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Design and Implementation of Destination Guidance System Based on Raspberry Pi

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Abstract

In the bus, the travel time to the destination of all passengers could not be estimated. Also, while applications related to bus information have become significantly commercialized, bus operation information cannot be obtained without using such applications and there are some difficulties for the elderly to use. This study designed and configured a system that uses Open API through Raspberry Pi and Arduino to provide passengers in the bus with not only estimated bus arrival times at each stop, but also other convenient services such as bus seating information, bus stop bell reservation, etc. It is expected that perception of buses, which are public transportation, will be improved through these enhanced services, thus leading to an increase in bus usage.

Keywords; *O2O service, Internet communication technology, Advertisement, Arduino, Raspberry Pi, Public transportation.*

I.INTRODUCTION

The local governments and public agencies in Korea have implemented various ITS systems to collect and process a variety of traffic information, and traffic information is being serviced to citizens through an assortment of methods such as the internet, mobile devices, and VMS [1]. When using public transportation, people can use public transportation information applications or map applications to determine how to get to their destination, duration, and public transportation time information [2-4]. The most well-known services include Kakao Bus provided by Kakao, Daum Map, and Smart Subway serviced by TeamDopple Ganger. People use such information to use their time efficiently [5-8].

The Bus Information Service (BIS) provides bus arrival time information through information terminals installed at bus stops, and the information terminals installed in the bus offer such information as the next bus stop and travel time to major destinations [9]. The basic principle of BIS is as follows. The current location information of the bus can be obtained using GPS. The obtained information is sent to webpages, mobile phones, and electronic signs at bus stops. The estimated arrival time based on the transmitted data is displayed [10]. Bus information terminals and commercialized bus information applications are currently used, but they have a disadvantage that users have to continuously look at the screen or smartphones [11]. Therefore, this study proposes that convenient functions be provided in the bus through Raspberry Pi and Arduino using Open API, in order to improve perception of buses that are public transportation, thereby increasing bus usage.

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II. RELATED WORKS

A.Open API

Open API (Open Application Programming Interface) refers to an Open API that can be used by anybody and offers programming authority for private application software or web services to developers [12]. API to be used for production in this study was provided with libraries to be added in projects. It wasexecuted according to the manual or was directly used with keys issued from sites [13].

B.Raspberry Pi and Arduino

Raspberry Pi, an ultra-small/ultra-cheap PC that has the size of a credit card, was developed by the British Raspberry Pi Foundation for basic computer science education at schools. Unlike Arduino, Raspberry can work like a PC by simply connecting a keyboard, a mouse, and a monitor. In other words, this product is similar to general desktop computers [14]. Arduino refers to the board (product) completed with a single board microcontroller based on open sources and its related development tools and environments. It provides the Arduino integrated development environment (IDE) and also allows software development and uploading of executable code [15].

C.GPS (Global Positioning System)

GPS is a system that provides location, speed and time measurement services using satellites. GPS can exactly measure 3D location, altitude, and time, and offers 24-hour continuous services. It is strong against climate conditions, interference, and disruption, and uses the same coordinate system all over the world [16].

III. SYSTEM DESIGN AND IMPLEMENTATION

A.System Design

This study used Raspberry Pi to load Open API (BIS) [17-20]. The collected information is processed to provide a variety of information including current location, estimated arrival time, etc. of city buses passing the corresponding bus stop [21].Bus information is displayed on the touchscreen, which is a Raspberry Pi module. This study proposes a system that uses Arduino to display on the Raspberry Pi touchscreen the information of the two functions of seating information and stop bell reservation through a WiFi module. The blueprint of this configuration is shown in Fig. 1.

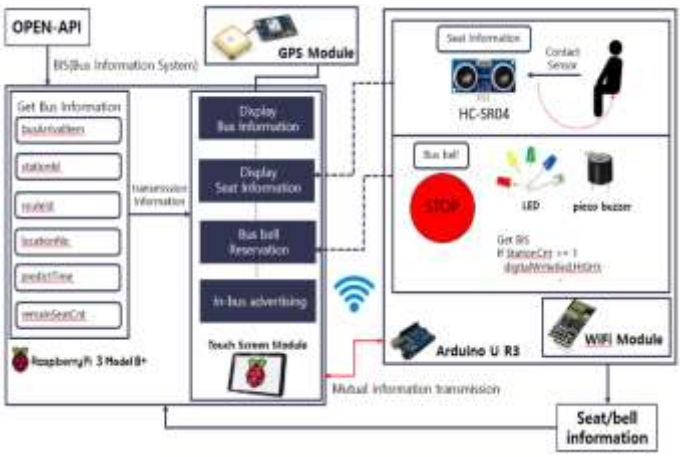

Fig. 1. System Architecture

This blueprint uses Raspberry Pi to load the open data bus information Open API. Then, XML information such as bus arrival information, bus stop information, bus route information, location information, and estimated arrival time, etc. are parsed. The distance and expected travel time according to the coordinates of the current location of the bus and the stops of its route are computed using a GPS module. Also, the expected arrival information of various buses is shown on the Raspberry Pi module touchscreen at each stop. Arduino is used for seating information function and stop bell reservation information. The seating information uses the ultrasonic sensor HC-SR04 to show whether a seat is available when body contact is detected within 3cm to the seat. The stop bell reservation function turns the LED at one stop before the bus arrives at the destination through WiFi communication using bus information received through Raspberry Pi. This is to increase bus usage by offering new convenience functions such as bus arrival information at bus stops, seating information, and bus stop bell reservation functions. The flow of these functions is shown in Fig. 2.

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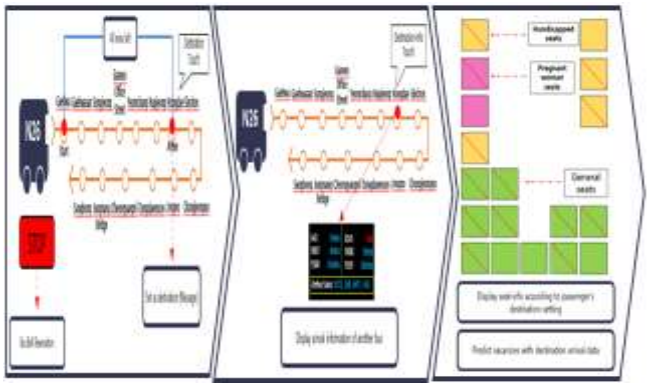

Fig. 2 System Flow

B.System Implementation

The system used in this study was configured using the Arch Linux ARM's AArch64 64-bit operating system, and Raspberry Pi was configured using Node.js through the Atom program.Bus arrival information algorithm obtains bus stop information by parsing Open API using Raspberry Pi in this study.In the bus arrival information algorithm, the bus stop query REST API URL and the bus route query service's route information item query API URL used the open data service keys to parse XML to obtain the bus information such as routeId, routeName, and predictTime to display the bus arrival information for each bus stop. Bus location information algorithm presents the algorithm that uses the Neo 6m v2 GPS module to load the GPGGA (Global Positioning System Fix Data) for the current bus location from the bus location information, and displays the coordinates of the bus on Raspberry Pi. Up until now, Korea used GPS information to collect bus location on the road and operation data in real-time to predict the route times of buses. The signal received from the GPS is used to determine the location of the current bus by using the latitude and longitude identified through parsing the $GPGGA value, which is the fixed value of the GPS output through the serial

Bus location information algorithm measures the body and contact distance using the ultrasonic sensor HR-SR04 to display the seating information. When a passenger sits in a seat, contact with the human body is detected at a specified distance through the ultrasonic sensor installed in each seat, and then the availability of the seat is visually expressed in the bus seating layout. Bus bells information algorithm sends bus arrival information from Raspberry Pi to Arduino through WiFi communication. When there is one minute left to the destination, the LED that represents the bus bell lights up.

C.Implementation Results

The configuration results of the system proposed in this study are shown in Fig. 3 to 6. Fig. 3 shows the list and expected arrival time of buses that will arrive at Eulji University, which is a station includedin the corresponding bus route.

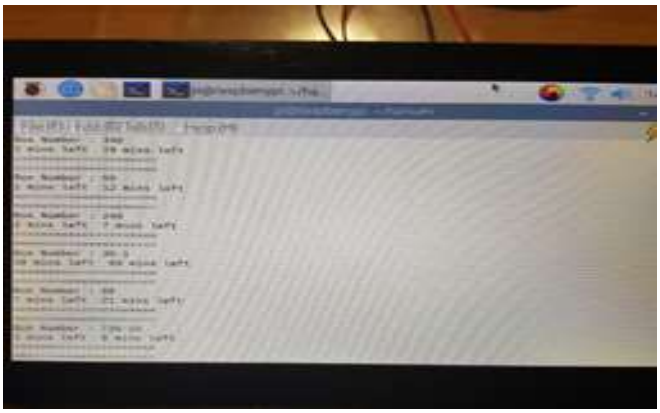

Fig. 3.System Implementation Result 1

Fig. 4 uses the GPS module (NEO-6M V2) to show the location of the current bus using the $GPGGA location information (latitude, longitude). Fig. 5 shows seat availability in the bus seating layout when a part of the body approaches within a scope set for the ultrasonic sensor

Fig. 4. System Implementation Results 2

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Fig. 5.System Implementation Result 3

In Fig. 6, the LED (bell) turns on one minute before the bus arrives at the station by receiving the arrival information of the bus through Raspberry and Arduino WiFi communication

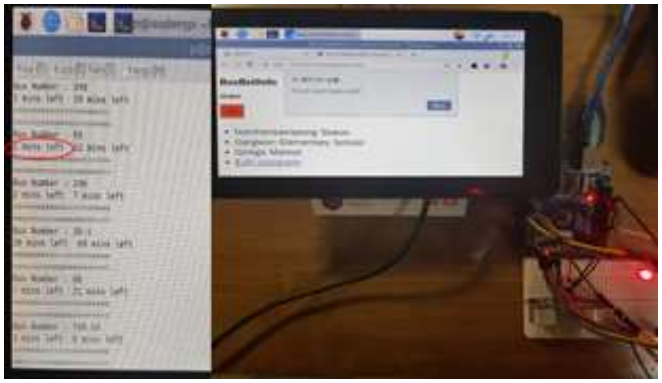

Fig. 6. System Implementation Results 4

IV.PERFORMANCE EVALUATION

Performance evaluation which was performed on bus arrival information and current bus location at the stops in the bus route through Open API using Raspberry Pi are shown in Fig. 7 to 9. Fig. 7 uses the Kakao Map application to compare whether the arrival time values of each bus at the bus stop were accurate when loading the bus Open API in Raspberry Pi. Using the REST method, the Eulji University stop ID was sent to the server. The bus arrival information list of the Eulji University stop and the arrival information list of the corresponding buses indicated on Kakao Map were compared. The results are shown in Fig. 8.

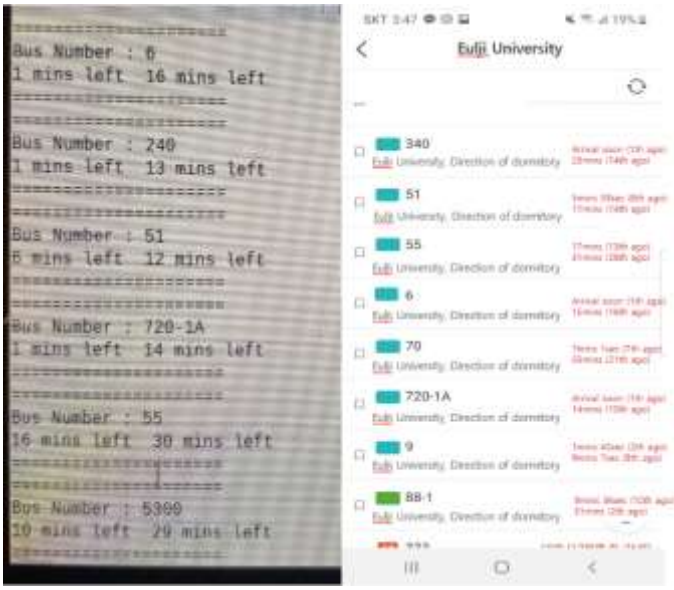

Fig. 7. Performance Evaluation 1

system / Bus number	Raspberry Pi B+	KaKao Map(Application)
6	1 mins left | 16 mins left	1 mins left | 15 mins left
51	6 mins left | 12 mins left	6 mins left | 11 mins left
55	16 mins left | 30 mins left	17 mins left | 31 mins left
720-1A	1 mins left | 14 mins left	1 mins left | 14 mins left

Fig. 8. Performance Evaluation 2

Fig. 8 refreshes and compares 10 times the list of the representative buses such as No. 6, 51, 55 and 7209-1A among the bus lists scheduled to arrive at the stop. Errors were found in No. 6, 51, and 55 buses while bus 720-1A had the same results both in the Raspberry Pi and Kakao Map applications. Buses with errors were not significant. Errors did not have significant impact as the scope of error was within 1 minute. The bus arrival information of the corresponding bus stops displayed by loading Open API from Raspberry Pi was found to be relatively accurate.Fig. 9 shows the result of parsing the $GPGGA location information from the Raspberry Pi GPS module (NEO-6M V2) to obtain the latitude and longitude, which were used to measure the distance in Google Map.

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Fig 9. Performance Evaluation 3

The home address was measured by presuming that it is the current location of the bus. The distance from the coordinates (37.50659, 126.962074) to the Eulji University bus stop coordinates (37.460484, 127.165958) was 18.71 km (11.62 mi). Upon comparing the distance with that on Google Map, the distance from the coordinates (37.50665, 126.962396) to Eulji University bus stop (37.460484, 127.165958) was also 18.71 km (11.62 mi), thus suggesting that the distance measurement results were accurate and had no errors.

V.CONCLUSIONS

In this study, bus location information and bus arrival information at each bus stop were displayed using Raspberry Pi and Open API. In addition, Arduino was used to design and implement bus seat availability and stop bell reservation functions. It was possible to easily identify bus arrival information and current location information without having to use bus applications. These new functions are expected to offer added convenience to passengers and thus lead to increased bus usage.
While it was possible to measure the distance between the location of the bus and the corresponding bus stop, it was difficult to measure the expected travel time due to limitations such as the bus moving continuously and that the GPS module could not properly load the values indoors. In the future, research will be continued on methods to accurately estimate the travel time to the destination.

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