Design and Development of Disabled Parking System for Smart City

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Abstract. Violation of the disabled rights has become one of the highly debated issues in today’s local community. Nowadays, the community is less aware of the abuse that occurs in their surroundings. In disabled-parking spaces context, it has become common to violate that allocated spaces without guilty. Having this situation is a complete disaster as it now becomes a norm for the non-disabled to park at the disabled-parking spaces. This project aims to design and develop alarm system in securing the parking spaces for the disabled by using current technology which is Internet of Things (IoT). The components used are Arduino UNO, RFID RC522 reader, HC-SR04 Ultrasonic Sensor, LED and buzzer as the alarm. This product system caters the understanding on how to protect the disabled-parking spaces.

1. Introduction

Urbanization in these few decades had been influencing the way citizen live and work. The urban areas are expanding at a breakneck pace, depending on the population and business activities and most importantly the growth of the population that proliferates in these regions [1]. In 2030, United Nations predicts that our population will be increased to 1.35 billion, and thus making it to more than 7 billion people currently [2].

In conjunction with the rise of the population, an example of what Smart City architecture looks like in which operating the cities in an innovative path is related to the solution of the urbanisation crisis [3]. In this case is the crisis about the disabled parking spaces violation by the non-disabled. This research is conducted to find a solution for the issue that uses the Internet of Things (IoT) technology as part of the building blocks for the research and development.

Urban areas are covering the population that is seeking the best lifestyle and fulfilling their needs. However, the problem with the urbanisation is that the vehicle parking spaces are becoming limited due to the high-density population. As the demand for parking spaces are increasing, some people tend to break the rules and violating others rights. In this context is violating the disabled parking spaces. Not only cars that violate, but even motorcyclist also take granted of the spaces to park their
motorcycle easily. It becomes a norm to the community, and if no further action or solution were taken, the disabled would be helpless in any situation.

Moreover, for the authorities to monitor the parking spaces are quite challenging as to detect illegal parkers cannot be recognised easily [1] - which made this a continuous problem for the disabled to face every day if there is no solution provided to them. The issue for the disabled parking spaces can be solved, and able-bodied can realise the importance of respecting the disabled rights. Hence, the outcome of this research can contribute for educating the people to aware the disabled place in the community.

This project intends to monitor the disabled parking spaces using the Internet of Things as a platform. The proposing project covers the usage of microcontroller platform, along with motion sensors and alarm system as to warn illegal parker. The prototype developed would picturised the situation in protecting the disabled parking spaces.

This paper outlines, introduction in the first part, which discusses on the overview and objective of the paper. Next part is related works. After that is the detailed discussion regarding the method, result and discussion. The last part refers to the final conclusion of this paper.

2. Related Works

The DisAssist System was developed to assist the disabled in finding their parking spots, at the real-time condition and also enable authentication of the parkers to be exactly legal to park at the reserved spots [1]. DisAssist System role enhanced the disabled experience in parking management system with the usage of Machine-to-Machine (M2M) technology that ease the findings of the disabled parking spaces. Furthermore, with the authentication system that enables the deserved parkers to park at their spaces (in this case is the disabled), can be monitor by the authority and further action can be taken to those who violated the rules and regulations. Another study developed locomotive alarm and parking system to monitor the locomotive using infrared technology. The function of the system is to automatically park, alarm and avoiding accidents between locomotives [4]. SmartEye was developed using infrared technology to monitor the parking spaces, and the sensors are put on the road. The information about the parking is then sent to the content management, known as SmartRep that collects the data about parking spaces. This system also comes with an application for the user to search empty parking spaces in the area. It transmits 433 MHZ signals onto the server with the use of monitoring the parking area.

Table 1 illustrates the comparison between the three of the related works. These comparison criteria are based on what technology does it use, involving the use of Radio Identification (RFID) and the law enforcement role in monitoring the system.

| Table 1. Comparison between related works. |
|-------------------------------------------|
| Wireless Sensor | Infrared | RFID Tag | Law Enforcement monitoring |
| DisAssist System | Yes | Yes | Yes | Yes |
| Locomotive Alarm and Parking System | No | No | No | Yes |
| SmartEye | Yes | No | No | Yes |

The Disabled Parking System is different from all the compared works as mentioned earlier. Instead of relying on law enforcement monitoring, the system can give alarm itself whenever violations have occurred. It is a burden for the authorities to come whenever a violation occurs. By using the alarm technology, Disabled Parking System can self-remove the violators by making them
like the attention to the public. Psychologically, the violators will be aware of their action, and with others also notice them, the probability is high that they will move to other parking spaces.

3. Implementation of Disabled Parking System

Figure 1 illustrates the flow of the Disabled Parking System. The process starts with a car entered the parking spot. Once it reaches a distance that is set up, the RFID reader will be activated to find any authorized RFID tag. If the RFID detected is legal, then the system will indicate that the parking is deserved to the disabled by blinking the green LED. Vice versa, the LED will blink red, and buzzer sound will be on to indicate that the violation of parking space by the non-disabled. Also noted that the red LED and buzzer will be sound as long as RFID reader cannot detect the RFID tag. By using this simulation process, the further steps can be planned especially on setting close approximation of the sensor and RFID reader.

![Flowchart for Disable Parking System working flow](image1)

**Figure 1.** Flowchart for Disable Parking System working flow

The design and development of the study involve three development sub-phases aimed to design a functional prototype as illustrated in Figure 2.

![Phases involved in the development of Disabled Parking System](image2)

**Figure 2.** Phases involved in the development of Disabled Parking System
3.1. System Visualization
In this step, the system is simulated through visual on how it should work based on the flowchart in Figure 1. Figure 3 and 4 is the visualisation of the Disabled Parking System. From this visualisation, it illustrates the suitability of the sensor location on the parking space. The sensor resided at the in front of the parking space as to detect any car entering the parking. In Figure 3 is the illustration of what the situation like when a car with ‘true’ RFID tag that can be resembled as the disabled. Similar to Figure 4, is the opposite situation when ‘false’ RFID tag is entering the spaces, activating the buzzer and LED to warn the violators.

![Figure 3. Disabled Parking System Visual of Car with RFID Tag](image1)

![Figure 4. Disabled Parking System Visual of Car without RFID Tag](image2)

3.2. Schematic Diagram and Assembles
The next part is to draw a schematic based on the visualisation of the Disabled Parking System. Schematic is important because it supports the comprehension of the system during the assembling part. Electrical components consist of several rules and understanding. The process of wiring must be done precisely by going through the calculations of how much voltage for each component and the flow of the wiring with a connection to Arduino Uno pin. Otherwise, the components will be damaged because of the overpower supplied to them. Below is the list of components that were identified and used for this project.

1) Arduino Uno – microcontroller as the main component
2) Ultrasonic Range Sensor HC-SR04 – sensor for detecting the car movement
3) RFID RC522 Reader – Passive RFID reader
4) Passive buzzer – sound alarm for the system
5) Red and Green LED – indicator for the disabled and able-bodied
6) 220 Ohm Resistor – Resist excessive current for LED
7) Breadboard – additional pin connector for Arduino Uno
8) Jumper wire – connect components to Arduino Uno
The Fritzing software is used to draw the schematics as it was the perfect tool that most developers used for their project. In this software, there are a lot of Arduino components, sensors and other related tools that can be used. Developers also can detect any error in the connection of the components and correct it right away.

Figure 5 illustrates the first connection to the breadboard for ultrasonic sensor HC-SR04. The sensor consists of four pins. The trig pin, echo pin, integrated power supply pin or ‘vcc’ and ground pin or ‘gnd’. The sensor works in a manner starting from echo that will spread the sonar around the area. Once it hit an object, it will reflect back to the sensor, and trig pin will read for further action. The ultrasonic sensor used 5V of power and did not need any resistor or transistor on the breadboard. The ability of the sensor in reading distances can be up to more than 70cm. For this project, the distance will be used less than 30cm for triggering RFID reader.

The second connection as in Figure 6 involves connecting the RFID RC522 Reader to the breadboard. RC522 reader consists of 8 pins in which for the project will be used only 7. Besides the ‘vcc’ and ‘gnd’ pin for power source and ground, the reader also being built with five other pins that will read and write the tags. It includes RST, IRQ MISO, MOSI, MISO and SCK. The RC522 only requires 3.3V and can be powered up directly at the 3V3 pin on Arduino Uno without using any components in the middle between them.

![Figure 5. Ultrasonic Sensor Connection to Breadboard](image1)

![Figure 6. RFID RC522 reader connection to breadboard](image2)

As in Figure 7, the final part of this assembly was the connection between passive buzzer and also the red and green LED. The buzzer used three pins with two of the jumper wire (‘vcc’ and ‘gnd’) shared the same current flow of the RFID RC522 and Ultrasonic sensor. Meanwhile, for the LED, it requires the 220ohm resistor because the LED only consumed 2V of power. Otherwise, it will be damaged because of the overpower.
3.3. Programming the Arduino Uno

The commanding of Arduino was done after the assembled part had completed. In this development process or known as sketches, the Arduino Integrated Development Environment or Arduino IDE was used and connected to the Arduino Uno using USB cable. There is two main part in the Arduino process; the setup and loop.

3.3.1. Setup Process. Before programming the main process, the Arduino Uno had to be defined first of its pin that connected to the component. The setup segment also must have contained the library that the program referred to. Arduino has many libraries for the components. For example, the RFID RC522 has its libraries to be used. Also, different RFID module also has different libraries to be used in the loop process.

The next part was defining the pins that were used to connect the components. The void setup function starts using the libraries, initialise variables and pin modes either input or output. The setup function only run once for each power-up of the Arduino Uno. Serial begin Sets the data rate in bits per second. The higher the rate of data, the faster the process of Arduino. For this project, it was suitable to set the data rate to only 9600 bauds. Another rate could be 115200 bauds, which was the fastest processing for the board.

3.3.2. Loop Process. Loop section is the primary process for Arduino. In this part, the loop function subject for checking the pin consecutively and allows the developer to change and respond of that pin. It controls the Arduino Uno behaviour by giving the task of what it should do. The sequence of the loop started with the programming of the ultrasonic sensor that converts microseconds to centimetres or inches.

Next, the loop would process the sensor by giving it a condition to carry out a certain task. In this project, the sensor would activate the RFID RC522 reader if the distance is less than 7 inches. Along with RFID reader, the buzzer also would sound, indicating the probability of a violation of the parking. Once RFID tag was found as true, the buzzer would stop.

In Figure 8, the program segment shows the RFID ‘false’ process. Once it detects the ‘false’ state, it then sounds up the buzzer with displaying the message. In Figure 9 is the program segment of ‘true’ state of RFID tag. Delay for this project was put for 10,000 milliseconds which equals to 10 minutes - which results in the sensor and RFID reader taking a new reading for every 10 minutes.

Figure 7. Passive buzzer and LED connection to breadboard
if (content.substring(1) == "HE 64 AE 73") {
    Serial.println("Hello dear, please remove your car. It's not yours...");
    for(i=0; i<100; i++){
        digitalWrite(buzzer,HIGH); // sound
        delay(1);//delay(ms)
        digitalWrite(buzzer,LOW);//not sound
        delay(1);//ms delay
    }
}

else {
    content.substring(1) == "17 D9 94 AB";
    Serial.println("Hi dear, this parking is for you. Have a nice day!");
    Serial.println();
    //exit(0);
    delay(10000);
}

Figure 8. Program segment of ‘false’ RFID tag

Figure 9. Program segment of ‘true’ RFID tag

4. Conclusion

Disabled Parking System was designed and developed as a conceptual guideline of how technology can be applied as to preserve disabled rights, specifically regarding parking rights. Through this project, the usage of Internet of Things (IoT) approach and technology can be broadened for more sophistication in concreting of disabled parking spaces protection.

References

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