Digital Integrated Circuit: Project

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Abstract: As more and more families have a private car, the need for parking lots is increasing dramatically. To make a better user experience, an intuitionistic display system is necessary. This article will give an overview about a new kind of display system constructed by digital components. Functions of this system will be shown in Multisim.

1. Introduction

Most car owners may have the experience that they cannot find a parking space or they may complain about the charging display function of the system.

This design is for improving the two problems mentioned above. First one is the indicator lights. For each parking space, there will be two indicator lights, one is red and the other one is green. When the place is free, the green light will be on, and vice versa.

Second one is to improve the performance of the charging display function. User can obtain the real-time information of the parking fee. After he leave the position, the expense will be shown on the display screen for some time.

2. Simulation and Results

2.1 Part 1 Indicator lights

First part is the indicator lights. As an example, the circuit gives a situation of 6 parking spaces and each positon has two lights. The whole circuit simulation is shown in Figure 1:

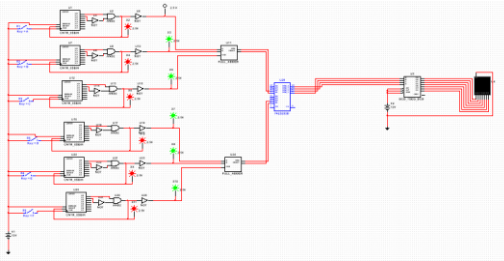

Figure 1

Because of the similarity of the circuit, here just analyze one unit of the it, which is shown in Figure 2. The physical model is shown in Figure 3.

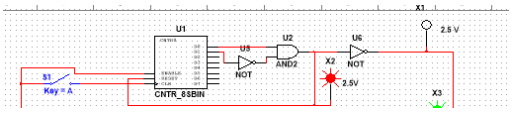

Figure 2

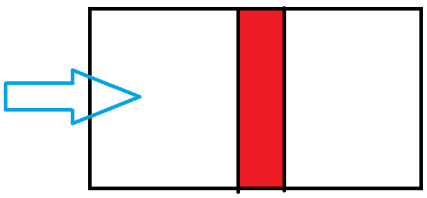

Figure 3

This is one unit of the whole circuit, which is the heart of this part. When a vehicle moves from the left to the right and goes through the red part, which corresponding to the key in the circuit. This key can be modeled as a pressure pickup. As an intuition, if a car goes through a place, since the car has four wheels, two were at front and the other are at back. Pressure of the red part follow the trend of curve shown in Figure 4, which proves the reliability of the model.

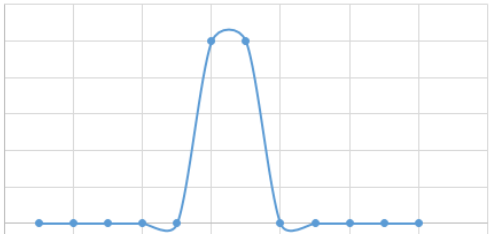

Figure 4

In the initial situation, the counter is reset which gives $D_0 = D_1 = 0$, and the green light is on. Once the key goes through an opening to the closing, the counter will record it and the output will become to $D_0 = 1, D_1 = 0$, which

lighten the red light and close the green light. At the same time, this signal will be transmitted to the full adder and the other display components shown below.

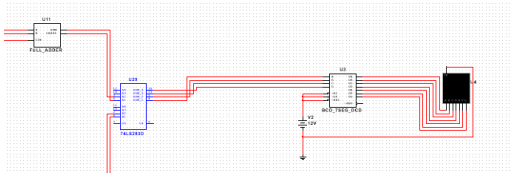

Figure 5

The digit display segment can show the number of free parking spaces.

When the car in the position goes away, which corresponding to another opening to the closing sequence. The counter will record it and the output will become to $D_0 = 0, D_1 = 1$. The counter will be reset, the output of each light and the digit display segment will make changes correspondingly.

2.2 Part 2 Charge Display

The circuit of this part is much more complicated than which in Part 1. For each position in Part 1, there is a Part 2 system. Here gives the system of one position.

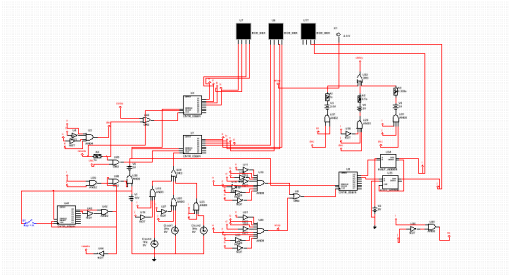

Figure 6

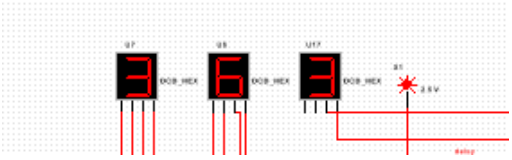

Figure 7

There are three digits display segments, the left two show the fee user need to pay, and the right one shows the expense of the position for each hour.

As a model, there gives the regulation that 1 second in the circuit correspond to 1 hour in real. One can only park his car in one position for 24 hours, or the red light will be lightened. The owner

will be informed to take away his car. During the first 12 hours, the expense of the position is 1 dollar per hour, and during the next 12 hours, it will become to 2 dollars per hour.

To achieve this effect, there applies the concept of finite state machine. For simplicity, take state 1 when the expense per hour is 1 dollar and state 2 corresponding to 2 dollars, state 3 is stop.

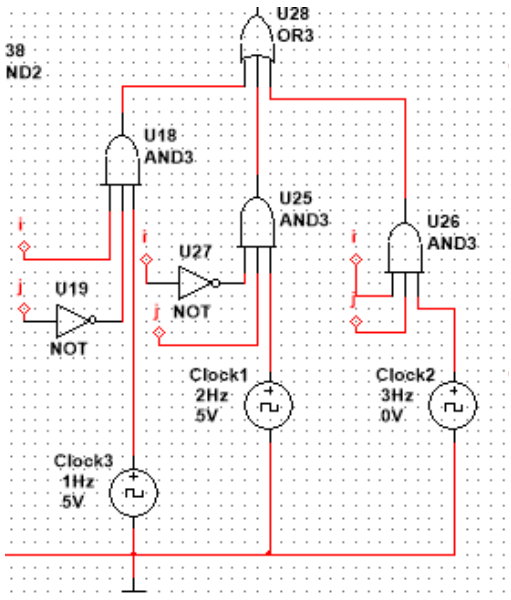

Figure 8

As shown in Figure 8, a unique pulse train will be given to the clock of counter 1 in each state. In state 1, the frequency of the pulse train is 1 Hz, and in the other two it is 2 Hz and 3 Hz (but no voltage supply). This setting gives the effect of change of expense per hour.

The “EN” of counter 1 is connected to an AND gate whose input is Vcc and a port in Part 1. Only when the position is occupied, the Part 2 will start working.

When the output of counter 1 is equal to 10, which means there will produce a carry bit. To realize it, here uses a delay component. In state 1, when the output of counter 1 is 9, a pulse will be given to counter 2 with a delay of 1 second, and in state 2, it becomes 0.5 second. This is also realized by the concept of FSM.

The realization of FSM is using a

counter. Since there are only three states, two bits is needed. Using i and j to denote the two bits. The first state is i = 1, j = 0. When the output of counter 1 and 2 is equal to 2 and 1, a pulse is transmitted to the FSM counter, which changes the output to i = 0, j =1. The whole circuit will move to state 2. Similarly, when i = 1, j = 1, it goes to state 3. The circuit is shown in Figure 9.

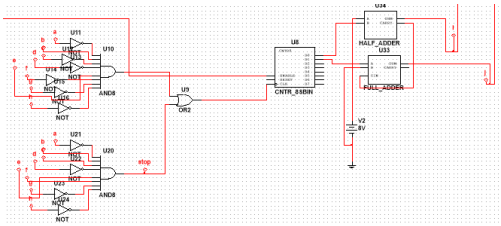

Figure 9

Next important design is to preserve the output on the display screen for 2 seconds which corresponds to 2 hours in real world.

To achieve it, one need to use the delay components and reset ports of the counter. When the position become free, a pulse will be transmitted to the reset ports with a delay of 2 seconds. In this duration, the user can pay the expense of parking. The circuit is shown below. The pulse goes along the blue line in the figure.

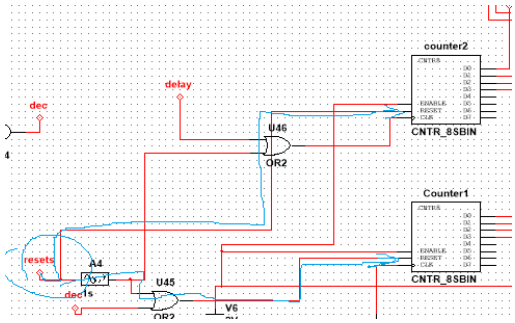

Figure 10

3. Some Problems in Simulation

In the circuit simulation part, here is a perplexed problem. If there is an inverter before a OR gate, if the output the inverter is HIGH, the output voltage will be 2.5V (Vcc = 5 V), which cannot enable the OR gate.

To overcome the situation, the

solution applied in this circuit is to add a DC power supply as 2V, which enhance the output voltage to 4.5 V, and 2V will not affect the performance when the output of the inverter should be LOW.

Second problem I met is the reset of the counter in Multisim does not operate as I imagined. The reset will happen in the next input. To make it work, the solution in this circuit is to use a delay to other input so that the other output can perform synchronously with the reset of the counters.

4. Conclusion and Prospect

This system can give some ideas for a real parking lots. To improve the user experience, the concept of “human-oriented" should be applied to design.

There are some potential points which remained to be improved.

1. The system can not only show whether there is a free space to park, but also give some indications to help the driver to park the car.
2. Give the exact position of the free parking space.
3. More detailed expense regulations such as for different kinds of vehicles and different time durations can be applied to the system.
4. Taking into a reservation management.