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Nomor: 842-D/3459/FT-UNTAR/VIII/2020

Dekan Fakultas Teknik Universitas Tarumanagara, dengan ini menugaskan kepada Saudara:

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Untuk melaksanakan **Mempresentasikan Hasil Penelitian** dengan data sebagai berikut:

Judul	:	Implementation of Rotary Parking System Model Using Wi-Fi as Transmission Media
Nama Seminar	:	Tarumanagara International Conference on the Applications of Technology and Engineering (TICATE) 2020
Peran	:	Pemakalah
Penyelenggara	:	Universitas Tarumanagara
Waktu Pelaksanaan	:	03 – 04 Agustus 2020

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23 Agustus 2020

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for the contribution as

ORAL PRESENTER

Paper Title

Implementation of Rotary Parking System Model Using Wi-Fi as Transmission Media

August 3rd - 4th, 2020 | Universitas Tarumanagara, Jakarta

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Implementation of rotary parking system model using wi-fi as transmission media

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Abstract. The increasing population in Indonesia affects the increase in private and public vehicles. This increase in vehicles causes various problems, one of which is the need for parking space. The need for parking space raises various other problems, namely, the reduction in green open land and rampant illegal parking on the side of the road which often causes congestion. Then we designed and implemented a model of the rotary parking system using Wi-Fi as transmission media. This model is expected to be developed further in solving the problem of parking space requirements. This system begins to work when a user logs in using a previously registered ID and password. The user then selects a particular deck through the built application on the smartphone. The user-selected deck will spin and stop so that the user's vehicle can enter into. After the vehicle is parked, the user reconfirms the control device and the security password will automatically be sent to the user's smartphone. To pick up the vehicle again, the user will enter the given password into the control device.

1. Introduction

The increasing population in Indonesia is currently affecting several sectors, one of which is the need for sufficient parking space. In 2010 the total population of Indonesia was 237,641,326 people, in 2017 Indonesia's population reached 262 million, increasing quite rapidly with a growth rate of 1.49% per year [1]. In 2019, the total population of Indonesia reached 268,074,565 people [2]. The increasing number of population in Indonesia is followed by the increasing number of private cars in Indonesia. The habit of Indonesian people who prefer to use private cars compared to public transportation is one of the factors causing the need for large parking space. This parking lot has several shortcomings, such as parking space that cannot accommodate all cars, the need for land to be used as a parking area, thereby reducing the availability of green open land, lack of security, making it prone to crime.

When the number of parked cars exceeds the parking capacity. Drivers will find it difficult to find an empty parking lot, so it takes a long time, especially during peak hours. As a result, there are many illegal parking on the side of the road which of course disrupts the flow of traffic and a number of pedestrians. To solve this problem, an adequate parking space is needed so that there is no more illegal parking on the side of the road.

The next drawback is the need for land to become a parking area. Opening a parking area requires sufficient land to accommodate cars, this further narrows the availability of green open land, especially in densely populated cities. The use of parking space is less effective due to the imbalance of private cars with the existing parking space requirements. This imbalance is largely due to ineffective land use planning and spatial calculation errors during the first planning stages [3].

A security system is also very much needed for users so that their parked cars are safe from attempted crime. There are many parking security systems in some densely populated city apartments which are prone to crime, even though there are security systems in use such as CCTV and guarding parking attendants or security guards. With increased security in parking lots, parking users will feel safe when they leave their parked car. From these problems, we need a tool which is expected to help reduce this parking problem. A tool that saves parking space and can reduce the potential for illegal parking and has a level of security system.

A smart parking system that simultaneously saves parking space is an idea that is expected to provide solutions for parking providers to these problems. In addition to saving land, this system is also able to reduce the possibility of illegal parking and reduction of green open land in densely populated cities. In addition, this system is also equipped with several sensors that are used to ensure the safety of each driver who will park his car.

In making this smart parking system, a prototype is needed which is expected to be developed in the future. The prototype of this intelligent parking system has been widely researched and designed like the Rotary Automated Car Parking System in [4]. This prototype is designed to use a 12V, 10W DC motor to drive it. In addition, this prototype also uses the AT89S52 microcontroller to drive the entire system contained in the tool. The Rotary Parking System itself was invented from 1918. At that time this system was built for the La Salle Hotel in Chicago and was designed by Holabird and Roche [5]. The technological era is developing rapidly in line with the needs of the problems that arise. The problems that arise can be overcome with technology, both in the fields of agricultural, education, and medicine [6]. The current industrial revolution 4.0 makes it very easy for humans to find information and do things quickly just by using the internet, or commonly known as the Internet of Things (IoT).

This IoT really helps humans find something that can make it easier for themselves to do something else, such as smartphones which are now equipped with various sensors and can even be used to communicate with other people around the world.

The design of this rotary parking system model utilizes Wi-Fi as a transmission medium for drivers with this system. Drivers will park their car on the decks that have been provided. There are several sensors on the deck which function to notify the system when cars are parked on the corresponding decks, this system can also notify the driver which deck is still empty and there is also a sensor that can turn on the lights on the deck when a car is parked. This information is sent using the Wi-Fi module as a transmission medium to a user's smartphone.

The rest of the paper is organized as follows. In Section 2, we discuss the research method used. Realization of the whole system model is explained in Section 3. Section 4 provides the results of the research and the discussion about them. The conclusion is explained in Section 5.

2. Research method

2.1. How the system works

The design of rotary parking system prototype using Wi-Fi as transmission media is divided into two parts, namely the electronic system part and the construction design. This system functions as a security system, as well as an information system. Users who want to park their vehicles must register their ID and password first. The model of rotary parking system block diagram can be seen in Figure 1. The realization of the construction design of this system uses materials in the form of steel and a bicycle gear that is welded to form a construction in the form of a rotary parking model. The realization of this construction design can be seen in Figure 2. The realization of the construction design on the deck is made based on the size of the car with a ratio of 1:43. The sketch of deck construction design can be seen in Figure 3.

When a user will park his/her car, the user will connect his smartphone to the control device by opening the application on the smartphone and entering the ID that was previously registered. Then the user selects a parking deck that is still empty according to the deck number. The deck's colour on the user's smartphone will automatically change from green to red. The deck will rotate until it reaches a position where the car can enter and then the lights turn on. Accuracy reading of deck position done by reading the infrared (IR) sensor. After the driver has finished parking the car, the control device will ask

for confirmation if the car is parked perfectly. The user will press the confirmation button on the keypad on the control device. Then the control device will send a security code to the user's smartphone.

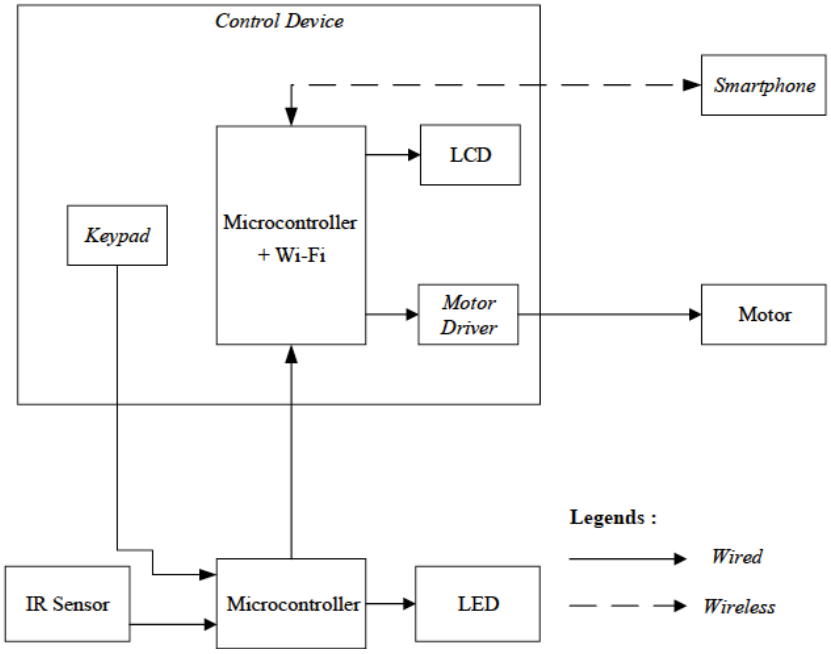
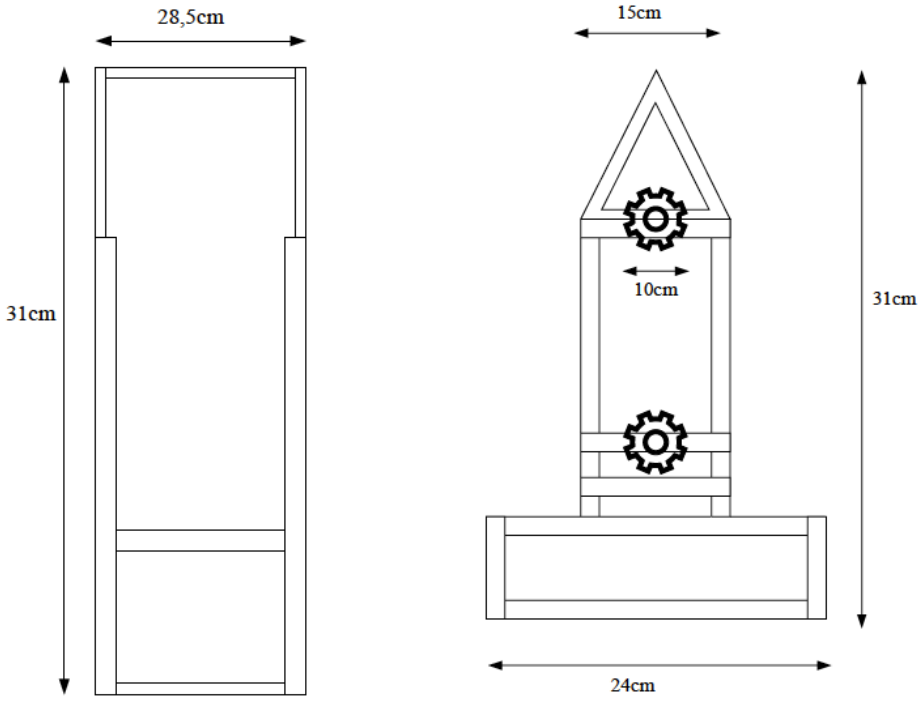
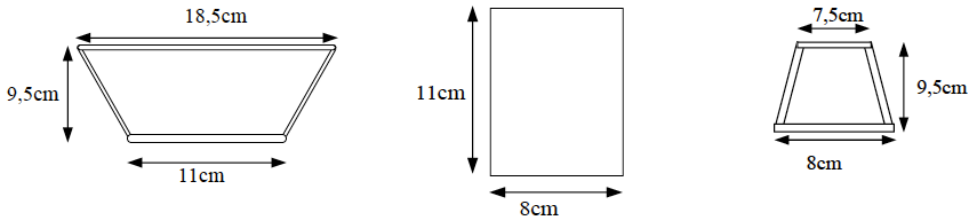


Figure 1. Block diagram of system design



(a) (b)

Figure 2. Prototype construction sketch (a) front view (b) side view



(a) (b) (c)

Figure 3. Prototype's deck construction sketch (a) side view; (b) top view; (c) front view

When the smartphone has received the security code, the deck will rotate and stop in a position between the two decks. The deck rotation is carried out using a motor controlled by the motor driver. The driver who wants to take the car out again will enter the code previously sent to the smartphone to the control device which will be displayed on the LCD. The deck will rotate so the driver can take the car back. When the car is out, the lights will automatically turn off then the deck will rotate and stop at a position between the two decks again.

2.2. Realization of the whole system model

Figure 4 shows the realization of the designed rotary parking system model. Motor driver module, keypad module, LCD module, IR module, LED module are connected with NodeMCU. NodeMCU acts as an input or output data processing module that is connected to the Android application [7] on the user's smartphone wirelessly. When a previously registered user wants to park his car, the user must enter the ID and password on the login page in the Android application on the smartphone. If successful, the application on Android will automatically move to the deck selection page which functions as an interface for the user to select the desired deck and find out which deck is still empty, green for decks that are still empty and red for decks that have been filled with other cars. When the user has selected the desired deck, the deck screen on the smartphone will automatically change color to red.

Information sent from the user's smartphone will be sent wirelessly to NodeMCU. NodeMCU will give commands to the motor driver to move the stepper motor [8-10] until the selected deck is in a position ready for use by the user. The selected deck will move around through the IR sensor which is placed on the right side of the construction, which aims to provide information to NodeMCU. If there is a deck being used, NodeMCU can send this information directly to the control device. Besides, the IR sensor is functioned to turn on the light in the form of an LED located at the corner of the construction.

The control device [11] functions as an interface for the user to get a parking security code which will be sent to the user's smartphone wirelessly. When the user has parked the vehicle properly, the control device will ask for confirmation from the user that the vehicle has been parked properly. This confirmation request will be displayed by the LCD on the control device. The user will confirm by pressing the "OK" button on the keypad so that the NodeMCU on the control device will send the command to NodeMCU on construction using serial communication. NodeMCU on the stepper motor will forward the command and move the stepper motor so that the deck will rotate and stop parallel between the two decks and the lights on the construction will automatically turn off. At the same time the control device will send a security password to the user's smartphone via the Android application on the password page.

When the user has finished carrying out his activities and wants to take the vehicle back, the user will enter the security password previously sent in the password page to the control device by typing it on the control device keypad and it will be displayed on the LCD and then pressing the "OK" button on the keypad. After the user has successfully entered the security password correctly, the NodeMCU on the control device will send the command to NodeMCU on the construction and forward it to the motor driver so that the stepper motor will drive the desired deck.

After the user takes the vehicle back from the deck, the IR sensor in the construction will read the existence of the car on the deck. If within the stipulated time that there is no car, the IR sensor will send the information to NodeMCU on the construction so that NodeMCU will automatically rotate the deck to a position between the two decks and the lights will automatically turn off.

Figure 4. Realization of the designed rotary parking system model

3. Results and discussion

3.1. Test results of stepper motor

Testing the stepper motor module is done by moving the stepper motor to shift the deck so that the deck will move and stop according to the desired position. The stepper motor will move clockwise or counter clockwise. If the deck is used or the user's car has been parked properly, the stepper motor will automatically move the deck to a position between the two decks. The average intersection distance on each deck is 1.18 cm. The furthest stopping deck is on deck 2, which is 1.5 cm and the most precise is on deck 6, which is 1 cm.

3.2. Test results of infrared sensor module

Testing of the infrared (IR) sensor module is carried out by knowing the minimum distance and maximum distance to place the IR sensor to detect objects. This aims to determine the ideal distance between the deck and the sensor module so that the LED lights in the construction can automatically light up when the IR sensor reads the deck. From the experiments, the sensor can read objects with a maximum distance of 13 cm. If the deck stops at a distance above 13 cm, the deck cannot be read by the sensor and the LED light on the construction cannot turn on.

3.3. Test results of infrared sensor module

The test parameters on this control device are divided into two, namely, the user security password reader when they want to take the vehicle back out and the accuracy of reading the LCD and keypad input and output on the control device. If the password entered by the user is wrong, the control device will automatically provide an invalid password information. To enter the password the user will type it through the keypad, and it will be displayed on the LCD. The testing result shows that system will automatically provide an incorrect password if the user enters the wrong password. This is one of the security systems in this system model.

3.4. Test results of smartphone connectivity with the esp 8266 module on NodeMCU

Testing smartphone connectivity with the ESP 8266 module on NodeMCU is done by calculating the distance between NodeMCU and the user's smartphone. The test parameter for this connectivity is to calculate the minimum and maximum distance between the NodeMCU module and the user's smartphone. It is found that the distance required by a smartphone to be connected to the ESP 8266 module on NodeMCU is less than 9 meters so that if the distance between the user's smartphone and the ESP 8266 module on NodeMCU exceeds 9 meters, the user's smartphone cannot be connected.

3.5. Overall system testing results

Testing the whole system begins by connecting the Wi-Fi connection on the user's smartphone with the ESP 8266 on NodeMCU, then logging in to the Android application, if the login is successful, the user can choose the desired deck. Once selected, the deck will rotate and the color of the deck display on the Android application will change to red. The sensor will read the deck and turn on the LED on the construction and the user can park the vehicle. After the user confirms the parking status on the control device that the vehicle is parked, the deck will rotate between the two decks and the LED will automatically turn off. At the same time, the security password will be automatically sent to the user's smartphone.

When the user takes the vehicle back, the user will enter the security password that was previously sent to the smartphone on the control device. The deck where the user's vehicle is parked will automatically rotate so that the user can take the vehicle back. The sensor will read the deck and then the LED light will turn on again so that the user can take the vehicle back and on the Android application, on the deck selection page, the deck color indicator turns green again. Testing the whole system can be seen in Table 1.

Table 1. Average of percentage errors of right ear HRIR models

No.	Experiment	Result
1.	Smartphone connectivity with NodeMCU via Wi-Fi	Max 9 m
2.	Login on the android application	succeed
3.	Selection of decks	succeed
4.	Deck turns	succeed
5.	Change Deck’s colour on application	succeed
6.	Sensor detects deck (LED on)	succeed
7.	Confirmation on control device (deck rotates and stops between two decks)	succeed
8.	Delivery of security passwords	succeed
9.	Confirm security password (deck rotates)	succeed
10.	The sensor reads the car's presence (the deck rotates and stops between two decks)	succeed
11.	Change colour of deck on application (green)	succeed

Table 1 gives the information about the distance limit required by the user to be able to connect his smartphone is 9 meters. After the user logs in with a registered ID and password, he can immediately select a deck. The deck that can be selected is the green deck. After the user selects a deck, the deck colour display on the smartphone will turn red and the security password will immediately be sent to the smartphone. The user will confirm after parking the vehicle. The user must enter the security password that was sent earlier if he wants to retrieve his vehicle.

4. Conclusion

Based on the results of testing and analysis of the system being designed, the following conclusions can be drawn. At first, the control device functions as the main controller on the system as well as an interface for the user to enter a security password and confirm parking. Second, designed Android

application functions as an interface for users who can provide information on the state of the deck. Information displayed is in the form of deck's colour, which is "red" if there was a previously parked vehicle and "green" when there is no vehicle on the deck. Then NodeMCU in this system functions as a hotspot so that it can be used as a server that functions as a sender of information in the form of data to the entire system and data processing to the user's smartphone.

Acknowledgments
The authors gratefully thank the Department of Electrical Engineering, Universitas Tarumanagara, Indonesia for facilitating the experiments of this research.

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