

Design and Realization of Parking System Prototype Using RFID Based Microcontroller with Reservation Service via Website for Four-wheel Vehicle

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ABSTRACT

Currently, parking management is implemented for four-wheel vehicles in the form of a barcode system printed on paper as identification of parking exits. This system has a weakness i.e. the barcodes are easily damaged or lost. A parking system using an RFID card as vehicle identification with a reservation service via the website is a solution to this problem. Infrared sensors are used to identify the presence of vehicles in the parking slot. Nodemcu is a microcontroller that is used as a central of RFID and infrared sensors processing and programmed using Arduino IDE. There are no special requirements to enter the parking area. The users are free whether they want to become members or not. Users are also free to make a reservation or not. A web application is designed using HTML, PHP, CSS, and JavaScript programming languages. The database utilizes MySQL and uses XAMPP as a server. Users can make reservations on the website while operators can see the display of vehicle identification results, reservation data, vehicle entry and exit history data, and parking fees. The website operator is accessed on a laptop and the user's website is accessed on a smartphone using a local network. Web applications can run properly according to the specified features. The RFID reader can read the card as well and the infrared sensors successfully detect the presence of a vehicle. The suggestions for the system that has been designed are to add features on the website to make it easier for operators and parking users and add a camera on the parking gate.

Keywords: *Parking, RFID, Reservation, Nodemcu, Website.*

1. INTRODUCTION

Every day humans do several activities that become their routine. To support the activities, humans need vehicles that will transport them from one place to another. Therefore, drivers need parking areas. Currently, the number of vehicle users is increasing every year. This condition is supported by the data from Badan Pusat Statistik (BPS) that show the number of vehicle users has been increased every year from 2015 to 2018 [1].

Parking management is applied to four-wheel vehicles by using a parking ticket when entering the parking gate. Then if they want to leave the parking area, they must queue up to check the ticket at the parking counter. Therefore, the queue sometimes becomes long and it takes a lot of time to leave the parking area due to the limitations of manual operator services. This system has a weakness i.e. there is no information on parking slots availability. The information system for the parking slots availability will help and save their time to find a parking space. So that

drivers can choose parking slots according to their wishes, a reservation system can also be applied.

The system that will be proposed in this study is a parking system for four-wheel vehicles using RFID based microcontroller with reservation service via the website. Reservation services can be made through the website. Parking users who already have an RFID card can only make a reservation. On the website, the administrator can see the display of vehicle identification results, reservation data, vehicle entry, and exit history data, and parking fees. By designing this system, it is expected to provide easiness and convenience for parking users.

2. LITERATURE REVIEW

Parking reservations have been discussed in [2] by making reservations on the website. Research [3] applied RFID (Radio Frequency Identification) technology to the parking gate using Arduino Uno as the controlling of the microcontroller. Research [4] applied RFID (Radio Frequency Identification) technology by

displaying information of empty parking slots on LCD. To detect vehicles in parking slots, infrared sensors and photodiodes are used and controlled by ATMEGA8535 microcontroller. Research [5] applied RFID (Radio Frequency Identification) technology as a tool to enter the parking area and controlled by Arduino Uno. LDR sensor is also used to detect and display the information of the available parking on LCD. A parking reservation system has also been discussed in [6] website-based. This research used an SMS gateway system with Gammu software as a confirmation when arriving at the parking area and leaving the parking area. In research [7], a parking system was created to display the availability of parking slots on the website and applied RFID (Radio Frequency Identifications) technology to the parking gate that is controlled by Arduino Uno and Wemos microcontrollers. In research [8], an RFID-based parking system with a PIC microcontroller to control the overall system was also made. In research [9], a web-based parking system was applied. Only registered operators can access the website and the operators will enter data of entry and exit vehicles on the website as well as data of vehicles that have lost their parking cards. In research [10], a website-based monitoring system for motorcycle parking was created. Infrared sensors are used to detect the presence of vehicles in parking slots and display information of parking slots availability on the website. In research [11], RFID was used as access to enter and exit the parking gate. Infrared sensors are also used to calculate the number of vehicles entering the parking area. In all systems, there are still shortcomings where the RFID parking system is not integrated with the web and provides reservation services.

3. METHODOLOGY

3.1. Block Diagram Design

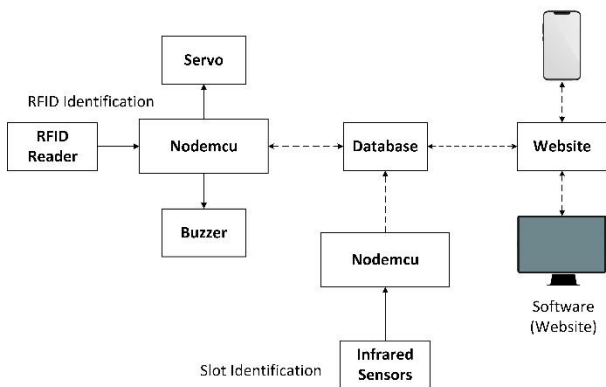


Figure 1 Block Diagram

Block diagram consists of two parts, namely hardware (RFID identification and slot identification) and software (web application). RFID is a system that used radio waves to transfer data [12]. It is used as access to enter and exit a parking gate. An RFID reader is connected to the nodemcu microcontroller. Nodemcu

is also connected with servo and buzzer. When the RFID card is brought near the RFID reader, the microcontroller will read the card number and send the data to the database using a local network and the card validation is carried out in the software section. If users have an RFID card, the buzzer sounds once. If users do not have an RFID card, the buzzer sounds 2 times. If the parking area is full, the buzzer sounds for 3 seconds. Next, for slot identification, the infrared sensor will detect the presence of the vehicle in the parking slot, the detection results are sent by a microcontroller to the parking database. The web application can be accessed through a laptop/computer or smartphone. The web is divided into two parts, namely for users and operators. The user part can make parking reservations only while the operator part will display the results of slot identification, reservation data, vehicle entry and exit history data, and parking costs for each vehicle.

3.2. Web System Design

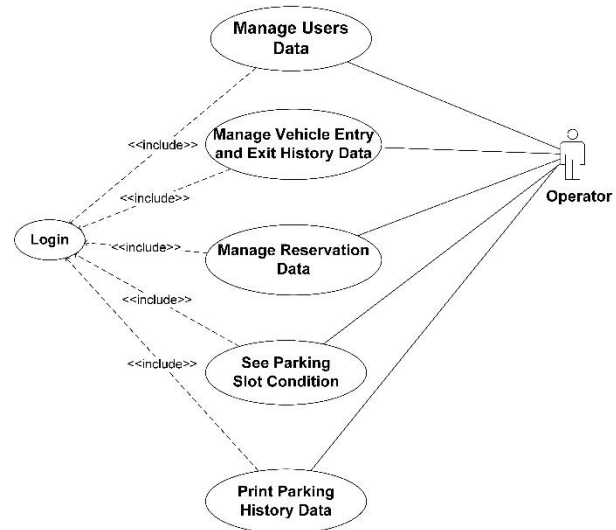


Figure 2 Operators Use Case Diagram

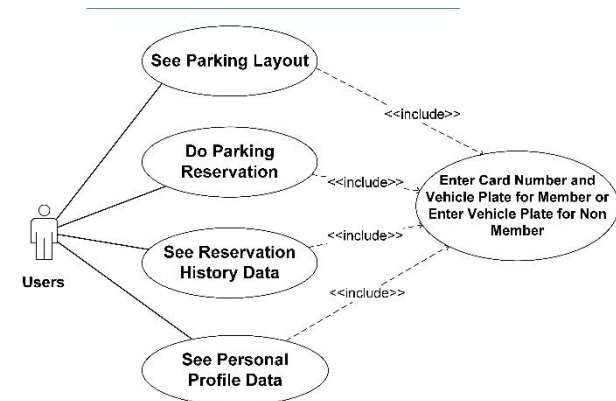


Figure 3 Users Use Case Diagram

A case diagram is a diagram that describes what functions can be performed by software and who has the right to use these functions [13]. In Figure 3, the operators have 5 main functions on the website. First, managing parking user data which consists of adding,

editing, and deleting users. Second, managing vehicle entry and exit history data which consists of viewing parking history, entering the vehicle registration plates, and displaying parking fees. Third, managing parking reservation data which consists of viewing reservation data and deleting reservation data. Fourth, managing the condition of the parking slots. Fifth, printing the parking history data. Next, the users have four main functions on the website; viewing the parking layout, making parking reservations, viewing the history of reservations, and viewing personal profile data.

3.3. Flowchart Design

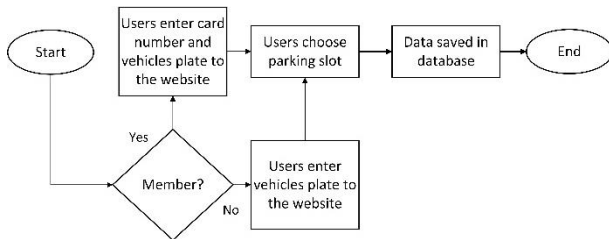


Figure 4 Reservation Flowchart

Figure 4 is a flowchart of the reservation process where the user will firstly access the website. If the users are members, they are required to enter the card number and the vehicle registration plate and if users are not members, they are required to enter the vehicle registration plate only. Then, they will be directed to the website page and the users can make a reservation. After that, the reservation data is saved to the database.

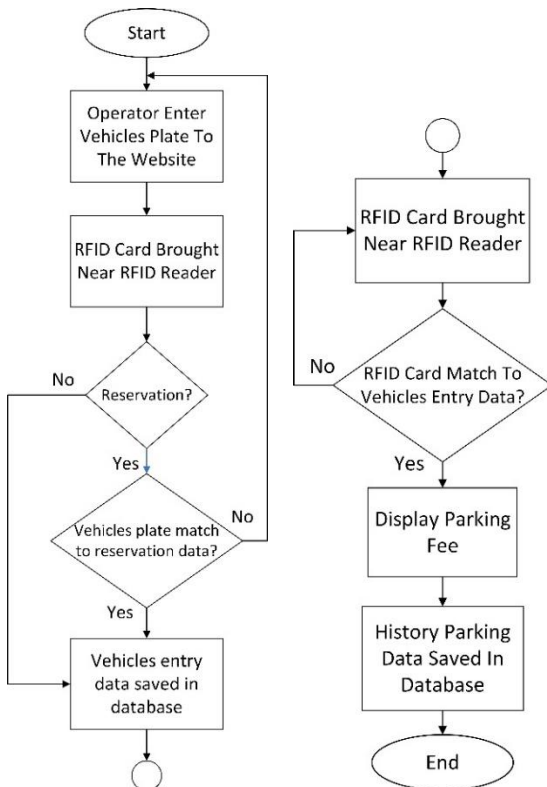


Figure 5 RFID Identification Flowchart

Figure 5 is a flowchart of the RFID card identification process when entering and exiting the parking lot. Operators are required to enter the vehicle registration plate then the users attach the card to the RFID reader. If the user has made a reservation, the vehicle registration plate will be checked whether it matches the reservation data. If it matches, the parking gate will open and the entry data are saved in the database. If the user has not made a reservation, the parking gate will open and entry data are saved in the database. Next, when the vehicle is about to leave the parking area, the RFID card is attached to the RFID reader and the microcontroller will read the data in the database whether the RFID card matches the data of the vehicle that has entered the parking area. If this is suitable, the vehicle parking fee will be displayed and the history of parking data are saved in the database.

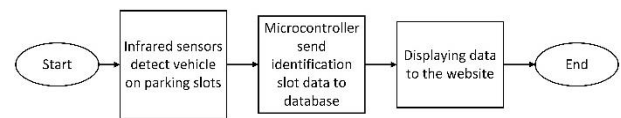


Figure 6 Slot Identification Flowchart

Figure 6 is a flowchart process showing slot condition information that explains the presence of a vehicle in a parking slot. First, the database will receive the infrared sensors detection data from the microcontroller. Then the data is displayed on the website.

4. RESULT

4.1. Wiring Diagram

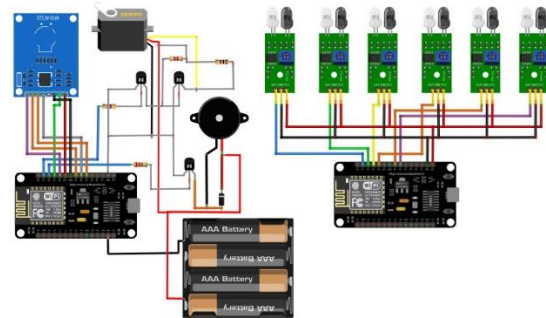


Figure 7 Wiring Diagram

Figure 7 is a wiring diagram of hardware. The components used are RFID Module Reader/Writer RC522 13,56 MHz, Infrared Barrier Obstacle Sensor FC-51, Nodemcu ESP8266 CP2102, Servo Motor SG90 9G, and Buzzer 5V.

4.2. Prototype System

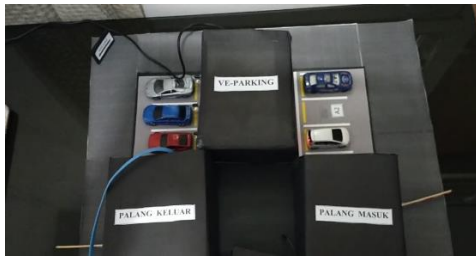


Figure 8 Prototype System

The prototype that has been made is 35 cm x 30 cm sized with 6 parking slots. Each parking slots are 4 cm x 7 cm sized and one infrared sensor are placed in each slot.

4.3. Manage Users Data



Figure 9 Registration Form

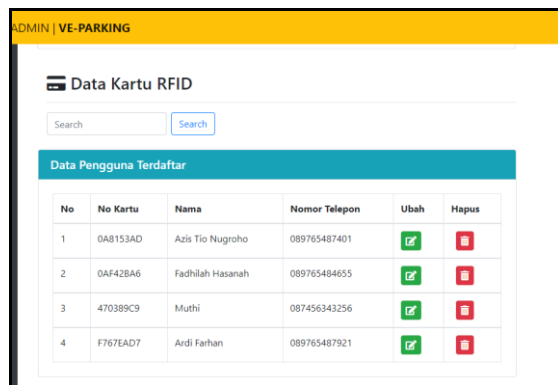


Figure 10 Member's Data

User's data management consists of adding new data, changing data, and deleting data. These activities can only be conducted by the operator. Data management do on the "Pendaftaran menu". When a new user wants to register, the operator clicks the "Pendaftaran menu" and then enters the data in the form shown in figure 6. The data entered is the card number, name, and telephone number. Data are already displayed on the web along with other data that have been previously entered.

4.4. Make a Reservation

Reservations are made by parking users. There are two types of users; members and non-members. The members are required to enter data on the card number and vehicle registration plate, while non-members are required to enter only the vehicle registration plate data. After that, they will be directed to the Home website menu. The Home menu displays the layout of the parking area that will be selected. After that, they click the Reservation menu. There is a form that the user must fill out. Operators can view the reservation data on the website. The operator clicks the Reservation Data menu to view the data.

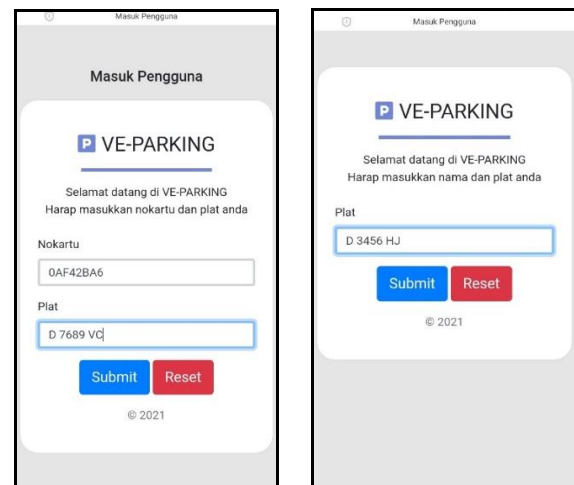


Figure 11 Users Enter Essential Data

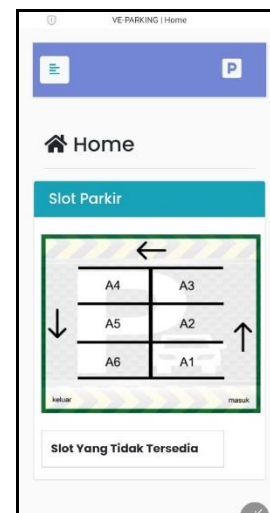


Figure 12 Home Users

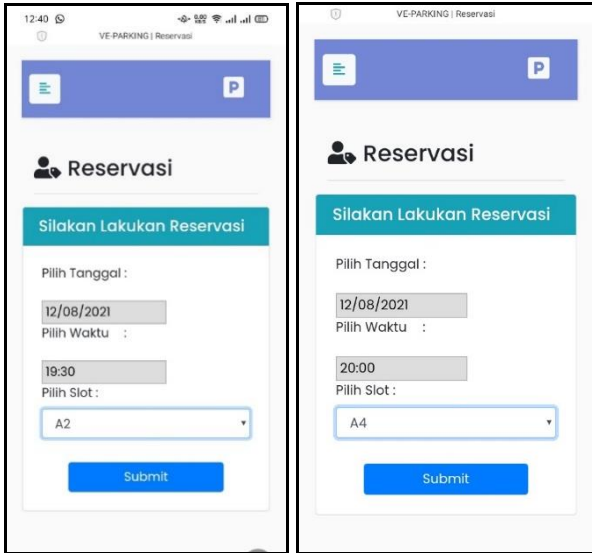


Figure 13 Do A Reservation

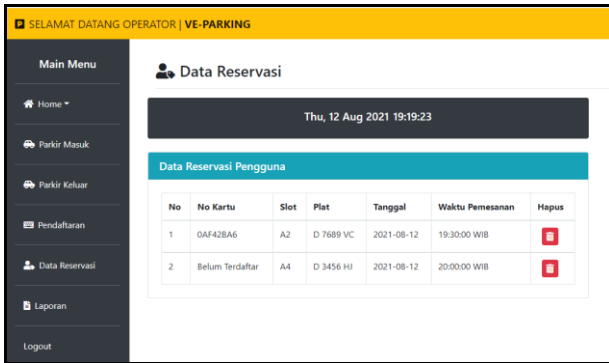


Figure 14 Do A Reservation

4.5. Entry Parking Gate

When a vehicle is arriving at the parking area, the operator clicks on the “Parkir Masuk” menu and enters the vehicle registration plate number.

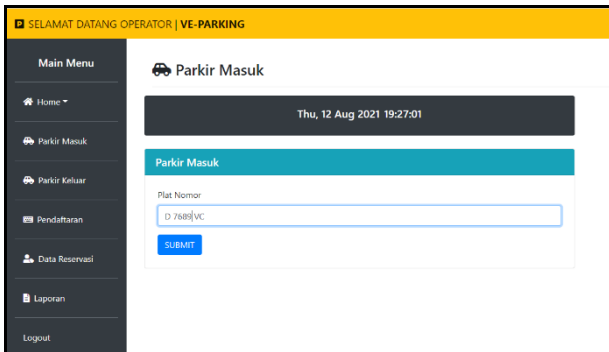


Figure 15 Enter Vehicle Plate To The Website

Then the users attach the RFID card to the RFID reader. If they are not members, the operator will provide a temporary card as entry access.



Figure 16 Scan RFID at Entry Parking Gate

After scanning the RFID card, the parking gate will open. The vehicle entry history data can be seen on the Home - Daftar Kendaraan menu. In addition, this menu displays the number of available slots.



Figure 17 Entry Parking Gate Opened

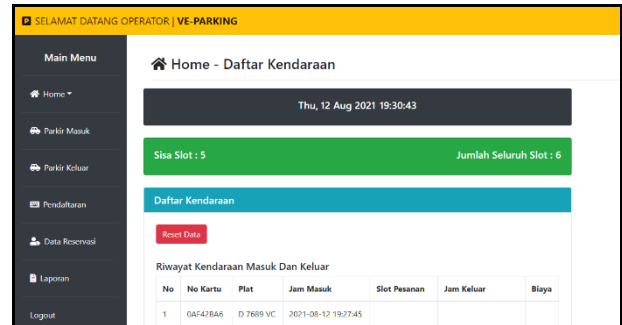


Figure 18 Home – Daftar Kendaraan Menu

4.6. Exit Parking Gate

When leaving the parking area, the users attach the RFID card to the RFID reader. The parking gate will open and the operator clicks the “Parkir Keluar” menu and then displays the parking fee.

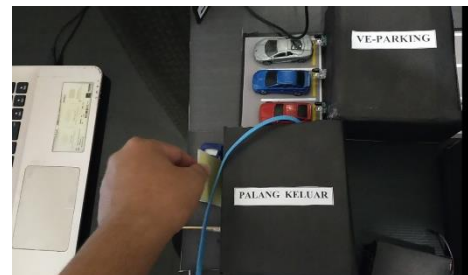


Figure 19 Scan RFID at Exit Parking Gate

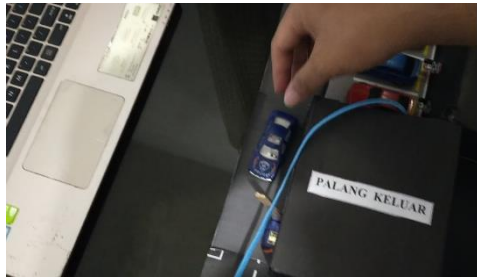


Figure 20 Exit Parking Gate Opened

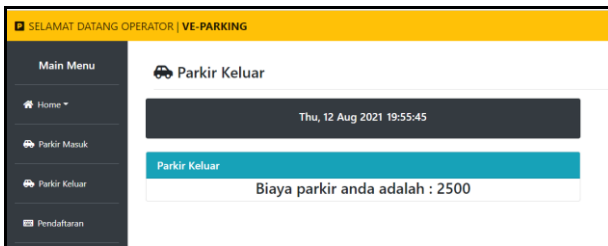


Figure 21 Display Parking Fee

4.7. Slot Identification

Slot identification data is displayed on the Home – Slot Parkir menu in real-time. The operator monitors the data to see the condition of the slots. Then, the operator checks the CCTV whether the vehicle is parked on the reserved slot. When there is a reserved slot, the condition of the slot will also change to be occupied.

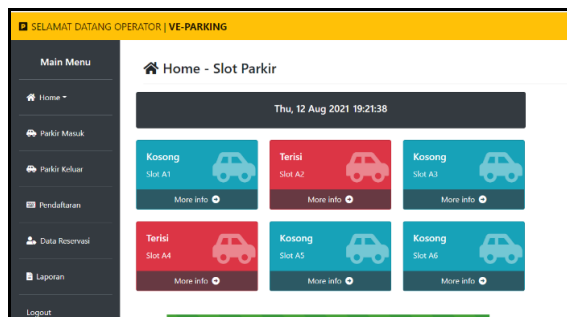


Figure 22 Condition When There Are 2 Slots Reserved

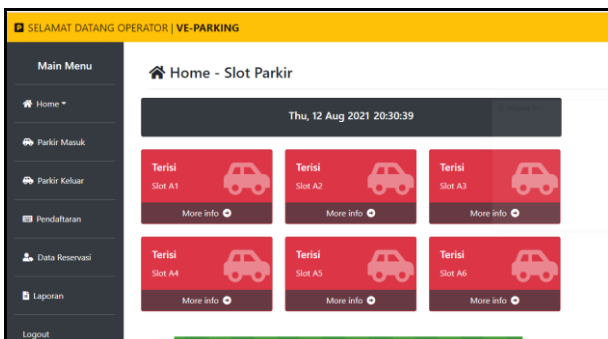


Figure 23 Figure 5 Condition When There Are All Slots Filled

5. CONCLUSION

RFID readers can read the card and the infrared sensors successfully detect the presence of a vehicle. In addition, nodemcu can send data in the form of parking slot conditions and card number data to the database when nodemcu and the server are connected to the same wifi. When sending the data, nodemcu already knows the destination of sending data using a URL. Then the users can make a reservation on the website. The web application can display the entry and exit history of vehicles, calculating and displaying vehicle parking fees, and displaying the condition of vehicles in the parking slots.

Future development can be made on the system to make a more practical system where operators do not need to check whether the vehicle is in accordance with the order manually. It is also necessary to add a camera to the parking gate. As well as providing compensation in the form of fines for parking users who do not fulfill their reservations.

ACKNOWLEDGMENTS

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REFERENCES

- [1] Badan-Pusat-Statistik, "Perkembangan Jumlah Kendaraan Bermotor Menurut Jenis," 2018. [Online]. Available: <https://www.bps.go.id/linkTableDinamis/view/id/1133>. [Accessed 6 3 2021].
- [2] G. I. Wilhamdika, I. M. A. Suyadnya and K. O. Saputra, "Rancang Bangun Sistem Reservasi Parkir Online Pada Pusat Perbelanjaan Di Kota Denpasar Berbasis Web," *SPEKTRUM*, vol. 6, no. 1, pp. 1-9, 2019.
- [3] W. A. Prasetyo, "Pengelolaan Sistem Parkir Dengan RFID Berbasis Arduino Uno," in *Sidang Fakultas Komunikasi dan Informatika Universitas Muhammadiyah Surakarta*, Surakarta, 2017.
- [4] A. Pranata, "Perancangan Prototipe Sistem Parkir Cerdas Berbasis Mikrokontroler ATMEGA8535," *Saintikom*, vol. 14, no. 2, pp. 131-140, 2015.
- [5] M. Agustin, "Desain Sistem Parkir Berbasis RFID," *JUPITER*, vol. 11, no. 1, pp. 21 - 28, 2019.
- [6] I. T. Pratama, G. A. Mutiara and D. R. Suchendra, "Sistem Reservasi Parkir Berbasis Web Di FIT (Fakultas Ilmu Terapan)," *e-Proceeding of Applied*

- Science*, vol. 3, no. 3, pp. 1855-1862, 2017.
- [7] D. Wicaksono, R. H. Hardyanto and P. W. Ciptadi, "Smart Parking Berbasis Web Di Universitas PGRI Yogyakarta," in *Seminar Nasional Dinamika Informatika 2020*, Yogyakarta, 2020.
- [8] S. Myint Naing and M. Oo Min, "Automated Multi-stored Car Parking System Using RFID," *American Scientific Research Journal for Engineering (ASRJETS)*, vol. 27, no. 1, pp. 65 - 81, 2016.
- [9] A. P. Kurniawan, "Efektifitas Sistem Informasi Parkir Berbasis Website Di Universitas Muhammadiyah Surakarta," *KomuniTi*, vol. 4, no. 1, pp. 1 - 8, 2012.
- [10] Efrizon, "Perancangan Sistem Monitoring Berbasis Web Pada Parkir Sepeda Motor," in *Seminar Nasional Teknologi Informasi, Komunikasi dan Industri (SNTIKI) 10, Fakultas Sains dan Teknologi, UIN Sultan Syarif Kasim Riau Pekanbaru*, Pekanbaru, 2018.
- [11] R. Soni, R. Malav, N. Sharma, S. Rahul and M. Navlakha, "RFID Based Automatic Car Parking System," *International Journal of Advanced Engineering, Management and Science*, vol. 2, no. 4, pp. 136 - 138, 2016.
- [12] A. Hayes, "Radio Frequency Identification (RFID)," 6 December 2020. [Online]. Available: <https://www.investopedia.com/terms/r/radio-frequency-identification-rfid.asp>. [Accessed 31 July 2021].
- [13] R. A.S and S. M, *Rekayasa Perangkat Lunak*, Bandung: Informatika, 2018.