E1201 PROJECT REPORT: ELECTRONIC ROCK PAPER SCISSORS

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Abstract:

Our circuit is designed as an electronic referee for the game of "Rock Paper Scissors". The choices made by the players and the winner of each game is indicated by a set of LED lights. Players are expected to make their choice via switches. These switches act as input signals to the logic gates, lighting up the LEDs, which indicate the winner of the game. If a tie occurs, neither of the LEDs light up.

Circuit Schematics:

In order to come up with a suitable design, we first determined a logic expression for the three cases: Player 1 Winning, Player 2 Winning, and Tie between the two players. The truth table, along with the corresponding operations, is given below:

P = paper; R = rock; S = scissors (eg. If P1 = 1, Player 1 chooses paper)
W1 = Player 1 wins; W2 = Player 2 wins; T = Tie between the 2 players
Truth Table

P1	S1	R1	P2	S2	R2	W1	W2	T
0	0	1	0	0	1	0	0	1
0	1	0	0	1	0	0	0	1
1	0	0	1	0	0	0	0	1
1	0	0	0	1	0	0	1	0
1	0	0	0	0	1	1	0	0
0	1	0	1	0	0	1	0	0
0	1	0	0	0	1	0	1	0
0	0	1	1	0	0	0	1	0
0	0	1	0	1	0	1	0	0

Table 1: Truth Table for Rock Paper Scissors

Assuming that the players know how to play this game and follow the rules by making just one choice at a time, the logical expressions for each of the three cases:

W1 = $P1\overline{S1R1}\,\overline{P2S2}R2 + \overline{P1}S1\overline{R1}\,P2\overline{S2R2} + \overline{P1S1}R1\,\overline{P2}S2\overline{R2}$
W2 = $P1\overline{S1R1}\,\overline{P2}S2R2 + \overline{P1}S1\overline{R1}\,\overline{P2S2}R2 + \overline{P1S1}R1\,P2\overline{S2R2}$
T = $\overline{P1S1}R1\,\overline{P2S2}R2 + \overline{P1}S1\overline{R1}\,\overline{P2}S2\overline{R2} + \overline{P1S1}R1\,\overline{P2S2}R2$

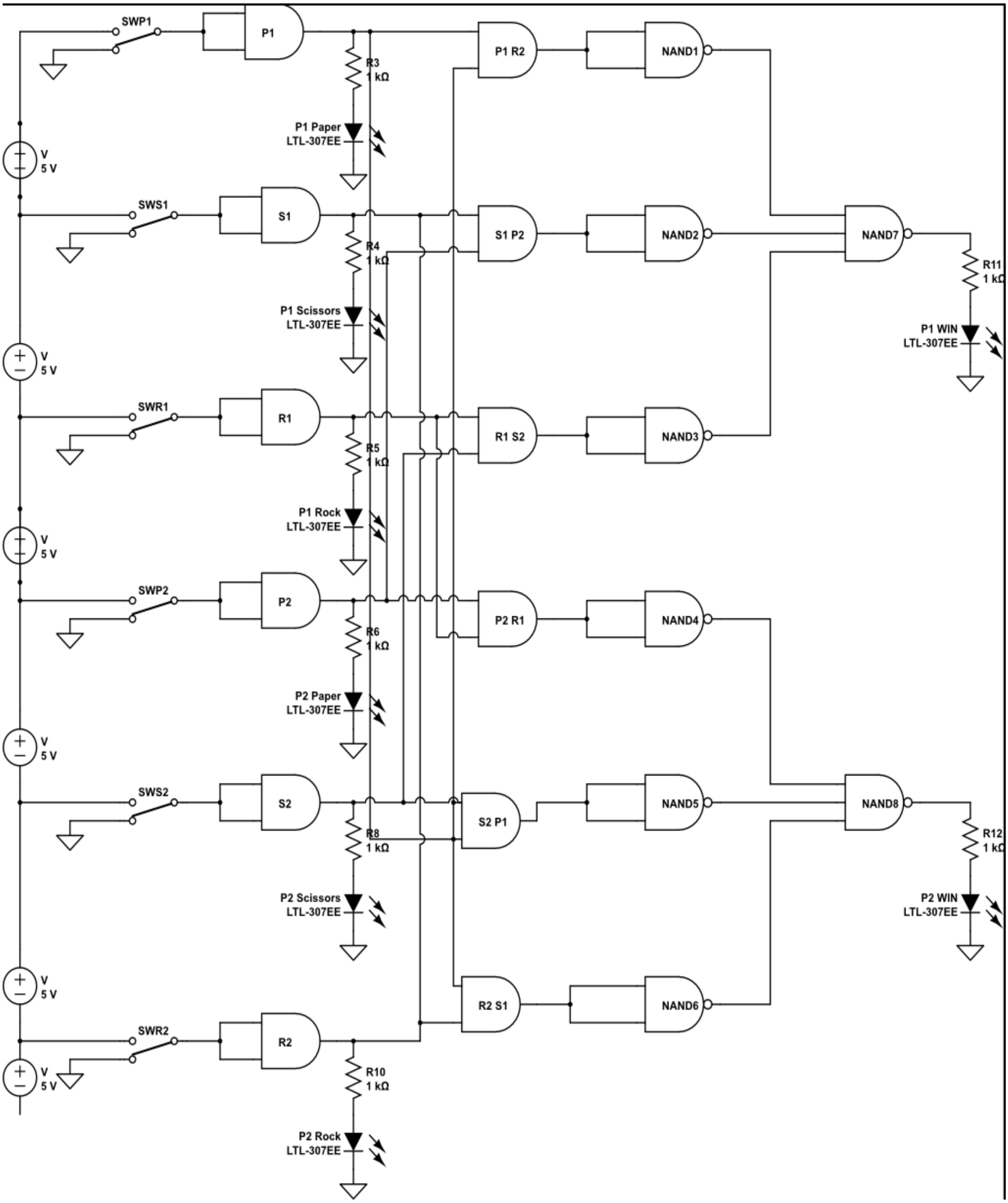

Figure 1: Final Design of the Circuit

The function of each component is explained below.

Switches:
We used 6 push button switches, each acting as an input for the 3 possible choices (paper, rock, scissors) made by the two players. In order to ensure that the LEDs indicating the players' choice and the LEDs showing the winner of the game, the players must keep pressing the switches as long as all the desired LEDs light up. The pushbuttons have 3 connections; one connected to the ground, one connected to the power supply and one connected to the logic gates. The power supply had a voltage of +5 Volts and when a button is pushed, it inputs a logic of 1 to the corresponding logic gates. When the button isn't pushed there is 0 Volts through the switch and a logic of 0.

Logic Gates:
The first sets of logic gates are AND gates, which are directly connected to the pushbutton. Both of the inputs are directly connected to the pushbutton. Since there are 3 possible choices for each player, there were a total of 6 AND gates in the first stage.

The outputs of these AND gates are connected to the LEDs indicating the choice of the players, as well as the second set of AND gates. The inputs of the second AND gates are designed such that the output would be 1 for W1 (ie. Player 1 wins) or W2 (ie. Player 2 wins). For example, for Player 1 to win Player 1 must make a choice of scissors and Player 2 must make a choice of paper. There are two other possible choices for Player 1 to win and hence there are 3 AND gates required to account for all of the cases in which Player 1 wins. Similarly, there are 3 cases for Player 2 to win. Hence in the second stage, there are a total of 6 AND gates.

In the third and final stage, the outputs of these two gates (note that the AND gates in Stage 1 divided into two groups: W1 and W2) are connected to NAND gates. The output of each AND gate in the second stage is connected to a NAND gate (both inputs are the output of each AND gate). These NAND gates are connected to two 3 input NAND gates and the outputs of these 2 NAND gates are connected to LEDs, indicating the winner of the game. Note that, in our original design we used OR gates; however, since our lab had only NAND and AND gates, we had to use NAND gates to account for the OR gates.

LEDs:
There are eight LEDs in total. The first six are used to indicate the choices of the two players. The other two are used to indicate the winner of the game. All of the LEDs were connected to 1K resistors to securely power the LEDs. In order to light up the LEDs with the desired intensity, we had to adjust the power supply to a voltage above a specific level.

Notes:

While designing, setting up and testing our circuit, we came up with possible improvements. These improvements would help the circuit to function better and make the game easier. For instance, using switches that turn on and turn off until only when the user presses them again would make this game a more comfortable experience. With these new switches, the players wouldn't have to keep the buttons pushed throughout the game.

Another possible improvement is adding a RESET gate. By adding a RESET gate, results (ie. the inputs and the outputs from the previous game) would be deleted and the game would start over.

Adding a counter! For players who love to compete and want to play Rock Paper Scissors multiple times, a counter would be a perfect modification to the circuit. In this way, the players wouldn't have to keep track of their scores since the counter would automatically count the players' scores.

We encountered a few unexpected challenges while setting up the circuit. While testing our first design, we realized that the AND gates weren't functioning properly. After conducting a further research on AND gates, we found out that our AND gates were open circuit. In order to ensure that the AND gates function properly we had to connect a resistor to the output of each AND gate. We also discovered that there was a floating voltage in our circuit, which occasionally made the wrong LED light up. This was because there were many wires.

We started the design process including an evaluate button so that the players could see their choices after both players had clicked the respective buttons. However, potentially due to the floating voltage as well as broken AND gates, our initial design didn't light up the LEDs in the way we wanted. Therefore, we changed the design to not include the evaluate button in hopes that a simpler design would make the non-ideal circuit work better.

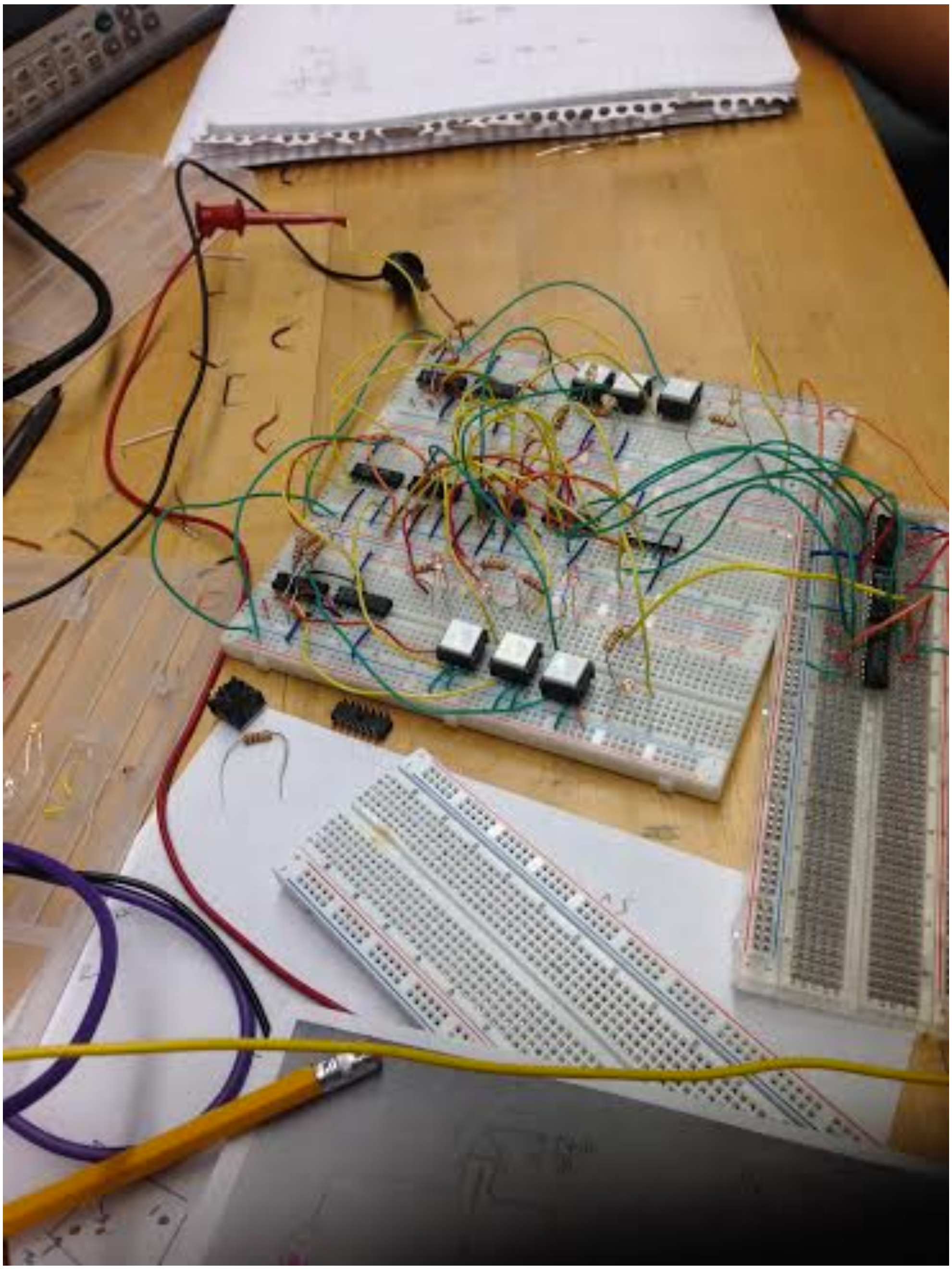

Figure 2: Our initial design with the evaluation button

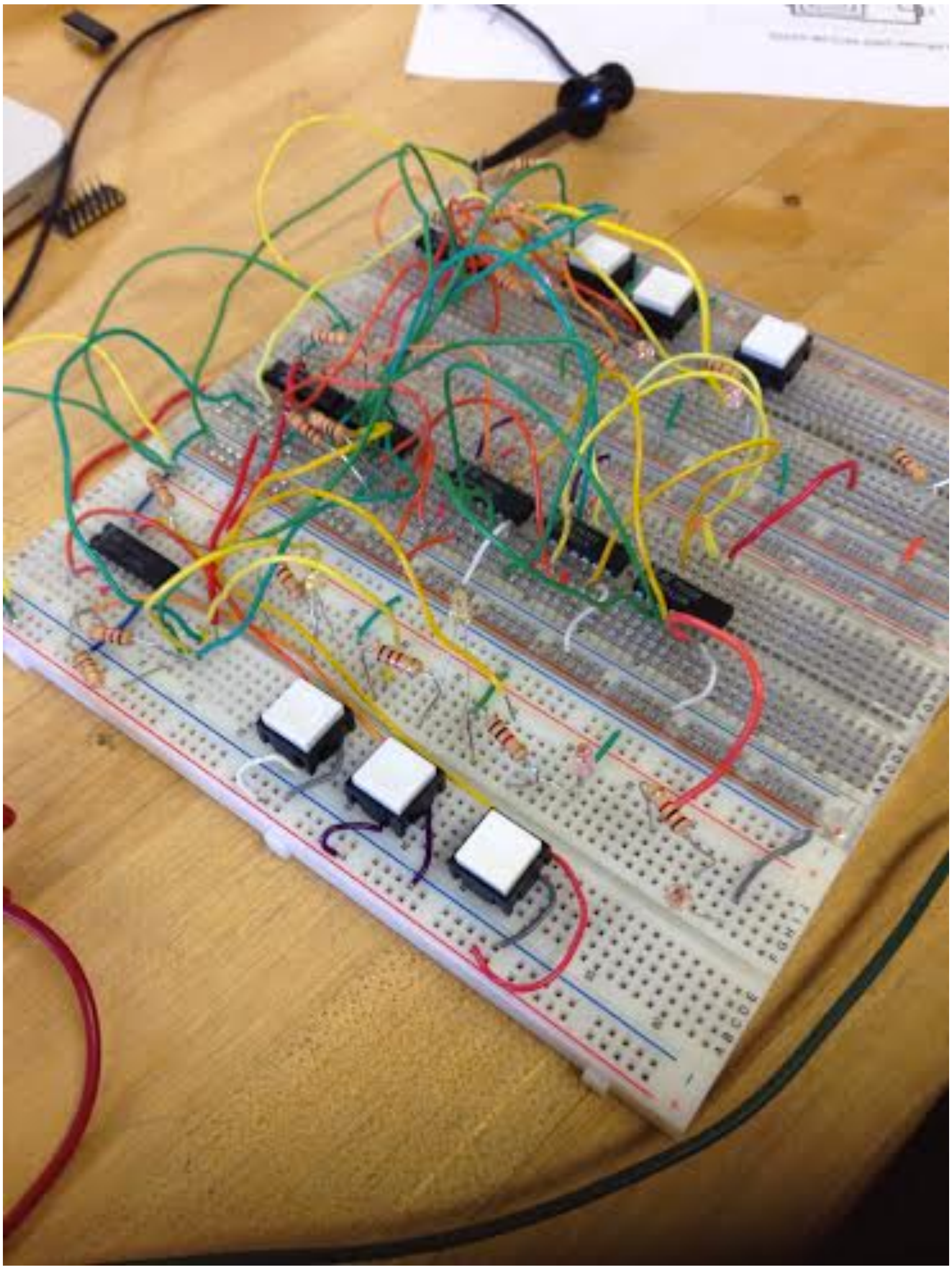

Figure 3: our final design, in which we reduced the number of logic gates as much as possible to reduce the chance of getting an error