FPGA LAB

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Tic-Tac-Toe Game

Tic Tac Toe is a very popular paper-and-pencil game in a 3x3 grid for two players. The player who makes the first three of their marks in a diagonal, vertical, or horizontal row wins the game.

Tic-Tac-Toe Game

Rules of the game:

A player plays the Tic Tac Toe game with a computer.

When the player/computer plays the game, a 2-bit value is stored into one of the nine positions in the 3x3 grid like Xs/Os in the real paper-pencil version.

Tic-Tac-Toe Game

The player plays the game by pressing the corresponding button.
Red/Green LED is lit in a position when the position is played by the player/computer respectively.
The player/computer wins the game when successfully placing three similar Xs/Os values in the following row pairs:
(1,2,3); (4,5,6); (7,8,9); (1,4,7); (2,5,8); (3,6,9); (1,5,9); (3,5,7).

Tic-Tac-Toe Game

The winner detecting circuit is designed to find the winner when the above winning rule is matched.

To detect an illegal move, a comparator is needed to check if the current position was already played by either the computer or player.

Moreover, No space detector is to check if all the positions are played and no winner is found.

Verilog Code

To control the Tic-Tac-Toe game, a FSM controller is designed as follows.
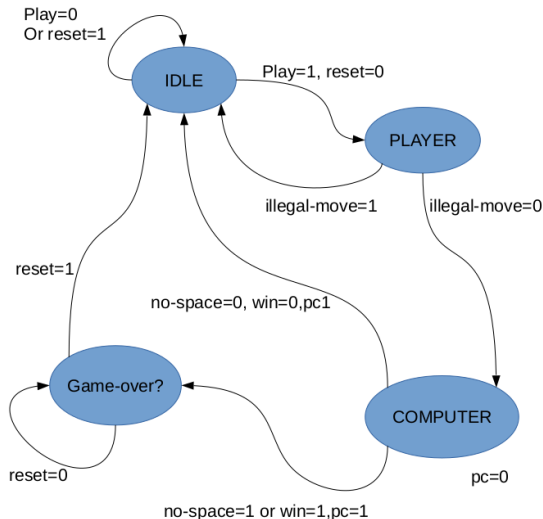
1. IDLE(00): when waiting for the player/ computer to play or when resetting the circuit, the FSM is at the IDLE state.

2. PLAYER(01): The player turns to play and 01 to be stored into the decoded position.

3. COMPUTER(10): The computer turns to play and 01 to be stored into the decoded position.

4. Game-over(11): The game is finished when there is a winner or no more space to play.

Inputs of the controller of the Tic Tac Toe game:

a. Reset :
- Reset $= 1$: Reset the game when in the Game-Over state.
- Reset $= 0$: The game begins.

b. Play:
- Play $= 1$: When in the IDLE state, play $= 1$ is to switch the controller to the PLAYER state and the player plays.
- Play $= 0$: Stay in the IDLE state.

c. PC :
- PC $= 1$: When in COMPUTER state, PC $= 1$ is to switch to the IDLE state and the computer plays.
- PC $= 0$: stay in COMPUTER state.

Inputs of the controller of the Tic Tac Toe game:

d. Illegal-move :
- Illegal-move $= 0$: When in PLAYER state, Illegal-move $= 0$ is to switch to COMPUTER state and let computer plays when $PC = 1$.
- Illegal-move $= 1$: Illegal moving from the player/computer and switch to the IDLE state.
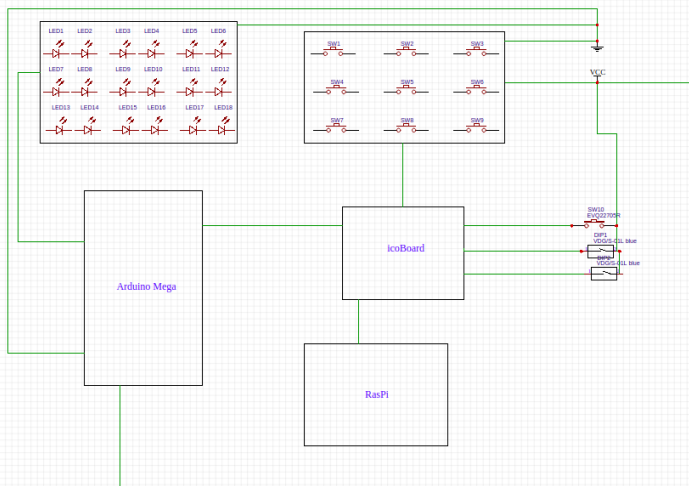
e. No-space :
- No-space $= 0$: still have space to play, continue the game.
- No-space $= 1$: no more space to play, game over, and need to reset the game before playing again.

f. Win :
- Win $= 0$: Still waiting for the winner.
- Win $= 1$: There is a winner, finish the game, and need to reset the game before playing again.

Circuit Diagram

The End