EL 4930 - System-on-Chip Design

Spring 2023

Homework 1

The Lab is a group assignment

Total: 100 points

(Deadline: 01.29.2023, 11.59pm)

Objective:

This is a warm-up homework for this class. In this work, you will implement a Hardware design of Pong Game on FPGA. The goal of this lab is to be familiar with the use of I/O peripherals, process the input signals and generate the outputs. Also, you will learn how to assign the board specific constraints to properly working with the FPGA board.

Pong Game:

The Pong Game is a simulated version of Table-tennis. Those who are not familiar with the Pong game, can read about it and check out how to play the game on the screen from the following web link.

https://en.wikipedia.org/wiki/Pong

Tools and Hardwares required:

1. Xilinx Vivado tool is required for this lab.
2. The BASYS 3 board will be used which has an ARTIX 7 FPGA.
3. A VGA cable for connecting with monitor
4. A USB-UART cable to program the board
5. A Monitor with VGA input port

Task Description:

There will be two players and one ping-pong ball. The players can move the bars up and down. The switch or push buttons on the board can be used as input from the players. There is one output: the VGA monitor. The VGA output generates the animation for the game. It shows the ball, player bars, and scores. The ball will have a triangle shape. The scores of the players will be displayed on the corresponding side of the bar of the player.

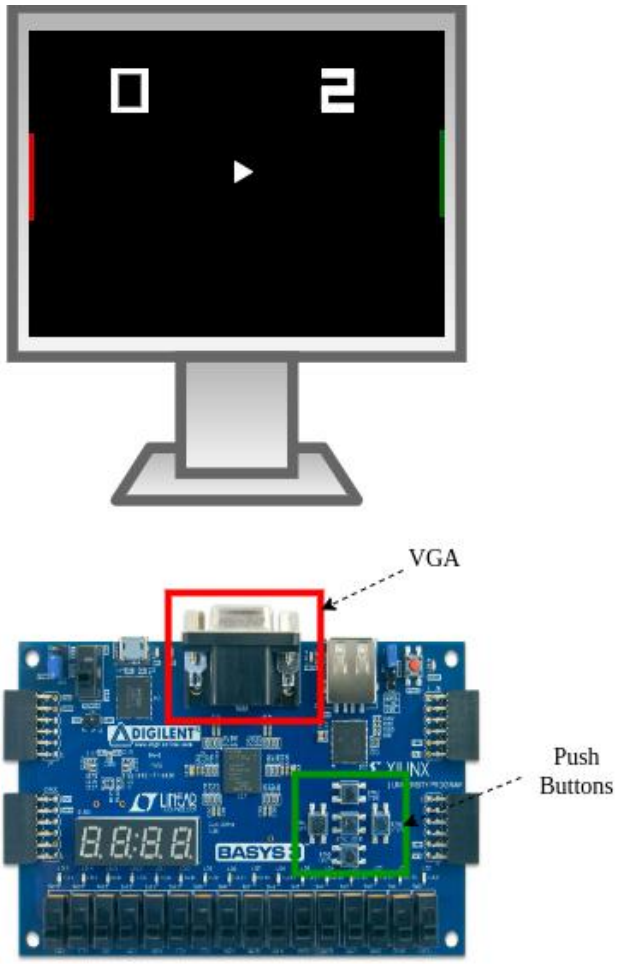

Figure 1: The demo setup, monitor and BASYS 3 FPGA

You can find the background and VHDL implementation of VGA controller from the following link.

https://forum.digikey.com/t/vga-controller-vhdl/12794

You must implement the core hardware module for the game and integrate the VGA controller with the others. Any Hardware Description Language (VHDL, Verilog, etc.) is fine for the implementation. BASYS 3 reference manual can be found from the following link.

https://digilent.com/reference/programmable-logic/basys-3/reference-manual

A high-level block diagram is provided below for your implementation.

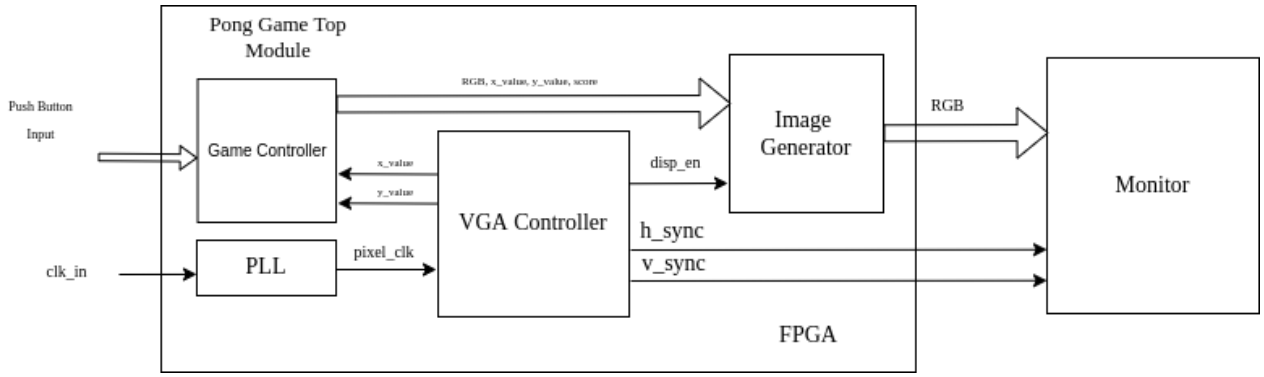

Figure 2: High level Block diagram of Pong Game Implementation

Submission Guidelines:

1. Include all source code and constraint files.
2. A video demonstration of the Game.
3. A short report describing the block diagram, implementation description, what problems you faced, and what you have learnt.

Grading Rubrics:

Implementation ---- 70%

Video Demo ---- 20%

Report ---- 10%