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CAR PARKING MANAGEMENT SYSTEM – AN ELECTRONICS SIMULATION STUDY

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Purpose of this paper is to study the integrated system development for car parking management through implementation by simulation model for avoiding congestions and maintaining harmonious environment until utilization of parking bay. Thermal gradient variation while movement of car can be measured through Infrared sensor. Based on the analog information received by the sensor in the Arduino Uno microprocessor, the servo motor opens the gate. Research limitations are there while proposing a customized automated vehicle parking system. The development of the system is required for parking car On-street, Off-street and Multi-level parking lots. Implications include unnecessary wastage of time for waiting to know the space availability and sometime uneven take-up.

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1. Introduction

Recent days, it's being observed in the urban areas that car parking management system is very much essential for knowing space availability at the entrance. In order to save time and avoiding confusion in the utilization of space effective car parking management is required. Authors have claimed that the existing techniques are not providing accurate information [1]. Still, there are several advancements are to be developed for easiness and perfectness in parking system. Taylor [2] investigated how government norms and rights influence parking management in German cities with different transportation and mobility cultures. Ahmed and Wei [3] have discussed about the car parking system based on Microcontroller. The authors concluded that this automated car parking system benefits humanity by saving time in monitoring parking lot availability and displaying the space on an LCD displayer utilising IR sensors at entry and exit. Uma *et. al.*,[4] have discussed about the necessity of automatic car parking system. Authors have suggested that the system is to be developed based on Internet of Things (IOT) for the real time environment. Janhvi *et. al.,*[5] have discussed about the requirements for making automatic smart car parking system. Bhansali *et.al.,* [6] have studied and developed application of a car space arrangement. Authors have discussed on establishment of arrangement made at the entrance through proximity sensor of car parking bay. Finally, the authors found that the devised approach improves and strengthens the present auto parking arrangement. Ali *et. al.,*[7] have agent-based simulation structure parking system for on-street car parking management. The success of the system was assessed based on answers from travellers in terms of parking availability, cost, walking distance, and time constraints. This system was installed in the Kingsford town centre to test different parking policies and other scenarios to see how they affect parking use and system performance..

The main objective of this project work is to develop the system for indicating the availability of space in car parking bay. The following chapters discusses on proposed model through flow chart, required components for development of system, electronics simulation and finally results and discussion.

2. Materials and Methodology

The proposed car parking management system consists of Arduino Uno R3 model microprocessor, IR sensor, servo motor, LED light and LCD display. Integrated operational block diagram of proposed model has been shown in Figure 1. Figure 2 shows the CAD model of space provided for car parking in (a) Top view and (b) in Isometric view. According to the information given from IR sensor to the Arduino Uno microprocessor board, the servo motor will be activated to open and close the entrance gate. Space availability will be displayed in the LCD display. LM2596 module is used to regulate the input voltage for providing desired output voltage to drive the components.

2.1. *Hardware components and its specifications*

The Arduino Uno R3 microcontroller board is based on the ATmega328p CPU. This is the heart of the overall system which requires minimum operating voltage of 5V. The board consists of 14 digital input/output pins and among these 6 pins is provided for pulse width modulation (PWM) outputs and another 6 pins are provided for analog inputs. Figure 3 shows that the Ardiuno Uno R3 microprocessor board and its specifications are tabulated in the Table 1. Special features of the ATmega328p microprocessor include analogue comparator (AC), analogue to digital converter (ADC), Universal synchronous asynchronous receiver transmitter, timer, and more [9].

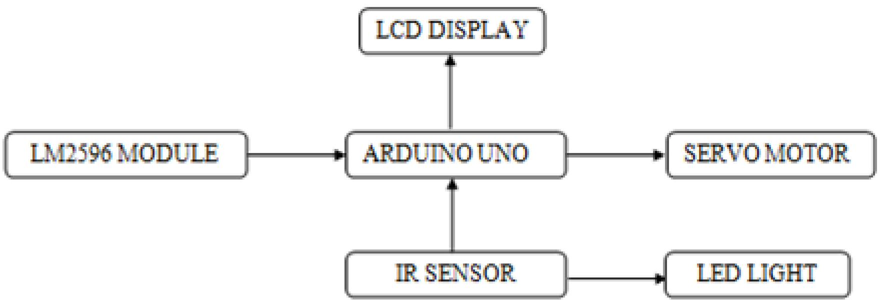

Figure 1. Proposed model Block diagram

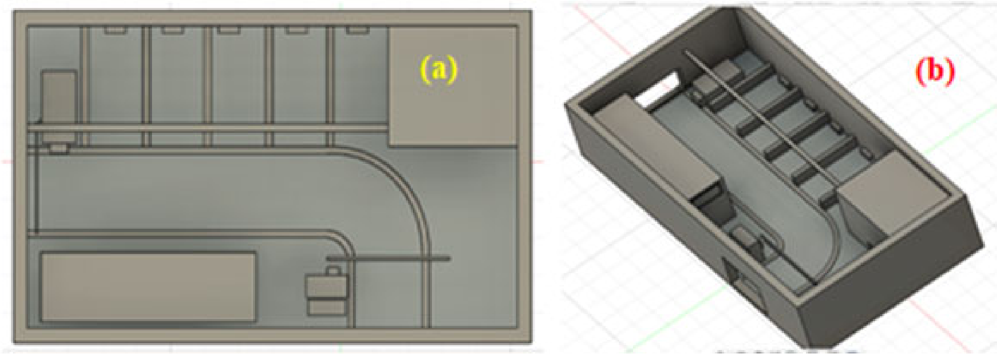

Figure 2. CAD model of parking area (a) Top view (b) Isometric view

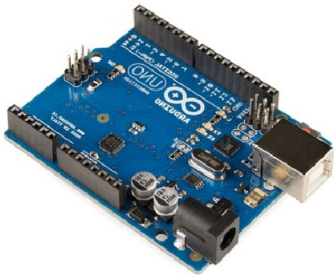

Figure 3. Arduino UNO R3.

Table 1. Specifications of Arduino Uno R3 board.

Parameters	Values
Min. Operating voltage	5 V
Input voltage limits	6 – 20 V
DC current on I /O pins	40 mA
Flash Memory	32 kB
Frequency (Clock – speed)	16 MHz

Figure 4 shows the Micro Servo motor and its specifications are tabulated in the Table 2. Servo motor is most commonly used for precision positioning control applications. It is operated by the information receiving from IR sensor through microcontroller. Such a device is attached at the entrance gate opening and closing.

Figure 4. Micro servo motor SG90.

Table 2. Specifications of Micro Servo motor SG90.

Parameters	Values
Min. Operating voltage	5 V
Torque	2.5 kg/cm
Rotation	0-180°
Weight of motor	9 gm
Dimension	22.8 mm X 12.2 mm X 28.5 mm

The IR transmitter and receiver, as well as the OP amp, Variable Resistor, and output LED, make up the Infrared (IR) sensor module. IR LEDs have emitting angle of approximately about 35°. IR receiver is the photodiode which is working when light falls on it. This is made comprised of a black colour covering on the outside that absorbs the most light. So, it is useful for IR detection. Detection distances vary from 2 to 12 cm. The output LED remains off if there is no car moving within the IR receiver's range. When a car is detected inside the IR sensor's range, the LED illuminates. Figure 5 shows the photograph of IR sensor and its specifications are tabulated in the Table 3.

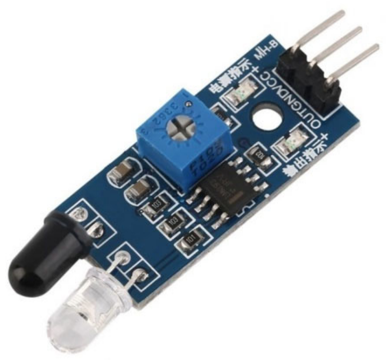

Figure 5. IR sensor.

Table 3. Specifications of IR Sensor.

Parameters	Values
Make	Micro - Epsilon
Detection distance	2-12 cm
Effective distance range	2-80 cm
Working voltage (DC)	3 – 5 V
Detection angle	35°

Figure 6 shows that the LCD Display and its specifications are tabulated in the Table 4. 16 X 2 LCD display has 16 Columns and 2 Rows of Pixel Dots. Mainly helps to display data received from the microcontroller.

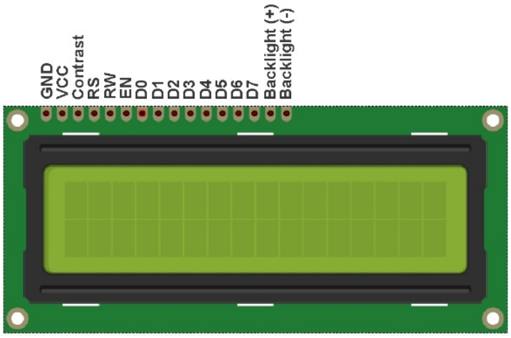

Figure 6. 16 X 2 LCD Display.

Table 4. Specifications of 16 X 2 LCD display.

Parameters	Values
Make	Shenzhen Shareway Electronics Co. Ltd.,
Operating voltage	4.7 – 5.3 V
Current utilization	1 mA with no backlight
Every character built	5 X 8 Pixel Box
Working modes	4 bit and 8 bit

3. Results and Discussion

3.1. *Electrical simulation*

Figure 7 gives the circuit design and simulation. The components used are six IR sensors, two servo motors, one 16x2 lcd display, one Arduino uno R3 controller, and four red colour led light for the simulation of the electrical circuit. In the circuit, when the Entry IR sensor output is high then the car is entering the parking lot, the barricade opens and it displays "welcome stay safe and wear mask" in the LCD. Once the car crosses the entry barricade in the parking lot the IR sensor output becomes low and the barricade closes. In this prototype of car parking management system has four parking slots which are represented as S1, S2, S3, S4, Each parking slot has one IR sensor. The car after entering the parking lot will proceed to the vacant slots available in the parking area, for example lets us consider the car enters the slot S1 the IR sensor output of the slot S1 becomes high and the value of the S1 in the LCD will change from "0" to "1" which means the slot S1 is occupied and the red LED will glow to show the parking slot is occupied. This is same for the rest of the slots S2, S3, S4. Once every slot in the parking is occupied the LCD will display "Parking Full". Now when a car enters the parking space the entry barricade will not open as the parking is full. When a car leaves from a parking slot, for example let us consider a car is leaving from a parking slot S1 the IR sensor output of the slot S1 becomes low and the value of the S1 in the LCD will change from "1" to "0" which means that the slot S1 is vacant and the red LED will stop to glow to show the parking slot is vacant. The car after leaving from the parking slot will go to the exit gate to leave from the parking space. Once the car reaches the exit gate the IR sensor output of the exit gate will become high and it displays "drive safe visit again" in the LCD. After the car passes the exit gate the IR sensor output of the exit gate will become low and the barricade closes.

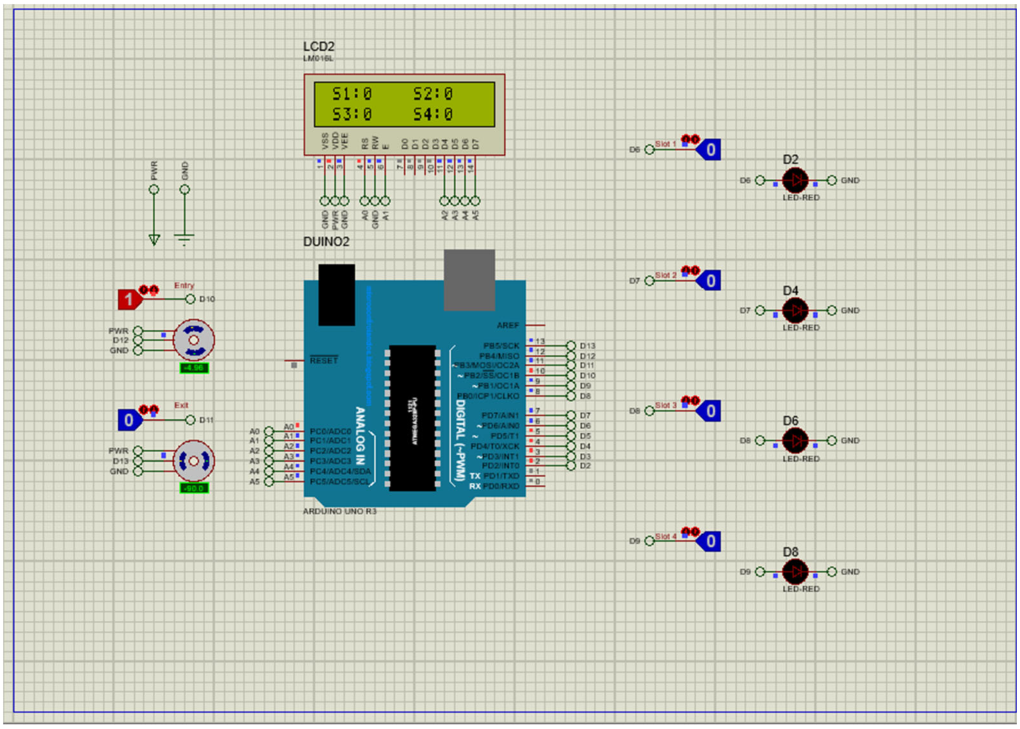

Figure 7. Electronic Simulation

In the circuit, Components used are one 16x2 LCD display, six IR sensors, two servo motors, four red colour LED light, one Arduino uno R3 for the stimulation of the electrical circuit. Vcc, Gnd, and out are the three pins on the IR sensor. The circuit's Vcc is connected to the Vcc of all six IR sensors; The Gnd of each of the six IR sensors is connected to the circuit's Gnd. The output of the Entry IR sensor is connected to the Arduino uno controller's digital pin 10, and the out of the exit IR sensor is connected to the digital pin 11 of the Arduino uno controller, in which digital pin 6 is attached to the out of the slot one (S1) IR sensor. The Arduino uno controller's digital pin 7 is coupled to the out of slot two (S2) IR sensor and digital pin 8 is coupled to the out of slot three (S3) IR sensor. The Arduino uno controller's digital pin 9 is coupled to the out of slot four (S4) IR sensor. Vcc, Gnd, and out are the three pins of the servo motor. Both the servo motor's Vcc and the circuit's Vcc are connected. The Gnd of both servo motors is connected to the circuit's Gnd, the out of the Entry servo motor is connected to the Arduino uno controller's digital pin12, and the out of the Exit servo motor is attached to the Arduino uno controller's digital pin13. Gnd and out are the two pins of the red LED light. The Gnd of all four LED lights is linked to the circuit's Gnd, and the out of the LED light in slot one (S1) is connected to the Arduino uno controller's digital pin 6. The output of the LED light in slot two (S2) is connected to the Arduino uno controller's digital pin 7. The digital pin 8 of the Arduino uno controller is connected to the output of the LED light in slot three (S3). The Arduino uno controller's digital pin 9 is connected to the output of the LED light in slot four (S4). For the LCD, the VSS, VEE, RW pins of the LCD are connected to the Gnd of the circuit. VDD of the LCD is connected to the +5v power supply and the pins RS, E, D4. D5, D6, D7 are connected to Analogue pins 0, 1, 2, 3, 4 and 5 pins of the Arduino uno controller respectively. Figure 8 shows the Arduino Uno code used to execute the electronic simulation.

```
void Entrance()
{
  entryCount = (entryCount + 1) % 4;
  entryCount -= exitCount;
  entryPrev = entryCount;
  Servo_Open(servoEntry);
  lcd.setCursor(0, 0);
  lcd.print("     Welcome    ");
  lcd.setCursor(0, 1);
  lcd.print("StaySafeWearMask");
  delay(1000);
  lcd.clear();
  LCD_Update();
  while(checkEntry == HIGH);
  Servo_Close(servoEntry);
  CheckLEDs();
}

void rideSafeMsg()
{
  delay(500);
  lcd.clear();
  lcd.write("  Drive Safe  ");
  lcd.setCursor(0, 1);
  lcd.write("  Visit Again  ");
}

void Exit()
{
  exitCount = (exitCount + 1)%4;
  Servo_Close(servoExit);
```

Figure 8. Arduino Code used for Electronic Simulation.

3.2. *Working model demonstration*

Figure 9 shows that the car entering at the parking space when it is at the entrance is shown in Figure 9 (a) and when the servo motor opens the gate shown in Figure 9 (b). Display in the LCD at the parking space has been shown in Figure 10 and Figure 10 (a) shows the "Welcome" message, Slot 1 occupied has been shown in the Figure 10 (b) and Figure 10 (c) shows that all the slots are full. In our car parking system, there are six infrared sensor and two servo motors. The four infrared sensors are used to detect the cars in the parking slot. Every parking space will have an LED at the top that will display the parking slot availability. When the parking slot is full of cars, the LED at the top of the parking slot will glow. And LED display will show how many slots are filled with cars. When the car gets entered, the infrared sensor will sense the car, and then it will check whether any empty slots are there. Then the servo motor of the entry gate open so that the car gets entered into the parking slot. Here the IR sensor in the parking slot will check whether the parking slot is filled or not. When it senses the car, the LED at top of the slot will glow. When the parking slots are filled, the display shows parking full and the servo motor will not open. When car is leaving from the slot, the glowing light will get stopped and the exit sensor will sense so that the servo motor will get opened. While the car entering at the parking slot1 shown in Figure 10(a) and when all the slots are occupied as shown in Figure 10(b).

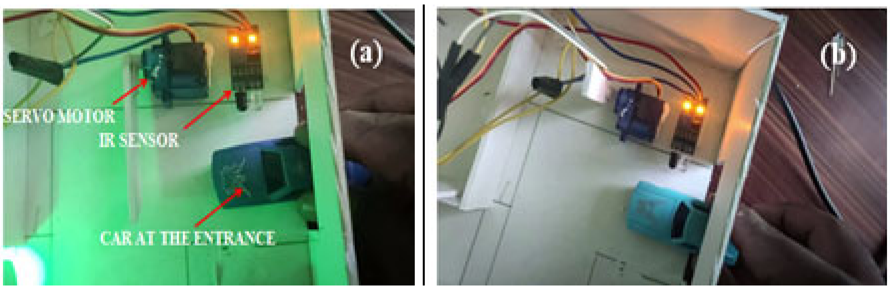

Figure 9. Car Entering the parking space (a) Entering at the entrance (b) Servo motor opened the gate

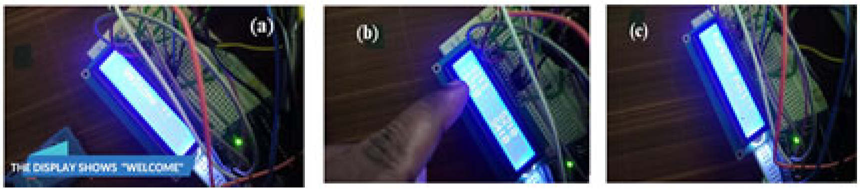

Figure 10. LCD Displaying at the parking space (a) “Welcome” message if space available (b) Slot 1 is occupied (c) all the slots are full.

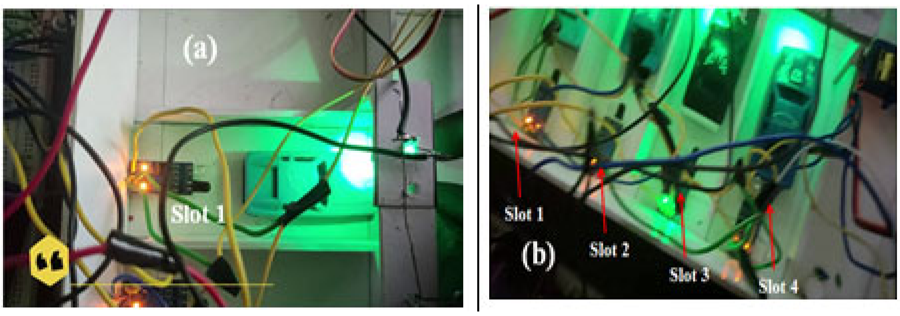

Figure 11. Car entering at the parking (a) Slot 1 and (b) Slot 1, 2, 3 and 4.

4. Conclusion

The developed system was tested using mini car at laboratory and it’s being evaluated by 4 different types of cars which will be provided in the slot. It is responsible for allowing the car inside of the parking place only if the slots are available. This is helping to maintain a harmonious environment whoever coming for parking. In future, this system would be enhanced to access the real time occupancy of individual parking lots at the mobile applications.

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