the LED can be replaced with a more powerful light source, such as a traffic light or a sign, to provide more visible parking occupancy information. The thresholds for detecting the presence of a vehicle in a parking slot can be varied to suit different types of vehicles. The proposed work can also be integrated with a payment system that charges vehicles relevant parking fees upon detection of their exit from the parking space.

In essence, the smart parking system using an induction loop detector not only addresses the immediate need for efficient parking management but also lays the groundwork

for future developments in intelligent transportation systems. As urban areas continue to face growing challenges in parking availability, this project serves as a noteworthy contribution towards creating smarter and more sustainable urban spaces.

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