PAC MAN-HHZ

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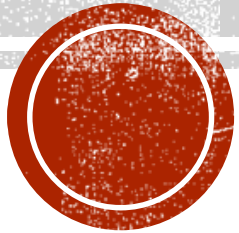
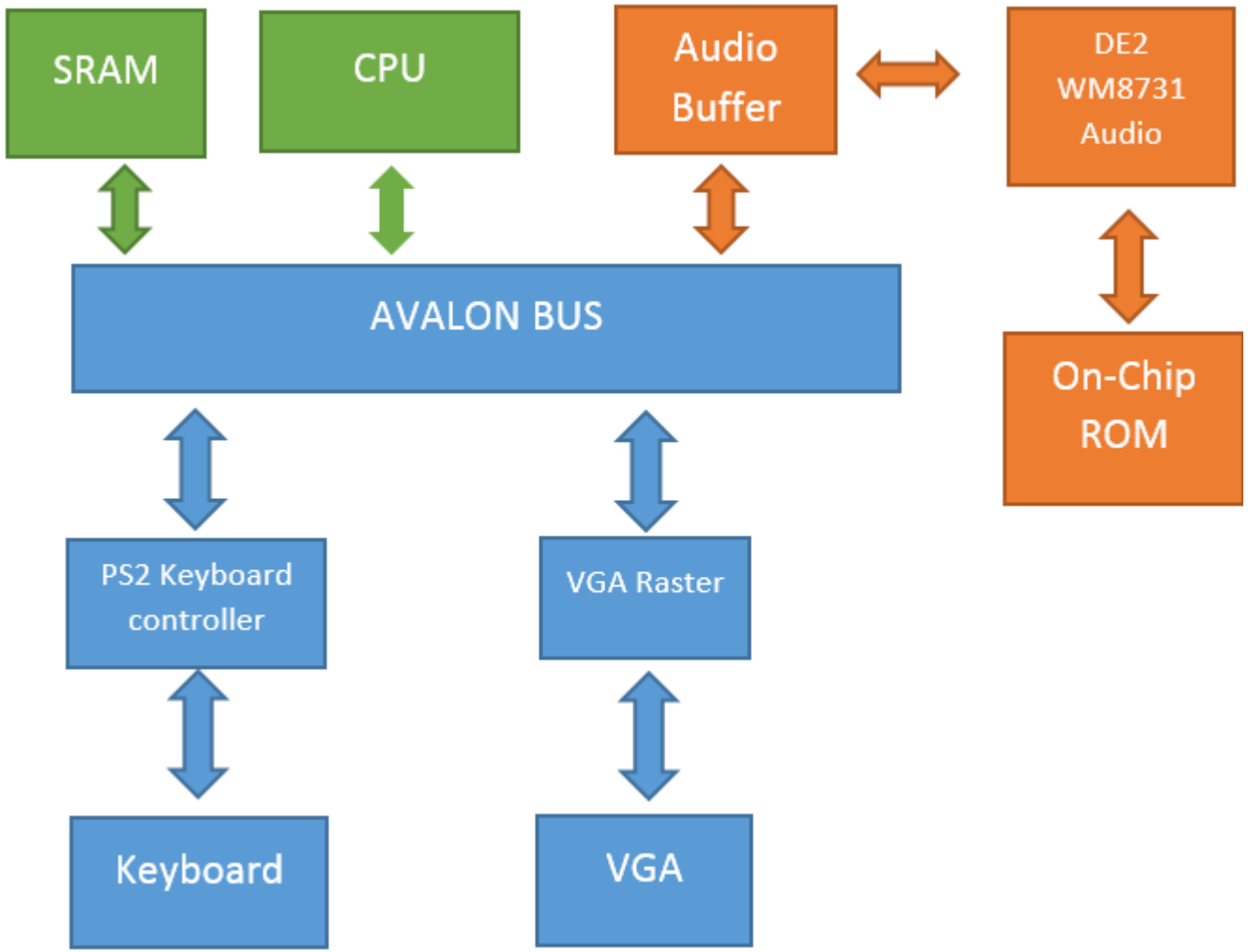


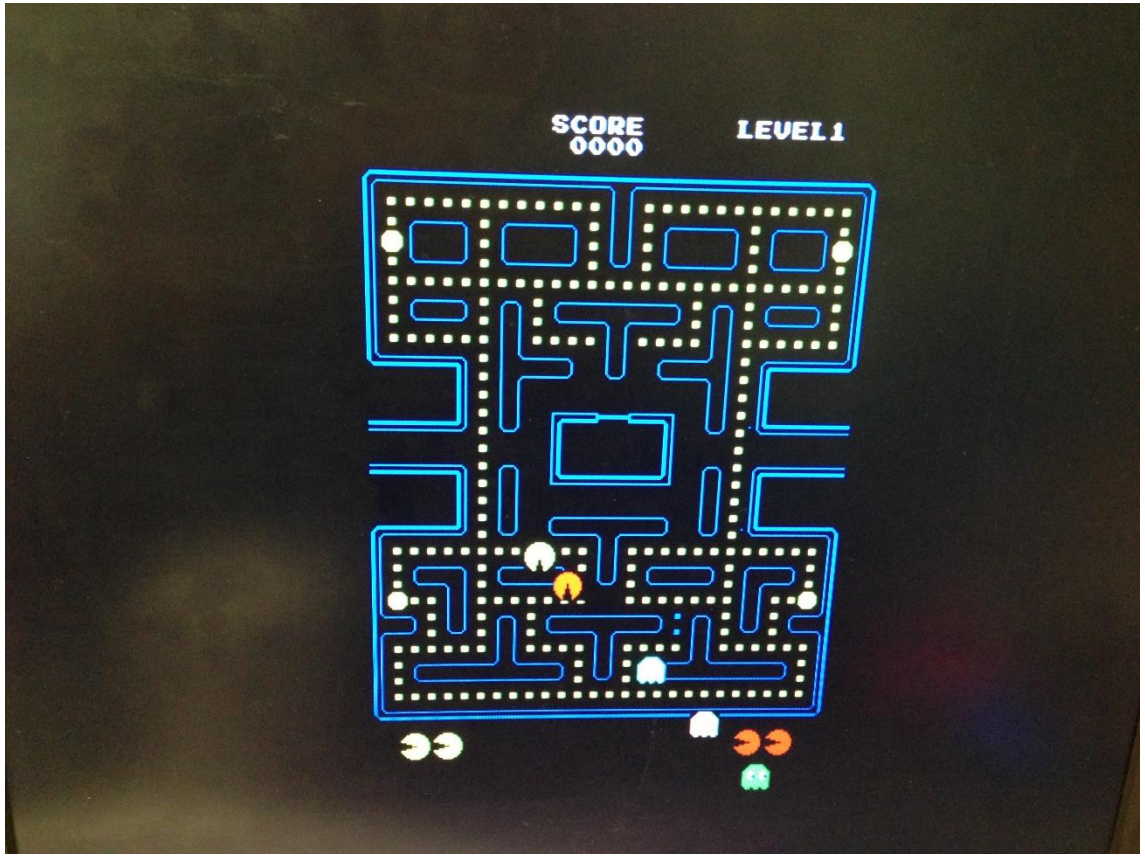
OVERVIEW

- The theme of our project is to create a Pac-Man-Like video game.
- The game is like the classical Pac-Man game and it should be running on a FPGA board and displayed on a VGA screen.
- Wolfson WM8731 audio CODEC is used to play in-game music
- PS2 key board controller is used to get input from keyboard to control the movement of Pac Man and in-game choice

ARCHITECTURE



VGA DISPLAY



BACKGROUND AND SPRITES

```
"0000000000000000",
"00000111111100000",
"0000111111111110000",
"000111111111111000",
"001111111111111100",
"011100111111001110",
"011000011100000110",
"011000011100000110",
"011000011100000110",
"011100111111001110",
"011111111111111110",
"011111111111111110",
"011111111111111110",
"011111111111111110",
"011110111101111100",
"001100011000110000",
"0000000000000000"
```

Ghost

```
"0000000000000000",
"000000111111000000",
"0000111111111110000",
"000111111111111000",
"001111111111111100",
"001111111111111110",
"011111111111110000",
"011111111100000000",
"011111100000000000",
"011111111100000000",
"011111111111110000",
"001111111111111110",
"001111111111111100",
"000111111111111000",
"0000111111111110000",
"000000111111000000",
"0000000000000000"
```

Pac Man

```
"000111111",
"001111111",
"011000000",
"110000000",
"110000111",
"110001000",
"110010000",
"110010000",
"110010000"
```

```
"111111111",
"111111111",
"000000000",
"000000000",
"111111111",
"000000000",
"000000000",
"000000000",
"000000000"
```

Maze

AUDIO

```
WIDTH=8;
DEPTH=53612;

ADDRESS_RADIX=UNS;
DATA_RADIX=HEX;

CONTENT BEGIN
0    :    00;
1    :    FF;
2    :    00;
3    :    FF;
4    :    00;
5    :    FF;
6    :    00;
7    :    FF;
8    :    00;
9    :    FF;
10    :    00;
11    :    FF;
12    :    00;
13    :    FF;
14    :    00;
```

IN-GAME Sound effect stored in ROM

```
unsigned char begin [] = {
        0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0xC
        0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0xC
        0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0xC
        0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0x00, 0xFF, 0xC
        0x1C, 0x20, 0x26, 0x2C, 0x32, 0x37, 0x37, 0x38, 0x35, 0x34, 0x3
        0x0B, 0x08, 0x09, 0x09, 0x09, 0x0D, 0x12, 0x19, 0x1C, 0x1A, 0x1
        0xF8, 0xED, 0xE8, 0xF2, 0xF3, 0xF1, 0xF0, 0xF4, 0x05, 0x10, 0x1
        0x20, 0x1E, 0x15, 0x0B, 0x04, 0xFA, 0xF0, 0xE6, 0xDC, 0xD9, 0xD
        0xF7, 0xFD, 0x01, 0x05, 0x07, 0x07, 0x05, 0x04, 0xFE, 0xF7, 0xE
```

BEGIN and INTERMISSION music stored in SRAM (DIRECTLY CONTROLLED BY CPU)

```
library ieee;
use ieee.std_logic_1164.all;
use ieee.numeric_std.all;

entity audio buffer is
```

CPU writes music data directly into audio buffer

SOFTWARE

- Linking Hardware: VGA, Audio, Keyboard.
- Logic: Pacman & Ghost Movement, Game Feature Implementation, etc.

LINKING HARDWARE

- **VGA**

```
#define IOWR_VGA(base, offset, data) IOWR_16DIRECT(base, (offset) * 2, data)

#define IORD_VGA(base, offset) IORD_16DIRECT(base, (offset) * 2)
```

- **Keyboard**

```
IORD_8DIRECT(KEYBOARD_BASE, 0)          // decide whether a key is pressed

IORD_8DIRECT(KEYBOARD_BASE, 1)          // read the keyboard code
```

- **Audio**
- **SDRAM**

```
IORD_8DIRECT(AUDIO_PLAYER_BUFFER_BASE, 0)      // flag, 0 → able to write

IOWR_8DIRECT(AUDIO_PLAYER_BUFFER_BASE, 0, song[i])          // write song
```

- **ROM**

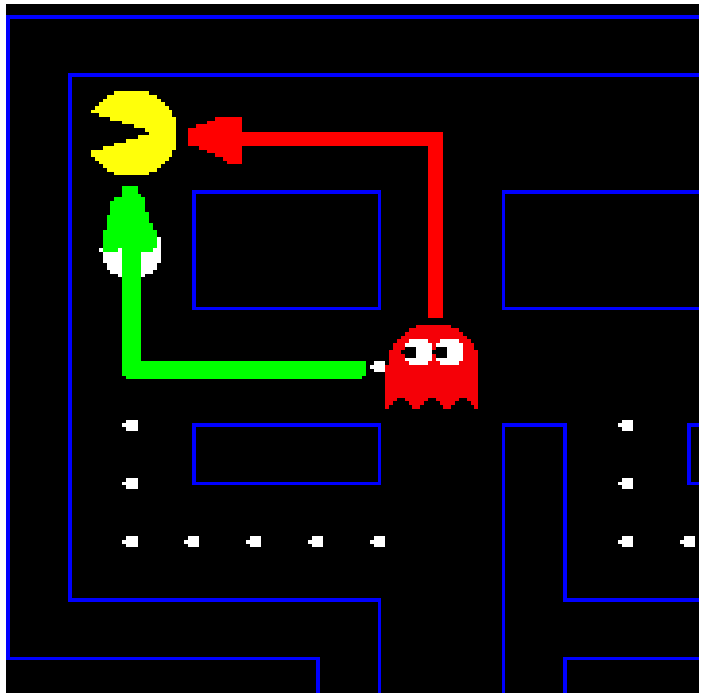
```
IOWR_8DIRECT(AUDIO_PLAYER_BUFFER_BASE, 1, 0x01);      // play song

IOWR_8DIRECT(AUDIO_PLAYER_BUFFER_BASE, 1, 0x02);      // change indicator
```

LOGIC - GHOST BEHAVIOR

- Two Modes: Random or Chasing
- Chasing Mode Policy: if there are available paths towards target select one of them, and if not, randomly select another path, but not backward direction.
- Weak Mode & Eaten by Pacman

LOGIC - GHOST BEHAVIOR

- Chasing Example



LOGIC – GHOST BEHAVIOR

Functions:

- int isAvailable(int ghostNum, int direction)
- int randomMode(int ghostNum)
- int chaseMode(int ghostNum, int x, int y)
- void moveGhost(int ghostNum)