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Research paper

Arduino Smart Parking Manage System based on Ultrasonic Internet of Things (IoT) Technologies

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Abstract

Nowadays, the Internet of things (IoT) plays an important role in our life by connecting things with humans via the internet. This study proposes a smart system based on Arduino components, website and mobile application. The system helps drivers to find an empty park space depending on the number of unoccupied lots in the park. The parking lots are impossible to be reserved with the ordinary parking system. This study provides a mobile app that can be utilized to find a free lot in a nearest park. Smart parking can increase the economy by reducing fuel consumption and pollution in urban cities. Moreover, it helps to reduce the time of finding car lot. Also, it helps the driver to find his car when he forgets the car location easily. However; the system adopts new tables' structure, yellow booking light in the parking lot, books and buys through app and gate monitor. Finally, the system shows the reserved, booked and empty lots in park for staff and drivers.

Keyword: *Smart car park, Ultrasonic sensors, Parking lot, Reservation*

1. Introduction

In the last few years Iraqi government is applying electronic services in order to provide a good and fast services to the citizens (Mohammed, Kadhim, Fuad and Jaber, 2014). The mobile application plays important role in public sector services (Anad, Kadhim, Mohammed and Albo baqer, 2018). It can also apply to the private sector such as- smart parking. The improvement of the current economic circumstances has helped many people to live luxuriously. Undoubtedly, having a vehicle is one of these luxuries (Yang, Portilla and Riesgo, 2012). The increase in the number of vehicles led to a shortage of parking places and severe traffic jams. Thus, this study addresses this problem by suggesting a way of booking a parking place through smart mobile applications. The drivers can space not find parking lot easily, thus, drivers park everywhere (Kianpisheh et al., 2012). The problem of not having enough parking places is a common problem in Iraq, even before this high increase in population. The idea of regulating the use of public parking places is based on the philosophy that they are (Kianpisheh et al., 2012)- Smart parking system (SPS) architecture with the ultrasonic detector (Grodi, Rawat, & Rios-Gutierrez, 2016).

Finding a parking lot in a multilevel parking lot is difficult, especially on public holidays or weekends (Srikurinji, Prema, Sathya, Manivannan, & Arasur, 2016). Smart Parking System Architecture Using Infrared Detector is an approach to solve this problem (Srikurinji, Prema, Sathya, Manivannan, & Arasur, 2016).

Parking is limited in most cities including entertainment such as-restaurants, movie and theatres, and major attractions like shopping malls, zoo and public park, around the world (Yan, Yang, Rawat, & Olariu, 2011),)Gillen 1978), lose timetable while searching for parking lots (Grodi, Rawat, & Rios-Gutierrez,2016). lives, The requirement of life increases day by day, civilized need centralized human facilities, shopping are an important view which provides a duplicate of services, more citizens are attracted to them (Polycarpou, Lambrinos, & Protopapadakis, 2013). As a result, inadequate parking supply can create problems for both (ordinary users and new user) (Ahmed, 2007).

In Iraq, the situation is somehow different than other countries due to the difficulty of finding parking lots. Therefore, divers stop the vehicle anywhere even in front of the house's gate. In addition, some of the parking are not authorized, that is why the parking cost is not fixed.

Moreover, the majority of facilities in the parking is unpaved, without lines, no lot index, no roof, no lights and unlimited time, that's why it is difficult to find parking lot because of unorganized parking, there is a small number of multilevel car parking. Thus, this study contributes to solving some of these problems by creating smart parking (mobile application, webs and Arduino technology). Parking is needed to be prequalified to attract the driver for using it. Majority of the public parking in Iraq currently operate without a computerized system. They usually require vehicle owners to walk around and manually check the occupancy of individual lots.

1.1 Related Works

Many studies are available about smart parking by using mobile app; two of them have been selected to review in this study. Because these are, have same concept, using table structure.

1.2 Smart Park in Malaysia

The study focused on calculating the shortest distance from the parking lot and making the information entrance, the information gained from the detection sensor and calculation from the shortest path algorithm is used to guide patrons to the parking lot. These operators use the sensors (information collection assist for manage and controlling) (Idris, Tamil, Noor, Razak, Fong, 2009).

1.3 Ksa Smart Park

Most of the developing countries nowadays use technologies to provide better services to people (Mohamme, Aboobaider, Ibrahim, Abdullah, Ali, Jaber and Shawkat, 2016). The study applied the smart parking to the KFUPM hostel students, which are mostly filled. The students lose time when looking for availability of parking lot. The system sends Short Message Service (SMS) to student Mobile and informs each student about the closest parking lot through a display board.

Using RFID reader to check Student smartcard for checking authorized and unauthorized students are shown in figure 1.

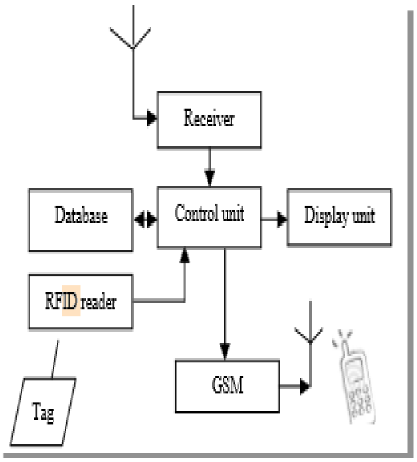

Figure 1:. Block Diagram of Central Control Unit

1.4 Proposed Architecture

The proposed architecture consists of four modules, as shown in figure 3.

System Overview

The main idea is dependent on IoT, the system depends on the Wireless Sensor Network (WSN) (Akyildiz, & Kasimoglu, 2004). It is derived from the concepts of IoT (Holler, Tsiatsis, Mulligan, Karnouskos, & Boyle, 2014).

Ultrasonic sensors transfer sound waves between 25kHz and 50kHz. The reflected energy is used to examine and detect the status of a parking lot. Ultrasonic waves are sent out from the head of an ultrasonic detection sensor every 60 milliseconds, and the existence or absence of vehicles is depending on time differences between the sending and receiving signals. Ultrasonic sensors can utilize to compute vehicles and estimate the occupancy status of each parking lot. (Mimbela, & Klein,2000).

Ultrasonic sensors technology is used to observe car parking. The Ultrasonic is installed above each parking lot to check the state of the available lot in each park, the use of ultrasonic sensors facilitates the implementation of the high-scale system at low cost. The system provides a mechanism to stop disputes in the car park and manages to minimize wasted time in looking for a parking space.

Ultrasonic sensors depend on sound instead of light and they work much better in outdoor environments (Kianpisheh, Mustaffa, Limtrairut, & Keikhosrokiani, (2012).

These sensors work through sending out a regular rhythm of high-frequency sound and calculate the time it gets the echo to return. The time of sending waves can be used to check the distance to the car based on the frequency of the pulse (Grodi, Rawat, & Rios-Gutierrez, 2016).

This system suggests using three colours for different park lots (Green, Yellow, Red) to guide driver with Park No. him/her with Guard Park to show them the right place (given to the driver when).

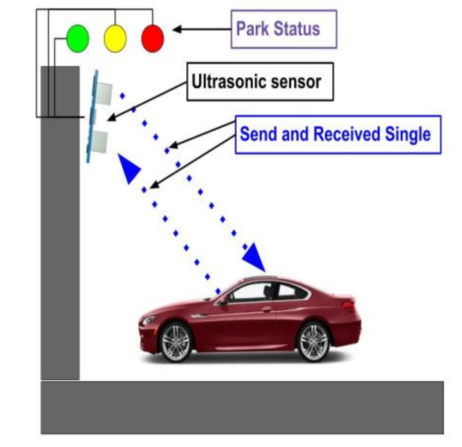

Figure 2:. Ultrasonic Sensor Work

In order to find the status of an individual parking lot, different methods have been utilized, such as the installation of ultrasonic sensors at each space (It requires many sensors) (Yamada, & Mizuno 2001).

Ultrasonic sensors are classified as nonintrusive sensors, meaning that they need simpler installation in contrast to intrusive sensors (Kianpisheh et al., 2012), for that reason, this study used the ultrasonic sensor.

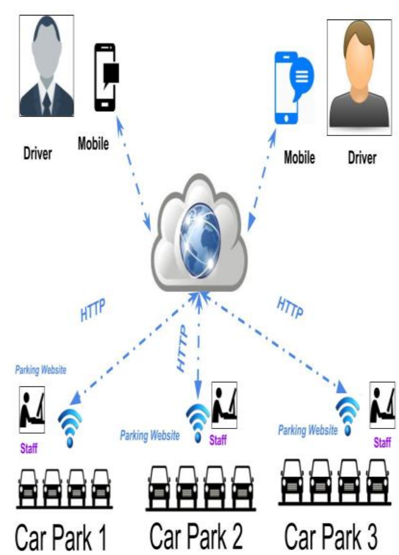

Figure 3:. Architecture of System (Arduino Smart Park System Description)

The creation of an easy-to-own mobile application, which will be available to all vehicle owners who can easily book a parking place. It saves the drivers time and effort in the search for the availability of parking lots (Lu, Lin, Zhu, & Shen,2009). Moreover, security to park section, also makes it easier for the owner of the Park to get rid of the tiring traditional calculation methods. Through the availability of such systems electronic work, the owner of the park is able to know the number of available vehicles and the number of reserved and vacant places. The most important benefit is the addition of the speed factor to work and accomplishs the task with less time and cost.

2. System Operation

This section describes the operations of the system. It includes two scenarios- one, the driver uses the QR code of the application to book free lots and to open the gate from the monitor.

The second scenario is when the driver does not use the application then he/she should use the monitor to find a suitable lot according to their needs.

2.1 Registration

Users, who want to send requests through a mobile application, should register as a member of the system. Our system contains the driver's details as Driver License, Driver's Name, Cell phone, Email, and License. After successful submission, as shown in figure 4;

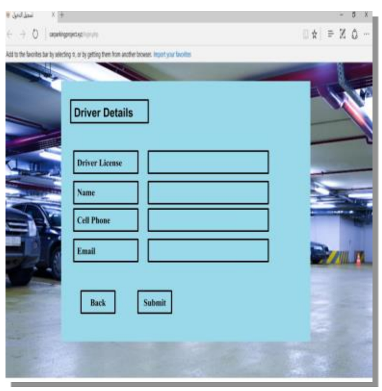

Figure 4:. Driver's Registration

The user must fill in the vehicle details after submitting form the driver's registration from. Vehicle details include Vehicle ID., Vehicle Model, and Vehicle Color, as shown in figure 5;

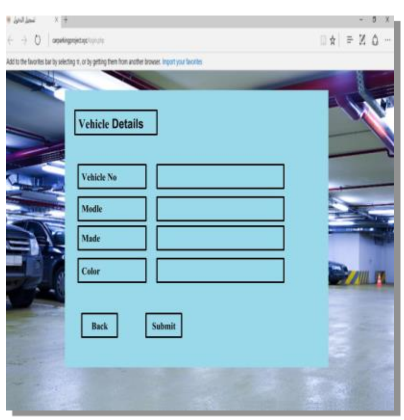

Figure.5: Vehicle Registration

2.2 Find the Nearest Work

At the beginning needs to, the user needs to install the application and register by inserting details all the including (Personal /Vehicle information), then search for the nearest park available to the driver's area as shown in figure 6;

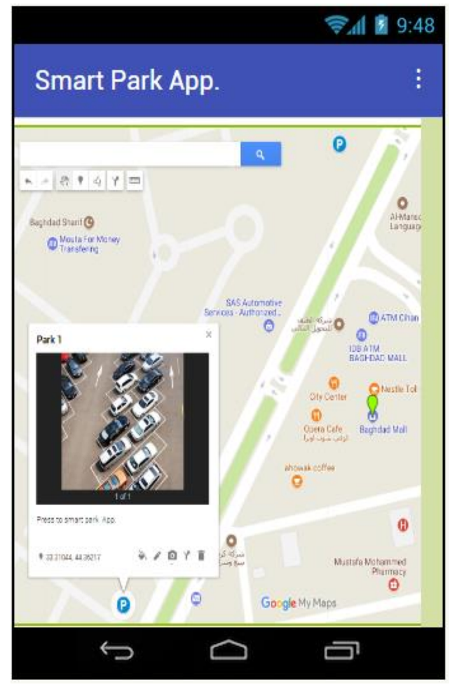

Figure 6:. Find the Nearest Park using Google Map

2.3 Booking Request

In order to book a parking lot, the system sends message contains the following attributes: User Name, Vehicle ID, Time In, Time Out and Payment Method as shown in figure 7.

Figure 7:. Booking Interface Request

2.4 Book Park

When a user sends a request to book a parking lot, the application will display all available parking lots, the driver chooses the best location. The system helps the staff to show the number of requests from the drivers including the 'Time In' and 'Time Out' for a particular park. The driver receives the number of park and QR to help the user to enter the park to provide accessibility to the park. The system will allow the staff to know the stutas of the lot (i.e., free reserved and occupied). As shown in figure 8 and table 1;

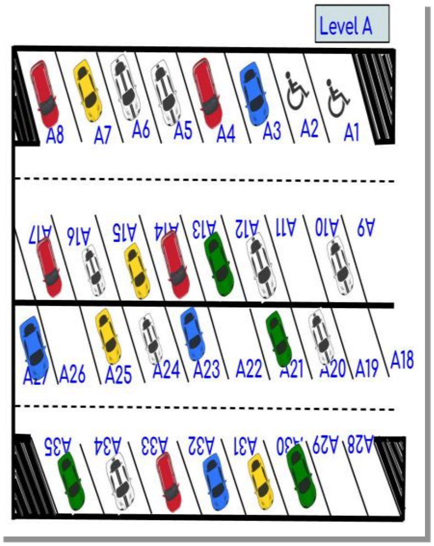

Figure 8: Best Location for Parking Space chosen by the Driver

Table1: System case operations for table cases

Vehicle ID	Parking Space	Case	Time In	Time Out	Payment Method
R21230 Baghdad	A-09	occupied	8:33 AM	10:44 AM	Cash
D7654100 Hilla	A-13	occupied	8:40 AM	8:44 AM	Credit Card
M33098 Hilla	A-15	reserved	8:42 AM	9:44 AM	Credit Card
R21230 Baghdad	A-16	occupied	8:45 AM	10:44 AM	Cash
R92390 Basrah	A-17	occupied	8:49 AM	10:44 AM	Cash
R27530 Wasit	A-18	occupied	9:09: AM	10:44 AM	Cash
R234530 Hilla	A-19	occupied	9:13 AM	10:44 AM	Cash
R995380 Basrah	A-01	reserved	8:34 AM	12:00 AM	Credit Card
R21230 Baghdad	A-02	occupied	8:35 AM	1:00 PM	Credit Card
M33098 Erbil	A-03	occupied	8:36 AM	2:00 PM	Credit Card
R234530 Dahuk	A-04	occupied	8:37 AM	12:00 AM	Credit Card
R773388 Kirkuk	A-05	occupied	8:38 AM	12:00 AM	Credit Card
S76598 Basrah	A-06	occupied	8:40 AM	1:00 PM	Credit Card
T600 Najaf	A-07	occupied	8:45 AM	6:00 AM	Credit Card
R975398 Kirkuk	A-08	occupied	8:49 AM	1:00 PM	Credit Card
R8075126 Najaf	B-01	occupied	8:38 AM	8:00 AM	Credit Card
R4758 Al Anbar	B-02	reserved	8:35 AM	2:00 PM	Credit Card
R70998 Dhi Qar	B-03	occupied	0.399306	1:00 PM	Credit Card
R975398 Najaf	B-04	reserved	10:35 AM	11:00 AM	Credit Card
R825790 Diyala	B-05	occupied	10:37 AM	1:00 PM	Credit Card
A33456 Najaf	B-06	occupied	10:39 AM	12:00 PM	Credit Card
B21240 Baghdad	B-07	occupied	10:41 AM	1:00 PM	Credit Card
M533076 Erbil	B-08	occupied	10:43 AM	2:10 PM	Cash
R985330 Dahuk	B-09	occupied	10:45 AM	3:10 PM	Cash
R987088 Kirkuk	B-10	occupied	10:47 AM	4:10 PM	Credit Card
Y58598 Basrah	B-11	occupied	10:49 AM	2:10 PM	Credit Card
K934500 Najaf	B-12	occupied	10:51 AM	2:14 PM	Cash
U977744 Kirkuk	B-13	occupied	10:53 AM	2:18 PM	Credit Card
H663311 Najaf	B-14	occupied	10:55 AM	2:22 PM	Cash
K9967 Al Anbar	B-15	occupied	10:57 AM	2:26 PM	Cash
F995544 Dhi Qar	B-16	occupied	10:59 AM	2:30 PM	Cash
C7799418 Najaf	B-17	occupied	11:01 AM	2:34 PM	Cash
Z7754310 Diyala	B-18	occupied	11:03 AM	2:38 PM	Cash
L809468 Najaf	B-19	Free	11:05 AM	2:42 PM	Credit Card
P98212 Baghdad	B-20	Free	11:07 AM	2:46 PM	Credit Card

The driver will get his booking receipt showing the booking information include QR code, the park number personal and vehicle information as shown in figure 9;

Figure 9: The parking lot booking receipt

2.5 Car Park

When the driver reaches the park guided by/using the message received from the system, drivers scans the QR Code image displayed in his/her mobile to enter the park as in figure 10;

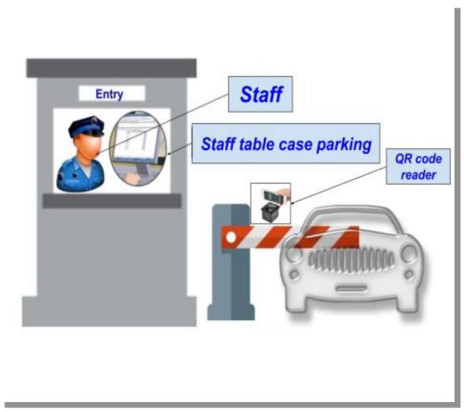

Figure 10:. The driver scan QR code from his/her phone

After completing the scan, the driver will provided with a receipt showing the short path to reserved lot as shown in figure 11;

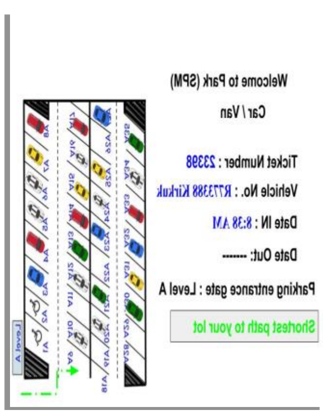

Figure 11:. Receipt showing all details to Driver

Sometimes, the driver does not follow the parking number that is sent to him by mobile application, the staff then faces a problem with other drivers that revives message but it already is parked from other drivers. The system can update the state of the parking lot to a pending state during the process of finding another available lot (empty or reserved). If the staff can be sure that the reserved park is not conflicted with another user, (from the table which includes Time-In and Time-Out) it changes the case to available. It means the state of the overall parking system can update in real time. Moreover, the system supports a permanent parking case in which the parking lot can be booked for a longer period of time.

3. The Algorithm of the System

The algorithms of the proposed system and implementation in this section

3.1 System Operations

When a user tries to find a parking lot, he should register to find a free parking lot by using the system, then he sends a request through the application. The system will get the request and check the table of available parking to receive the message and to check the park using table and LCD display based on an ultrasonic sensor. When a car reaches a parking lot, the drivers should be verified by staff. This verification process is achieved via checking the parking website. If the information is correct, the driver received a receipt and enter the park. Later, the driver checks if the lot is empty. If so, then he will park and the change the state from reserved to park. If the current car parking space is full, the system will send a new message that includes-Try another Park! Unavailable Space, as shown in Figure 12;

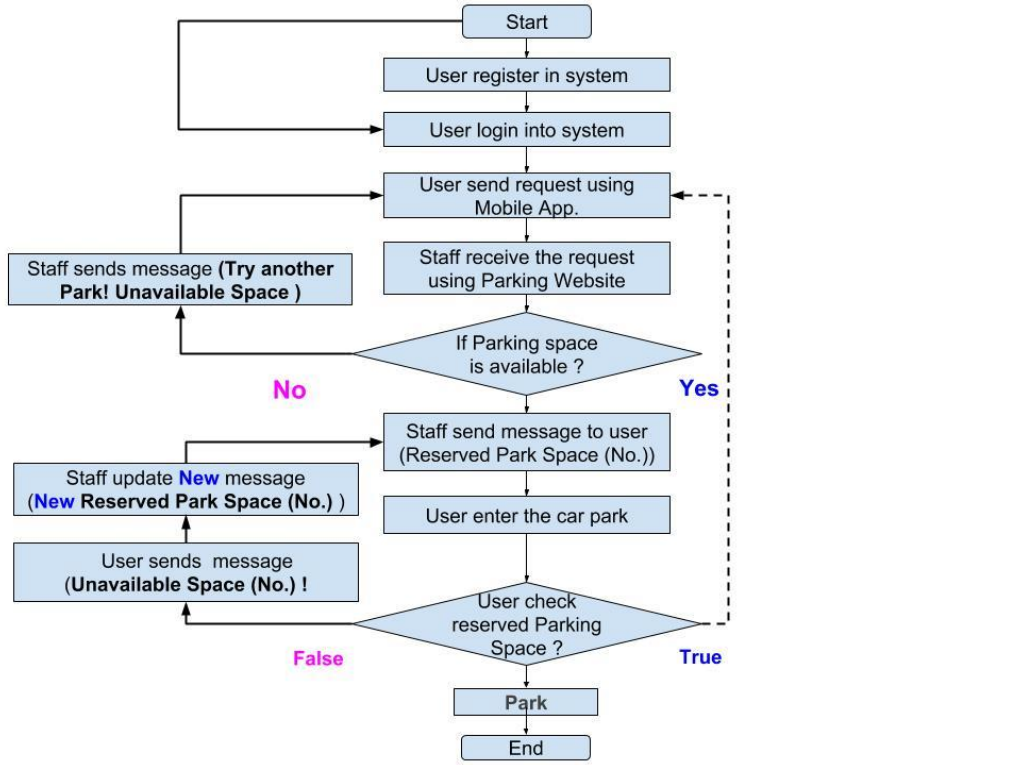

Figure 12:. Algorithm of System Operations.

3.2 Update Table

After parking the car, the ultrasonic sensors detect the change in the signal. The system updates the state of each lot every 2-3 minutes to update the table case, the achieved by the setting of the system as shown in figure 13;

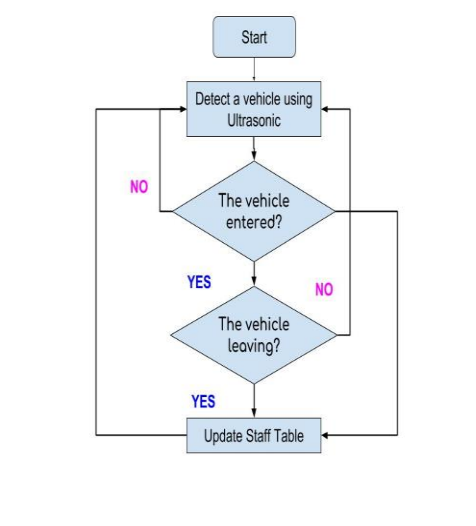

Figure 13:. Algorithm update staff table

Update urgent data on a new vehicle park contains the new address. The new message will be selected based on the reserved parking lot of the current vehicle.

3.3 Monitoring System

Figure 15 shows the state switch for each individual parking lot. The parking lot can be in one of the following four statuses: Busy, Lot, Reserved and Unavailable. The existing status for each single parking lot state is recorded in a database. The system ensures that only the allowed state switch will pass. This system checks the queries of the database for booking and determines if some users do not arrive a coordinate to their reservations.

The system can receive a request from users and keep it in the database for current busy park and recognize if some users failed to reach their reserved parking lot.

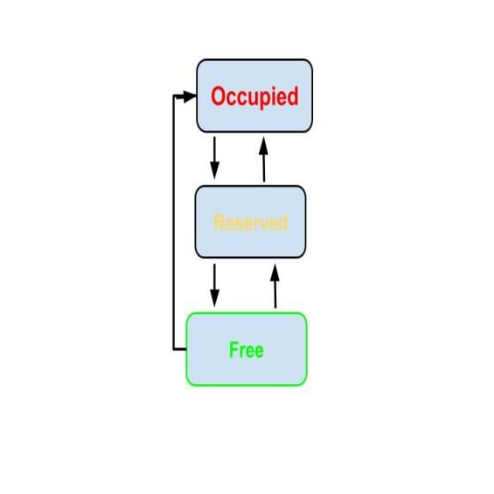

Figure 14:. Diagram for single parking lot

3.4 Arduino Components

The system uses the following components:

Arduino MEGA 2560 R3

LCD: LiquidCrystal_I2C library

Servo Motor (SG90)

Wi-Fi_ Esp8266

Ultrasonic

Push button

Breadboard

3.5 Hardware Schematic

3.5.1 Implementation System

The system uses Ultrasonic sensors to detect the parking status. System as shown in figure 16;

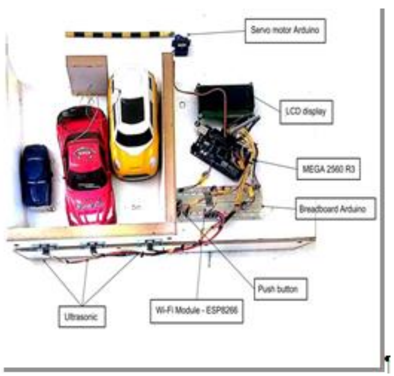

Figure 15:. Implementation of Elements in the System

The staff can control the system by checking the table as shown in table 1 and by using LCD display as shown in figure 16.

Figure 16:. LCD Display

3.6 System Schematic

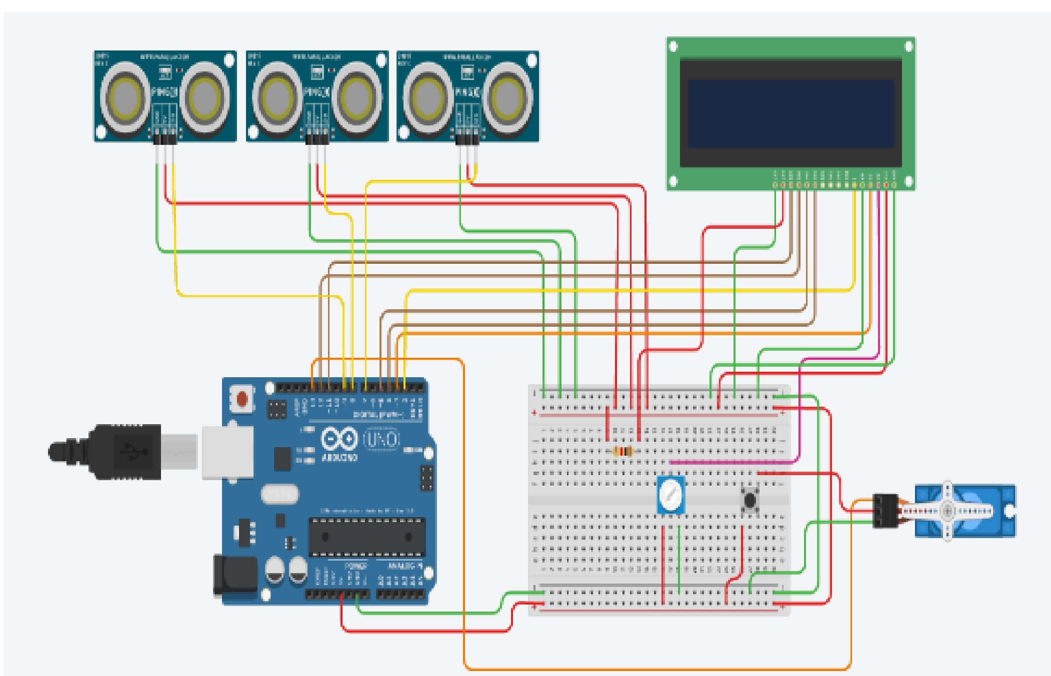

Figure 17: Arduino Electronic Circuit (Smart Parking Manage System)

Table 2: Comparison of the normal parking, smart parking and Arduino Smart Park System.

	Easy to Find	Easy to Use	Smart	Can Control	Waiting	Losing Fuel Consumption	Save Time
Traditional Car Park	χ	χ	χ	χ	χ	χ	χ
Smart Car Park	χ	√	√	√	√	χ	√
Arduino Smart Car Park	√	√	√	√	√	√	√

4. Conclusion

The proposed system improves the performance by decreasing the empty space in a parking, and missing numbers of drivers who fail to find a parking space, reducing the cost of fuel to find a parking space, reducing air pollution when the user tries to find parking lots, adapted in environmentally friendly cities, our system can be in public and private sectors. The update of the state or website can be sent as the message for users which can make the driver more satisfied, put less effort on the user, the system benefits both the users and the owner of the park to go. The system minimized the waiting time of the user to find park lot. Managing smart parking becomes a strategically issue to process, for economic interest beside the research interest.

FUTURE WORK

In future, we will study include an additional component and field as the User Identification, National Number, and solving urgent cases by applying an urgent table.

In order to make a database for everyone's entering and leaving the parking lot, an important step that serves security in general for Iraq and especially for Ministry of Interior and National Security is needed to stop car bomb in Iraq.

There will be a general idea of the numbers of cars entering and leaving the parking lots and a plan to expand the parking in particular in every state and region and for the development of the city and its services can be generated.

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