Article

Development of Smart Parking Systems using RFID Sensors for Online Verification in Different Areas

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Abstract:
This research aims to develop an intelligent parking system with online authentication in different areas using RFID sensors and to confirm the development results of the system through functional tests. This research is research and development (R&D) using a prototype model. The data were then analyzed using qualitative descriptive analysis techniques. The result of this study is an intelligent parking system that uses RFID sensors for online authentication in different areas, and the test results show that the average card authentication time at parking portals in different areas is 2.3 seconds. Based on the test results, the resulting smart parking system using RFID sensors for online verification in different areas can work as expected.

Keywords: Online Verification, Firebase, RFID Sensor, Functionality, Smart Parking

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1. INTRODUCTION

As time passes, people will continue striving to improve their quality of life and productivity. The technologies that support them continue to evolve and become more advanced. (Rachmaniar & Lamada, 2018) Higher scientific developments also influence more sophisticated technological applications. Technological developments naturally impact people's lives on land, in the air, and at sea. Everyone needs unlimited space to meet life's needs, such as time efficiency and ease of processing. A two-wheeled or four-wheeled vehicle is one of the pillars of life dynamics effectiveness and efficiency. Parking portal systems are familiar to us in our lives today. The presence of parking portals makes parking facilities more organized and safer. Automated technology and intelligent systems are being developed to meet human needs. One of them is the transport area for the safety and convenience of a special parking system. The weakness of the current parking portal system is a non-online database, so his RFID tag cannot be used at parking portals in different regions, preventing a customer from traveling with the same ID card.

The parking system shortage solution is to develop an intelligent parking system with RFID sensors for online authentication in different areas and use RFID sensors to verify online ID data for open portal parking systems in

different areas. We are implementing it using an ESP32 as a microcontroller and using Firebase for database storage. A customer card allows you to open a parking portal in another area. By applying online customer ID data, Firebase can recognize customer ID data until it finds it, and the ESP32 microcontroller reads it until the parking portal starts running.

2. THEORY

A. The Component used for Smart Parking

The parking system is developing rapidly, as evidenced by the fact that parking systems are very efficient in big cities in Indonesia. (Zain et al., 2017) Smart parking is part of the Internet using sensors communicating remotely and exchanging information using communication protocols. Smart parking helps drivers find open parking spaces and keeps their vehicles safe. According to (Maulana, 2020), the Firebase Real-time Database is a real-time database stored in the cloud that supports various platforms such as Android, iOS, and the web. Firebase data is stored in a JSON (JavaScript Object Notation) structure. The Firebase database is automatically synced with the client apps you connect to. Cross-platform apps using the Android SDK, iOS, and JavaScript automatically get the latest data updates when your app connects to Firebase servers.

A microcontroller is a computer without a human interface such as a monitor, keyboard, or mouse. The essential parts of a microcontroller chip are the processor, memory (ROM and RAM), input/output devices, and extensions (internal and external) such as analog-to-digital converters (ADCs) and digital-to-analog converters. (Ida Rachmaniar Sahali et al., 2018).

The ESP32 is a microcontroller introduced by Espressif System, the successor to the ESP8266 microcontroller (M.Tiga, 2021 & P.D.P.Adi, 2022). This microcontroller already has a WiFi module installed on the chip, which is very helpful for creating IoT application systems. It can also be used as an input or output to drive LCD screens, lamps, and DC motors. (Muliadi et al., 2020). According to (Onibala et al., 2015), RFID (Radio Frequency Identification) is a technology for identifying objects by combining the high-frequency portion of the electromagnetic spectrum with electromagnetic or capacitive coupling. An RFID system, tag, or transmitter is usually attached to the object. Each carrier label may contain unique information, such as the item's serial number, model, color, and location. When this tag passes through a field created by a compatible RFID reader, the information contained in the tag is sent to his RFID reader for the object identification process.

A micro-servo is a motor with a closed feedback system that sends the motor's position to the servo control circuit (Prasetyo, 2017). This servo later drives the opening and closing of the parking portal. The Arduino IDE (Integrated Development Environment) is the software used to program the Arduino and upload it to the Arduino board. The Arduino IDE is also called a text editor because it allows users to edit, build and verify program code using the source code.ino file extension. (Kumara, 2019).

3. METHOD

A. System Design

The system Design/architecture in Figure 1 shows the intelligent parking system we are designing. This innovative parking system uses ESP32, Firebase, RFID, and Parking Portal technologies. When the driver attaches the card to the RFID reader, ESP32 matches the ID on the driver card with ID data in Firebase, and if the driver ID matches any data in Firebase, ESP32 commands the parking portal to be open. In addition to describing the architecture, when a customer registers a card for the first time via an Android application, records the customer's card ID data, and stores the ID data in Firebase, the card registration phase collects the customer's name, email address, and after scanning your nim. The card RFID sensor and card ID data were retrieved and stored in the database. Instructions for registering a customer card for the smart parking system. It will be saved in the database later. First, enter your name, email address, nim, scan the card with an RFID sensor to get the card's ID, and store it in an online database.

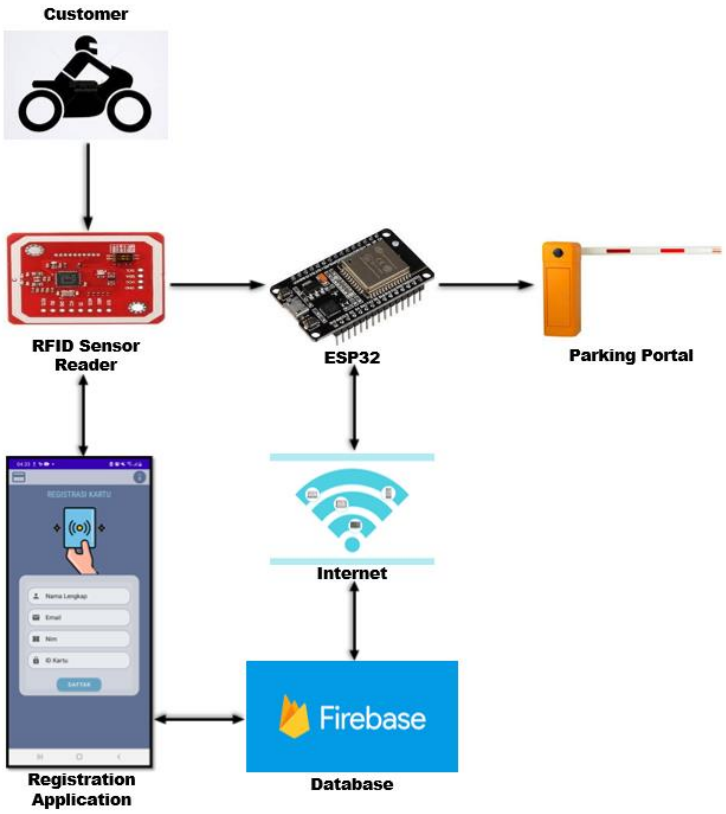
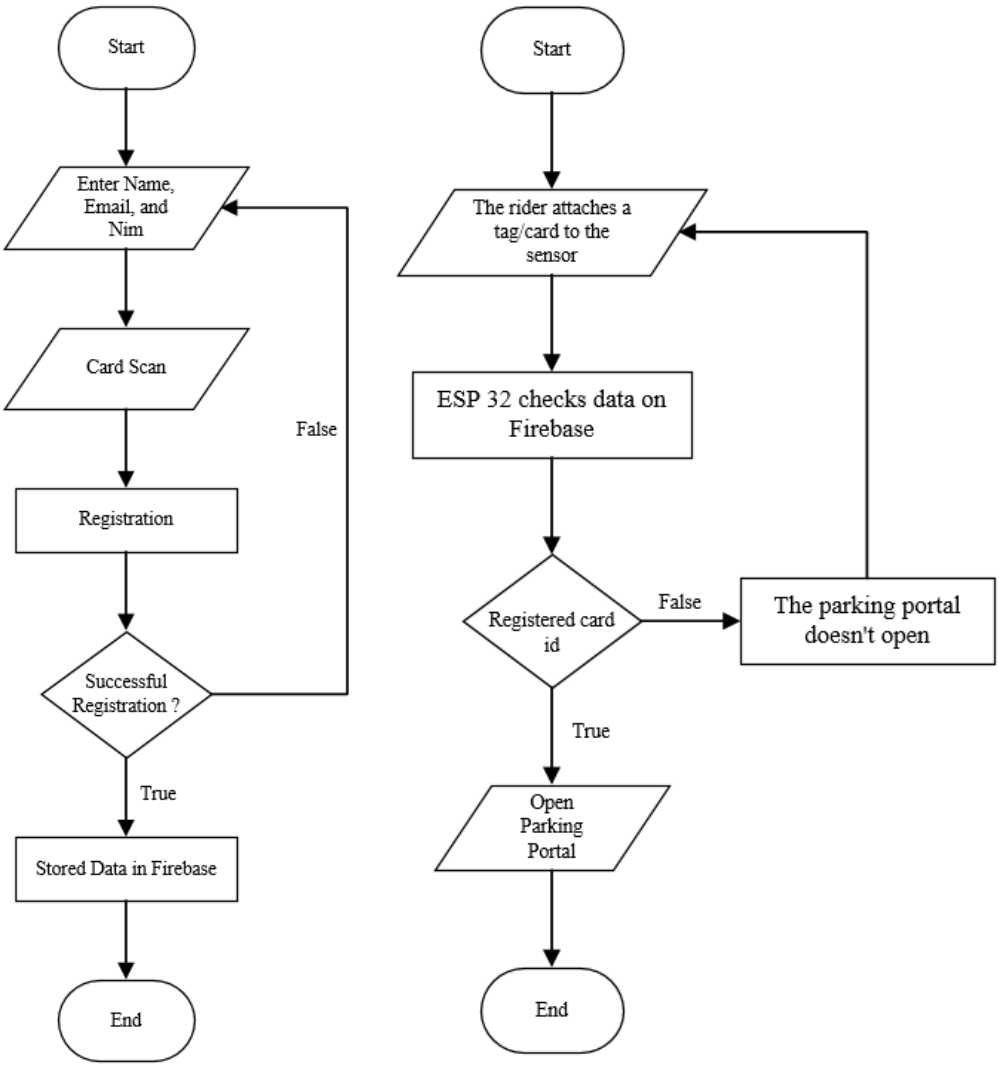


Figure 1. System Design



(a) (b)

Figure 2. (a) Card registration flowchart, (b) Work flowchart of Parking Portal for Online Verification

Here's how the portal parking system works: First, when a customer attaches a card to the RFID reader sensor, ESP32 matches the driver's card ID with existing ID data on Firebase, and if the driver's card ID matches any data on Firebase, ESP32 Inform that the portal is open and customers are welcome.

4. RESULT AND DISCUSSION

Perform tool testing based on the intelligent parking system tool design created. The collected data is in the form of customer card registration tests using RFID sensors and verification time tests for opening portals in different areas.

Figure 3. Prototype Results

Test card enrollment in your application. This card enrollment test begins by entering your name, email address, and NIM. After that, if the customer attaches the card to the RFID sensor and successfully acquires the card ID, the card registration is successful. Table 1 is a test table for registering card IDs in an online database.

Table 1. Customer registration test results in the application

No	Customer	Card Scans		Description
		Enroll	Get Id	
1	User 1	Succeed	Succeed	successful registration
2	User 2	Succeed	Succeed	successful registration
3	User 3	Succeed	Succeed	successful registration
4	User 4	Succeed	Succeed	successful registration
5	User 5	Succeed	Succeed	successful registration
6	User 6	Succeed	Succeed	successful registration
7	User 7	Succeed	Succeed	successful registration
8	User 8	Succeed	Succeed	successful registration
9	User 9	Succeed	Succeed	successful registration
10	User 10	Succeed	Succeed	successful registration
11	User 11	Succeed	Succeed	successful registration

No	Customer	Card Scans		Description
		Enroll	Get Id	
12	User 12	Succeed	Succeed	successful registration
13	User 13	Succeed	Succeed	successful registration
14	User 14	Succeed	Succeed	successful registration
15	User 15	Succeed	Succeed	successful registration
16	User 16	Succeed	Succeed	successful registration
17	User 17	Succeed	Succeed	successful registration
18	User 18	Succeed	Succeed	successful registration
19	User 19	Succeed	Succeed	successful registration
20	User 20	Succeed	Succeed	successful registration

Suppose the customer wants to use the card in another area portal that is registered in the database. In that case, it will test the recognition of the customer card ID which is validated in another area parking portal, and if the card is successfully validated, the parking portal will open. In Table 2, this test aims to average the results of enrolled cards so that they can be validated in different portal areas.

Table 2. Test Results for Customer Card Detection for Online Verification.

No	Customer	verification time	Status	Parking Portal
1	User 1	4,5 second	verified	open
2	User 2	0,7 second	verified	open
3	User 3	0,1 second	verified	open
4	User 4	1,4 second	verified	open
5	User 5	0,2 second	verified	open
6	User 6	1,9 second	verified	open
7	User 7	4,3 second	verified	open
8	User 8	0,9 second	verified	open
9	User 9	3,6 second	verified	open
10	User 10	3,1 second	verified	open
11	User 11	1,4 second	verified	open
12	User 12	1,7 second	verified	open
13	User 13	1,2 second	verified	open
14	User 14	1,9 second	verified	open

No	Customer	verification time	Status	Parking Portal
15	User 15	1,9 second	verified	open
16	User 16	1,5 second	verified	open
17	User 17	11,9 second	verified	open
18	User 18	0,9 second	verified	open
19	User 19	1,0 second	verified	open
20	User 20	2,6 second	verified	open
Average Open Portal Verification Time				2,3 second

Based on the results of direct testing, the development of intelligent parking systems with RFID sensors for online authentication in different areas is progressing as expected.

5. CONCLUSIONS

The development of intelligent parking systems with RFID sensors for online authentication in different regions led to online customer card authentication system tools in parking portals in other areas. The designed device performed as expected by the researchers based on the results of customer card verification tests on parking portals in various regions, with an average verification time of 2.3 seconds over 20 customer card attempts and achieved speed.

AUTHOR CONTRIBUTIONS

Conceptualization; Suhartono[S.S], M.S.Lamada[M.S.L], S.G.Zain[S.G.Z], Sanatang[S], A.Dhetryansah[A.D], Methodology; [S.S],[M.S.L],[S.G.Z],[S],[A.D], validation; [S.S],[M.S.L],[S.G.Z],[S],[A.D], formal analysis: [S.S],[M.S.L],[S.G.Z],[S],[A.D], investigation; [S.S],[M.S.L],[S.G.Z],[S],[A.D], data curation; [S.S],[M.S.L],[S.G.Z],[S],[A.D], writing—original draft preparation; [S.S],[M.S.L],[S.G.Z],[S],[A.D], writing—review and editing; [S.S],[M.S.L],[S.G.Z],[S],[A.D], visualization; [S.S],[M.S.L],[S.G.Z],[S],[A.D], supervision project administration; [S.S],[M.S.L],[S.G.Z],[S],[A.D], funding acquisition; [S.S],[M.S.L],[S.G.Z],[S],[A.D], have read and agreed to the published version of the manuscript.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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