

Pong

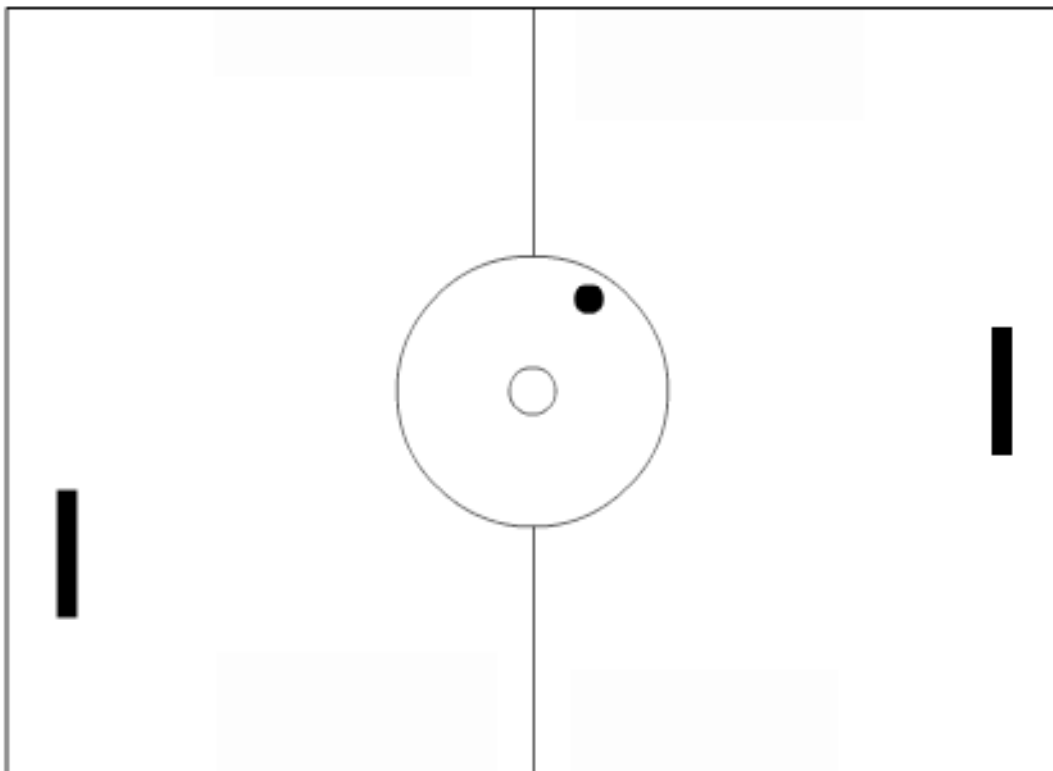
CSEE 4840 Spring 2012 Project Design

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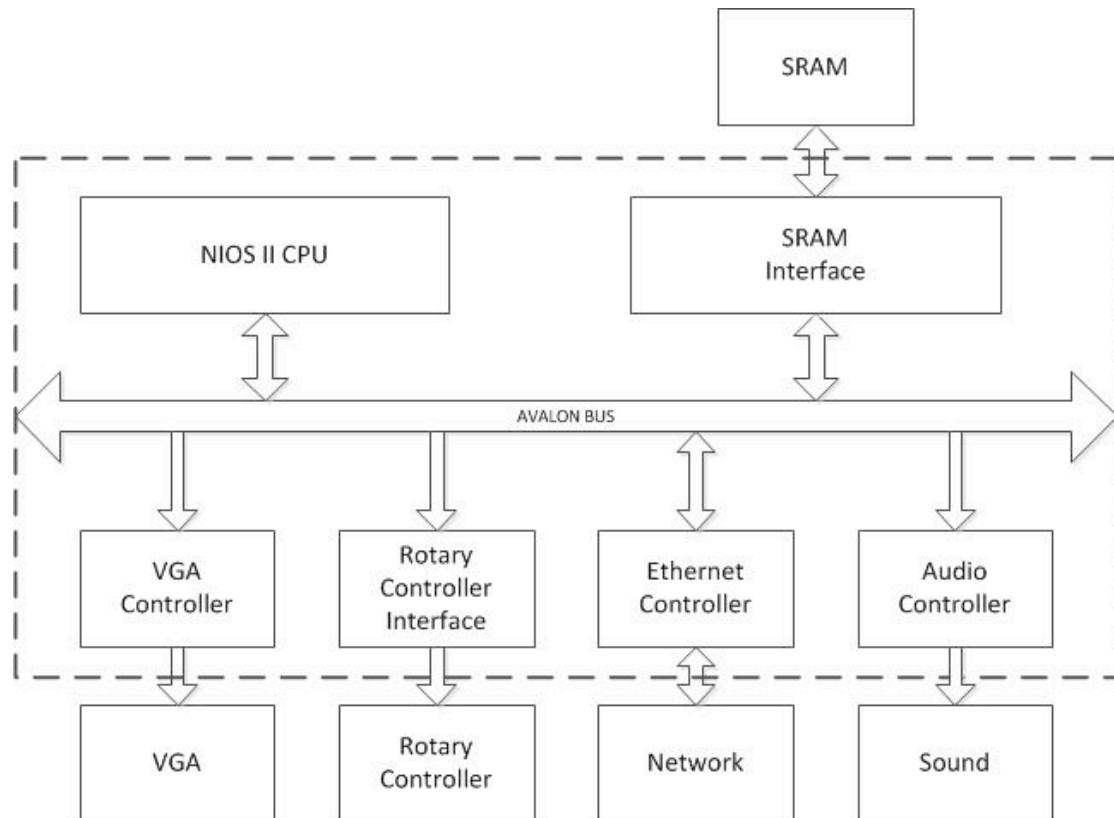
1 Introduction

Our project goal is to design a Pong video game. The rule is easy: Both of the players try to kick the moving ball with a paddle, the winner is the one who makes the other lose the ball. Our design is based on the Altera FPGA Board.

There are several aspects we will focus on:

1. The paddle can only slide along one side of the screen.
2. The game can be displayed on VGA and controlled by keyboard, mouse, or rotary controller.
3. Players can play with AI or with another one on same keyboard or different FPGA board through Ethernet.

2 Block Diagram



3 Hardware

The 512K SRAM will be used for program, audio, and VGA data. We can use the same method in Lab3 to set them as the Avalon peripheral. We can use code to control the interface with the Avalon bus.

We will use two kinds of implementations for VGA. The default background will be set in the hardware design process. And for the movement components, we will combine the software and hardware like Lab3 to achieve this. Finally, using the interface module, we can reveal the image on the monitor.

For the audio part, we will use the Philips speaker to produce the sound. The sound should be produced in some specialized situation and the control signal will be generated from the audio controller.

Rotary controller can realize the control through different input sequences. A and B, as two input signals of the rotary controller, will produce a sequence when rotary controller is rotated by one gear (the binary coding of the sequence is listed in another part relating to rotary controller). The input signals A, B can be connected to DE2 board through GPIO interface.

4 Software

Software will control the movement of ball and paddle, sound, Ethernet communication and AI.

When the ball touches paddle or wall, software will control the VGA controller to make the ball move another direction and tell the audio controller to generate a sound effect.

There will be an interrupt signal from rotary controller. When rotary controller generates a signal, software will know the direction (i.e. up or down) and make the paddle move.

If two players play the pong through Ethernet, software needs to send the data of ball movement and paddle movement to each other. If one player play with AI, software need to make a decision to move the paddle depend on the movement of ball.

5 VGA Controller

The VGA Controller will be based on the `de2_vga_raster.vhd` file provided in Lab 3. The clock which is originally set to 50MHz will be reset to 25MHz for the VGA protocol. Vertical and horizontal blank signals tell the vga whether or not to draw the default background and sync signals tell the vga_raster to draw something besides the default background.

Because the background is a static image, the VGA Controller will always show the background in hardware without any communication with the software. The software merely tells the VGA controller where to draw the ball and the paddle (controlled by the rotary controller).

6 Ethernet controller:

In this project, networking and synchronization will be used between two different terminals, i.e., players. Both terminals will be interacting with each other through Ethernet connection. As in Lab2, Altera DE2 board's DM9000A chip which contains a fast 10/100 Mbps transceiver is employed to communication under CSMA/CD protocol.

During the communication, 2 players will send UDP/IP packages to each other and both terminals are treated equally (assuming they are both masters or slaves). Mainly two kinds of packages are passed around: paddle displacement event and Pong displacement event. Whenever one terminal makes a movement of paddle or change the movement of pong, corresponding package will be sent to another

terminal. If the movement of pong has not been changed by the paddle, corresponding package relating the movement of paddle and the movement of pong will also be sent to another terminal. Once receiving the package, terminals would update their own screens after package validation. On the other side, the sending terminal would update its own screen on the successful transmission of package.

The movements of paddle and pong are controlled by each terminal's clock. Both clocks will be started at the same time. Each will count automatically afterwards. A pong movement table is maintained in each terminal for the purpose of next movement event. On the receiving of pong movement event package, the pong movement table will be updated in receiving terminal. (Intuitively, sending terminal will update its own table) According to this table, each terminal can handle pong and paddle movement and determine if one terminal has lost pong or not.

7 Rotary Controller:

Rotary controller is the controller of the paddle which can realize the control through different input sequences. When the rotary controller is rotated by one gear, A and B, as two input signals, will produce a sequence listed below. By judging the order of the sequence, we know whether it is clockwise rotation or not. Furthermore, we can correspond to the movement of paddle. The input signals A, B can be connected to DE2 board through GPIO interface.

Binary Code for Clockwise Rotation			Binary Code for Counter-clockwise Rotation		
phase	A	B	phase	A	B
1	0	0	1	1	0
2	0	1	2	1	1
3	1	1	3	0	1
4	1	0	4	0	0

8 Audio Controller

A sound data, which contains the amplitude information of a record of sound, will be saved into audio controller. Once the ball touches the wall or paddle, Nios II system will generate a control signal to audio controller. And audio controller will send data to the ADC and generate a sound effect.

The sound data of a .wav file can be imported into matlab and transferred into the format we need.

9 Milestones

Milestone I

- Set up peripherals of the project, i.e. VGA controller, RAM, Rotary Controller
- Ping---Pong pad can be controlled By Rotary Controller
- The ball can move as expected

Milestone II

- Game has sound effect when ball touch pad or wall
- Ball speed can be changed
- Player can play with AI

Milestone III

- Players can play through Ethernet
- Improve the effect of ball's image and moving
- Add background picture