Online Information of Parking Area Using Ultrasonic Sensor through Wifi Data Acquisition

Dadan Nurdin Bagenda¹, & Crisyanto Parulian²

¹Electronics Department, Politeknik Negeri Bandung, Bandung, Indonesia  
Email: dadannb@polban.ac.id¹, crisyanto.p@gmail.com²  
²Information Technology Department, STMIK LPKIA, Bandung, Indonesia  
Email: chrisyanto.p@gmail.com

Abstract — Nowadays, malls and other public places in the city are facing problem in providing proper and huge parking area for their visitors’ vehicles. Also, the lack of human resource for the parkers makes the visitors difficult to find the available space to park their cars due to the less information they get during finding the parking space. Moreover, those who are seeking the parking space have to drive around the parking area for more than once, which is wasting their time a lot. Therefore, the malls and other public places need the best solution to this problem. The online parking information system is really needed to make the parking system better. This system uses a network sensor consisting of HC-SR04 ultrasonic module to detect the parking slot availability, HC-SR04 which is accessed by Arduino Nano, and the data that is sent to the server uses esp8266 wifi module. Further, the server processes the data and display the information on webpage application as well as desktop applications in the form of the parking area map. This system will show the available space that can be accessed on website and PC with a few second delays and simple wiring system.

Keywords: parking area information, arduino, ultrasonic, wifi esp8266, webpage, network sensor.

1. Introduction

The population of Indonesia is growing every year which is followed by the increasing of needs in owning the vehicles. It means that the need of parking space in public places is highly required. Unfortunately, the increase of need for parking space is not followed by the increase of its quantity. This kind of problem is often found in many big cities in Indonesia. Bandung, one of the big cities in Indonesia, has many malls that do not provide good parking system. They do not have clear information about the availability of parking space which makes the visitors difficult to find parking space for their car. According to the background above, the writers identify some issues: (1) the information of the available parking space can only be obtained from the parkers, which the number of the parkers itself does not balance with the number of visitors, (2) the information of available parking space is not easily found by the visitors, they waste their times to go around the entire parking area to find a space [1].

This research is the solution for the problems above, by: (1) detecting parking space using the ultrasonic sensor network, HC-SR04 ultrasonic which is read and accessed (optimization program [2]) by Arduino Nano and then sent through wifi esp8266, (2) developing web and desktop applications to provide the information parking space quickly to the visitors. The following table shows the domain of this study and the gap between the present research and the previous researches.
Table 3.1 Research domain

| Reference No. | features used | Parking system |
|---------------|---------------|----------------|
|               | Arduino       | Ultrasonic     | Web app | wifi | Optimization |             |
| 1. [3]        | X             | ✓              | X       | ✓    | ✓            | ✓            |
| 2. [4]        | X             | X              | X       | ✓    | ✓            | ✓            |
| 3. [5]        | X             | ✓              | X       | ✓    | ✓            | X            |
| 4. [6]        | X             | X              | X       | ✓    | ✓            | ✓            |
| 5. [7]        | ✓             | X              | X       | ✓    | ✓            | ✓            |
| 6. [8]        | X             | ✓              | X       | ✓    | ✓            | ✓            |
| 7. [9]        | ✓             | ✓              | ✓       | ✓    | ✓            | ✓            |
| 8. [10]       | X             | X              | X       | X    |             | ✓            |
| 9. [11]       | ✓             | ✓              | ✓       | ✓    |             | ✓            |
| 10. [2]       | X             | X              | X       | X    | ✓            | X            |
| **THIS RESEARCH** | ✓            | ✓              | ✓       | ✓    | ✓            | ✓            |

The above references are listed below:
1) M.Y.I. Idris, and team “Parking Guidance System Utilizing Wireless Sensor Network and Ultrasonic Sensor” Malaysia 2009 [3]
2) Amin Kianpisheh, N.M., P. L. and P. K. “Smart Parking System (SPS) Architecture Using Ultrasonic Detector” Malaysia 2012 [4]
3) Luz Elena Y. and team “A Summary of Vehicle Detection & Surveillance Technologies used in Intelligent Transportation Systems” U.S. 2007 [5]
4) Wagh, Manisha Bhende and Sanjeev “Intelligent Car Park Management Sys. using Wireless Sensor Network” Dypiet University of Pune 2015 [6]
5) Pradana, G.R. and team “Smart Parking Berbasis Arduino” Ind 2016 [7]
6) Widodo, S., Pramono, S. dan Argawadana "Informasi Sistem Parkir Menggunakan Mikrokontroler Dan Ultrasonik” Indonesia 2016 [8]
7) Palentei, E “Sis. Perparkiran Cerdas terhubung Web” Indonesia 2013 [9]
8) Anindita, A., Sudjadi, S. and Darjat, D. “Sistem Informasi Area Pafkir Berbasis Mikrokontroler Atmega 16” Indonesia 2013 [10]
9) AK, S.A.M “Sistem Monitoring Tempat Parkir Dengan Sensor Ultrasonik Berbasis Arduino Uno Pada Cibinong City Mall” 2016 [11]
10) Dadan and team "Pengaruh Struktur Pemrograman Dan Compiler Pada Kecepatan Operasi Menggunakan Arduino Uno," 2016 [2]

As we can see from the previous researches above, they explain that using the level option compiler can reduce the time of program processing up to 78.23% of the standard compiler [2] with the following code:

```cpp
#pragma GCC optimize ("-O3")
```
Shihabudin stated that the accuracy of HC-SR04 reaches 3mm [11], and the writers use the following formula to calculate the distance.

\[ S = \frac{(t_{IN} \times V)}{2} \quad \text{... [3]} \]

Distance = Time difference x velocity / 2

2. **Methodology**

2.1 **Research Methodology**

The methodology used in this research is experimental quantitative. The testing, measuring and reading module, merging, re-testing and developing the system are conducted in this research to get the expected result. The stages of research plan and performance indicator are as follows:

| Research Activities                                      | Performance Indicator                                    |
|----------------------------------------------------------|----------------------------------------------------------|
| Accessing HC-SR04 using Arduino Nano                     | Obtaining distance data between sensors and objects.     |
| Testing wifi esp8266 using serial monitor at (PC)         | Obtaining Modules that work in accordance with AT commands|
| Testing dummy data delivery from arduino to DBMS via wifi | Obtaining results of data sent from arduino in the database |
| Testing ultrasonic data delivery to the database via wifi | Obtaining distance from ultrasonic data in the database   |
| Developing database & web App of parking area map, as the information of parking area | The availability of website for parking information for the user |
| Output: This system can be used to provide /obtain the information of parking slots availability |

The hardest part of this research is transferring the data from arduino via wifi to the database that uses php script as API (App Programming Interface) to connect to the database.

2.2 **Research Diagram Block**

Each sensor module consists of ultrasonic HC-SR04 proximity sensor that is processed by Arduino Nano and transferred to the server via serial to wifi esp8266. This sensor module is installed in each parking slot. These modules are hardware that is integrated by Access Point TP-LINK TL-WA701ND with the PC as the server.
2.3 Installation Of The Sensor Module In The Parking Slot

![Installation of sensor module in the parking slot](image)

The sensor module obtains the distance data changes between the parking ceiling and the floor, and the car. The ceiling and the floor distance can be adjusted by using potentiometer so that it can be applied at 4 m max distance.

2.4 Module Sensor FlowChart

The process flow applied to Arduino Nano as module processor sensor. Simply beginning with distance measurements, then compared to potentiometer reading as a setting, if the distance is shorter than the setting then it is identified that there is a car being parked in this slot. Even though the car is not detected, the sensor module always transfers the data to the server with specified delay (sec).

2.5 Flow Chart of Application Desktop and Web as Servers

The following figure shows the process flow applied to the PC as servers. Algorithms on the Desktop and Web Application are the same. Simply begins by reading the received data from the sensor module i.e. "id_slot status", 1 shipment contains 2 data. After that, this data is updated to the database for every new data acceptance.

3. RESULTS

In this part, the writers will describe the results of each sub-system testing, and continue with the result of the testing for the whole system. This part also presents the prototype.

3.1 The Result of Subsystem Testing

The test result shows that the detection of HC-SR04 sensor distance to the object is relevant to the reference testing [12], which is completed with other data errors. They are mentioned as follows.

- The further the object from the sensor, the higher the level of error detection on the ultrasonic sensor. At 2-30cm error = 0cm, at 60-120cm error <= 1cm, at 150-320cm error <= 2cm, at 320-399cm error <= 3cm.
- If the distance is <2 cm, the ultrasonic will detect the distance about 0cm.
- If the distance is >399, the ultrasonic will detect the distance about 0 cm.

Here is the result of the sensor module implementation that has been equipped with arduino nano, wifi and potentiometer. To adjust the detection distance, we only have to rotate the potentiometer. This module is pasted over the parking slot so that it can detect the car.
The test results the range of wifi module ESP8266, to time replay and number of RTO (request time out). This wifi module is tested for its connection with AP (Access Point) TP-LINK TL-WA701ND. The conclusion of this test is mentioned below.

The distance from AP (Access Point) to wifi esp8266 do not affect the average time replay significantly. From 0 meter to 70 meters, there was no RTO (Request Time Out) that occurs when trying to “ping” the IP address wifi esp8266. This is already good enough. At 75 meters, wifi esp8266 experiences the RTO as much as 3 times when the “ping” is done, the wifi is not connected to AP.

The following image is a model of 2-floors parking lot. This model is made resemble to real parking slots in the 2- floors basement parking lot with three slots for each floor.

3.2 Application Interface

* Biru Untuk Slot Yang Sudah Penuh
* Merah Untuk Slot Yang Dapat Digunakan

* Silahkan Pilih Basement
  * Basement 1
  * Basement 2

* B2-01 Ada
* B2-02 Ada
* B2-03 Kosong
The web and the desktop application are adapted to the design and the model that is made, 2-storey basement parking lot and each floor consists of 3 parking slots. The following information is the steps to use the web application. Click the ‘Basement 1’ button to check the status of the parking slots which are located in basement 1. Do the same action for basement 2. “Ada” it means “Exist/Disable” with blue color, and “Kosong” it means “Empty/Available” with red color.

3.3 The Results of Whole System Testing

Testing the whole system is equipped with all subsystems and potentiometer. The result of the system testing is presented in the table below.

| No. Slot | Parking Slot | Web App | Desktop App |
|----------|--------------|---------|-------------|
| B1-01    | exist        | exist   | exist       |
| B1-02    | exist        | exist   | exist       |
| B1-03    | exist        | exist   | exist       |
| B2-01    | exist        | exist   | exist       |
| B2-02    | exist        | exist   | exist       |
| B2-03    | exist        | exist   | exist       |
| B1-01    | empty        | empty   | empty       |
| B1-02    | empty        | empty   | empty       |
| B1-03    | empty        | empty   | empty       |
| B2-01    | empty        | empty   | empty       |
| B2-02    | empty        | empty   | empty       |
| B2-03    | empty        | empty   | Empty       |

From the table above, it states that the system runs smoothly; unfortunately there is a delay in updating the information. The testing of updating information speed has been conducted by recording the time when sensor detects the car until the status in the application is updated.

The delay test is conducted 25 times with the following results; the average delay that required for the information to appear on the user interface is 5.4 seconds, with 9 second of maximum delay and 2 second of minimum delay.

4. Discussion

4.1 Conclusion

The research concludes that: by applying this system, parking slot information can be seen by the visitors who are seeking the parking space; the wiring sensor is very simple, the information for parking space can be obtained faster, with the average delay of 5.4 seconds for updating on user interface display.

4.2 Constraints

This system still has a lot of shortages due to limited time and funds. Therefore, the researcher presents the obstacles that can be the idea for the further research. They are as follows.

This web server application is not hosting. The system is not integrated with the local parking system because of the difficulty in obtaining the rights access in parking companies. This system has not been interconnected to other parking lots. It means that if the parking area is fully occupied, the system can direct the visitor to the nearest parking lot. The server must be developed so that it can update data faster. The parking detection system cannot be set outdoor.
5. Acknowledgment

The researcher would like to thank to all parties who have contributed in this research, especially to the BEC ISS parking management system for the access to the parking location, the interview, documentation, etc. Lastly, the researcher would also like to thank to the Research Center Departments in Polytechnic State of Bandung for providing the funds and all facilities used for this study.

6. References

[1] Anindita, S. Sudjadi and D. Darajat, "Sistem Informasi Area Parkir Berbasis Mikrokontroler Atmega 16," Semarang, 2013.

[2] D. Kho, "Teknik Elektronika," 2017. [Online]. Available: http://teknikelektronika.com/cara-menghitung-nilai-resistor-untuk-led-light-emitting-diode/. [Accessed 29 Agustus 2017].

[3] D. N. Bagenda and R. Hudaya, "Pengaruh Struktur Pemrograman Dan Compiler Pada Kecepatan Operasi Menggunakan Arduino Uno," in SNTEI - Seminar Nasional Teknik Elektro Dan Informatika ISBN: 978-602-18168-0-6, Makassar, 2016.

[4] D. Santosa, "Galeri Pustaka," 7 Mei 2013. [Online]. Available: http://www.galeripustaka.com/2013/05/pengertian-cara-dan-jenis-parkir.html. [Accessed 15 April 2017].

[5] G. Pradana and R. Wardani, "Smart Parking Berbasis Arduino Uno," Jurnal Elektronik Pendidikan Teknik Elektronika, vol. v, pp. 32-40, 2016.

[6] K. Zuhri, "sebatekno," 9 Oktober 2015. [Online]. Available: http://www.sebatekno.com/jenis-atau-type-arduino. [Diakses 15 April 2017].

[7] M. B. &. S. Wagh, "Intelligent Car Park Management System using Wireless," International Journal of Computer Applications, vol. 122, pp. 1-6, 2015.

[8] M. Idris, E. Tamil, N. Noor, Z. Razak and K. Fong, "Parking Guidance System Utilizing Wireless Sensor Network and Ultrasonic," Information technology Journal, vol. II, no. Issn 1812-5638, pp. 138-146, 2009.

[9] Mimbela and L. E. Y. e. all, "Summary Of Vehicle Detection And Surveillance Technologies Used In Intelligent Transportation Systems," Mexico, 2000.

[10] Amin Kianpisheh, "Smart Parking System (SPS) Architecture Using Ultrasonic Detector," International Journal of Software Engineering and Its Applications , vol. 6, pp. 51-58, 2012.

[11] Palantei and Elyas, "Pengembangan Sistem Perparkiran Cerdas Terintegrasi Web," STMIK Diponegoro, Universitas Hasanuddin.

[12] S. A. M. AK, "Sistem Monitoring Tempat Parkir Dengan Sensor Ultrasonik Berbasis Arduino Uno Pada Cibinong City Mall," Prosiding SENIATI Book-2, no. isbn 2085-4218, pp. B.350-B.355, 2016.

[13] Shihabudin Achmad Muhajir A.K, "Sistem Monitoring Tempat Parkir Dengan Sensor Ultrasonik Berbasis Arduino Uno Pada Cibinong City Mall," SEMINAR NASIONAL INOVASI DAN APLIKASI TEKNOLOGI DI INDUSTRI (SENIATI), no. ISSN:2085-4218, pp. B.350-B355, 2016.

[14] Sarono Widodo, "Informasi Sistem Parkir Menggunakan Mikrokontroler Dan Sensor Ultrasonik," JURNAL TELE, vol. 13, pp. 13-18, 2015.