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APPLYING ARDUINO FOR CONTROLLING CAR PARKING SYSTEM

Abstract

With increasing automobiles in the parking space, we could face problems like unplanned parking, lack of discipline, wasting time and fuel while looking for free space around the parking ground. These problems could be solved by applying Arduino for controlling car parking system. The proposed system will detect an available parking slot in short time, saves fuel, offer monitoring car parking system with low consumption, easy to implement and inexpensive.

1. INTRODUCTION

An important factor which leads to a parking problem is human behavior. Due to time deviation in arrival rate, habitual parking lots cannot be concerned with the user. So, the users indiscriminately park the car in a parking space, and some do not have space, and they park outside of parking space.

Fully automated systems are being adopted in industries across the world at a rapid rate (Al-Tabatabaie & Hama, 2017). Control systems are replacing manual operators and fully automated machines are replacing human labor. Less personnel and smarter machines mean less operating and labor costs while increasing the quality of the products or services offered.

This study will increase the quality of service of parking lots by integrating a smart system which assists motorists in finding vacant parking slots (Bonde, Shende, Kedari, Gaikwad & Bokre, 2014). It will provide system with information to assist in monitoring the vehicles safely.

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Arduino will be used as a controller to the system, Arduino is an open-source prototyping platform based on easy-to-use hardware and software (Official Arduino website), support allows external USB hardware (an Android USB accessory) to cooperate with an Android-powered device in a special accessory mode. When an Android-powered device is in accessory mode, the connected accessory acts as the USB host (powers the bus and enumerates devices) and the Android-powered device acts in the USB accessory role. The accessory mode is ultimately dependent on the device's hardware and not all devices support accessory mode (Official Arduino website).

Recently there are a number of researches have been done for car parking using Arduino with different ideas like using Internet of things (IOT) technology (Ghosh, Prusty & Natarajan, 2018; Kadhim, 2018; Yuvaraju & Monika, 2017), some researchers used fuzzy design (Ganesh, Deepak, Naveen & Raghu, 2014; Rashid, Rahman, Islam, Alwahedy & Abdullahi, 2019; Syam, Piarah & Jaelani, 2015), and some researchers used image processing (Al-Kharusi & Al-Bahadly, 2014; Mallikarjun, Harikishan, Sharath & Rakesh, 2019), while others use it with GSM module using mobile (Ba Sabbea et al., 2018; Rahayu & Mustapa, 2013; Ramani, Valarmathy, Vanitha & Thangam, 2013). The intelligent or smart parking system must be proposed for searching the vacant or about to vacant parking space (Aalsalem, Khan & Dhabba, 2015). In smart parking system, users can access data to determine the availability of spots for parking, then have card notify the entrance time, at the exit, there will be a small pad to type in the card number to check how much money have to pay before opening exit gate. Thus, smart parking will increase the application of existing parking, which leads to greater income for parking holders. It also benefits the environment and plays a major role in creating an eco-friendly environment.

2. THE INSTALLMENT SYSTEM

To have proper knowledge about the hardware components as well as the software components of the project is a must. Arduino Mega 2560 played a vital part in this project as it contains all the software data in it. The required hardware components for the project are:

2.1. Arduino Mega 2560

The Arduino Mega is a microcontroller board based on the ATmega2560. The ATmega2560 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega2560 achieves throughputs approaching 1 Minute Per Second per MHz allowing the system design to optimize power consumption versus processing speed (Al-Tabatabaie & Hama, 2017; Official Arduino website) . The Mega 2560 is as shown in figure 1.

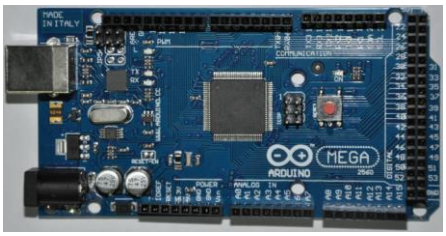


Fig. 1. Arduino Mega 2560 board

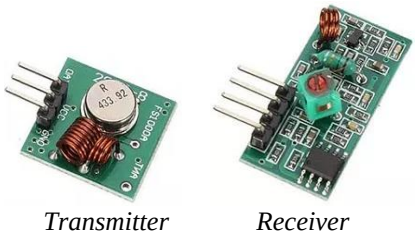
Where figure 1 shows all pins outputs digital, analog, power and ground, details as shown in table 1.

Tab. 1. Technical specification for Arduino Mega 2560

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7–12V
Input Voltage (limit)	6–20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by boot-loader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
Length	101.52 mm
Width	53.3 mm
Weight	37 g

2.2. RF Module (radio frequency module)

Is a small electronic device used to transmit and/or receive radio signals, as shown in figure 2. This post is popular to monitor RF for frequency of 433MHz Transmitter/Receiver modules with Arduino.



Transmitter *Receiver*

Fig. 2. RF "Transmitter/Receiver module"

2.3. L293D motor driver

H-bridge is an electronic circuit that enables a voltage to be applied across a load in either direction as shown in Figure 3.

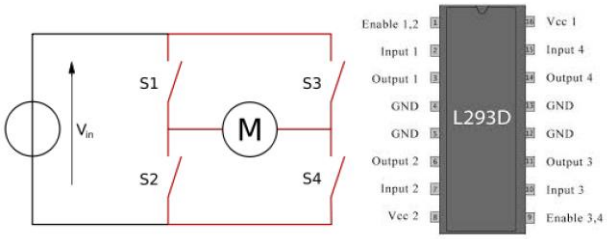


Fig. 3. L293D motor driver module

These circuits are often used to allow DC motors to run forwards or backward in robotics and other applications.

2.4. DC Motor

Is a rotary electrical machine, the most common types rely on the forces produced by magnetic fields as shown in figure 4.

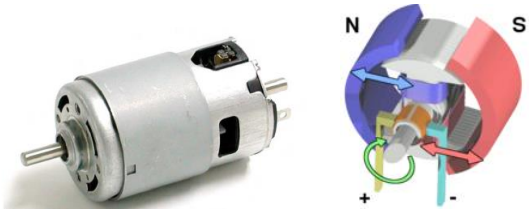


Fig. 4. DC step motor

The DC motor converts from direct current electrical energy into mechanical energy.

2.5. Ultrasonic sensor

Is Range Detection Sensor to indicate the empty slot in the garage, as shown in figure 5.

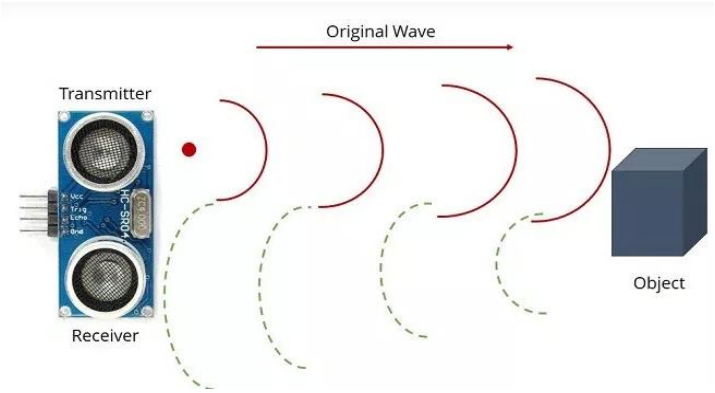


Fig. 5. Ultrasonic range detection

By measuring the distance to find the empty slot in parking to park the car and help the driver to find the slot easily. The ultrasonic sensor determines the distance to an object by using sonar. Here's what happens:

1. The transmitter (trig pin) sends a signal: a high-frequency sound.
2. When the signal finds an object, it is reflected and…
3. The transmitter (echo pin) receives it.

3. METHODOLOGY

The proposed system architecture idea present as shown in Figure 6.

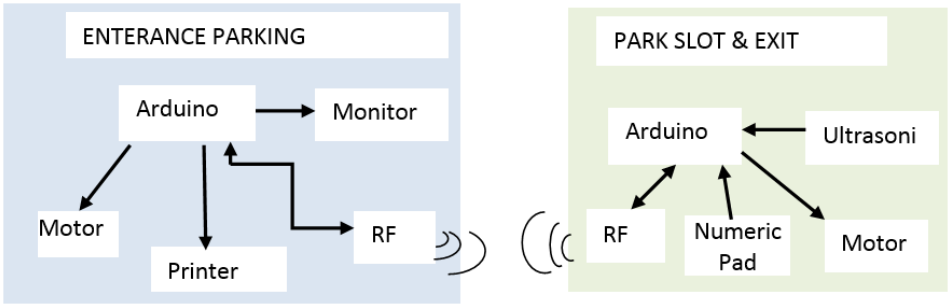


Fig. 6. System architecture idea

The methodology of Automated Car Parking System is made up of 2 major components: Arduino Mega 2560 and RF Module. The coding of this system has been done using the ArduinoIDE programming language. The monitor will display the number of available slots and will have an RF Receiver Module to get updates about the empty parking slot.

When a car will come, the operator will send an instruction through Arduino to open the gate using RF Transmitter Module, the ultrasonic will sense which slot number car barked and through Arduino will update the monitor display at the entrance. DC motor helps the gates to open up when it gets the signal from Arduino, Arduino will only get the signal to DC motor using RF Receiver Module. The timer will be started as soon as the gate opened. The operator will print slot number, time and the code number in the small paper for the driver to take it. The code number will be saved in the system against a slot number.

For parking out the user must make payment to be provided with a code to the operator at the exit gate. After the user makes payment must type the code number at the numeric pad at the gate to let the operator giving the command to park out the car. The operator will update the empty slot information to the monitor display at the entrance using the RF Transmitter Module. The block diagram for the park system is shown in Figure 7.

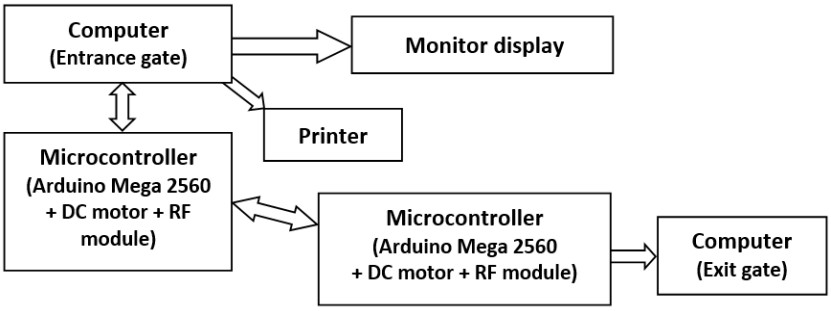


Fig. 7. Prototype block diagram for automated car parking system

4. WORKING PROCEDURE

This section will explain the working procedure for the prototype block diagram in Figure 7 at the computers in the entrance and exit gates. That would be done by simplifying the work using flowcharts.

4.1. Computer (Entrance Gate)

The monitor will display the available free slots where the user can park, the calculation would be saved in the computer as follows:

Total slot = n; Busy Slot = a;
After every entry:
a = a + 1; Free Slot = n – a;

The flowchart for the entrance computer is shown in figure 8.

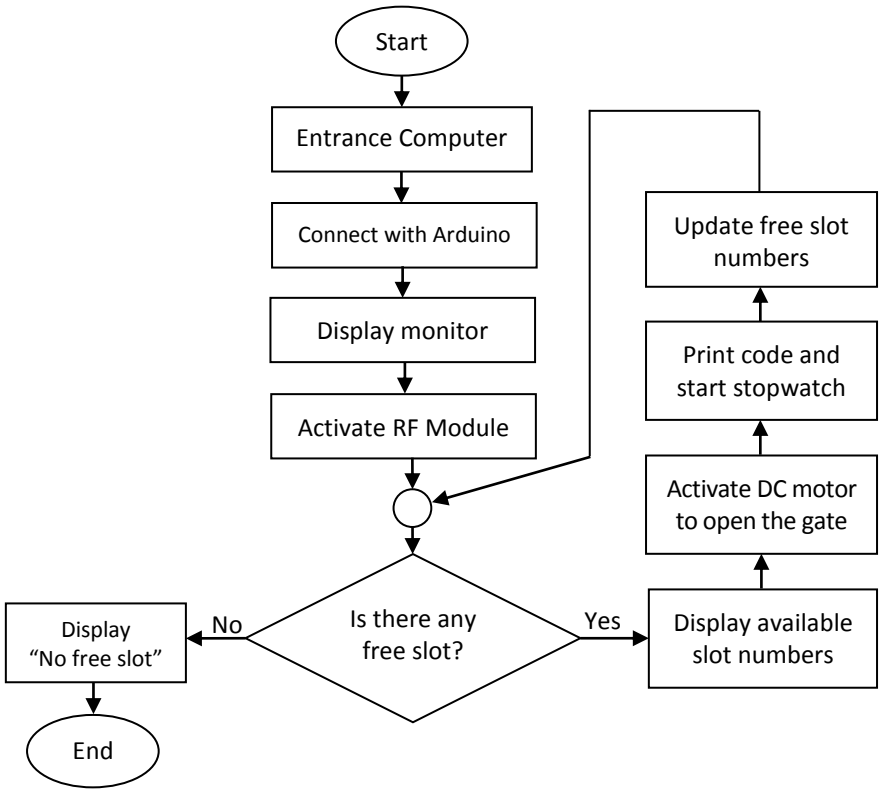


Fig. 8. Flowchart for the entrance gate

4.2. Pricing principle and time limit

The pricing principle and time limit for automated car parking system will be saved inside the computer database, the customer should put the ticket inside the machine to check how long stayed and gives how much have to pay. This time as shown in table 2 given below:

Tab. 2. Time limitation plan for car parking system

Place name	Time limit (hours)	Price per hour (in USD)
Shopping Mall	3	1.25
Amusement Park	4	1
Hospitals	2	0.5
Office space	Office hours	Free for worker only

As shown in table 2, plan for each place required to apply the Arduino system with a price to pay for each time limitation, where the price will be the number of exceeding the time limit. For example, the price is 1.25 USD for parking 3 hours in the shopping mall and it would be 2.5 USD if exceeded 3 hours. However, it would be 3.75 USD if exceeded 6 hours. The same process would be applied to other places.

4.3. Computer (Exit Gate)

The ultrasonic will record in the map any available slot and update the computer, the gate will not open unless money has been paid, type in the code using numeric pad to activate Dc motor to open the gate as shown in figure 9.

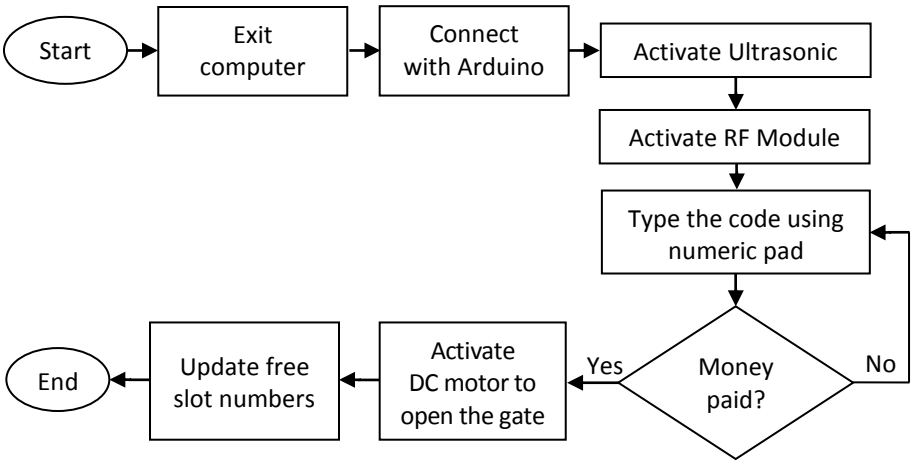


Fig. 9. Flowchart for the exit gate

5. EXPERIMENTAL RESULTS

The CPS (Car Parking system) has been tested and verified for the required results. The CPS is able to carry out the prime functionality of searching for an empty parking slot and communicate that path to the car. For data analysis and results, it has been compared between the normal car parking and CPS prototype by calculating savings and fuel consumption. The approximate calculations were as shown in table 3.

Thus, the proposed system relatively is higher than it is in the existing systems. From the experiment, results shows that when car numbers increases, will cause to reduce the detection accuracy. The reduction in accuracy was due to installing one ultrasonic sensor for every three slots. To maximize the accuracy of the proposed system suggest the installation of 1 sensor per parking slot. Thus, for each slot, the accuracy of detection is 100%.

Tab. 3. Approximate calculations of experimental results

Parameters of comparison	Normal car parking	Car Parking system
Space needed per slot (ft)	15/8	15/8
Maintenance cost per month (USD)	200	87.5
Staff needed at the parking	5	2
Detection of empty slot	Have to search manual	Use IR & Ultrasonic sensor
Parking method	Manual	Path tracking
Fuel consumed per hour per 100 km (liter)	2	1.4
Average distance traveled by a car to park in or park out (km)	46.11	38.7
Fuel consumed per car to park in or park out a car (litre)	0.276	0.085
Average time needed to park in or park out a car (minutes)	7.5	2.5
Average time to wait in a queue (minutes)	5–10	1.5
Time saved (minutes)	6	1

6. CONCLUSIONS

After applying the CPS it is found that the system can be introduced and will be beneficiary for many countries. The main benefits are time and fuel saving, it is also providing sustainable parking in an eco-friendly manner. There is less maintenance cost for this system so it helps the property developer in cost saving, and reduces the traffic jam. It will help the developers to increase their income as well as it helps the government by increasing tax revenue. Therefore we should introduce CPS and enjoy the benefits.

7. FUTURE ENHANCEMENT

It is possible to enhance the system by including different applications, such as internet booking by utilizing GSM, where the driver can book for the parking area at home or while in transit to the shopping center. Also, it is possible to include image processing to the system to recognize the cars by their number plates, by using this type of technology users can directly pay the car parking using a mobile phone.

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