EEL 4930/5934 - System-on-Chip Design

Spring 2025

Final Project 1

Total: 100 points

Objective:

The goal of this project is to develop a System-on-Chip (SoC) that can play the pong game from Lab 2 with the addition of audio feedback for different game scenarios.

Tools and Hardware required:

1. Vivado
2. Real Digital Urbana Spartan 7 FPGA.
3. Micro USB cable to program the board and display the output in the terminal
4. HDMI monitor
5. PuTTY or Minicom, or etc.
6. Stereo audio speaker

Task Description:

1. Generate audio tables for different game scenarios.
2. Develop a non-DMA version of lab 2 to play pong and integrate audio.
3. Develop a DMA version of the project for improved performance.
4. Develop the PWM driver necessary to output audio

Task 1: **10 Points**

In this task you will be creating the 8-bit audio tables that correspond to songs that will be output when certain pong events occur.

- When a win or loss occurs, it will play “Marry had a little lamb” like the example link provided in “Resources.”
- When a ball hits a paddle, it will play a single 0.25s long tone.
- When a point is scored, it will play a single 0.25s long tone that is different from the paddle tone.

You will need to develop a table of values that correspond to the song notes. You may also need a table of values for chosen tones.

Task 2: **20 Points**

For this task, you will be developing the PWM driver to run the audio out port on the Urbana Board. This will be the PWM driver from the Real Digital instruction or your own implementation.

Task 3: **30 Points**

For this task, you will be developing the SoC with no DMA. This system will be the Player vs. Environment implementation from lab 2. You will be adding the necessary fabric hardware to run the PWM. You will also be developing the extra software needed to play the audio forms for the scenarios listed in Task 1.

The song and tones described in Task 2 should be output from the board and audible.

Task 4: **30 Points**

This is the same as Task 2, but using the AXI CDMA to send notes to the PWM driver.

Resources:

Link for Audio Out Port description:
https://www.realdigital.org/doc/496fed57c6b275735fe24c85de5718c2#audio-out-port

Link for PWM operation and IP development:
https://www.realdigital.org/doc/822e17a669a05f748c80af2274478bb5

Link for "Marry had a little lab" example:
https://www.youtube.com/watch?v=2ossqNn3d1k

Submission Guidelines:

1. A video demonstration of what you have running.
2. The report

Grading Rubrics:

Video demonstrating Tasks 1,2,3, and 4 ---- 40%
Group presentation and question responses ---- 30%
Peer review ---- 20%
Report ---- 10%