Parking Management System Prototype Using Multiplatform Based NodeMCU

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***Abstract* – Currently, the parking management implemented in several public places has not been managed properly, resulting in a buildup of vehicles and it is difficult for many vehicles to find a parking space. The Maspul Jaya boarding house as an example has challenges in managing parking because there are a large number of residents with 60 rooms and a limited number of parking lots, which means residents often have difficulty getting a parking space in the boarding house area. This research aims to design a prototype parking management system using NodeMCU and RFID card technology as a replacement for room number stickers on Maspul Jaya Boarding House residents' vehicles with a multiplatform Android and iOS-based application connected to the network. The data obtained will be processed by the microcontroller and sent to the database server and then displayed in the application. The application testing method used is Blackbox and direct testing of the system hardware. The results of this research are that at the entrance gate, residents can enter through the parking barrier if the driver brings the vehicle close to the infrared proximity sensor, the RFID card is registered, the card status is active and the driver is not detected as being parked. When all conditions are met, the servo as the entrance parking gate will open, and the opposite condition will occur on the side of the exit gate. The maximum reading distance between the object and the sensor is 8 cm and RFID cards can be read at a maximum distance of 3 cm. Apart from that, the results of black box testing on the input-output of this application function well and are free from errors so that monitoring can be carried out via the application on data related to empty parking slots and the history of vehicles that have been parked using both the Android and iOS platforms. With this system, parking management at the Maspul Jaya boarding house will become more organized and efficient.**

Keywords: NodeMCU, RFID, Multiplatform, infrared proximality sensor

I. INTRODUCTION

Technological development has played an important role in various aspects of human life, and society's need for technological progress continues to be influenced by these developments. Automation systems, especially in the industrial world, have become a familiar thing, where equipment control is carried out automatically with the help of machines that have been programmed so that it becomes more practical[1]. One area that is experiencing rapid development in this regard is vehicle parking with the use of microcontroller technology which is currently developing and collaborated with other technologies such as Internet of Things (IoT) technology and Radio Frequency and Identification (RFID) technology [2][3]. Smart parking is an efficient solution in managing parking, especially in public places with many users such as shopping centers, hospitals, offices, hotels and boarding houses so that parking users and managers do not have difficulty finding and managing empty parking spaces[4][5][6].

The Maspul Jaya boarding house as an example has challenges in parking management because of the large number of residents with 60 rooms and limited parking. So far, parking management is still manual and irregular, causing residents to often have difficulty finding a parking space in the boarding house area. This research aims to design a prototype of a parking management system based on NodeMCU and RFID card technology which can be used as a verification medium as a replacement for room number stickers on each boarding house resident's vehicle. This system will allow residents to gain access to parking lots with the help of RFID cards and parking management will become easier, organized and efficient [7].

Research related to parking management has been carried out, including research [8] regarding a method for tracking empty parking slots, by embedding ultrasonic sensors in each slot to indicate the condition of the parking slot. The next research was conducted by [9] where infrared sensors are used to identify the

presence of vehicles in the parking slot. Furthermore, research conducted by [10] connecting an ultrasonic sensor to the NodeMCU then monitoring via the web in real time. Similar research continues to be developed as carried out by [11] which utilizes NodeMCU as the central controller and RFID as access which can be managed via the web.

Based on the problems and several reviews of related research, the author developed this by designing a parking management system for the Maspul Jaya boarding house using NodeMCU connected to Firebase by utilizing RFID tags as the ID for each boarding room number and the management is carried out by the boarding house keeper who can be directly accessed using the application which is multi-platform based, namely Android and IOS.

II. BASIC OF THEORY

A. Multiplatform

Multiplatform is computer software that can be run on various computing platforms. Multiplatform software is divided into two types, the first requires building itself or compiling for each supporting platform, and the second can be run directly on each platform without special preparation. Multiplatform is a statement for a program or application where the application can be run on more than one operating system, namely Windows, Android, Blackberry, macOS, Symbian, etc [12].

B. Flutter and Dart Programming Language

This framework is an opensource mobile framework created by Google. Which is used to build applications for both the Android operating system and the IOS operating system. Dart language is a programming language by Google which is a general-purpose language that can be used to develop various platforms including web, mobile server, and AOT. This language is also the standard language used by Flutter [13].

Figure 1. Flutter

C. NodeMCU ESP8266

NodeMCU ESP8266 as a microcontroller as a control tool. This tool consists of several parts that are connected to each other. Starting from the ultrasonic sensor measuring the water level then sending it to the microcontroller after which it is processed so that it can be accessed and displayed by the Android application as well as monitoring it in real time [5][14].

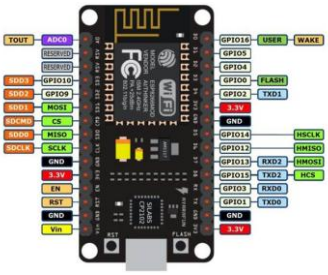

Figure 2. NodeMCU ESP8266

D. Infrared Proximity Sensor

he Infrared Proximity Sensor Module or better known as the Obstacle Detection Sensor for electronics technicians has a voltage characteristic of 5 volts dc which is the same as the microcontroller's voltage requirements so there is no need to make a special power supply or voltage source for this module, it just needs to be paralleled with the microcontroller's voltage source. When receiving data, this module uses infrared rays to detect objects or surfaces in front of it [11].

Figure 3. Infrared Proximity Sensor

E. RFID (Radio Frequency Identification)

RFID technology is an automatic system for capturing wireless data, which consists of two parts: tag (transponder) and reader. A tag is a silicon chip that contains information, usually a unique identification number, that can be read by an RFID reader via radio waves. Depending on the radio frequency and power source, the reader can pick up radio waves at a range of between three and thirty feet and read the digital information stored on the chip [15][16].

Figure 4. RFID Reader

F. Servo Motor

A servo motor is a motor with a closed feedback system where the position of the motor will be informed back to the control circuit in the servo motor. This motor consists of a motor, a series of gears, a potentiometer and a control circuit. The potentiometer functions to determine the angle limit of servo rotation. Meanwhile, the angle of the servo motor axis is set based on the width of the pulse sent via the signal leg of the motor cable [17].

III. METHOD AND DESIGN

The methods used in this research include system analysis, system design with two stages, namely the hardware design stage and the software design stage, the final stage of system testing using the black box technique testing method to find out whether the function of the system being built is as expected.

The components used in the hardware are NodeMCU esp8266 (1 piece), infrared proximity sensor (2 pieces), RFID tag (2 pieces), servo motor (2 pieces). For software components, use Ardunino Software, Visual Studio Code software for building Android and iOS applications with the Flutter framework.

This Parking Management System uses ESP8266 as a central controller which is connected directly via the internet network and smartphone. The NODEMCU esp8266 is the main microcontroller to control the sensors that will run, such as the infrared proximity sensor which functions as a reader when there is a vehicle at the parking gate, the Servo motor which functions as the gate for entering and exiting the parking lot, the RFID reader as an RFID tag identification system which Utilizing radio waves, an RFID tag is a device that is attached to an object that will be identified by an RFID reader. All data is stored in Firebase and can then be accessed on a smartphone. Smartphones also function here to manage boarding house resident data, active and inactive status of boarding house resident tag cards. More details can be seen in Figure 5.

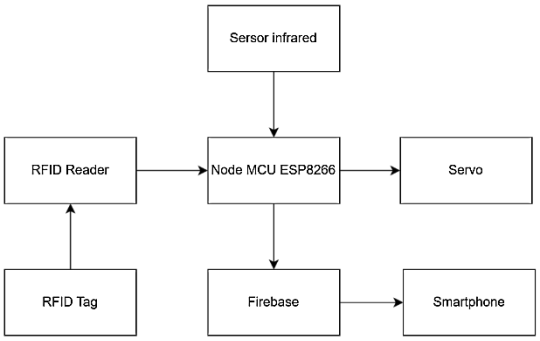

Figure 5. System block diagram

The description of the working process of the designed tool is shown in the form of a flowchart as in Figure 6. This Parking Management System starts from the NodeMCU as the central controller which then reads the Infrared sensors at the entrance or exit gates and then the RFID reader reads the ID on the RFID card. then check whether the ID has been registered in the database or not. If it has been registered, the servo as a parking barrier will open and the tagged ID will be registered in the database. Meanwhile, an overview of the flowchart of the application for parking management design can be seen in Figure 7.

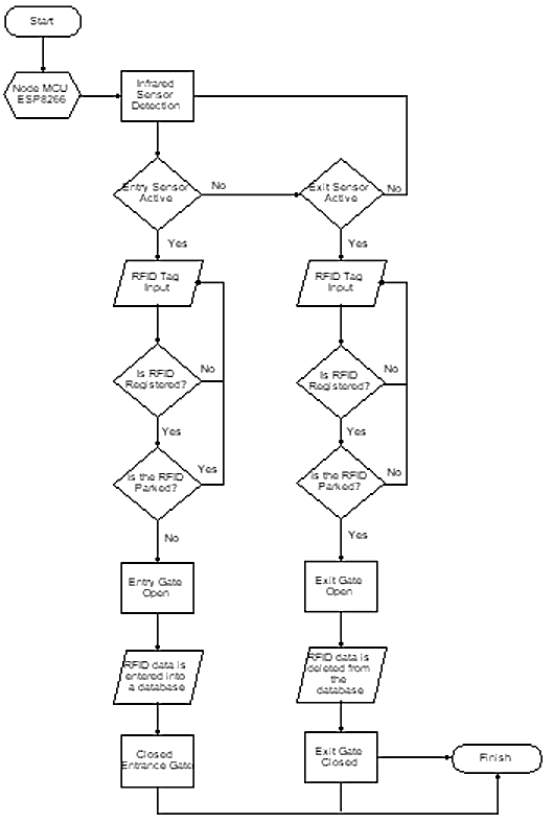

Figure 6. Parking Management System Flowchart

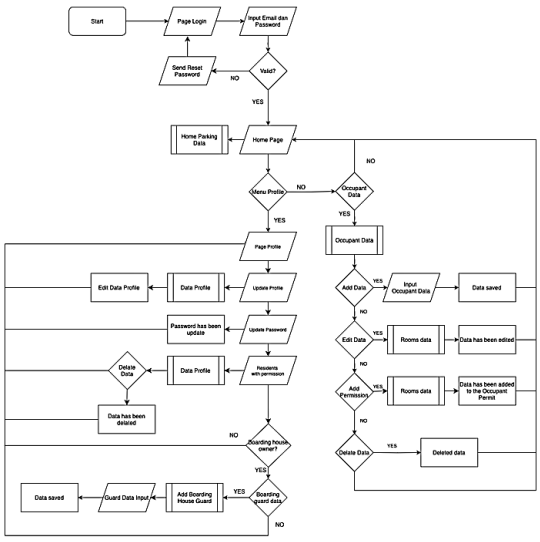

Figure 7. Parking Management Application Flowchart

In this application there are two roles, namely boarding house keeper and boarding house owner as admin, as a boarding house owner you can add boarding house keeper to log in to the application, in this application there is a home display that displays various data, this application can also add boarding house residents while registering an RFID ID card which is used to enter the parking gate and add data on boarding house residents who want permission to leave.

IV. RESULTS AND DISCUSSION

A. Circuit of Parking Management System

This parking management circuit consists of RFID tags. RFID reader, Infrared Sensor, Servo NodeMcu 8266 found at the entry and exit gates and their respective roles as seen in Figure 8.

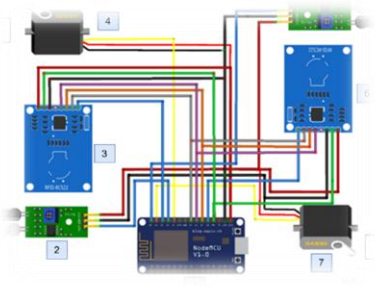

Figure 8. Circuit of Parking Management system

An explanation of each component in Figure 8 is as follows:

1. ESP8266 as a control center and module that is connected to applications via the internet.
2. Infrared proximity sensor to detect car or motorbike objects when you want to enter.
3. RFID tag as an RFID card detector to get the ID on the card.
4. Servo motor as a parking barrier that will open if certain conditions are met.
5. For the exit gate, there is also an infrared proximity sensor to detect car or motorbike objects when you want to leave.
6. For the exit gate, there is also an RFID tag as an RFID card detector to get the ID on the card.
7. For the exit gate, there is also a Servo motor as a parking barrier which will open if certain conditions are met.

B. Parking Management Application

In this circuit of parking management applications, there are several displays, namely the login page, forgotten password page, home page, list of residents currently parking, registered residents page, residents data edit page, add boarding house residents who want permission page, boarding boarders add page. , profile page, profile update page, page to change the login password, page for adding boarding house guards, page for listing boarding house owners who have been given permission, page for opening and closing the parking gate manual. Some results from a series of applications can be seen in Figure 9.

Figure 9. Parking Management Application

C. System Testing

Testing is carried out in 2 ways, namely Prototype Tool testing (hardware) and application testing (software).

1. Prototype Testing

The first test, namely testing on the infrared sensor, was carried out to determine the function of the infrared sensor for detecting objects at the entrance and exit gates. Whether the sensor is functioning or not can be observed using the serial monitor in the Arduino IDE software. Infrared sensors generally read objects at a distance of 2-30 cm (adjusted with a potentiometer). In this test the potentiometer on the infrared sensor is set to normal conditions. If the output value is 0 then there are objects detected and if the value is 1 then no objects are detected. The test results can be seen in Table 1 below:

Table 1. Infrared Sensor Test Results

Trials	Distance Between Sensors to Object	Information
1	0-2 cm	Detect
2	2-4 cm	Detect
3	4-6 cm	Detect
4	6-8 cm	Detect
5	> 8 cm	Not Detected

Next, testing the servo motor circuit aims to determine the condition of the gate when the servo motor opens and the servo motor closes, which can be seen in Table 2 below:

Table 2. Servo Motor Test Results

No.	Gate Condition	Motor Servo (°) (angle)	Information
1.	Open	Rotates 90° Counterclockwise	Success
2.	Close	Rotates 90° Clockwise	Success

Next, the RFID Reader test aims to determine the RFID reader reading of the RFID card, namely in the form of output on the serial monitor as in Figure 10.

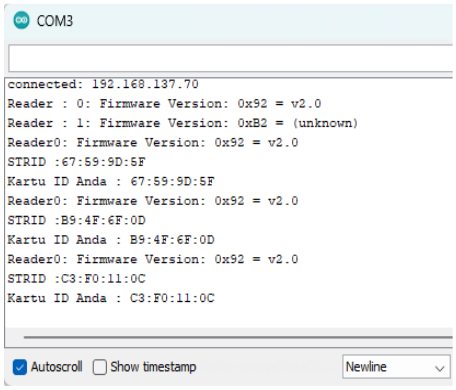

Figure10. Serial output RFID reader

After all device testing is complete and meets expectations, Prototype Testing is carried out on the Parking Management System Entrance Gate Using NodeMCU which has been designed and created previously. In this test we will carry out tests on the IR Sensor, registered RFID, RFID Status and parked drivers for the entrance gate as in Figure 11 with the test scenario as in Table 3 below.

Table 3 Prototype Testing at Entrance Gate

Testing Scenarios				
Sensor infrared	Registered RFID card	RFID Card Status	RFID card in the parking lot	Results
Object Detected	Registered on the database	Active	Not parked yet	Open Servo
No Object Detected	Registered on the database	Active	Not parked yet	Servo Not Open
Object Detected	Registered on the database	Active	Parked	Servo Not Open
No Object Detected	Registered on the database	Active	Parked	Servo Not Open
Object Detected	Registered on the database	Not Active	Parked	Servo Not Open
No Object Detected	Registered on the database	Not Active	Not parked yet	Servo Not Open
Object Detected	not registered in the database	Not Active	Not parked yet	Servo Not Open
No Object Detected	not registered in the database	Not Active	Not parked yet	Servo Not Open

Based on table 3, boarding house residents can enter through the parking barrier by bringing the vehicle closer to the infrared proximity sensor, a registered RFID card and the status on the card, namely active and the driver is not temporarily parked.

Next, Prototype Testing at the Exit Gate of the Parking Management System Using NodeMCU which has been designed and created previously. In this test we will carry out tests on the IR Sensor and parked drivers at the exit gate as in Figure 12 with the test scenario as in Table 4 below.

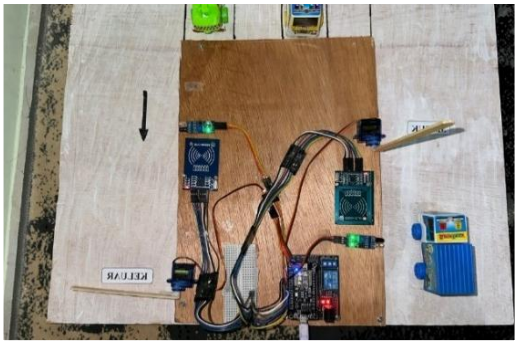

Figure 11. Prototype Testing at the Entrance Gate

Based on table 4, boarding house residents can exit through the parking barrier, at the exit gate if the infrared sensor detects an object and when the boarding house resident taps the card with the card while it is parked, the servo as the parking gate will open.

Table 4 Prototype Testing at Exit Gate

Testing Scenarios		Results
Sensor infrared	RFID card Status	
Detected object on the sensor	Boarding house residents' cards are not allowed while parking	Servo Will Open
Detected object on the sensor	Boarding house residents' cards are not allowed while parking	Servo is not open
No object detected on the sensor	Boarding house residents' cards are not allowed while parking	Servo is not open
No object detected on the sensor	Boarding house residents' cards are not allowed while parking	Servo is not open

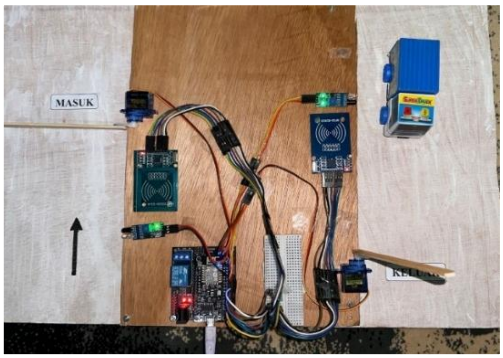

Figure 12. Prototype Testing on Exit Gate

2. Application Testing

Testing this application uses the black box method, namely to find out whether each function in the application can function properly and is free from

errors [18]. The form of testing is by visiting one by one the pages in the application and testing whether the data has been sent or not. The following is the appearance of the application when testing using the Android platform as seen in Figure 13, while the test display on the iOS platform is seen in Figure 14. The overall test results can be seen in Table 6.

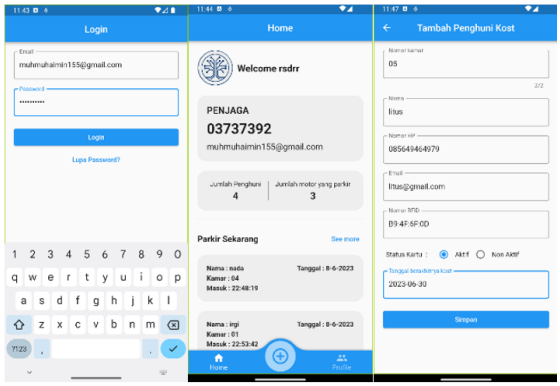

Figure 13. Display of the Android Platform

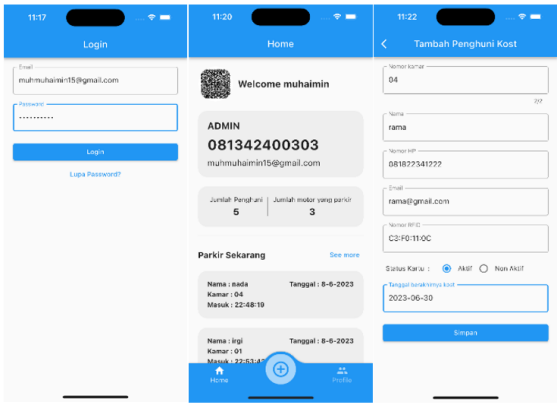

Figure 14. Display of the iOS Platform

In this system application, it does not display empty parking slots as in research [7][19][20] but can only monitor vehicles according to RFID tag data registered in the database, which means that the parking lot at the boarding house has been arranged to place vehicles according to the RFID data registered in the database. This is different from research [5] which uses a QR Code to detect parking users.

Based on the results of black box testing carried out on the application, it was concluded that all input output functionalities of this multiplatform based parking management system can function well and as expected and are free from errors.

Table 6. Application Testing

Testing	Result	Information
Enter the email and password of the boarding house owner or boarding house keeper	√	Successfully entered the home page
Enter the email of the boarding house owner or boarding house keeper	√	Successfully sent the password reset link to email
Enter room number, name, cellphone number, email, RFID number, card status and boarding end date	√	Successfully added boarding house residents
Change one of the data that has been input.	√	Data updated successfully
Add resident data	√	Data added successfully
Deleting resident data	√	Data deleted successfully
Enter the cellphone number, name, email or profile photo you want to change	√	Profile changed successfully
Enter the old password and the new password	√	Password changed successfully
Add the boarding house keeper's cellphone number, name and email	√	oarding house keeper data successfully added
Enter the condition of the bar you want to open or close	√	The bar has been successfully opened or closed
Select one of the data that has been listed as permission to delete residents	√	Successfully Erasing Data

V. CONCLUSION

After testing the parking management system prototype using a multiplatform-based NodeMCU, it can be concluded that at the entrance gate, occupants can enter through the parking barrier if the driver brings the vehicle close to the infrared proximality sensor, the RFID card is registered, the card status is active and the driver is not detected as being parked. When all conditions are met, the servo as the entrance parking gate will open, and the opposite condition will occur on the side of the exit gate. The maximum reading distance between the object and the sensor is 8 cm and RFID cards can be read at a maximum distance of 3 cm. Apart from that, the results of the black box testing on this application function well and are free from errors so that monitoring can be carried out via the application on data related to empty parking slots and the history of vehicles that have been parked using both the Android and iOS platforms. With this system, parking management at the Maspul Jaya boarding house will become more organized and efficient. The weakness of this research is that there is no validation system for boarding house residents, so it is possible for it to be misused by other

people. Apart from that, to make it safer and minimize vehicle theft at boarding houses, perhaps a security system such as finger printing can be added. Applications can be developed in terms of appearance to make them more attractive.

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