**Signal and Image Processing Letters**
Vol. 3., No. 3, 2021, pp. 26-36
ISSN 2714-6677
https://simple.ascee.org/


# Parking System Using Nodemcu Microcontroller Based Infrared Sensor

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ARTICLE INFO

**Keywords**
Sensor IR
Website
Microcontroller
Internet of things

ABSTRACT

Vehicles are one of the important things in supporting the mobility of people and goods quickly, safely and comfortably. Cars are one of the most widely used types of vehicles because they can accommodate many people or goods. This study aims to make a prototype of an organized parking lot so that it is easier for car users to find parking. The system in this study uses a NodeMCU microcontroller as the controller. Infrared sensors are used as sensors to detect the state of the parking area. The system has two outputs in the form of an LED and a website. Infrared sensors can detect all parking area conditions, LEDs run according to parking area conditions, and the website can be used as remote monitoring of the parking area of this system. Parking area users can easily find an empty parking area.



## 1. Introduction

One of the widely used vehicles is the car. Cars are preferred by consumers due to their larger size, allowing them to carry families or more goods compared to two-wheeled vehicles. Corresponding to their larger size, car users also need to consider the size of parking areas, one car parking space can accommodate four two-wheeled vehicles [1]. However, the growth of vehicles, especially cars, has not been accompanied by an increase in parking spaces. Parking spaces have become essential because vehicles require parking areas for extended periods according to their type and needs. Recently, parking spaces have received more attention due to the inadequacy of available spaces. Consequently, many private vehicle users, especially car owners, face difficulties finding parking in public places such as tourist spots, shopping centers, and office buildings [2]-[4].

The need for parking in shopping malls or multi-story buildings still faces challenges in managing parking, as the available parking spaces often do not match the number of arriving vehicles. Car users frequently encounter difficulties and confusion when searching for vacant parking spots. Some users even have to circle the parking area multiple times to find an empty spot [5][6].

Surbakti & Sadli stated in their research that the advancement of transportation technology should be complemented by the development of technology and electronics [7]. In Nataliana Decy's study, infrared sensors were utilized to detect parking space availability [8]. Muhammad Ali Imron also researched an automatic car parking information system. This research employed infrared sensors connected to a microcontroller [9]. Another study on an intranet-based parking system was conducted by Putra Fakhri Brilians. The intelligent parking system used IoT to create a miniature parking area, and the parking lot's conditions could be monitored through Firebase Android [10].

Parking refers to temporarily or long-term leaving a vehicle stationary due to the driver's negligence. According to the law, parking on the road's center is prohibited, but parking on the roadside is usually allowed [11].

Internet of Things (IoT) is a term that has gained popularity recently. In short, it refers to objects around us communicating with each other through a network like the internet [12]. The term "Internet of Things" was first coined by Kevin Ashton in 1999. Nowadays, many major companies such as Intel, Microsoft, Oracle, and others are heavily involved in IoT research [13].

Based on the parking issues mentioned, there is a need for innovation by leveraging technology to assist car users in finding parking spaces more easily. By utilizing the Internet of Things (IoT) method, car users can locate vacant parking spaces before entering the parking area through an intranet, making it more convenient for them to park their cars [14].

## 2. Method

### 2.1. System Design

The planning of the web-based car parking system with indicator lights is carried out in two stages: hardware design and software design. In the first stage, planning is done using block diagrams and an explanation of the system planning. In the second stage, software development is designed, including flow diagrams, programming, and device testing.

#### 2.1.1. Hardware Design

The hardware design for this parking system uses IR (Infrared) sensors. The IR sensors are used to detect changes in the parking area, specifically the movement of cars within the parking space. In addition to the IR sensors, the parking system utilizes three LED indicators. The IR sensors and LEDs are connected to the NodeMCU microcontroller using AWG cables. Fig. 1 shows the block diagram of the device's operation.

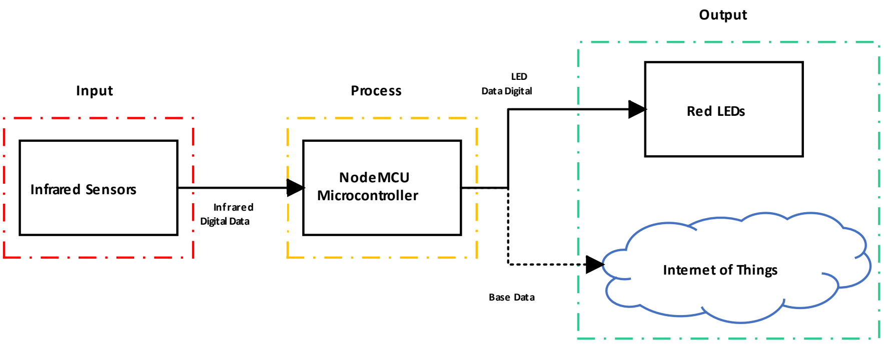



**Fig. 1.** Block Diagram of the System

This web-based parking system with LED indicators has one input, which is an IR sensor, and in this system, three IR sensors are used. The NodeMCU microcontroller is used in this process since it connects to the intranet. By using the NodeMCU, the system can be connected to the intranet by entering the wireless fidelity (Wi-Fi) IP address and password. The output of the system is three red LEDs, and the intranet output is accessed through a specific website for this parking system.

The mechanical part of the web-based parking system uses plywood, formed into a flat square shape resembling a parking space. The mechanics also include parking space boundary lines to clearly indicate parking boundaries. The mechanical setup includes support legs for the parking area, and a mini system is placed inside a box at the bottom.

The sensor and LED mechanics use blue filament material, resembling parking space wall boundaries. The IR sensor is placed at the parking space boundary, along with an LED positioned above the IR sensor. Each parking space has an IR sensor and a red LED indicator. Fig. 2 shows the prototype hardware design.

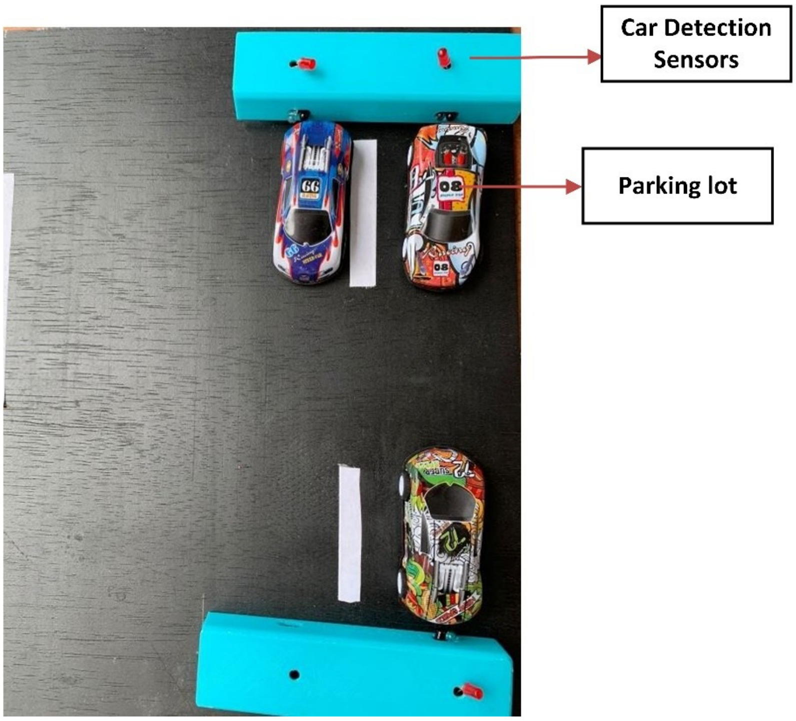



**Fig. 2.** Parking Prototype Design

Fig. 2 represents the prototype design of this parking system. There are two outputs: LEDs as direct indicators in the parking spaces and IR sensors facing the parking area to detect the presence of cars. Inside the box, the NodeMCU microcontroller and its PCB are placed.

The hardware design continues with creating a wiring diagram of the components used. The assembly involves connecting all the device's cables to obtain sensor readings. All sensors are connected to the controller. Fig. 3 shows the wiring diagram of the system.

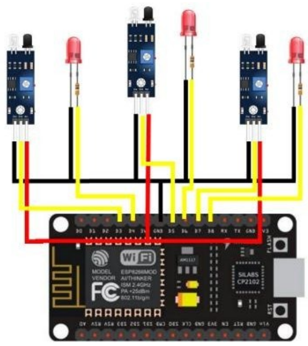


**Fig. 3.** System Component Wiring Diagram

Based on Fig. 3, the entire system circuitry is powered by a USB cable from a DC power source, and all components are interconnected through a central controller. NodeMCU operates at 5-12 volts and supplies power to the IR sensors and red LEDs. The IR sensors and LEDs are connected using cables and can be seen in the Table 1.

**Table 1.** Wiring pins

| NodeMCU Pin | Devices |
|---|---|
| D3 | Sensor IR 1 |
| D5 | Sensor IR 2 |
| D7 | Sensor IR 3 |
| D4 | LED 1 |
| D6 | LED 2 |
| D8 | LED 3 |

### 2.1.2. Algorithm/Flow Diagram of the System

In the second stage, the software design process involves programming for the NodeMCU controller. The program will be created using the Arduino IDE application and downloaded to the node board via a USB cable. Fig. 4 illustrates the flow diagram of the system.

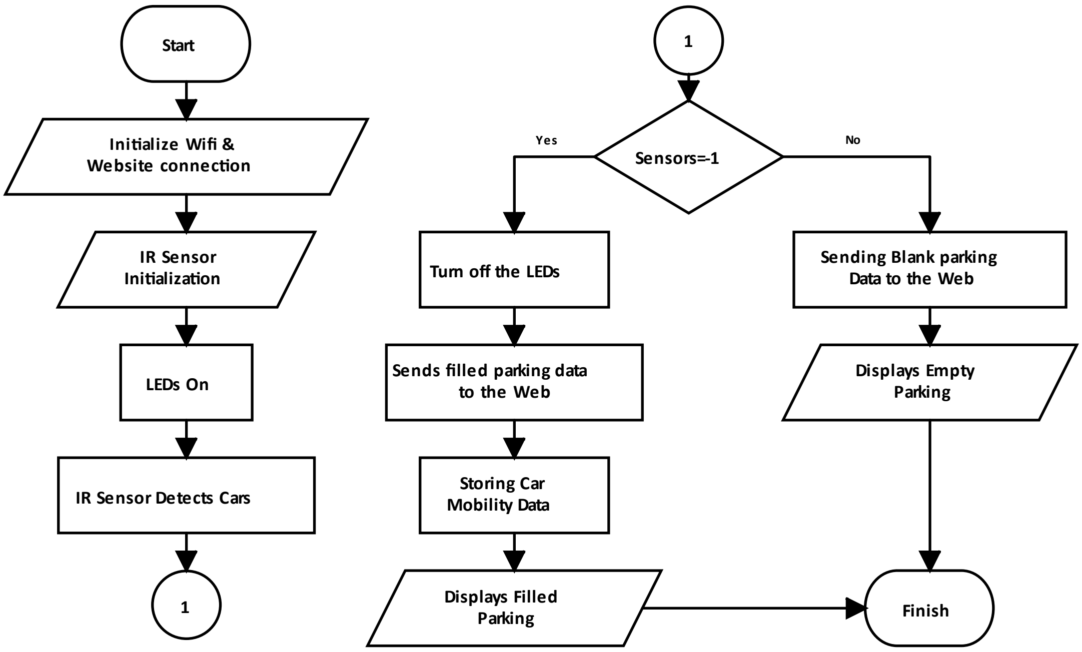



**Fig. 4.** System flow diagram

The flow diagram explains the working of one sensor, and the working of each sensor is the same. This system is a website-based system, and it needs to be connected to Wi-Fi first. Wi-Fi with an intranet connection will link the system to MySQL and PHPMyAdmin, Laragon, and Visual Studio Code as applications for creating and managing the parking system website. Besides accessing the intranet, NodeMCU also controls the IR sensor and the response from the LED. The LED lights up if the parking space is empty; otherwise, the LED will turn off if the parking space is occupied by a car. Additionally, the system can be monitored through the website, which has a specific bar to display the parking conditions.

## 2.2. Customer Interface

The customer interface consists of three bars. If the bar is green, the parking space is empty; otherwise, if the parking space is occupied, the bar will change to red. The layout of the intranet system block diagram can be seen in Fig. 5.

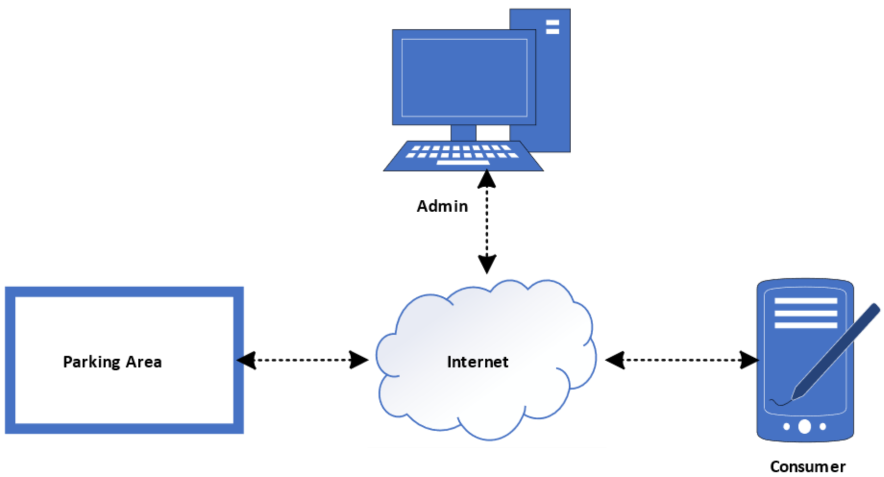



**Fig. 5.** Intranet system block diagram

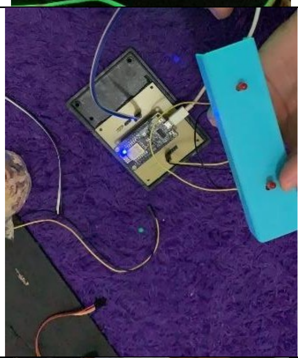
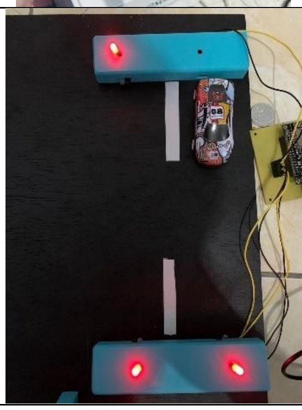
This parking system uses an intranet to connect parking conditions to the user's website, as shown in Fig. 5. Parking conditions are sent to the intranet, and the admin managing the parking system updates the parking conditions whenever changes occur. Subsequently, customers can view the parking conditions online. By connecting to the intranet, customers can monitor the parking conditions.

## 3. Results and Discussion

### 3.1. Hardware Testing

This research's parking system utilizes several components to support the functioning of the empty parking space detection device. Table 2 provides an explanation of the equipment used in this study.

**Table 2.** Equipment description

| No | Part | Description | Image |
|---|---|---|---|
| 1 | Mini system | Mini system in the form of a PCB that connects the MCU Node, 3 IR Sensors and 3 LEDs |  |
| 2 | Mini system and parking area barrier | The Mini system is connected to the Sensor and LED using a cable that is plugged in from the PCB according to the pin used |  |
| 3 | Parking gate | As one of the additional condiments for entering cars |   |
| 4 | LED condition is on (parking lot is empty) | If a parking space is not occupied by cars or is empty, the LED will light up |  |

The dimensions of the prototype hardware used in this research are shown in Table 3. The miniature used in the parking area gate is also equipped with a toy car as the parked car object.

**Table 3.** Equipment dimensions

| Description | Dimension (cm) | Payload |
|---|---|---|
| Flat square | 30×30 | All miniature parking condiments |
| Parking Barrier | 05×10 | IR sensor and LED |
| White border | 10 | Car Miniature |

Fig. 6 shows the overall picture of the tested parking miniature. The miniature has dimensions as described in Table 2. The miniature includes a parking area gate, and the miniature parking area is also equipped with a toy car as the parked car object.


**Fig. 6.** Prototype construction results

## 3.2. Software Testing

Fig. 7 displays the result of the program testing to verify whether the system can work properly by testing the sensor and observing the program's output through the serial monitor.

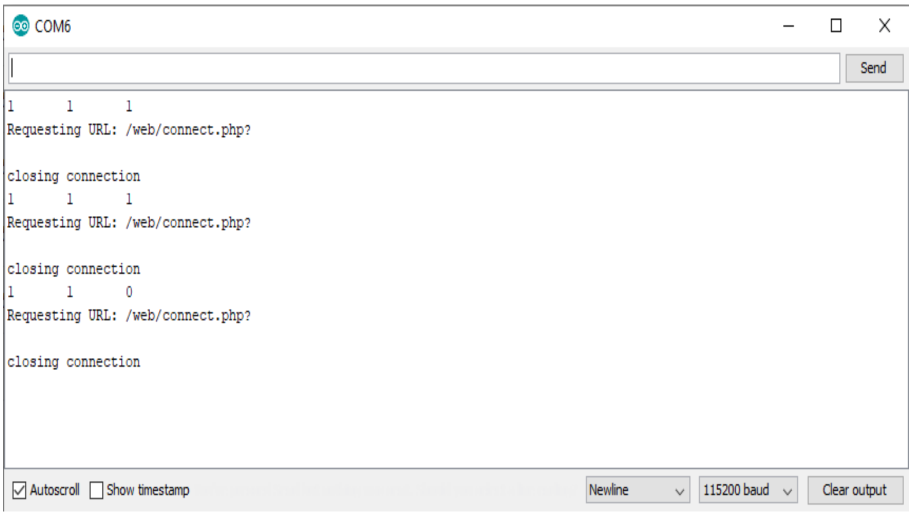



**Fig. 7.** Arduino serial monitor test

The software was also tested to assess the success of the created website. Fig. 8 shows the first test, where the system is tested for connectivity to the intranet to access the website.

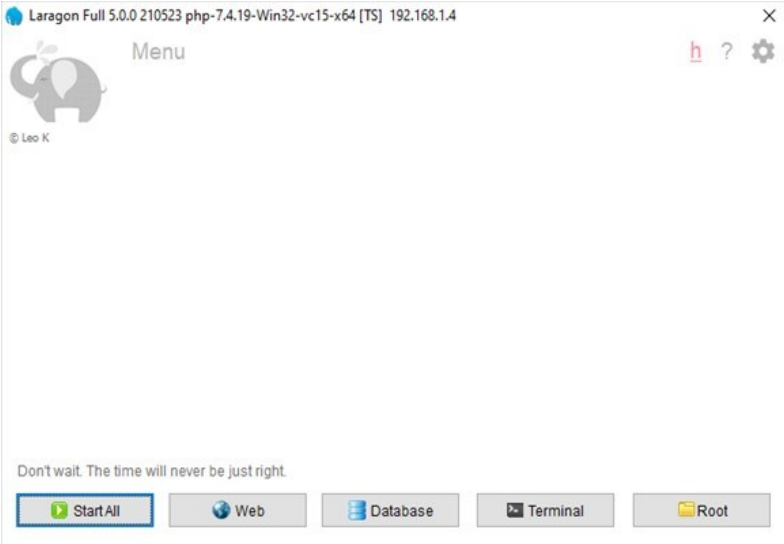



**Fig. 8.** Laragon testing

Fig. 9 represents the test to check whether the website successfully displays data to the user interface. The test is conducted to ensure that the website functions as intended, informing users about available parking spaces and providing information related to parking lot occupancy at specific times.

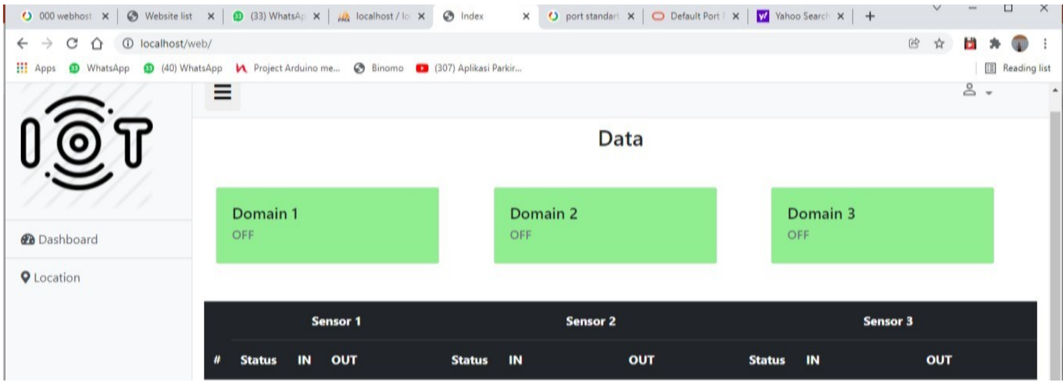



**Fig. 9.** Website display test

## 3.3. Measurement And Testing Data

### 3.1.1. IR Sensor Measurement

Table 4 provides information regarding the measurement of the IR sensor. The data was collected with the sensor placed at distances of 10 cm and 2 cm from the object. At a distance of 10 cm, the sensor can detect an object directly in front of it; otherwise, it may have difficulty detecting an object. The voltage measurement of the IR sensor showed a very slight difference of 0.2 volts.

**Table 4.** IR sensor measurement

| Component | Voltage measurement when not detecting | Voltage measurement when detecting | Sensor farthest measurement | Nearest sensor measurement |
|---|---|---|---|---|
| | Voltage (Volts) | | Length (Cm) | |
| Infrared sensors | 5.00 | 5.02 | 8 – 10 | 2 |

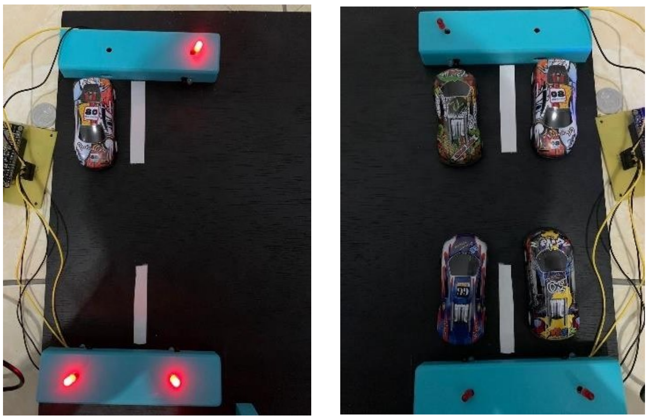
### 3.1.2. Sensor and LED Response Testing

Table 5 explains that the system has succeeded in each test condition. The LED lights up when the parking space is empty, represented by a value of 1. Conversely, the LED turns off when the parking space is occupied by a car, represented by a value of 0.

**Table 5.** Sensor and LED testing

| No | Condition | Parking 1 | | Parking 2 | | Parking 3 | | Description |
|---|---|---|---|---|---|---|---|---|
| | | Sensors 1 | LED 1 | Sensors 2 | LED 2 | Sensors 3 | LED 3 | |
| 1 | Empty Parking | Does not detect | 1 | Does not detect | 1 | Does not detect | 1 | Succeed |
| 2 | 1 Filled | Detect | 0 | Does not detect | 1 | Does not detect | 1 | Succeed |
| 3 | 2 Filled | Detect | 0 | Detect | 0 | Does not detect | 1 | Succeed |
| 4 | Fully Loaded | Detect | 0 | Detect | 0 | Detect | 0 | Succeed |
| 5 | Fully loaded | Does not detect | 1 | Detect | 0 | Detect | 0 | Succeed |

The LED response has been successful, even though the IR sensor has a delay of a few seconds. However, the system still functions properly. Besides the delay, the IR sensor has some drawbacks in detection, as it may sometimes detect objects other than cars, causing the LED to turn off even when there is no car in the parking space. The testing results can be seen in Fig. 10.



(a) (c)

**Fig. 10.** Sensor and LED testing (a) empty parking space and (b) occupied parking space

Table 6 describes the LED delay in detecting the presence of a car. The delay is caused by the data processing of the NodeMCU, as it also sends data to the website. Each testing condition for the parking system was conducted in a single experiment.

**Table 6.** LED delay testing

| No | Conditions | Delay LED 1 (second) | Delay LED 2 (second) | Delay LED 3 (second) |
|---|---|---|---|---|
| 1 | Empty parking to on | 3 | 7 | 5 |
| 2 | Parking on to Empty | 4 | 4 | 5 |

### 3.1.3. Wi-Fi Connectivity Testing

Fig. 11 displays the interface when the NodeMCU is being connected to the intranet, and a "requesting" message appears. If successful, a connection success message will be displayed, and the data sensor reception on the website can be started.

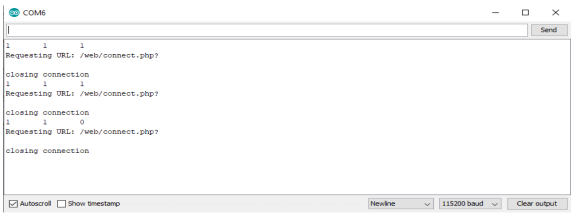



**Fig. 11.** Intranet connectivity testing

Wi-Fi connectivity testing was performed three times with different Wi-Fi connections, as shown in Table 7.

**Table 7.** Sensor and LED testing

| No | Wi-Fi | Time to connect to Intranet (second) |
|---|---|---|
| 1 | Kost bibit unggul | 10 |
| 2 | Juru gentong | 7 |
| 3 | Iphone | 15 |

Table 7 presents the results of the tests with different Wi-Fi connections. The Wi-Fi connection can affect the device's performance due to the speed of the Wi-Fi connection. The faster the Wi-Fi connection linked to the system, the better the performance of this parking system. Each Wi-Fi connection test was conducted once.

### 3.1.4. Website Testing Results

The testing results shown in Table 8 followed the sensor and LED experiments with five website experiments that provided information consistent with the sensor and LED testing, indicating that the sensor and LED testing were successful in achieving the research objectives. Bar 1, Bar 2, and Bar 3 represent the conditions of each parking space. The bars are green if the parking space is empty, and they turn red if the parking space is occupied. The website's domain functions similarly to the LED, providing indications of parking space conditions to potential users. With this website, users can monitor the availability of empty parking spaces in a parking lot. The testing results for this system can be seen in Table 8.

**Table 8.** Sensor and web testing

| No | Condition | Parking 1 | | Parking 2 | | Parking 3 | | Description |
|---|---|---|---|---|---|---|---|---|
| | | Sensors 1 | LED 1 | Sensors 2 | LED 2 | Sensors 3 | LED 3 | |
| 1 | Empty Parking | Does not detect | 1 | Does not detect | 1 | Does not detect | 1 | Succeed |
| 2 | 1 Filled | Detect | 0 | Does not detect | 1 | Does not detect | 1 | Succeed |
| 3 | 2 Filled | Detect | 0 | Detect | 0 | Does not detect | 1 | Succeed |
| 4 | Fully Loaded | Detect | 0 | Detect | 0 | Detect | 0 | Succeed |
| 5 | Fully loaded | Does not detect | 1 | Detect | 0 | Detect | 0 | Succeed |

The website testing can be considered highly successful. Website errors are usually caused by poor intranet connectivity and sensor data reading errors. In addition to providing parking space information, this system can also display the record of parked cars, storing the date and time of entry and exit in the web database so that someone can track the movement of a car entering and exiting the parking lot. If further developed, this system can be integrated with a parking payment system, allowing users to know the amount of fees incurred. The website testing results can be seen in Fig. 12.

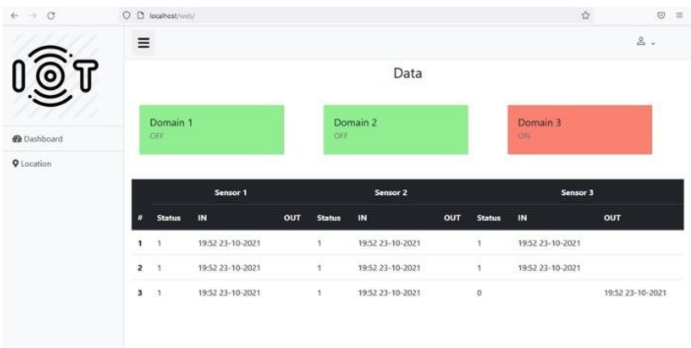


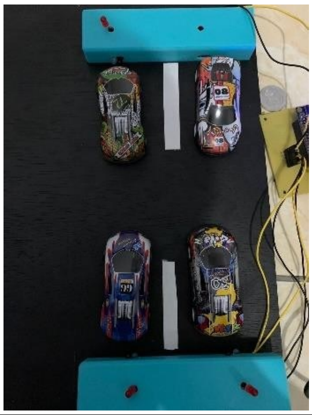
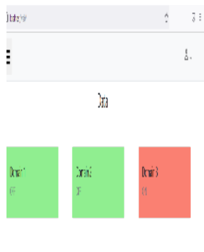

**Fig. 12.** Website testing

However, this parking system's website has the drawback of requiring constant refreshing to monitor the system. Every time a car enters or exits, the website needs to be refreshed to update the availability status of parking spaces.

### 3.1.5. Overall System Testing Results

The final testing is the overall system testing, focusing on the system outputs, namely the LED's on-off state and the website display. From the experiments in each subsection, it can be concluded that this system has functioned according to the research objectives. Table 9 explains the overall system testing results.

**Table 9.** Overall system testing

| No | Conditions | Description | Image |
|---|---|---|---|
| 1 | Sensor and LED Testing | Testing has been successful, system errors usually occur because the sensor detects objects outside the car |  |
| 2 | Sensor and Web Testing | Testing has been successful, normal web errors due to poor intranet connectivity, as well as sensor data that detects objects outside the car |  |

The web-based parking system with LED indicators has been proven to work according to the research objectives. The sensors can successfully detect the presence or absence of cars in parking spaces. When a car is present, the NodeMCU turns off the LED and sends an indication to the website with a red color bar, as well as records the parking time. When a car exits the parking space, NodeMCU turns on the LED, changes the bar color to green, and adds the time of car exit at the bottom of the website.

## 4. Conclusion

Based on the results and discussions presented earlier, it can be concluded that the previously troublesome parking management system, where car users were unaware of parking conditions, can be solved through the innovation of a web-based and LED parking system.

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