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# Digital Logic Design Final Project Report

SMART CAR PARKING SYSTEM

BEE 11-B GROUP NUMBER 4

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# INTRODUCTION

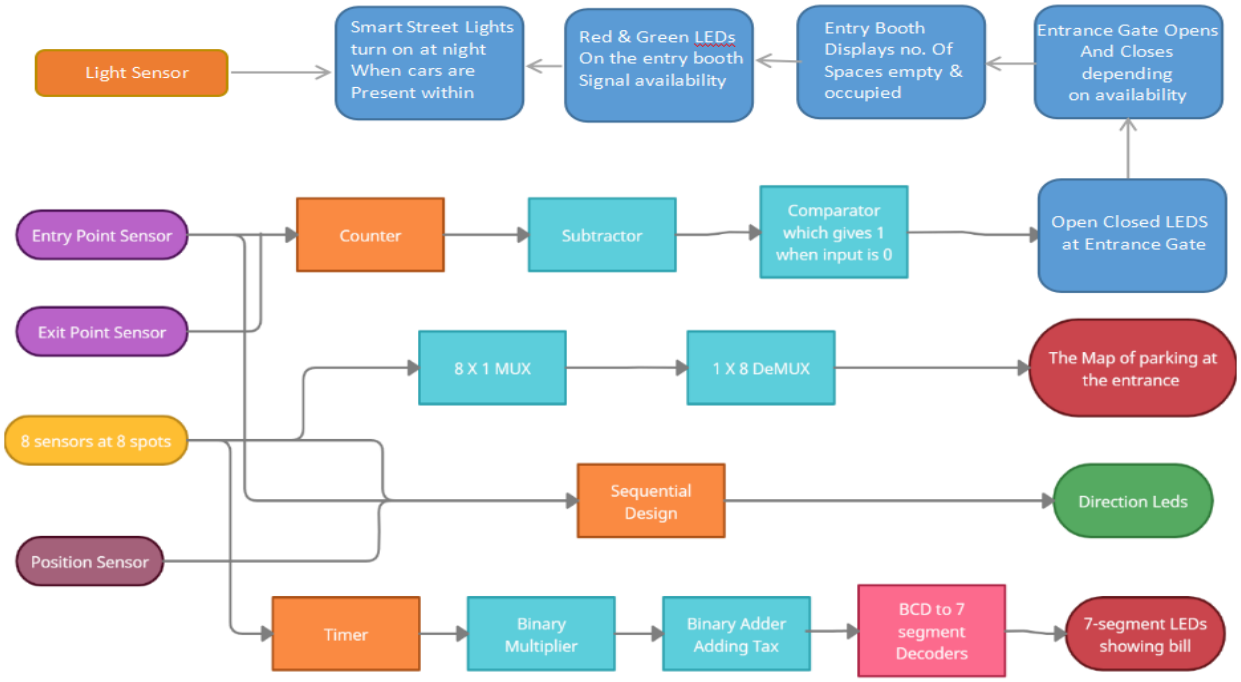
One of the major techniques that forms the basis of all digitally integrated circuits is Digital Logic Design. Using these techniques, we have come forth with a system aimed at aiding drivers with parking.

Due to the rapid increase in the number of vehicles on the road, traffic problems are also on the rise. This is due to the fact that the current transportation infrastructure and car parking facilities developed are unable to cope with the influx of vehicles on the roads. One main problem is revealed to be the lack of a proper system to help vehicles park efficiently, given the exponential rise of huge parking areas and vehicles alike.

To alleviate the aforementioned problems, we have developed a “Smart Parking System”. With the implementation of the Smart Parking System, patrons can easily locate and secure a vacant parking space at any empty car park spot that is deemed convenient by them.

The main aim of this project is to effectively and efficiently provide a system that; helps in reducing the traffic that occurs within parking lots, furthermore works to reduce the time lost while searching around a place that is already at maximum capacity. Vehicle detection plays a crucial role in this, as the smart parking system is implemented through a system that uses the help of various sensors and counters, which help in keeping a check where a spot in the parking lot is currently empty and guides the drivers to that spot with the help of LEDs.

The block of the system proposed is



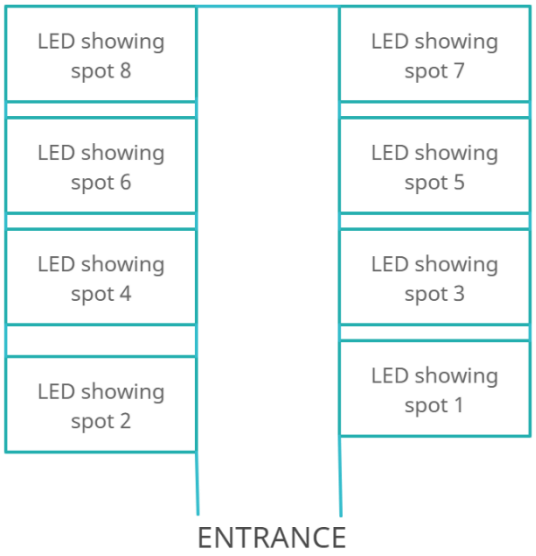

The parking space indicator and the smart streetlights are implemented with two motion sensors located at the entrance and the exit of the parking lot, along with a light sensor for the smart street system. A counter keeps track of the number of cars that have entered and not left the parking lot in real time. Two 7-segment LED displays located on the entry booth display are showing the number of spaces available and occupied. A green and red LED indicate the availability in the parking lot, green indicating available while red indicating not available; fully occupied.

When practically implemented, once the Parking Lot is fully occupied, a signal will be sent to close the entrance gate until one or more cars leave the parking lot. There are two LED displays located on the entrance gate reading: “open” and “closed” which will turn on based on whether there is space available in the parking lot or not.

Since our project is made with 8 parking spots, the street lights within the parking lot will automatically turn on when the total number of cars within the lot are from 1-8 and also when the light sensor senses no light, thus logic zero, which will only occur from sunset to sunrise; when darkness is present. At all other times the streetlights will remain off to conserve energy.

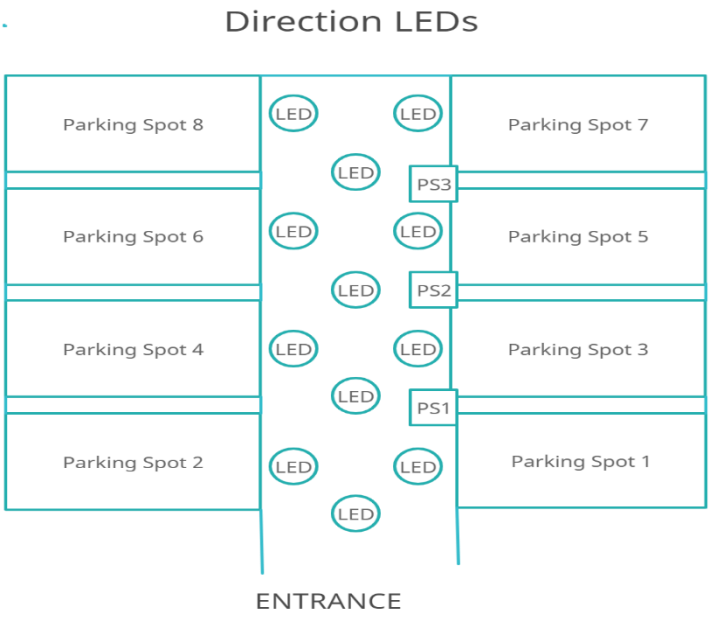
We also have a car parking map at the entrance which gives a visual depiction of which spots in the parking are available and occupied.

Car Parking Map at the entrance showing which spot is available




The system will take input from 8 sensors installed at 8 different parking spots and then a multiplexer will be used to convert these inputs in to one output. That output is again de-multiplexed at the entrance giving 8 outputs which are then connected to 8 LEDs in the parking map.

Once the car enters the car parking, there are direction LEDs integrated into the road which guides the driver where to park.




The implementation of Direction LEDs is a pure sequential design where we followed the design procedure, defined our states, made state table and implemented it with 3 flip flops.

As soon as the car is parked in one of the spots, the billing system will be activated. Billing system of parking lot is made such that it increases the parking bill after every hour and also tax is included in the bill. The bill is then displayed using seven segment LED system. Each of the 8 parking places have the same arrangement of LEDs and integrated circuit for displaying bill. But in our project, we have made the billing system for only one parking place.

The parking price is 5 Rupees for 1 hour and it goes on increasing till the vehicle is parked in the parking lot, and tax of 2 rupees is added in the total parking price which is then displayed.

## Design steps and Procedure:

Complete design of the project is categorized in four parts and design steps and procedure of each part is as follows.

### Parking Space indicator

- Sensors located at the entrance will give the inputs to the counters as each vehicle enters.
- The counter is constructed using the help of d flip flops.
- If a vehicle or vehicles exits the parking lot, a subtractor will deduct that specific number from the counter's output.

- The final number of occupied places counted will be displayed on a 7 segment LED display.
- The counted number will be subtracted from the total number of places available (8) using a subtractor and will be displayed as the number of free spaces available on a 7 segment LED display.
- If the counter reaches a total count of 8, then the red LED will be switched on and green LED switched off.
- The Entrance Gate will be closed, and the gate LED display will stop displaying "OPEN" and "CLOSED" will be displayed instead.

## Smart Street Light System

- Motion sensors located at the entrance and exit will count number of vehicles currently in the lot with the help of a subtractor.
- A light sensor will sense light and send a signal.
- A comparator is used to limit the allowance of the lights to turn on only when 1-8 cars are present.
- The streetlights are allowed to turn on only when the light sensor senses no light; gives a 0 signal and if cars are present within the lot at the same time.

## Empty and Filled Slots Indicator

In order to design a map of car parking which will give an idea to the user of empty and filled slots in the parking we proceed as:

- Eight sensors at 8 parking spots which will give 8 inputs whether the slot is empty or full.
- Since there are 8 inputs so we use 8x1 multiplexer. Here we have used 74ls51, which will convert 8 inputs to one output.
- Counter (74LS90) will be used. A D-Clock generator is used to produce a series of alternating inputs.
- The output is again De-multiplexed using two De-mux (74HC238). Here another D-Clock generator is used.
- The output from De-mux will now serve as input to Now 8 flip-flops (DTFF).
- In the ends 8 Green LEDs are connected to these Flip-Flops output which will give the final illustration of car parking states

## Direction LEDs

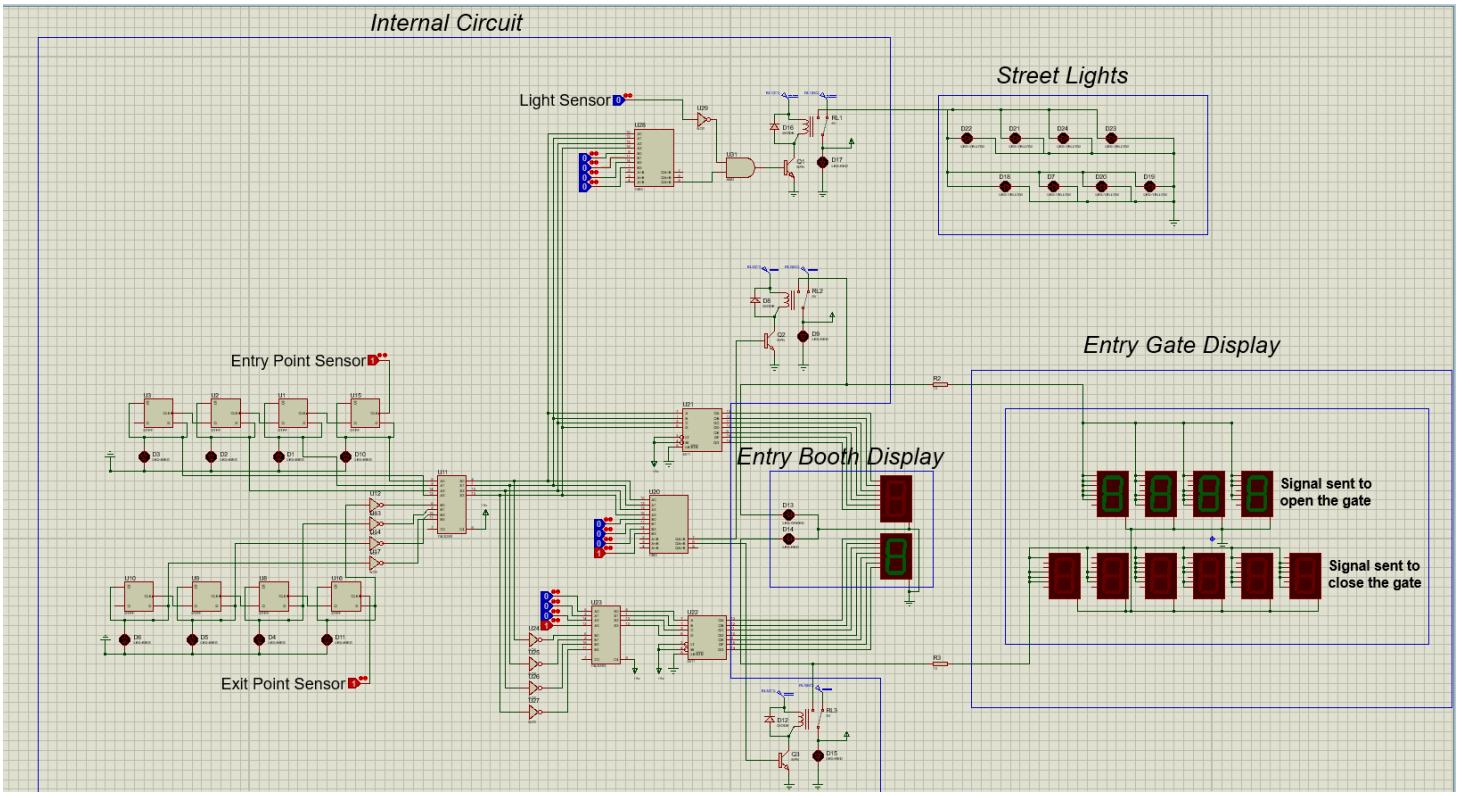
- First, we defined our states i.e. different situations which can exist in this module.
- Then we draw the state diagram and make state table.
- Then we make K-maps and defined next state and LEDs as functions of present state and inputs. So, our design is a Mealy machine design.
- As we have about five states, so we used three D-flip flops for first three LEDs respectively.
- For the next three LEDs, we implemented with exactly same logic but now we take position switch 1 as entry point input and position switch 2 as position input.
- Similarly, for LEDs 7, 8 and 9, same logic is applied but entry input is position switch 2 and position input is position switch 3.
- For last three LEDs, as there is not position switch ahead so there is no position input and position switch 3 is taken as entry input

## Billing Display

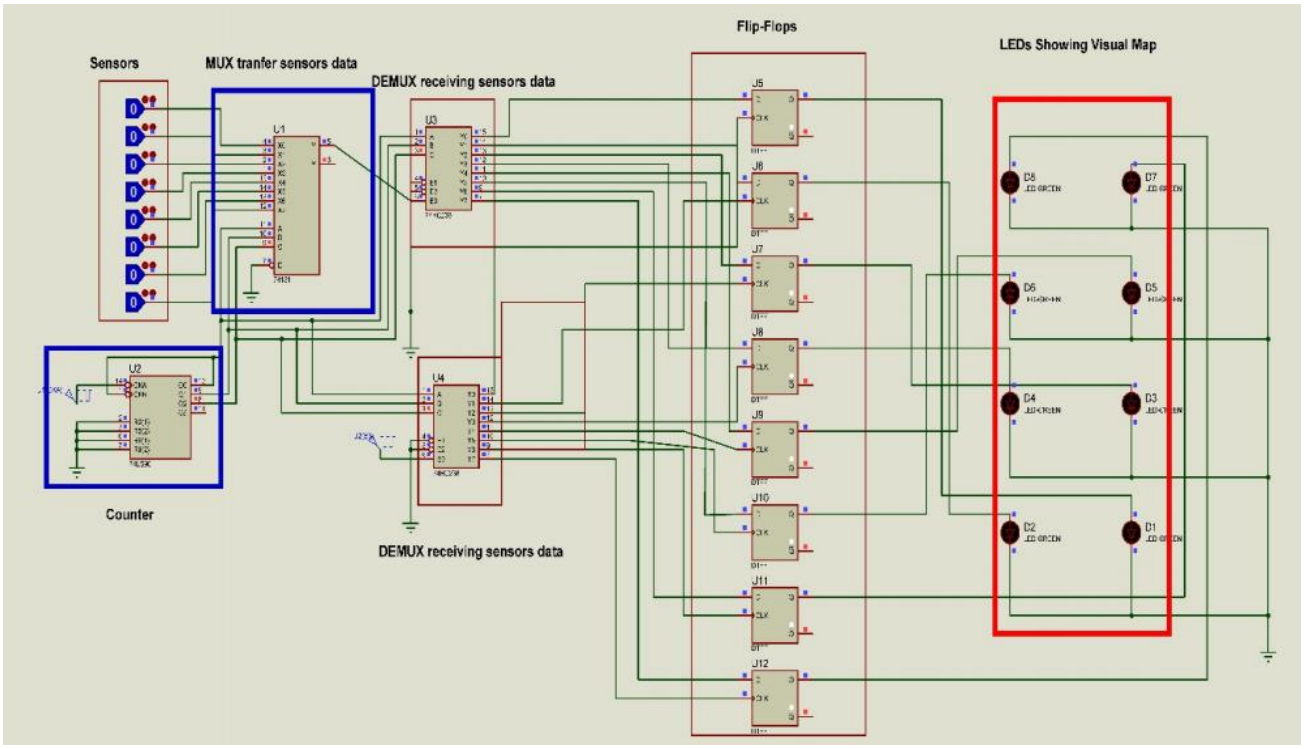
- LED at each of the 8 parking places in Car park turns on as car is parked there and remains on, till the car is there.
- This LED act as the input for the counter which is designed to count the number of hours. Clock frequency in the counter is adjusted that it counts 1 after every 1 minute and this one-minute time delay is considered as 1 hour delay in our project.
- The counter we used for counting the number of hours is made of JK flip flops, whose design can be varied according to the number of hours allowed for the parking.
- And the clock which is inserted in the above counter is made using BCD counters, BCD counters are cascaded in special arrangement for this purpose. So that after every 1 minute, which we consider as one hour the JK flip flop counter counts another hour.
- The number of hours of car park are then multiplied by 5 in a binary multiplier, as 1-hour parking bill is fixed as 5 rupees.
- Then a 2 Rupees of Tax is added in the bill in a BCD adder.
- Finally, BCD output is displayed on 7 segment LEDs using a BCD to 7-segment decoder.
- The billing system of car parking is made for six hours. So JK flip flop counter is made such that it counts till 6 and then resets.

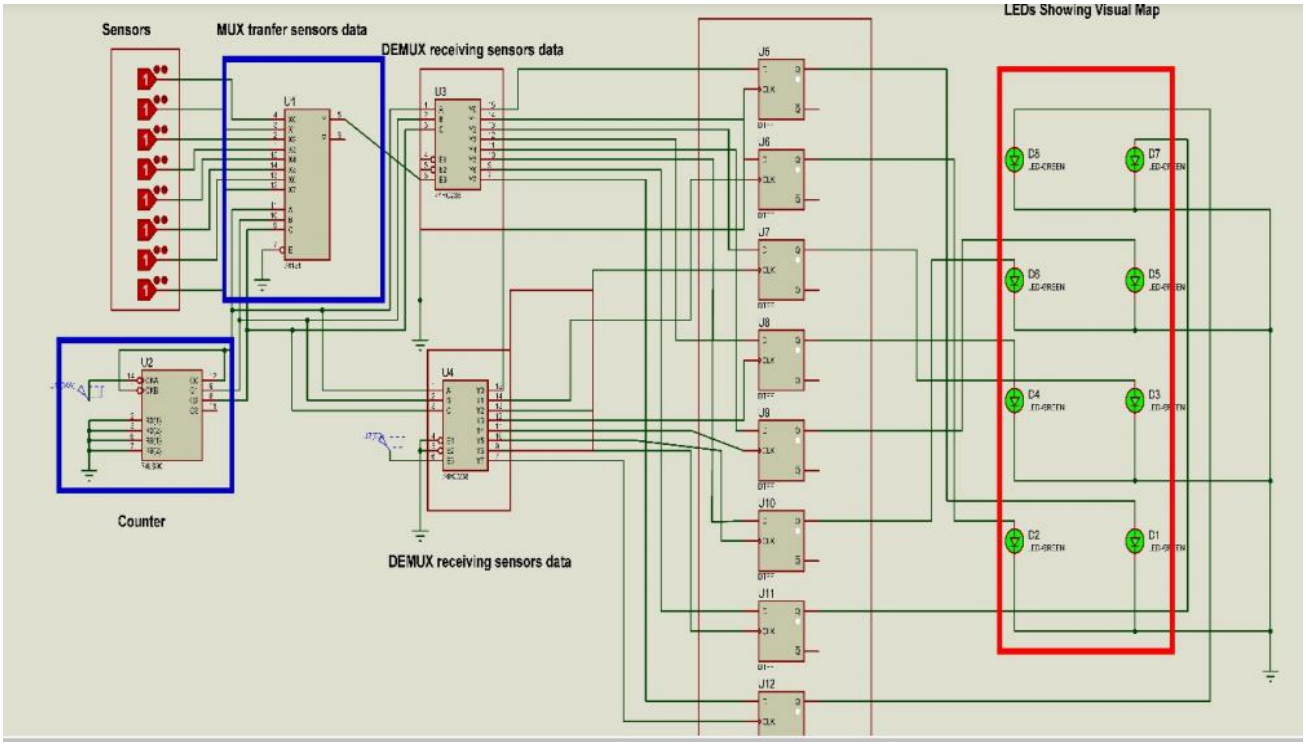
# Schematic Diagrams

## Parking Space indicator & Smart Street Light System

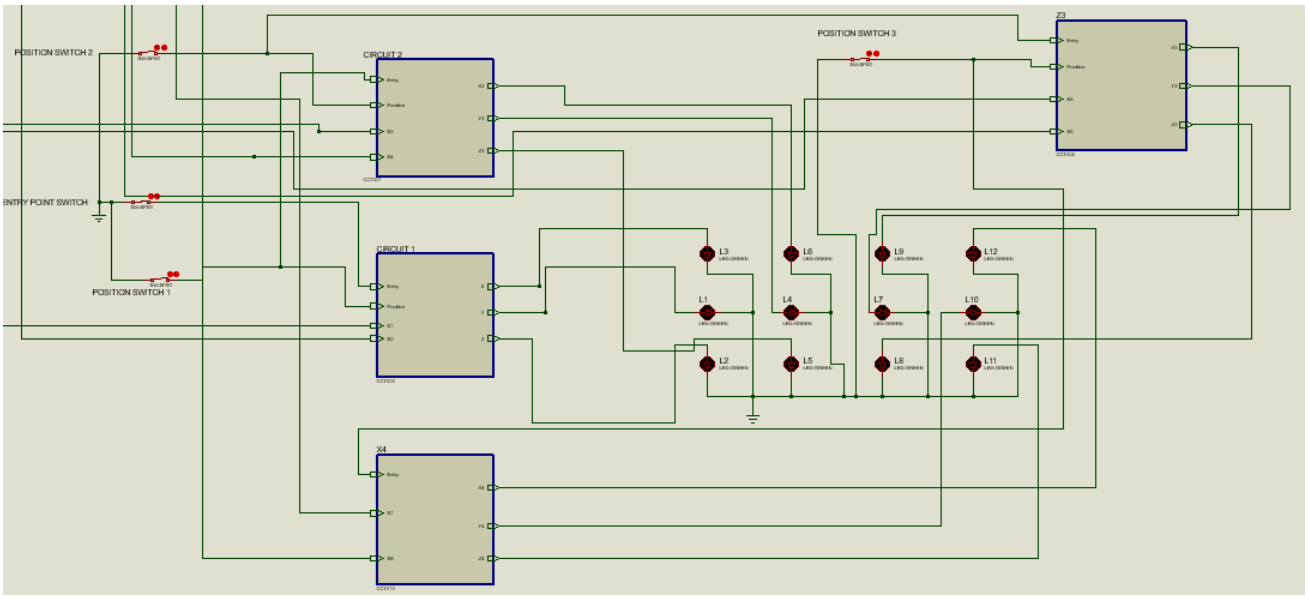



## Empty and Filled Slots Indicator

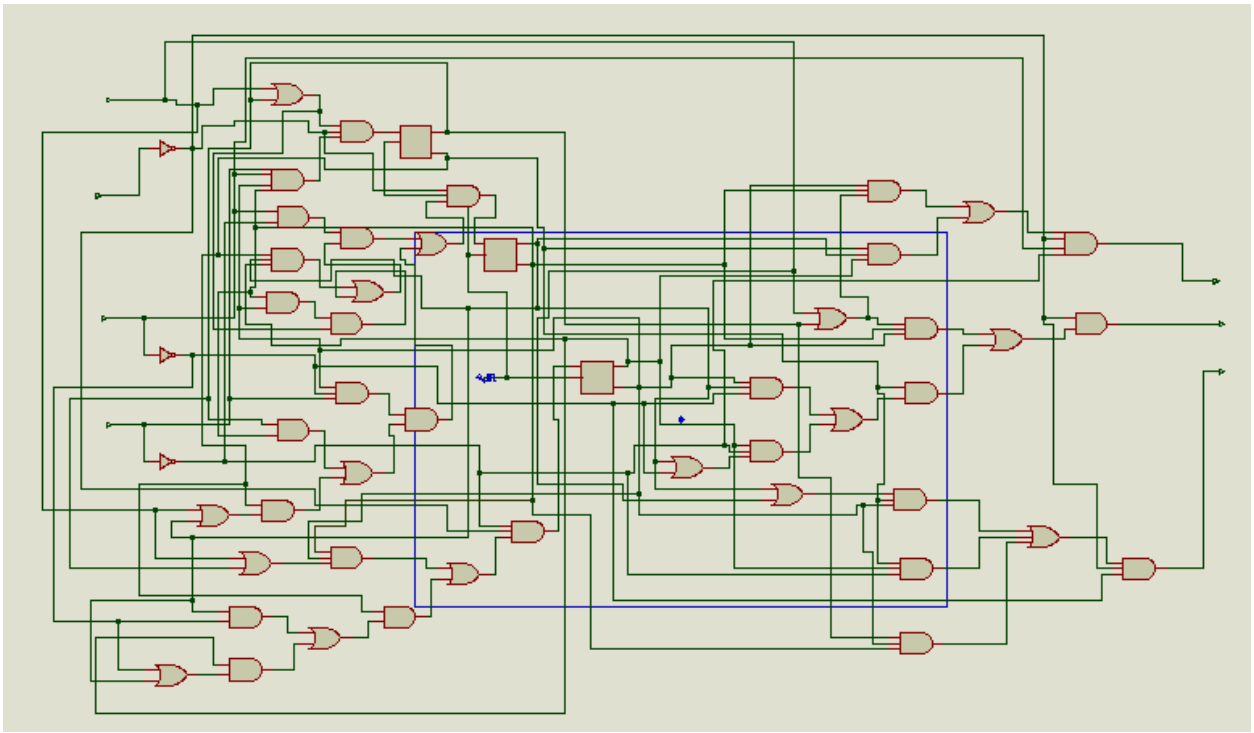


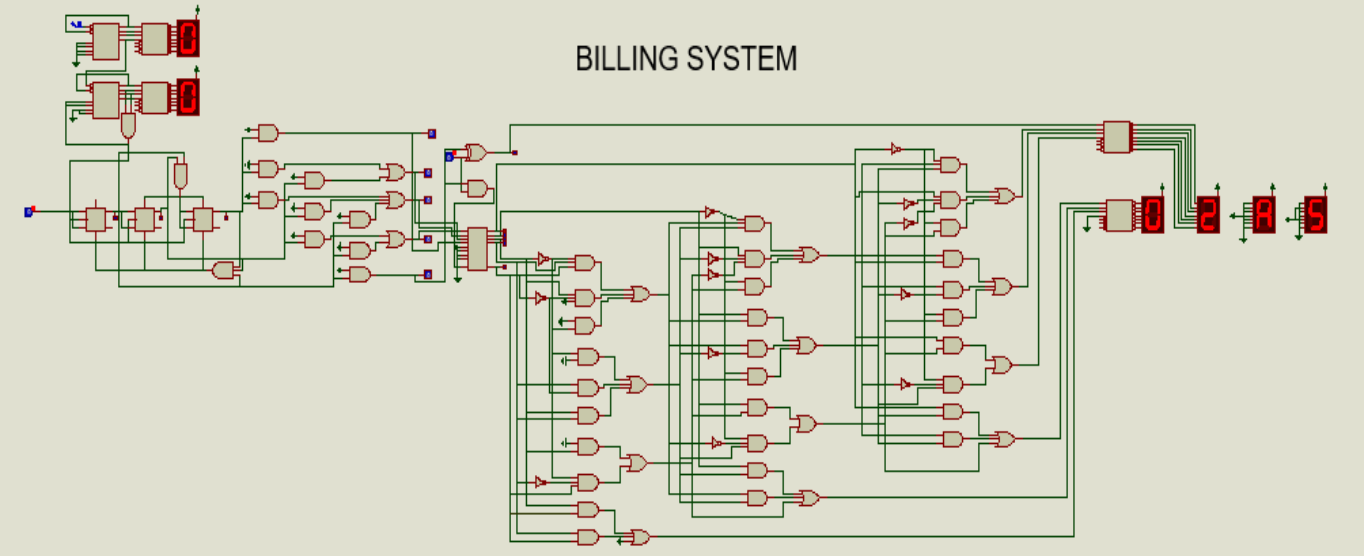

## Direction LEDs:




## Circuit 1 & 2 (Child Sheet) of above Figure:



## Billing Display:




## Circuit Working:

### Parking Space indicator & Smart Street Light System

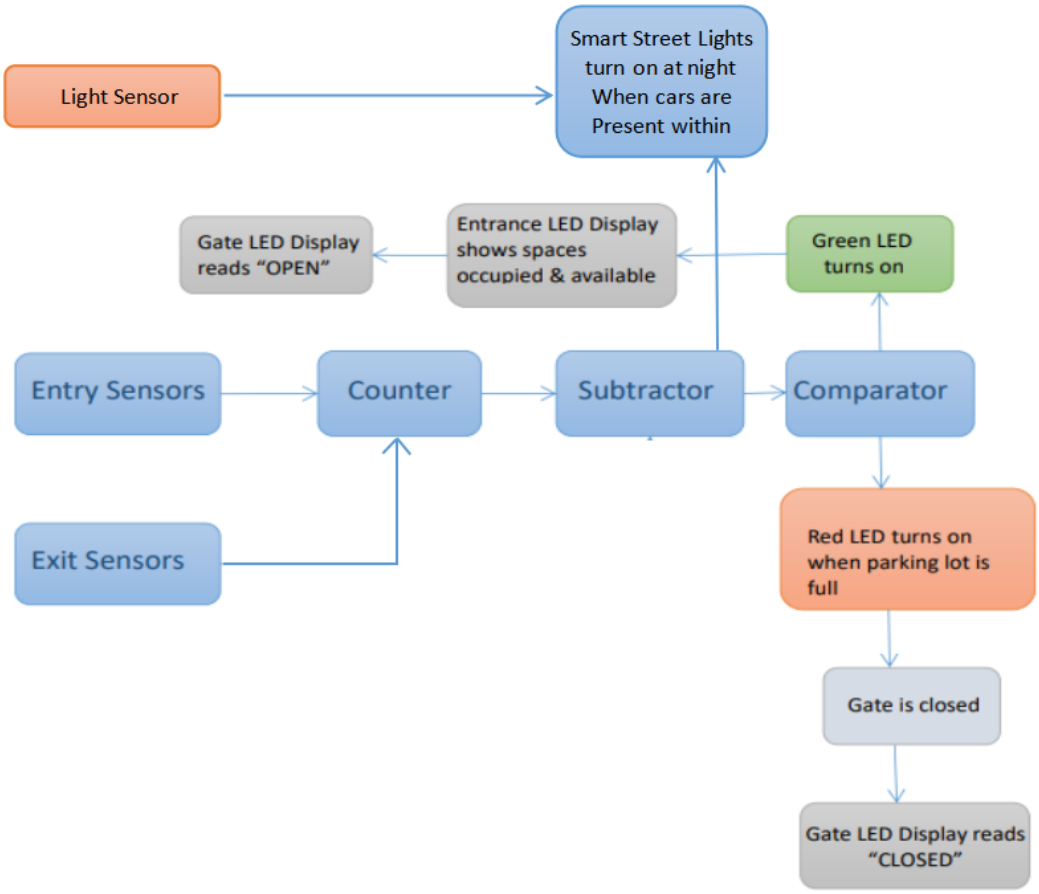
The design of parking space indicator is made of two sensors namely entry point sensor and exit point sensor both of which are connected to two 4-bit asynchronous counters made of D flip flop. When entry point sensor value is 1, it means that a car is entered and similarly when value of exit point sensor is 1 it means that car has left the parking place. Both this sensor are placed on the entrance of car park as exit and entrance of parking place is same.

As total number of parking places are 8, so to display that how many parking places are occupied and how many are empty, a red and a green 7 segment displays are used respectively. When there is no parking place left there is an arrangement of 7 segment displays on the entrance gate showing that parking place is “CLOSED” , and when practically implemented a signal is sent to close the entrance gate, otherwise “OPEN” is displayed.

Basically, the outputs of both counters act as an input for 4 bit adder, where the NOT of output of exit point sensor counter is given as input so it act as a subtractor. The output of the adder then goes to comparator, which checks that whether the adder output is 8 or less that, if later is the case it turns on the GREEN LED which gives a signal to OPEN arrangement of 7 segment display, So open is displayed whereas if output of adder is 8, it means that all parking places are occupied so it turns on RED LED, which gives a signal to CLOSED arrangement of 7 segment display. To

provide enough voltage to 7 segment displays and LEDs to turn on simultaneously a relay circuit is made for open as well as closed arrangement of 7 segment displays, and also for the streetlights.

The outputs of the first subtractor are compared with 0000 using a 4 bit comparator, if the outputs are larger than 0; they are from 1 to 8; A>B, then this output is compared with whether the light sensors sense light; 1, or they do not sense any light; 0, using the help of a NOT & AND gate, if the sensor senses no light; 0 and A>B =1 at the same time, only then the street lights will turn on, or else they will remain off for energy conservation.




## Empty and Filled Slots Indicator:

The basic purpose of this category in design was to identify or indicate that which parking place is empty and which is occupied, so to give direction LEDs an easy way to follow the path for empty places.

This is designed by using 8 different sensors which are installed at 8 different places so to show which of the parking places are empty and which are occupied. These sensor values are given as input to multiplexer. Select lines of multiplexer are given with the help of BCD counter. And an alternating pulse input i.e. a DClock is given to the counter.

Then two demultiplexers are used. Therefore, after demultiplexing inputs, again 8 inputs are obtained for 8 LEDs. The outputs of Demultiplexers are given to D flip flops which are directly connected to 8 different LEDs.

Then according to the different inputs, respective LEDs are turned on or off. The parking places where LEDs are on are the filled one's and vice versa.

## Direction LEDs

For the first three LEDs, we defined the states and then, from these we made state diagram and state table and defined next states which are inputs to our D-flip flops and output functions. Then for next 9 LEDs, similar sequential design procedure is opted to design them. So, the states we defined are as follows:

State 1 (000): Initial State. No Car entered the parking yet. Everything will be off.

State 2 (001): Car enters. First two spots are both available.

State 3 (010): Car enters. The first spot is available but the second is filled.

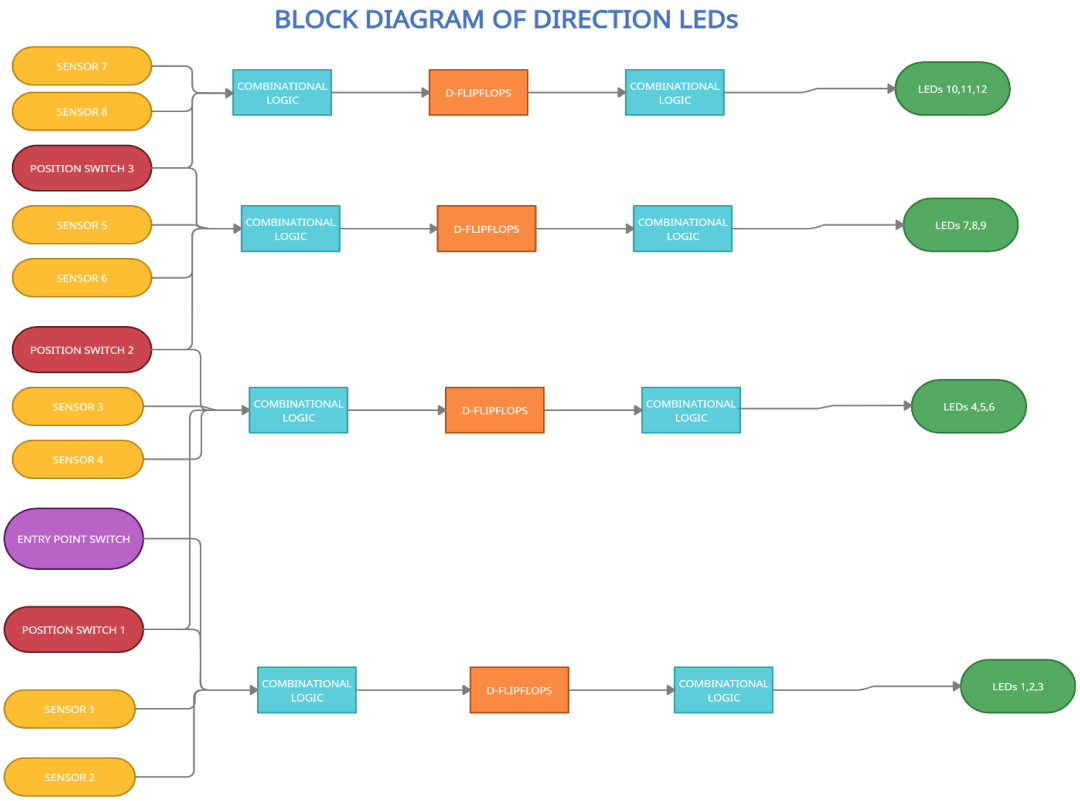
State 4 (011): Car enters. The second spot is available but the first is filled.

State 5(100): Both spots are filled.

If state 5 occurs then it will be the same state as 001, 010 or 011 for next three LEDs. To check this state, we have position switch between spot1, 2 and spot 3, 4. When this switch will be logic 1, it will do the same as entry point switch for next two spots.

We haven't used Position Sensor 1 as input, because when it will be 0 this state table will work. When it will be 1, next state will be 000 and L1, L2 and L3 will also be zero. Then this PS1 will act as entry point sensor for the next three LEDs and design procedure will be same then. For the next LEDs the logic is similar except we will treat previous position switch as their entry point input. So, they will only be turn on when the car crosses the position switch 1. For the last three LEDs, similar logic is implemented but there is no position switch ahead so, the position sensor input will be eliminated.

All of this arrangement gives all possible directions of empty places for the car to park there, initially it gives the nearer to the entrance but if driver skips that place, design directs the driver to the next empty place. In this way it goes on until the car is parked.




## Billing System:

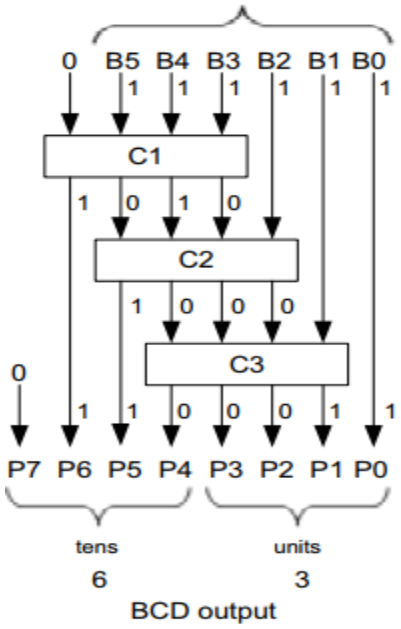
The design for the billing system contains a timer circuit that is built from a cascade of two asynchronous, falling edge triggered BCD counters with the simple trick to reset the counters at the corresponding times. The counter for the lower seconds' digit runs continuously. The upper seconds' digit counter needs to be reset after 59 seconds to avoid counting to 99 seconds. This is achieved by connecting the asynchronous reset input of the counter block to its Z1 and Z2 outputs. This is achieved by connecting Z1 and Z2 outputs to an AND gate whose input is then given to counter reset. Therefore, as soon as the counter reaches 60, it is immediately, asynchronously reset after 59 seconds, i.e. 1minute which is considered as 1 hour in hour project.

This output of AND gate is given as a clock in 3-bit counter of JK flip flops. As the parking place timing is made 6 hours, so to reset counter after 6 instead of 7 and AND gate is used whose inputs are $Q_A$, $Q_B$ $and$ $Q_C$ and whose output is given to Active high clear of every flip flop of the counter, thus counter resets at 6 instead of 7.

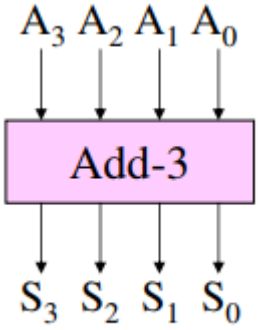
Then number of hours are multiplied by 5 in a binary multiplier as parking price of 1 hour is decided to be 5 Rupees. The output of binary multiplier is then added with 2 Rupees of tax in a BCD adder which is designed using a half adder and a four-bit full adder IC 4008. Then total bill of car park is displayed using seven segment display LEDs.

The output of BCD adder was a six bit binary output which was converted to BCD and then displayed on LEDs via 7447 ICs, with the following special combination of the "Add combination".

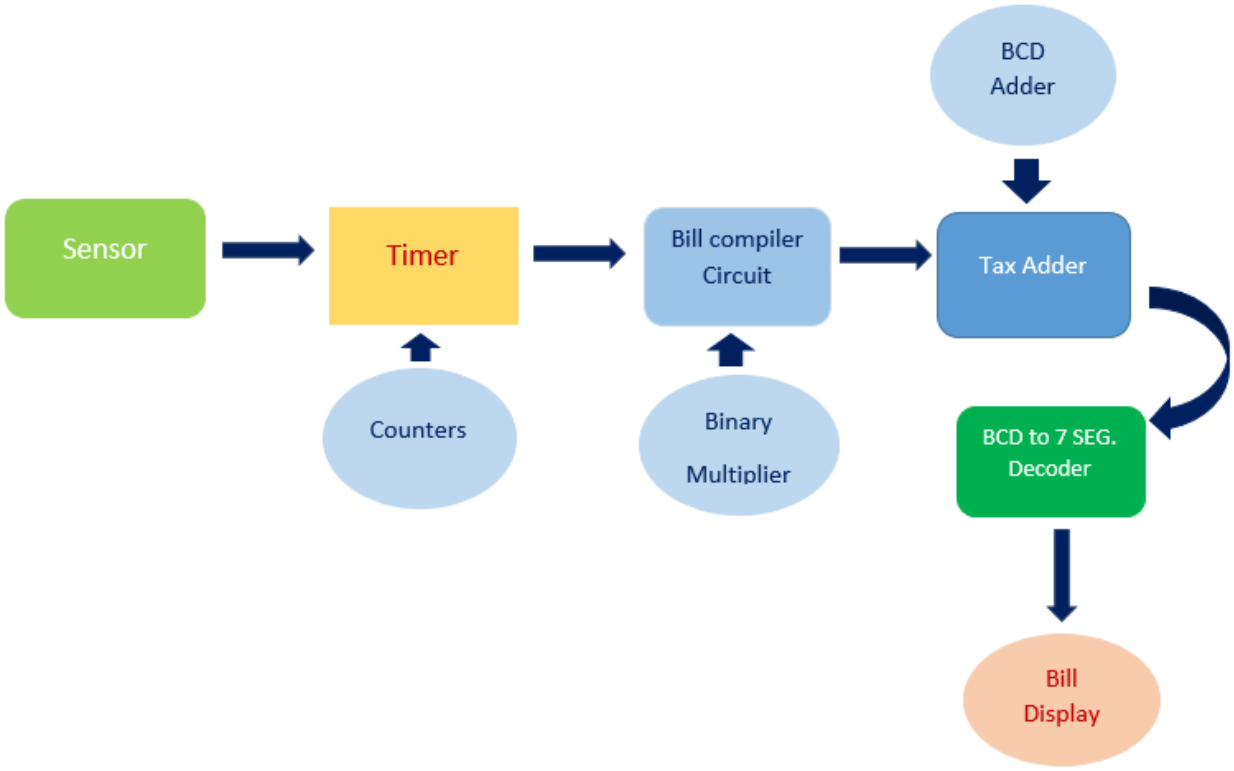
Truth Table for Add 3 module




| $A_3$ | $A_2$ | $A_1$ | $A_0$ | $S_3$ | $S_2$ | $S_1$ | $S_0$ |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |
| 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 1 | 0 | 1 | 0 | x | x | x | x |
| 1 | 0 | 1 | 1 | x | x | x | x |
| 1 | 1 | 0 | 0 | x | x | x | x |
| 1 | 1 | 0 | 1 | x | x | x | x |
| 1 | 1 | 1 | 0 | x | x | x | x |
| 1 | 1 | 1 | 1 | x | x | x | x |




$$S_3 = A_3 + A_2A_0 + A_2A_1$$
$$S_2 = A_3A_0 + A_2A_1'A_0'$$
$$S_1 = A_3A_0' + A_2'A_1 + A_1A_0$$
$$S_0 = A_3A_0' + A_3'A_2'A_0 + A_2A_1A_0'$$




## Results and Achievements:

At first, we had aimed to design our project for 10 parking spaces as we had purposed in the abstract but later on we managed to design our project for only 8 parking spaces.

It was mainly due to the issue of the 16x1 MUX & DeMUX ic in the proteus library, as it was not working correctly with this design.

By manually designing the circuit without the use of the MUX would have taken a lot of time and the resulted circuit would have been much more complex. For future work the design can be extended for numerous LEDs and parking spots.

One problem faced in the billing system was the conversion of 6 bit binary numbers to BCD, this was overcome by designing a circuit specifically for this purpose.

Another problem faced while designing the Parking Space Indicator was the shortage of voltage provided to the 7-segment LED displays and the LEDs, this was overcome by creating a relay circuit for each of the two outputs of the comparator to provide enough voltage to power all the LEDs.

One other problem faced in this project is that the billing system works for 6 hours, this can be improved and further complicated for it to work for 24 or more hours in future projects.

## Recommended Future work:

In the future this project can be further enhanced by integrating Credit/Debit card payment for the billing system, and creating a billing booth for the parking staff where a display will show the hours each vehicle has occupied a parking space for and subsequently the current total bill that has been generated for each of the vehicle.

Further improvements that can be made include designing the circuit so that the directional LEDs light up all the way till the first empty spot available and to integrate further sensors in the road to allow for two lanes of cars to simultaneously be guided by the directional LEDs to the nearest empty car space available.

An additional feature can be the division of the parking space for cars and motorbikes. Each of the vehicle entering will be asked to input whether they are riding a motorbike or car at the entry gate or weight sensors will be used to asses if it is a car or motorbike entering and then the vehicle will be directed to an empty parking space in their respective designated area in the parking system with the help of directional LEDs.

A token system can also be introduced that allows entry only upon the generation of a token and allows exit only when the said token is given back at the exit.

## Conclusion:

The smart parking system is considered beneficial for the car park operators, car park patrons as well as for the conservation of the environment as it significantly reduces the amount of fuel burned going around in circles trying to find an empty spot. As this system is completely digitally implemented, there is no more need for Parking Workers, thus reducing the overall cost required to maintain the huge parking spots that are located outside of shopping malls, theaters, hospitals and airports e.t.c. Thus, the implementation of this project solves problems from an environmental perspective to the perspective of a business where the cheapest yet most efficient solutions are preferred to avoid the expenditure of unnecessary excess money.

In Conclusion, the Smart Parking System is proposed to help combat the problems that arise in parking lots by providing a system that helps drivers to smoothly and quickly allocate an area to park without creating unnecessary traffic jams and wasting time going all around the parking lot.