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A development of Intelligent Parking Control System Using Sensor-based on Arduino

Myung-Jae LIM[1], Dong-Kun JUNG[2], Young-Man KWON[3]

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Abstract

In this paper, for efficient parking control, in an Arduino environment, an intelligent parking control prototype was implemented to provide parking control and parking guidance information using HC-SR2O4 and RC522.The main elements of intelligent parking control are vehicle recognition sensors, parking control facilities, and integrated operating software. Whether the vehicle is parked on the parking surface may be confirmed through sensor or intelligent camera image analysis. Parking control equipment products include parking guidance and parking available display devices, vehicle number recognition cameras, and intelligent parking assistance systems. This paper applies and implements ultrasonic sensors and RFID concepts based on Arduino, recognizes registered vehicles, and displays empty spaces. When a vehicle enters a parking space to handle this function, the automatic parking management system distinguishes the registered vehicle from the external vehicle through the RC522 sensor. In addition, after checking whether the parking slot is empty, the HC-SR204 sensor is displayed through the LED so that the driver can visually check it. RFID is designed to check the parking status of the server in real time and provide the driver with optimal route service to the parking slot.

Keywords : Arduino, RFID. Parking Space, Intelligent Parking Control System, Mobile Pay

Major Classification : Artificial Intelligent, Image Classification, Feature Exdtraction

1. Introduction

With the recent surge in urban vehicles, problems such as traffic congestion and parking space search have arisen. In order to overcome the problem of searching for parking spaces, large-scale underground parking lots are being developed in places where there is high demand for parking lots such as downtown areas (Kong & Lee, 2017). The technology-based intelligent system developed within the intelligent transportation system (ITS) needs to be implemented to inform the driver of the distribution of parking levels between or specific parking spaces different from the number of available parking spaces. These ITS-based information systems are operated by using various sensors to detect the presence of machines in parking spaces such as magnetic, infrared, or ultrasonic sensors. These sensors must be installed in each parking space and require considerable installation and maintenance efforts (Muftah & Fernstrom, 2016). Therefore, this paper proposes an unmanned parking control system. Systems that do not control parking automatically by humans, a system that identifies parking areas available in parking

1 First Author, Professor, Department of Medical IT, Eulji University, Korea, Email: lk04@eulji.ac.kr
2 Co-Corresponding Author, Professor, Department of Medical IT, Eulji University, Korea. Email: tchung@eulji.ac.kr
3 Corresponding Author, Professor, Department of Medical IT, Eulji University, Korea. Email: ymkwon@eulji.ac.kr

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lots, a system that guides incoming vehicles to empty parking spaces, a system that provides location of parked vehicles, a free parking system (Steela, Birdsong, & Reddy, 2019).

2. Literature Review

2.1. Parking Control System

A Parking Control System, used for efficient parking, is a system that manage and support parking, including guidance on parking facilities, parking space reservations, vehicle safety management, parking location check, parking fee payment, and broadcasting nearby road conditions (Halleman, 2003).

2.2.1 Remote control Method

A remote controller receiver is mounted on the parking circuit breaker to operate the circuit breaker using a wireless remote controller in the vehicle. It's a simple way to use it, so it's suitable for places with low breakdowns, low cost, and low number.

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2.2.3 RF Method

When a reader is installed in front of a parking breaker and attached to a vehicle, a card recognizes vehicle information and control access. Suitable when there are many incoming vehicles such as apartment complexes and residential and commercial.

2.2.4 Recognize a car number Method

The vehicle is recognized at the time of entering and exiting the vehicle, and the license plate of the vehicle is photographed to manage the recognition result. Operation of the parking circuit breaker by transmitting the license plate to the PC in a photo/video. There is no hassle in enabling rapid vehicle inquiry, and it is suitable for large apartments and residential and commercial complex facilities (Edin & Una, 2018).

2.2 Arduino Board & Sensors

Arduino is a developer platform equipped with a microcontroller capable of program operation. It has a variety of functions so that even developers with professional knowledge in need of complex functions can be satisfied. It also provides a wide range of scalability. Due to its wide range of application, Arduino is actively applied in the educational field where creative and convergent activities take place.

2.3 Ultrasonic Sensor

Sensors use the characteristics of ultrasonic waves, which have frequencies (about 20 kHz or more) that are too high for human ears. Ultrasonic waves can be used on air, liquids, or solids.

Figure 1 : Arduino Board & Sensor

With high frequency and short wavelength, ultrasonic waves can be used for high resolution measurement. The wavelength used in ultrasonic sensors is chosen by the sound speed and frequency of sound waves of the medium, for example, 1mm to 100mm in the sea, 0.5mm to 15mm in the metal detection, and 5 to 35mm in air. The ultrasonic sensor has the same transmission device and reception device of ultrasonic waves, and as for the sensor material, a self-deformation material (ferrite, etc.) or a voltage and electrical deformation materials are used. Figure 2 shows the Arduino ultrasonic sensor HC-SR204.[4].

2.4 RFID

RFID refers to a technology that enables identification of objects such as objects or people using radio frequency (RF). RFID is used as a method of storing information in an RFID tag composed of an antenna and a chip, attaching it to an application target, and then recognizing information through an RFID reader (Faiz, Patrik, Saideep, Omkar, & Nikhilkumar, 2016). RFID is used in a similar manner to reading an existing barcode. However, unlike barcodes, data can be recognized without direct contact with an object or using any aiming line. In addition, multiple information may be recognized or modified at the same time, and information may be recognized even if there is an obstacle between the tag and the reader. RFID allows a large amount of data compared to barcode. Nevertheless, the speed of reading data is very fast and the reliability of data is also high. Data can be repeatedly recorded

according to the type of RFID tag, and can be used semi-permanently unless there is physical damage (Guo, Dong, Li, & Gao, 2017).

3. Intelligent Parking Control System Design and Implementation

Intelligent Parking Control System (Smart Parking) refers to a system that automatically manages the system without human control, to identify available parking slots, guide vehicles to empty parking spaces and bill parking fees. It includes an inter-road vehicle navigation support system that has minimum impact on traffic. Unlike conventional methods, vehicle information is transmitted to the parking DB with vehicle number recognition that minimizes unrecognition and error range through multi-shot, and the driver completes parking according to the signal and guidance control system. Before or during parking, the parking fee is settled through various payment methods through an unmanned calculator, and then FREE-PASS is performed with parking number recognition. In addition, I would like to consider the mobile parking payment method.

It can also be applied to the parking management and management fee system of newly constructed apartment complexes. It is expected to completely solve the problem of parking services in buildings, residential and commercial complexes and apartment complexes that have been a problem.

3.1 System Design

The system in this paper aims to effectively manage parking spaces and promote driver convenience by using various sensors such as RFID sensors and ultrasonic sensors based on Arduino. When parking, RFID distinguishes registered vehicle and external vehicle and a vacant seat is displayed by ultrasonic sensor. This enables the parking lot to be managed by a control system.

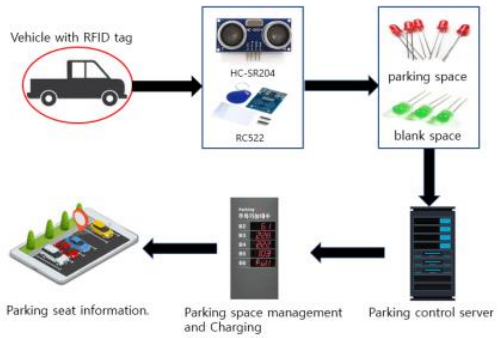

Figure 2 : Intelligence Parking Lot Control System Diagram

Figure 2 shows the overall conceptual diagram of the parking control system designed in this paper. The components of this system are as follows. HC-SR2O4 and RC522 distinguish the parked vehicles and information about available slot is displayed on LEDs. The parking control server manages the parking lot status DB, displays the remaining parking space, and bills external vehicles. Finally, when a registered vehicle enters the parking lot, Control System managed by lot status DB navigates the driver to vacant slot.

3.2 System Algorithm

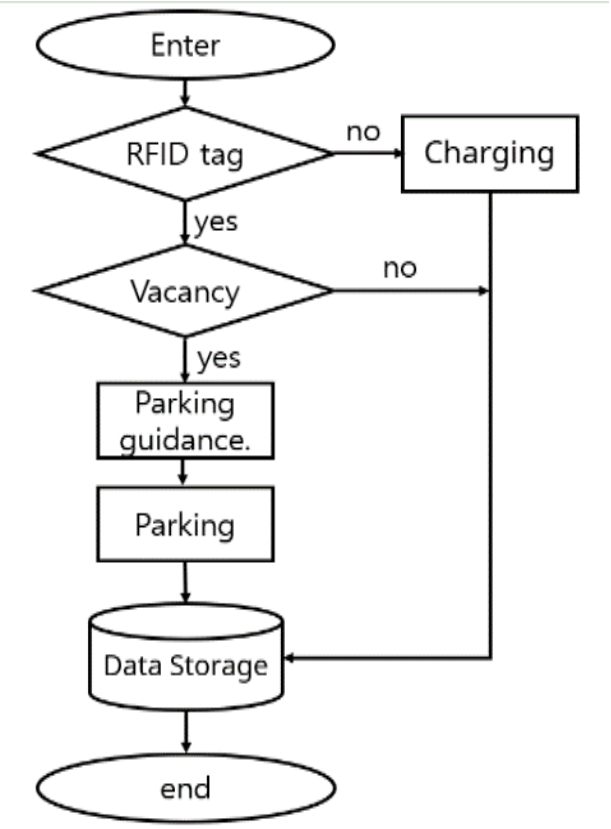

Figure 3 : Parking Lot Control System Flow

Figure 3 above shows parking space management and guidance algorithm using HC-SR204 and RC522. First, HC-SR204 sensor recognizes that the vehicle has entered the parking space. Next, by reading the RFID tag attached to the vehicle with RFID reader installed in the parking space, vehicle is classified into registered or external group. LED is designed to display a red when the vehicle is parked in the parking space and a green when empty. Parking management RFIDs include RFID readers/liters of

a wide range of frequencies, including active 2.45 GHz, active 433 MHz, ultra-high frequencies (UHF 865-868 or 902-928), high frequencies (13.56 MHz), and low frequencies (125 kHz and 134 kHz). RFID leaders or questioners of parking management RFID comply with various international standards such as ISO and EPC Global Gen 2 and are key components of many Internet of Things (IoT) projects. The RFID reader for parking management is used in various industrial fields. Mining operations, construction companies, and manufacturers can track high value assets because of their long reading ranges through active 2.45 GHz and 433 MHz readers. For inventory tracking and monitoring, supply chain and manufacturing customers can choose either UHF 865-868 or 902-928 RFID reader due to read speed, accuracy and low system cost. Other valuable assets, such as game chips and library books, can be tracked using a high frequency 13.56 MHz reader. In addition, when monitoring items in liquid or metal-based environments, they are selected by companies with high frequencies of 125 kHz and 134 kHz. In addition, information about the slot is stored in the server. Based on this information, when the RFID tag enters the RFID reader area, it generates ‘enter’ signal, and ‘leave’ signal when the vehicle is out of the area. When a vehicle with an RFID tag enters the parking lot, it checks the current parking lot status stored in DB and guides the closest slot to the driver's house according to the information stored in the tag. RFID readers installed at each intersection are designed to guide the vehicle to the parking space by indicating the direction for destination.

3.3 System Implementation

The following specifications of the ultrasonic sensor were observed, designed, and implemented. The ultrasonic range module HC-SR204 provides 2cm-400cm non-contact. Measurement function and range accuracy can reach 3mm. The module includes an ultrasonic transmitter, receiver, and control circuit. The basic principle work is as follows.

1) Use IO trigger for a high level signal of at least 10us.
2) The module automatically transmits eight 40 kHz, detects whether one of the following exists, and resends the pulse signal.
3) When the signal returns through the high level, the high output IO duration is the time from ultrasonic transmission to return.

The following are the precautions for implementing Arduino. It is not desirable to connect the module directly to electricity. When connected to electricity, the GND terminal must be connected first. Otherwise, it affects the normal operation of the module. When testing an object, the area is more than 0.5 square meters and if the plane requests it as smoothly as possible, it affects the measurement results.

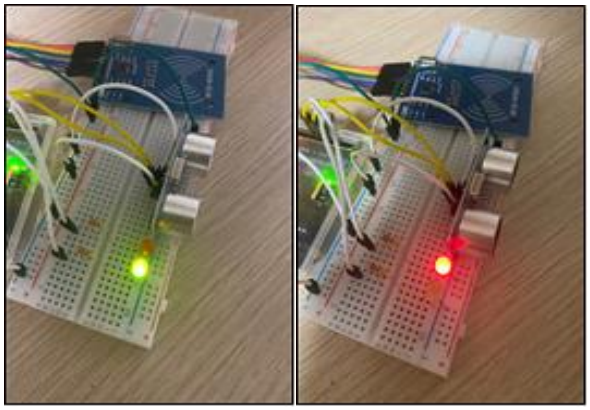

Figure 4 : Parking Signal

Figure 4 shows the implementation of parking space management using Arduino HC-SR204 and RC522. The left side indicates an empty slot, and the right side indicates occupied slot.

```
#include <SPI.h>
#include <MFRC522.h>
#define RST_PIN
#define SS_PIN
MFRC522 mfrc522(SS_PIN, RST_PIN);
void setup() {
        Serial.begin(9600);
        while (!Serial);
        SPI.begin();
        mfrc522.PCD_Init();
        mfrc522.PCD_DumpVersionToSerial();
        Serial.println(F("...")); }
}
    void loop() {
         if ( ! mfrc522.PICC_IsNewCardPresent()) {
                  return;
         }
```

Figure 5 : HC-SR204 and RC522 Code

Figure 5, the content of the source code below is an implementation part for Arduino HC-SR204 and RC522 interworking, and expresses the basic setting values and the process for repeated execution.

Figure 6 is the content that implements the operation of the control system, and red and blue signals may be operated using the result of the recognized image.

```
int trig = 2;
int echo = 3;
void setup() {
      Serial.begin(9600);
      pinMode(trig, OUTPUT);
      pinMode(echo, INPUT);
}
void loop() {
       digitalWrite(trig, HIGH);
       delayMicroseconds(10);
       digitalWrite(trig, LOW);
       int distance = pulseIn(echo, HIGH) * 340 / 2 /10000;
       Serial.print(distance);
       Serial.println("cm");
       delay(100);
}
}
float duration, distance;

if ( ! rfid.PICC_IsNewCardPresent() ||
! rfid.PICC_ReadCardSerial()) {
digitalWrite(6, HIGH);
delayMicroseconds(2);
digitalWrite(6, LOW);
duration = pulseIn(5, HIGH);
distance = ((float)(duration * 340) / 10000) / 2;
if(distance < 20){
digitalWrite(3,LOW);
digitalWrite(4,HIGH);
}
else {
digitalWrite(4,LOW);
digitalWrite(3,HIGH);
}
}
MFRC522::PICC_Type piccType
= rfid.PICC_GetType(rfid.uid.sak);

if (piccType
!= MFRC522::PICC_TYPE_MIFARE_MINI &&
piccType
!= MFRC522::PICC_TYPE_MIFARE_1K &&
piccType
!= MFRC522::PICC_TYPE_MIFARE_4K) {
}

if(rfid.uid.uidByte[0]== A &&
rfid.uid.uidByte[1]== B &&
rfid.uid.uidByte[2]== C &&
rfid.uid.uidByte[3]== D) {
digitalWrite(3,LOW);
digitalWrite(4,HIGH);
```

Figure 6 : System Implementation Code

4. Conclusion

This paper proposes an intelligent parking management system with the following functions to solve various problems caused by a lack of parking space. First, we quickly implemented prototypes at a low cost using Arduino. Through this, we simulated whether it can be applied and utilized in real situations. The functions of the proposed system can be divided into parking space management and guidance information management. The parking space management function is a function that displays the total number of parking available by checking and notifying parking sections, and the information management function is a function that presents the most suitable parking location through machine learning for frequently parked places. When a vehicle enters a parking space to handle this function, the automatic parking management system distinguishes the registered vehicle from the external vehicle through the RC522 sensor. In addition, after checking whether the parking slot is empty, the HC-SR204 sensor is displayed through the LED so that the driver can visually check it. RFID is designed to check the parking status of the server in real time and provide the driver with optimal route service to the parking slot. Through this function, the presence or absence of a parking space can be checked, limited parking space usability and parking convenience can be expected to be improved by giving management convenience and accessibility, and environmental improvement such as minimization of idling is expected.

As a future research project, since this paper presented a prototype for simulation, there are some areas to be supplemented in the lack of camera recognition rate, malfunction of the interlocking device, and response speed. In addition, it is necessary to add a function for space management for the elderly and pregnant women as a space for the transportation vulnerable, which is being realized in actual parking spaces.

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