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Research Article

Smart Seat Notice System for Handicapped Based on Open API

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Abstract: According to the Seoul Metro, the number of civil complaints regarding pregnant women's caring seat in 2018 was approximately 27,600 cases. Pregnant women who are the beneficiaries of this system cannot use such seat properly, creating a negative view in the society. In this study, user information is collected using database and the subway information such as arrival time is received through Open API for 'Pink Light' which has not been used properly after its introduction. Such system is supplemented using RFID or QR Code and ultrasonic sensor, and the real-time seating chart for pregnant women and general passengers in the subway train is introduced using a simple application for solving the problem. In the end, this study intends to design and implement a system that can promote the convenience for both pregnant women and general passengers by ensuring pregnant women to be able to use pregnant women's caring seats freely without having a regard for other passengers' feelings and by increasing the number of general passenger seats.

Keywords: Open API, RFID, QR Code, Arduino, Bluetooth, Wi-Fi

1. Introduction

The subway, an essential public transportation in our lives, is so crowded during rush hour where passengers have almost no space to move inside the train. Regardless of the fact that subway is used by so many people, the number of seats in subway trains is significantly insufficient. The system called 'Pink Light' was first introduced in Busan in 2016 and this is a system that when a pregnant woman possessing a key chain-shaped radio transmitter gets on the subway, a receiver installed on a pregnant women's caring seat column detects the signal from the radio transmitter and informs with lighting and voice guidance that a pregnant woman is on board. It has been four years since this system was first implemented, but it is difficult to see an actual pregnant woman using pregnant women's caring seats up to now. Therefore, various countermeasures including automatic announcement using a built-in chip in a key chain and a challenge for leaving subway seats for pregnant woman unoccupied have been introduced for supplementing the system, but no improvement has been made so far **(Seong-Won Min, et.al, 2017; Se-Hwan Park & Jong-Kyu Park, 2016).** More systems for protecting and considering the weak should be implemented. Handicapped seats and pregnant women's caring seats are in the same context.

In this study, user information is collected using database and subway information such as arrival time is received through Open Application Programming Interface (API) **(Danupon Kumpanya & Sattarpoom Thaiparnat, 2015; Sang-Yule Choi, 2015).** In addition, an application is developed in order to supplement the system by introducing real-time seating chart for pregnant women and general passengers in the subway using RFID or QR Code and ultrasonic sensor **(Myong-Yeal Lee & Jae-Pyo Park, 2016; Dae-Chul Joo, Mee-Rhan Kwon & Seung-Jung Shin, 2017).** In the end, this study intends to design and implement a system that can promote both the convenience for pregnant women for using pregnant women's caring seat and the convenience for general passengers.

2. Related Works

2.1. Open API

Open Application Programming Interface (API) is an application program development environment that is open to anyone for use. This is a collection of prearranged protocols and tools that enables easy development of any application program, and program developers can develop an application program easily using a number of open

APIs even if they do not know the detailed functions of the operating system **(Lee Ji-Won & Nam Doo-Hee, 2012; Sug-Kyu Jung, 2017).**

2.2. RFID

It is also called radio identification and this identification system reads data stored in tags, labels, and cards with a built-in semiconductor chip using wireless frequency in a non-contact way. radio frequency identification (RFID) tags can be divided into active type RFID tags requiring power and passive type RFID tags operated by a reader's electromagnetic field (**Lee Ju-Ho, Kwon Oh-Heum & Song Ha-Ju, 2012; Joon-Seok Jung, Jong-Man Kwon, Joseph Mfitumukiza, Soon-Ho Jung, Min-Woo Lee & Jaesang Cha, 2017).**

2.3. Quick Response (QR) Code

This is a grid-patterned 2D code that can contain more information than a barcode. User can receive a variety of information by scanning a QR code with smartphone **(Lee Yong-Jae, Kim Young-Gon & Park Tae-Sung, 2011; Jun-Won Ho, 2016).**

2.4. Arduino

Arduino is a tool for developing interactive objects and digital devices that can detect and control a physical world, and it refers to open source computing platform and software development environment based on a simple micro controller board **(Ma Seok-Beom, 2014; Yong-Min Kim, Woo-Suk Lee, Oh-Seok Kwon, Kye-Dong Jung & Jong-Yong Lee, 2016).**

2.5. Wi-Fi

This is a wireless technology combined with High Fidelity (Hi-Fi) and it refers to a wireless LAN technology that enables high-performance wireless communication. Wi-Fi uses 2.4 GHz band and 5 GHz band frequency designated as the ISM Band (Industrial Scientific and Medical Band) **(Cho Hyun-Joon, Park Jin-Soo, Lee Dong-Ki & Kim Dong-Hyun, 2014; Eun-Soo Choi, Min-Soo Kang, Yong Gyu Jung & Jean Kyung Paik, 2017).**

3. Smart Seat Notice System

3.1. System Design

In this study, the seating availability for a user is determined using collected information, and data indicating whether a seat is occupied is provided. A system to collect user information using database, judge the availability by the user, send seating information through Android, and display seating information on the Android touch screen using Arduino Wi-Fi module is suggested. The relevant system design drawing is shown in Figure 1.

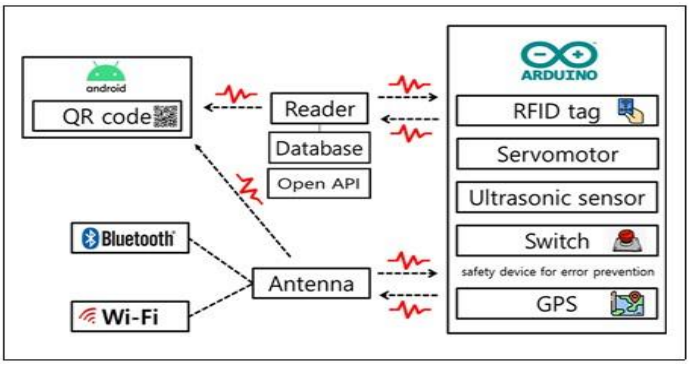

Figure 1. System Architecture

When a user tags RFID tag module prepared at the bottom of the seat with a card containing the previously collected user information using database or a key chain where an exclusive chip is inserted, the user information is compared and if it matches, the seat will be opened using servomotor. If the user information is not registered or a strong pressure is applied to the seat before it is opened, an emergency alarm will sound for approximately 10 seconds in order to prevent general passengers from taking the seat. A separate QR barcode is produced next to Tag module additionally so that passengers can scan and use the barcode with their smartphone in case they forget to carry or have lost the card. An ultrasonic sensor (HC-SR04) enabling the distance measurement was used for seating information.

When the user's body approaches the sensor within 3 cm, the seating availability is displayed on the user's smartphone app in real time. The pregnant women's caring seat location and seating availability checking system and pregnant women's caring seating arrangement are separated from general passenger seats to increase the number

of general passenger seats. The seating availability checking system can be applied to general passenger seats. It is expected that applying the seating availability checking system to general passenger seats along with an increase in the number of general passenger seats in future will improve the satisfaction of general passengers. In addition, the goal is to increase the use rate of public transportation and subway by introducing functions differentiated from the previous ways to use the subway and providing convenience for people of all ages.

3.2. System Implementation

The system in this study was implemented on Microsoft Windows 10 64bit operating system, and Arduino and App Inventor, the exclusive app development platform for Android, were used. The algorithm shown in Figure 2 checks whether a passenger is allowed to use the seat using the user information from database and RFID tag, measures the contact distance with the passenger's body through ultrasonic sensor (HR-SR04), and displays seat information.

If a passenger whose information is not stored tags, an emergency alarm will sound briefly, and if a registered passenger tags, the seat will be opened to allow the passenger to take a seat. When a passenger takes a seat and the contact with his/her body within a certain distance is detected through ultrasonic sensor installed on the seat, the information of the relevant occupied seat is displayed visually on the subway seating chart. However, if the contact with the passenger's body is not detected for 10 seconds, the seat and algorithm will return to the default status. Next, the value measured by Arduino module is sent to the application through Bluetooth module.

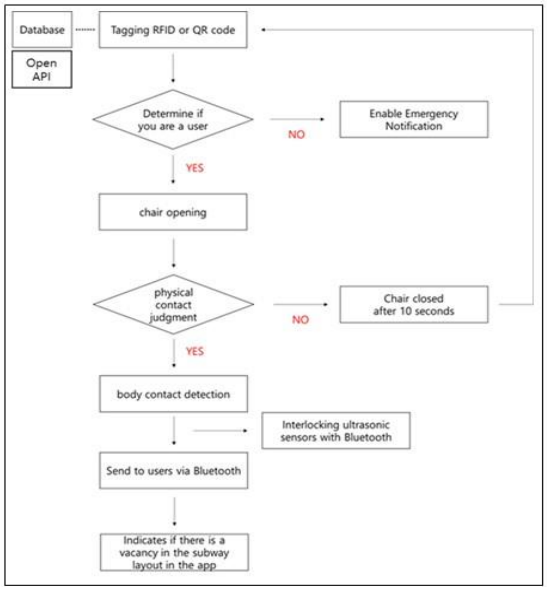

Figure 2. Subway Seats Information Algorithm

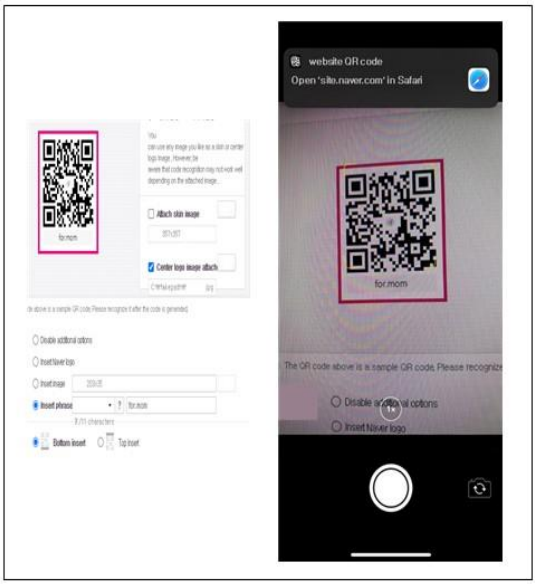

Figure 3. QR Code Fabrication and Drive Screen

After an exclusive QR code is produced, a separate QR barcode is produced next to RFID tag module installed at the bottom of the seat additionally, so that passengers can scan and use the barcode with their smartphone in case they have forgotten to carry or have lost the card. The application module recognizes a QR code through camera using QR code reader to receive information easily. The QR code production process and the screen displayed when the application leader operates are as shown in Figure 3.

3.3. System Implementation Results

The implementation result of the system suggested in this study is as shown in Figures 4, 5, and 6. In Figure 4, when a user tags RFID tag module, his/her information is compared with the user information collected in advance and if the information matches, the servomotor will be opened. At this time, it is configured to sound an emergency alarm for 10 seconds if the user information is not registered or a strong pressure is applied to the seat before the seat is opened. A QR barcode is produced additionally for use in case users have forgotten to carry or have lost their card. They can scan the barcode using their smartphone to use the seat. An ultrasonic sensor (HC-SR04) enabling the distance measurement was used for seating information. If a user's body approaches the sensor within 3 cm, the seating availability will be displayed on the user's smartphone app in real time. Figure 5 shows the database enabling strict passenger identification produced in order to prepare a successful countermeasure for the 'Pink Light' system.

Personal information, pregnancy status or available period were entered to identify the user information clearly when the user tagged with a RFID or a QR code. Since the collection of personal information for a personal study was prohibited by the Personal Information Protection Act, only name and pregnancy status fields were included. Improvement is necessary in future for more accurate identification. Only minimum required information will be collected for the protection of personal information.

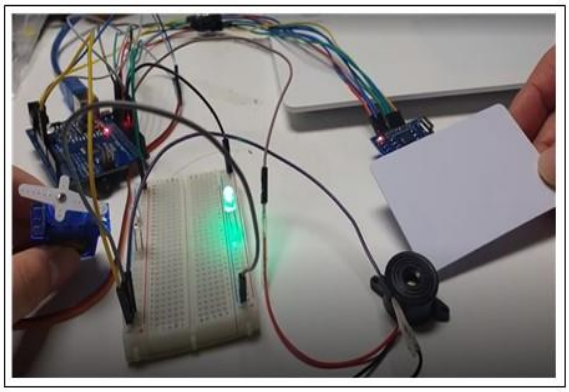

Figure 4. System Implementation Results 1

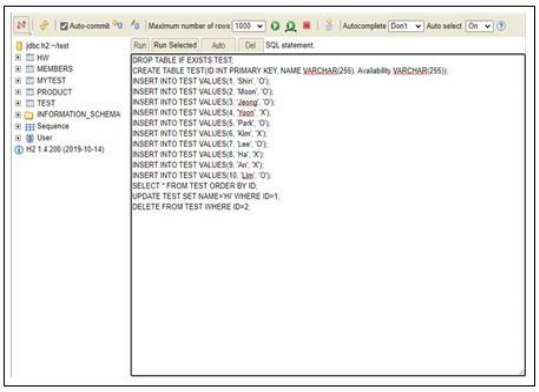

Figure 5. System Implementation Results 2

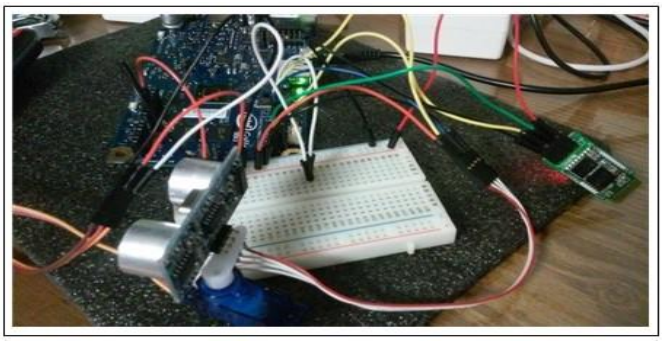

Figure 6. System Implementation Results 3

In Figure 6, the system was implemented to close the servomotor in case no approach to ultrasonic sensor within the set range was made for 10 seconds. An ultrasonic sensor (HC-SR04) enabling the distance measurement was used for seating information. If a user's body approaches the sensor within 3 cm, the seating availability will be displayed on the user's smartphone app in real time. A 4-channel servomotor was used for enabling manual opening of servomotor in order to prevent jamming due to a system error or other reasons.

4. Performance Evaluation

User information is collected through database using Arduino, and the performance evaluation of the app linked with ultrasonic sensor and Bluetooth is as shown in Figures 7 and 8. In Figure 7, the name and availability for use were collected from database where the information of users registered as a pregnant woman was entered. To prevent the reuse of the card after delivery, the administrator receives an application including an appropriate period after delivery and modifies the algorithm directly. Since the collection of personal information for a personal study was prohibited by the Personal Information Protection Act, only name and pregnancy status fields were included. In future, improvements will be made for more accurate identification and a function will be added to delete a user from the user list automatically without the administrator's modification. In addition, only minimum required information will be collected for the protection of personal information. In Figure 8, the contact distance with a human body measured through ultrasonic sensor HR-SR04 is received through Bluetooth and the seating information is displayed. When a user takes a seat and the contact with his/her body within a certain distance is detected through ultrasonic sensor, the availability of the relevant seat will be displayed visually on the real-time subway seating chart. Subway arrival time and information are received using Open API, and then the subway line used by the user and the relevant subway are selected and the seating availability is displayed on the real-time subway seating chart.

SELECT * FROM TEST ORDER BY ID;

ID	NAME	AVAILABILITY
1	Shin	o
2	Moon	o
3	Jeong	o
4	Yoon	X
5	Park	o
6	Kim	X
7	Lee	o
8	Ha	X
9	An	X
10	Lim	o

Figure 7. Performance Evaluation 1 – Database

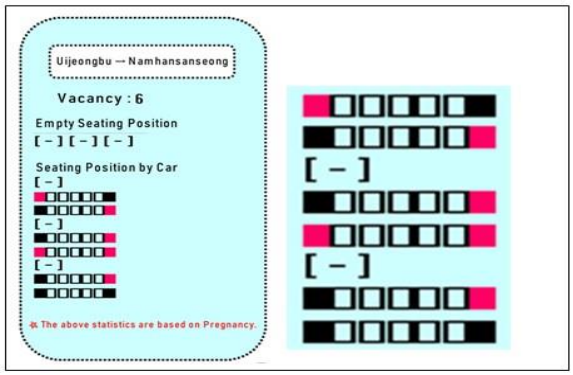

Figure 8. Performance Evaluation 2 - App

In Figures 9 and 10, the arrival time values of each subway train on the relevant station were compared using Kakao Map app in order to determine whether those values were accurate if the subway Open API was imported on Arduino. The result of sending Namhansanseong Station ID to the server using the REST method and comparing the list displaying the relevant subway train arrival information with the subway train arrival information list of Namhansanseong Station displayed on the Kakao map is as shown in Figure 10. In Figure 10, the list of subway trains a, b, c, and d among the list of subway trains scheduled to arrive at the relevant station was compared after renewing the list for 10 times. The subway trains showing a margin of error included a, b, and c, and in case of subway train d, the comparison result on Arduino and Kakao Map app was identical. The subway trains with a margin of error had a relatively smaller margin of error. The margin of error was within one minute, so it had no significant effect on the time, and relatively accurate result of subway train arrival information on the relevant state was obtained by importing Open API on Arduino. The convenience in using subway without checking the subway train arrival time in the app is provided using this function.

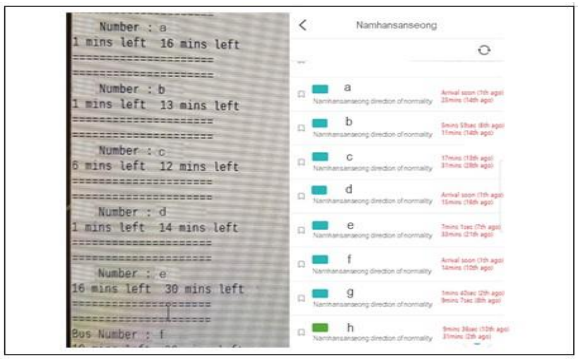

Figure 9. Performance Evaluation 3 – App

subway \ system	Arduino	KaKao Map (APP)
a	1 mins left | 16 mins left	1 mins left | 15 mins left
c	6 mins left | 12 mins left	6 mins left | 11 mins left
d	16 mins left | 30 mins left	17 mins left | 31 mins left
e	1 mins left | 14 mins left	1 mins left | 14 mins left

Figure 10. Performance Evaluation 4 - App

5. Conclusion

In this study, subway train arrival time and information are received using the information of users registered as a pregnant woman from database and Open API. Users are allowed to use the seat if their identification is authenticated by one simple tagging using RFID and QR code. In addition, the real-time seating chart is designed and implemented, and when a user took a seat on an authenticated seat, the seating status is checked using ultrasonic sensor and such status is delivered to the user through Bluetooth and Wi-Fi. The pregnant women's caring seat location and seating availability checking system and pregnant women's caring seating arrangement are separated from general passenger seats and the number of general passenger seats is increased. The seating availability checking system can be applied to general passenger seats.

It is expected that applying the seating availability checking system to general passenger seats along with an increase in the number of general passenger seats in future will enhance the satisfaction of general passengers. The use rate of public transportation and subway should be improved by introducing functions differentiated from the previous ways and providing convenience for people of all ages. In addition, the safe board and exit function was also considered, but there was a limit to add this function due to the limitations in the fixed travel time in the subway. Further studies are planned to find a measure to address the limitations and add various functions in the future.

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