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Mastermind

Overview:

For our project we are creating a version of the game mastermind. The players will buttons on the FPGA to set their desired patterns and submit them. They will lock in their selection by pressing the center button (btnS). The left/right button (btnL/btnR) are used to change the peg that is being selected. The up/down button (btnU/btnD) are used to change the color of the peg that is undergoing selection. 4 RGB leds will be used to display colors to the player. By using simple high/low voltage output from the FPGA, this gives us 8 possible color options. The 7 segment display will be used to provide guess feedback. An “X” (looks more like “H”) will denote a matching color and location, a “O” will denote a matching color and wrong location, and a blank display will mean that a peg did not match color or location. One switch on the FPGA will be used to switch between History and Guess modes. Finally, the leds above the switches will denote what turn it is.

Game Rules:

The player is the *codebreaker*. The codemaker (FPGA) will randomly generate a “code” pattern of four pegs of various color. Duplicates are allowed, so the player could even choose four code pegs of the same color. The chosen pattern is stored in registers on the FPGA, “visible” to the codemaker but not to the codebreaker.

The codebreaker tries to guess the pattern, in both order and color, within 8 turns. Each guess is made by setting the leds to the desired colors and hitting the submit button (must be in guess mode). Once placed, the codemaker provides feedback by setting the seven segment display to “X”s, “O”s, and blanks to denote correct color and location, correct color/wrong location, incorrect color and location respectively.

If there are duplicate colours in the guess, they cannot all be awarded a key peg unless they correspond to the same number of duplicate colours in the hidden code. For example, if the hidden code is white-white-black-black and the player guesses white-white-white-black, the codemaker will award two “X”s for the two correct whites, nothing for the third white as there is not a third white in the code, and another “X” for the black. No indication is given of the fact that the code also includes a second black.

Once feedback is provided, another guess is made; guesses and feedback continue to alternate until either the codebreaker guesses correctly, or 8 incorrect guesses are made.

The goal is for the codebreaker to guess the code correctly within the 8 turns. And alternative method can allow for players to alternate games with an opponent, the winner being the person who correctly guesses the code in less total turns.

Grading Rubric

Pattern selection (25%) - Used when the player makes an attempted guess at the code. This will use the left/right buttons to change which led is being selected, and the up/down buttons to change the color of the led undergoing selection. The player will then submit their guess using the center button

Blink Under Selection (10%) - Causes the RGB led that the user is in the process of selecting to blink. This differentiates the led under selection from the others.

Pattern Feedback (20%) - After each guess, the FPGA will compare the guessed pattern to the hidden code. For every color that matches a hidden peg's and its location, the seven segment display will display an "X". For every color that matches a hidden peg's color, but not its location, the seven segment display will display an "O". For every color that matches no hidden peg's color or location, the seven segment display will not display a digit. This display will be aligned left. For example, if there is 1 "X", 2 "O"s, and 1 blank, then the display will be "XOO ".

Turn Counter (5%) - The leds above the switches on the FPGA will be used to keep track of the current turn in guess mode. In history mode, the leds will show what turn the player is viewing history of. This will be explained again in the next section

Memory (10%) - Used to store the previous guesses and feedback of the codebreaker. This information will be accessed when in history mode.

History Mode (20%) - History mode can be turned on by switching the rightmost switch to the "1" position. In history mode, the player can analyze previous guesses and their feedback results. The up/down buttons allow the user to look back and forth through their previous turns. The 4 RGB leds display the guess colors for the turn under analysis. The seven segment display displays the feedback that was given after that turn's guess was made. The led lights above the switches on the FPGA will reflect what turn number the player is currently view history of. History mode is turned off by switching the rightmost switch back into the "0" position.

Start Game/Fail Functionality (10%) - Automatically handles resetting the game (upon winning or running out of turns) and clears the code register so that the codemaker can initialize a new code. After clearing all history/code, a new code is initialized and a new game begins.

Materials

1. 4 RGB leds for color selection
2. Variety of resistors
3. Breadboard
4. Wires