Hand Gesture Recognition

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Abstract

This report is the study of the technique used for recognizing basic hand gestures like swiping to control various activities and simulating the result to check the best parameters and conditions and algorithms for the swift functioning of the circuit.

1. Introduction

Hand gestures are one of the many ways to make the current technologies more user friendly and exciting. Imagine unlocking your door with just a gesture! Such technologies also find use in advanced robotics. Here in this project a system is developed for recognizing various hand gestures (discussed in the next section). Then a particular use case of such a system is discussed. Optical sensors are used for the 'sensing' part and then the next block uses the output of those uniquely placed sensors to output which gesture was made. After that, a mathematical model is attached to each gesture and an output is displayed on a 7 Segment LED display.

2. Goal

The goal of the project is to identify various hand gesture like swiping left or right and using it to activate various functions. The gestures that we are trying to recognize are:-

1. Swiping Left and Right.
2. Making a Fist
3. Complete opening of the Palm.

The major use of such a system can be seen in the automobile industry which can reduce driver's visual and cognitive demands. In the new era of automated cars basic controls can be linked to various hand gesture to allow the driver to control the vehicles position. Hence such a system would play an indispensable role in the ”automated world”, ranging from door opening sensors to, as mentioned above, automated cars this system will find its use in umpteen places.

3. Importing Blocks of the Circuit & Idea Summary

3.1. *The Optical Sensor Input*

The input is generated using the optical sensor TCRT5000. The led and the photo diode are powered by a 5V supply and the output voltage is taken at the collector.

The data for the output depending on the distance of the hand from the sensor is as follows.

Distance (in mm)	**Output Voltage (in V)**
2	0.27
4	1.2
6	2.4
8	3.8
10	4.3
12	4.9

TABLE 1. Variation of Output Voltage with Distance

This is the basic building block of our circuit. When we pass our hand over the sensor, it’s voltage drops. We use this fact to proceed. Since the output of the sensor ranges from 0-5V, it is anyway perfect for us to convert into the digital spectrum. In the digital world 0V is taken as 0 ad 5V as 1. For the digital part of our circuit we are using the CPLD Krypton Board. In this basic building block the output from the sensor goes into the krypton board which coded in a particular fashion as to respond correspondingly to the input. Here for the basic building block circuit when our hand is near the sensor, the particular LED doesn’t glow, but when our hand is sufficiently close to the sensor it causes a particular LED to glow (as shown in the pictures below- the yellow box encloses the LED which is supposed to glow).

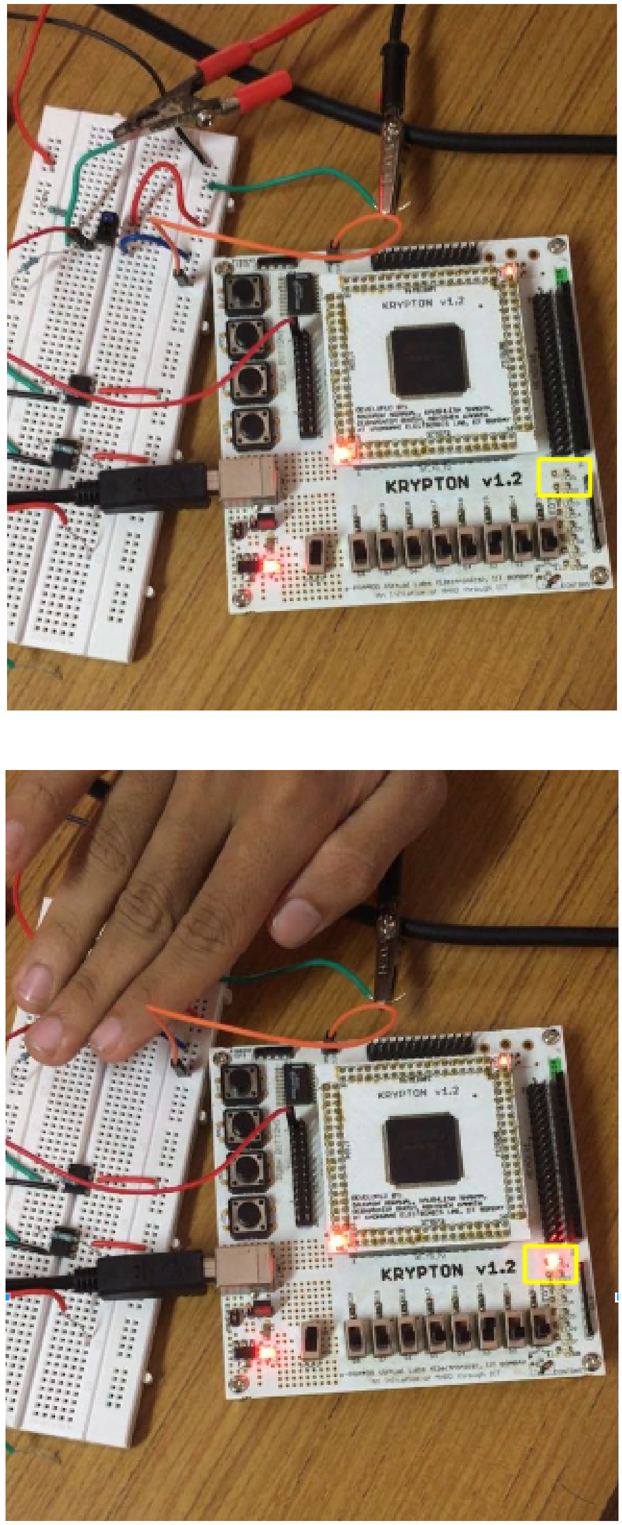

FIGURE 1. Optical sensor arrangement feeding its output as an input to the Krypton Board (The change can be seen in the yellow box from the first to the second image)

But the problem we had with this circuit is that, for the krypton board to recognize the input as 0 the voltage has to be very near to 0. So from the observation table our hand has to be very near to the sensor (¡4mm). This is practically undesirable. We thus need a solution for this. For the same reason we use the following- Comparator

3.2. *The Comparator Circuit*

We are using the IC LM 311 to use as an voltage comparator. The voltage switching point is set at around a voltage 4V. The supply voltage to the Op-Amp is +5V and ground. Referring to the table1 we can see that setting the switching point at 4 V gestures are recorded for any distance less than 9mm making it more user friendly to use the device. This is an important change because in real life we can't always keep out hands very close to the sensors.

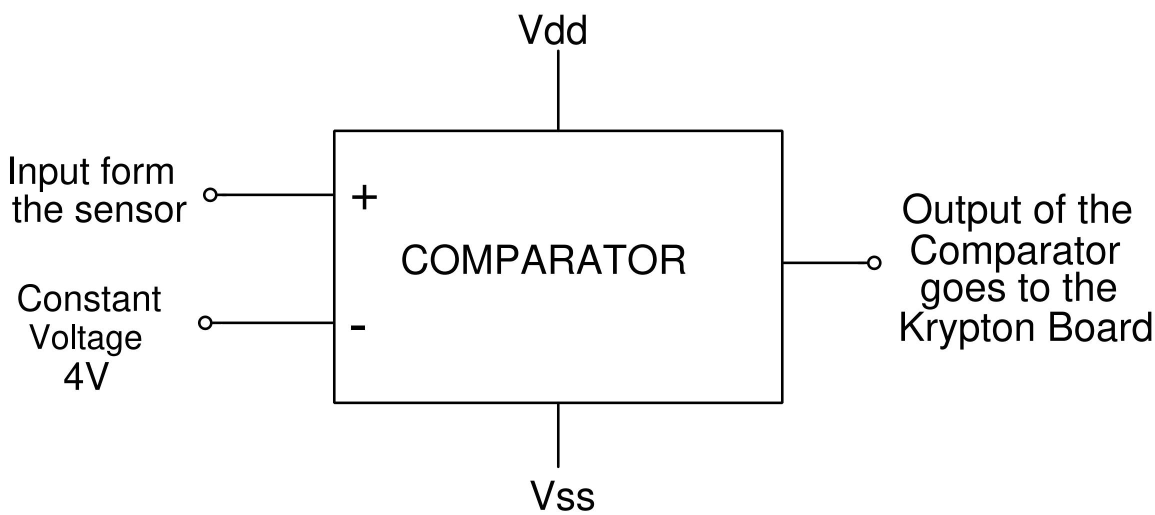

FIGURE 2. Block Diagram for a Comparator

3.3. *The working algorithm on the Krypton Board*

Now after taking input from the sensors we will give it to the Krypton Board. Coming to the application of left/right swipe the positioning of the sensors would be next to each other, separated by enough distance. When our hand passes over any of the sensors the output for that particular sensor would be 1, since the voltage would drop below 4V. When there is no hand over the sensor the output of the sensor is 1.

For representation of the system (also for the simulation) we create a Finite

State Machine (FSM), which is then represented in VHDL Language (& compiled in the Quartus Software, and Simulations done on the same). The algorithm goes as follows: We have three states : Rest, State1 and State2. The input 10 takes the system from rest to State1, a further input of 01 takes it from State1 to State2. This two inputs occur when you swipe left. After this when there is no hand over the sensors the input automatically becomes 11 which sends the system to the rest state. The output is therefore deemed 1 when the input changes from 10 to 01. For right swipe the occurrences of the events is exactly opposite. The FSM is shown in the below picture.

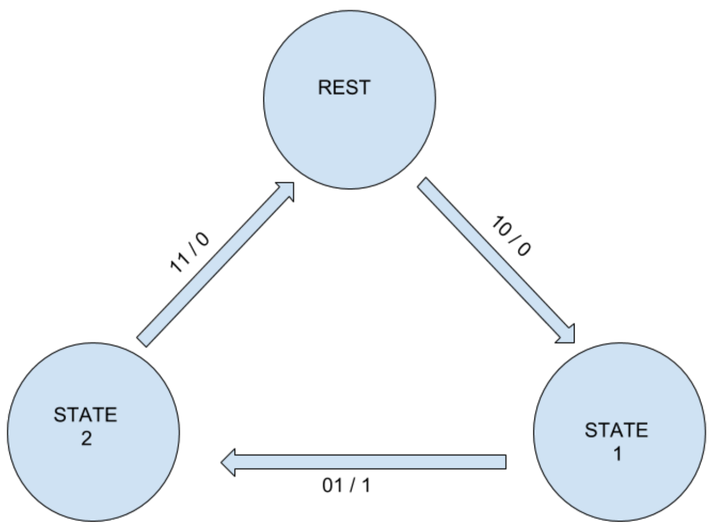

FIGURE 3. Finite State Diagram for recognizing a swipe

4. Project Setup

For the simulation to be done there is a need for a clock which samples the input at least every 20ms. So the requirement is for a clock of 50 Hz. But unfortunately there is only a 50 MHz clock available. So, a clock divider is used, which takes the input a 50 MHz clock and the output as an approximate 50 Hz clock. The simulation result for the code for this s attached in the lower sections. The circuit for this purpose consisted of D-Flip Flops. Their arrangement is shown below. After this a mathematical operation is attached to each of the gesture type. 'Left' is assigned to subtract 1, 'right' is assigned to add 1, 'up' is assigned to multiply by 2, 'down' is assigned to subtract 2 and any tilt movements multiply by 4. All the operations are performed modulo 10.

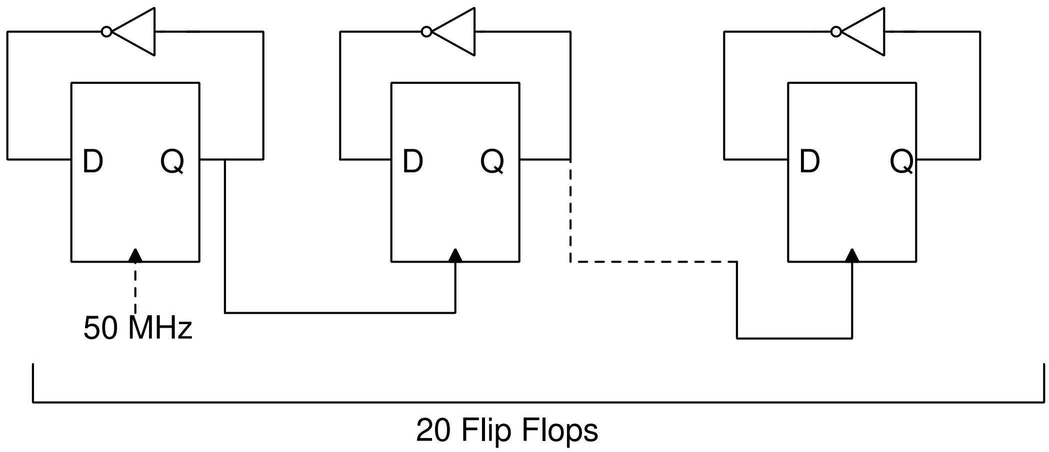

FIGURE 4. Arrangement of D-Flip Flops

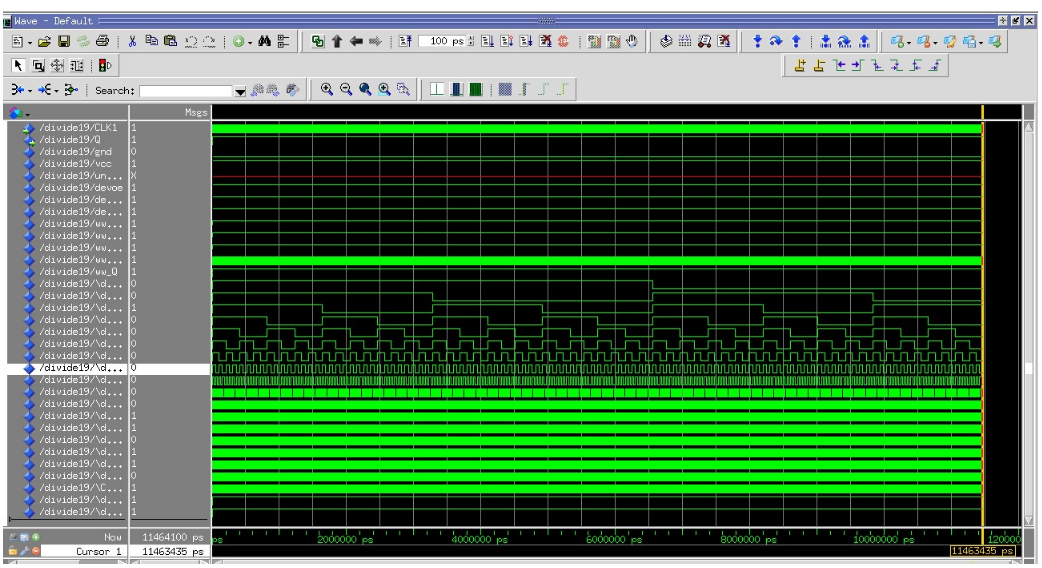

FIGURE 5. Simulation for the clock

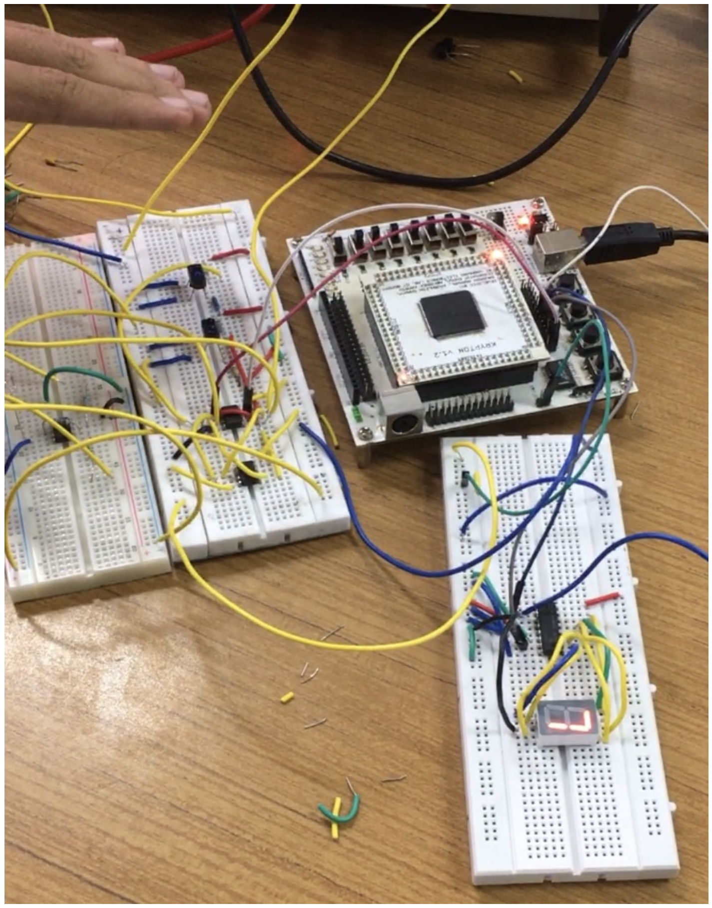

FIGURE 6. Full arrangement for the project

5. Conclusion

A sensor based system for hand gesture recognition was built. Optical sensors were employed and with the help of the Krypton board (taking input from the meticulously placed sensors) gesture recognition was achieved. Then each of the gesture was associated with a mathematical operation (modulo 10) and the result displayed on an LED display. All this was successfully showcased in the final demo of the project.