Reconfigurable Computing Final Project Requirements – Fall 2023

Introduction

Your task is to design and build a complete “brick breaker” or “breakout” video game using the DE10-Lite FPGA board and a VGA monitor.

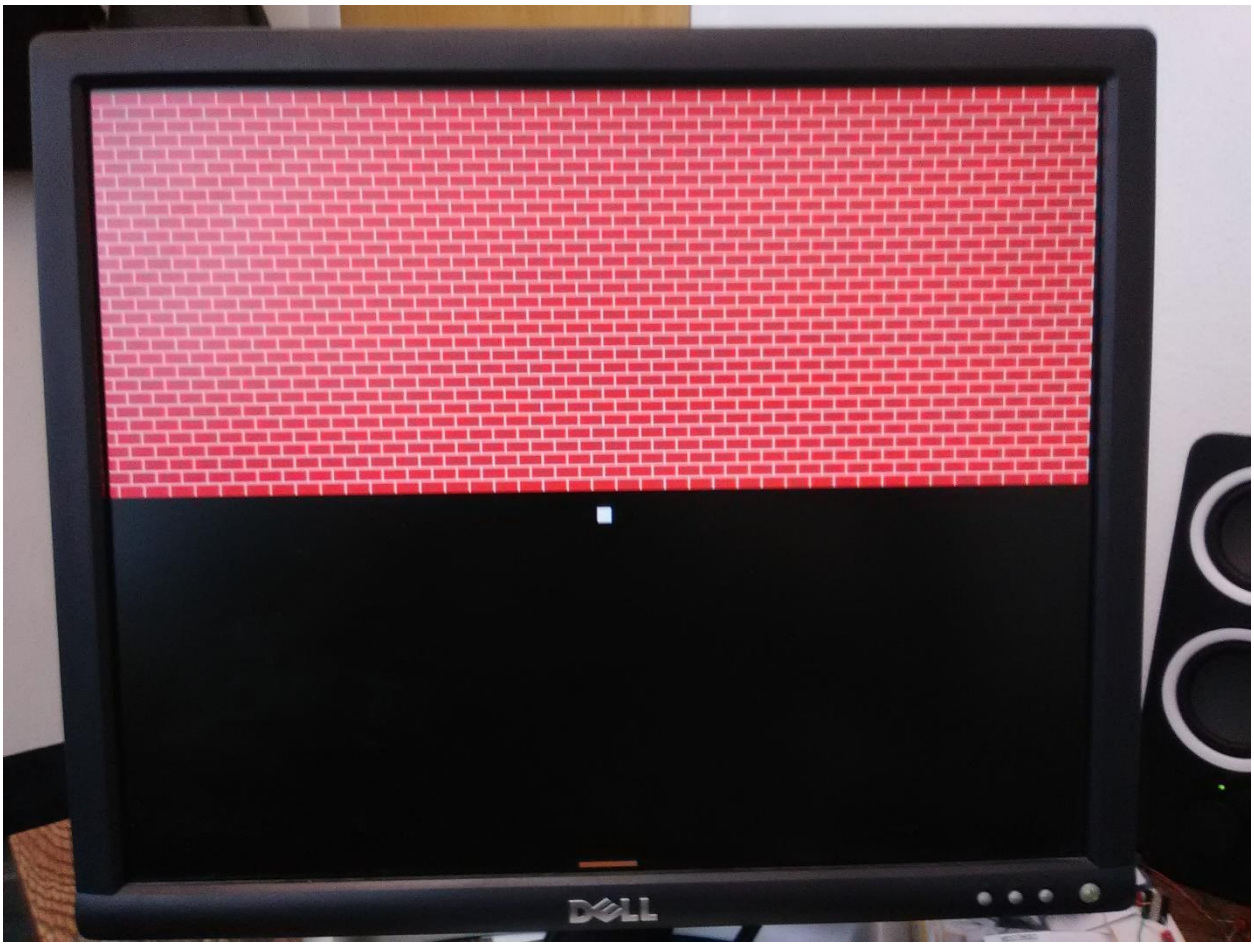

Figure 1: Screen shot as play commences.

Requirements

1. The digital design must be done in VHDL.

2. The game image shall be 640 pixels wide by 480 pixels tall.

3. Use the two push buttons on the DE10-Lite board to control game play. One button resets the game, the other drops a new ball. The user may request 5 new balls, after which the game is over and reset must be pressed to continue.

4. Upon reset, the upper half of the screen (240 lines) shall be filled with red bricks separated by white mortar. Brick dimensions shall be 15 pixels wide by 7 pixels high. 1-pixel-wide strips of mortar completely separate every brick from each of its neighbors. Neighboring rows of bricks shall be offset by half a brick, thus every other row shall be aligned vertically.

5. Upon reset, a brown paddle will appear at the bottom of the display. The paddle shall be 40 pixels wide by 5 pixels tall.

6. Screen portions not occupied by bricks, mortar, ball, or paddle shall be black.

7. When the "drop ball" button is pressed (and there are balls remaining), a ball will drop straight down from a randomly-chosen point along the horizontal center of the screen. The ball shall be a white square or octagon with dimensions 10 pixels by 10 pixels. Pick an appropriate rate of movement for the ball.

8. The user can move the paddle from side-to-side along the bottom of the screen. The paddle movement can be controlled by either a potentiometer interfaced to the FPGA's ADC (required for ECE 5730), or via the on-board accelerometer (required for ECE 6730, extra credit for 5730). Potentiometers (sometimes called rheostats) are available for checkout or purchase from the ECE store.

9. If the ball misses the paddle and falls out the bottom of the screen, the ball "dies" and a new ball must be requested. The ball bounces off the paddle, the sides of the screen, and the top of the screen. Come up with a scheme for changing the ball direction as it bounces off of these surfaces.

10. If the ball "hits" one or more bricks, the ball bounces off AND causes those bricks to disappear from the wall. Entire bricks must disappear (i.e. no partial bricks shall remain on the screen). Only bricks that have been hit by the ball disappear. The object of the game is knock all of the bricks out of the wall before all 5 balls have been lost.

11. Produce 4 unique sounds using the FPGA and an external speaker. One when the ball hits the paddle, one when the ball hits the top or side of the screen, one when the ball breaks a brick, and one when the ball dies.

Report

Complete a lab report that complies with the requirements listed in the "FPGA Assignment Grading Rubric" available on the main Canvas page.

Grading

You can get partial credit on the project even if it is not 100% functional. Here is the breakdown:

Feature	**Points**
Paint initial screen with bricks, mortar, and paddle	10
Paddle can move correctly from side to side (potentiometer [5730] or accelerometer [6730])	10
"Drop ball" button is functional	5
Ball correctly bounces off of paddle, top of screen, and sides of screen	10
Ball correctly falls off bottom of screen	10
Ball correctly knocks bricks out of wall	10
Sound works correctly	10
Entire game is operational	15
Report	20
TOTAL	**100**