Networked Air Hockey Video Game

CSEE 4840 Project Design - March 2010

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Abstract

The main goal of the project is to implement an Ethernet-based interactive and addictive game (similar to air hockey game) that can be played between two players over two different terminals. The project will be implemented on Altera Cyclone II FPGA with the development of the game strategies done in a combination of both hardware (in VHDL) and software (in C).

1. Int roduction

The Ethernet based networked Air Hockey game is a representation of the real air-hockey game that has an air hockey table, two paddles and a puck. The VGA screen is modified to represent the actual table. The game consists of two-players where each player controls the position of their paddle with respect to their mouse.

There is a score display that displays the score of each player. The game gets over when the score reaches definite limit(in our case 10 points). The players can change the course of the puck by hitting it with their paddle. Thus, the movement and direction of the puck changes as each player hits the puck or when the puck hits the surface of the table with the exception of the goal area.

2. Rules of the Game

- The first person to score 10 points by shooting the puck into opponent's goal wins the game
- A point is counted for the player, when the puck goes inside the opponent's goal
- The boundary/reach of each player i.e. till where he/she can hit the puck is predefined
- Once a goal is made, the puck resumes its normal movement towards the player who received the point

3. Design

Figure 1 illustrates the block diagram of our single terminal system.
It has four blocks namely:

- CPU: This is a Nios processor that controls the peripherals and the memory
- VGA: This is the display unit where the GUI is presented to the players
- PS/2 Mouse: This peripheral device is the control that that the players use to move their paddles on the VGA
- Memory: It is a basic SRAM memory component which is a slave to the CPU
- Avalon bus: Interconnects the modules

Figure 2 illustrates the two terminals connected using Ethernet. The basic idea in networking these terminals to accomplish a two player environment is to receive and transmit the paddle coordinates and the puck coordinates among the terminals. The score keeping data is also networked for dynamic score keeping.

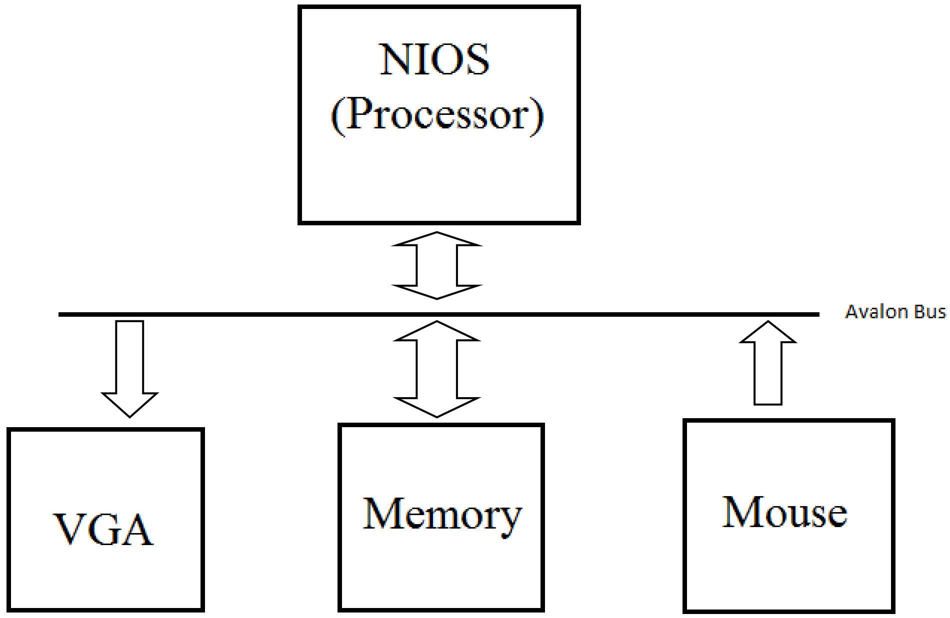

Figure 1: Basic Architecture of Single Terminal

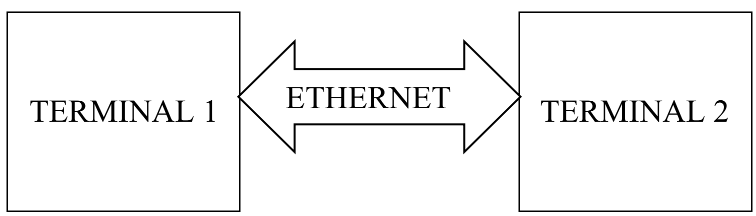

Figure 2 : Terminals connected via Ethernet

3.1 Mouse Interfacing

PS/2 Mouse Movement Data Packet

The standard PS/2 mouse interface supports the following inputs: X (right/left) movement, Y (up/down) movement, left button, middle button, and right button. The mouse periodically reads these inputs and updates various counters and flags to reflect movement and button states. The standard PS/2 mouse sends movement and button information to the host using the following 3-byte packet (Figure 3):

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Byte 1	Y over-flow	X over-flow	Y sign bit	X sign bit	Al-ways 1	Middle Btn	Right Btn	Left Btn
Byte 2	X movement							
Byte 3	Y movement							

Figure 3: PS2 protocol

The values of movement are 9-bit 2's complement integers, where the most significant bit appears as a "sign" bit in byte 1 of the movement data packet. Their value represents the mouse's offset relative to its position when the previous packet was sent, in units determined by the current resolution. The range of values that can be expressed is -255 to +255. If this range is exceeded, the appropriate overflow bit is set. Using these X and Y coordinates we will be controlling the movement of the paddles. However there needs to be a horizontal limitation to the movement of the paddle.

3.2 GUI

Figure 4 shows the GUI for our air hockey game. The white circles represent the paddles and the black circle represents the puck. There are two slots at either side of the table where the puck disappears into the goal area. The two vertical lines (not the center line) indicate the horizontal limitation each player is subjected to for their paddle movement.

The score keeping is maintained at the bottom of the VGA display.

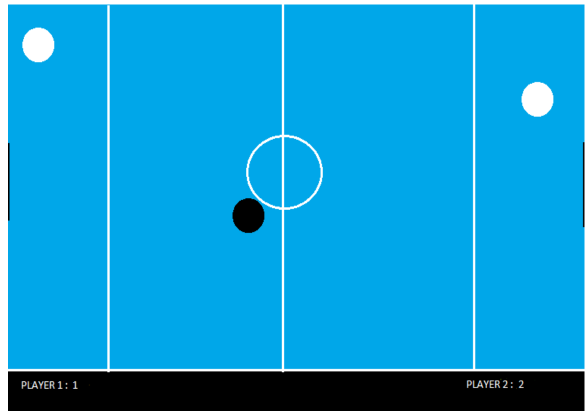

Figure 4: GUI

3.3 Physics modeling of collision handling event

Modeling the interactions and movements of the puck and paddle will be conducted in software. We are assuming the interaction between the paddle and the puck involve elastic collisions. We will also take into account the affect of friction of the table on the puck.

The velocity of the paddle is determined by the rate of movement of the mouse. From the PS2 protocol, the x and y co-ordinates of the previous location are available and hence the speed of the paddle can be calculated. If the puck hits any of the right or the left sides, the direction of the puck needs to be reversed in X direction. Similarly if the puck hits any of the top or bottom sides, the direction needs to be reversed in Y direction. We assume the paddles are not affected by the collisions. This means that after a collision, only the puck will change direction.

Let *m_puck* and *m_paddle* be the mass of the puck and paddle respectively and *u_puck* and *u_paddle* be the initial speed of the puck and the paddle respectively and *v_puck* and *v_paddle* be the speed of the puck and paddle after collision respectively According to our dynamics, *v_paddle* will be zero. Assuming elastic collision between the puck and the paddle, at the moment of collision the momentum conservation can be written as:

$$m\_puck * \overline{u\_puck} + m\_paddle * \overline{u\_paddle} = m\_puck * \overline{v\_puck}$$

So, if the player wishes to hit the puck with a higher force, it is formulated as an increase in velocity of the mouse at the time of collision.

Collision would have said to be occurred if addition of the radius of the puck and the paddle is lesser than the distance between their centres. Once the new velocity of the puck is calculated, it will be damped due to the co-efficient of kinetic friction μ_k. The frictional force will then be calculated as follows:

$F_{fric} = \mu_k * N$
$= \mu_k * m\_puck * g$

References:

1. http://www.computer-engineering.org/ps2mouse/
2. http://hyperphysics.phy-astr.gsu.edu/Hbase/colsta.html