Midterm Project

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Abstract

For this project we learned how to control external inputs and outputs from the DE1-SoC board as well as we developed a snakes and ladders game in C++. We demonstrated our understanding of C++ and how to implement embedded features using a class hierarchy. The project itself was a resounding success as we went from controlling speakers with simple tones to generating sound effects during and throughout a text-based game.

Introduction

The goal of this lab was to demonstrate what we had learned throughout the first semester of the course. To show our understanding the the C++ and its applicability to the DE1-SoC board we implemented the playing of tones on a speaker. This utilized our knowledge of C++ as well as the knowledge of writing and reading data from the DE1-SoC board. It also tested our ability to find relevant information in the manual from the board to control a device from scratch. The second part of this lab was a creative game and demonstrated our working knowledge of C++.

Software and Hardware used

- DE1-SoC board
- MobaXterm
- Speaker
- Ethernet to USB adapter
- CLion

Lab Steps

1. Generating tones on the speaker
    a. Found the relevant information for the DE1-SoC manual in order to find the register values the output pins
    b. Built a method which generated the correct wave form to play based on an inputted frequency.
    c. Improved the method to go from looping infinitely to playing for a specified duration
    d. Implemented a way to map notes to frequencies
    e. Developed a user interface to control the speaker
    f. Developed sound effects based on sheet music and methods to play them off the speaker
2. Snakes and Ladders
    a. Developed the base structure for the game as an object
        i. Basic class design and listed out methods which needed to be developed
    b. Implemented the constructor for the game object
        i. Created the board array and Boolean arrays
        ii. Gave the game its own speaker object
    c. Implemented playerTurn
        i. Simulated a roll and then moved the player
        ii. Used player pressing enter as the way to stop game from playing out on its own
    d. Implemented aiTurn
        i. Simulated a roll and then moved the player
    e. Added in sound effects for the player landing on a ladder or a snake
    f. Adding a winning sound effect
    g. Added math problems for player engagement
3. Finalized documentation
4. Recorded, created and uploaded video of project

Lab Discussion

The main focuses of this lab were demonstrating what we were able to do with the board and all the resources at our disposal minus other individuals. The lab focused on learning something new and expanding on our previous knowledge and code.

In order to control the speaker we found the correct register in order to output current to the correct pins. Once this was accomplished we used the timer in order to generate an analogue wave form for 440 hz. Then this was abstracted into a method which could play any frequency. A mapping solution using two arrays was then created to map strings to a given frequency. This was then implemented along with a user interface to give the user control over the speaker. The user interface can be found in Main.cpp (appendix B). The class that controls the speaker can be found in appendices C and D.

Creating the snakes and ladders game started with deciding how I would implement my code. We came the decision to create a game object which contained all the necessary variables and stored information for the board and player positions. It also created a board variable which contained array. This array stored the position of where the given spot on the board would take you. For most positions it was just the index, but for snakes and ladders it contained the place in which the ladder or snake pointed to. An example board is defined in SnakesAndLadders.cpp (appendix E). This allowed us to move the player to its new position as simple as just getting the value of the array at the new positions index. After implementing a simple winning function and adding looping between the player and the AI we added in sounds for when the player lands on a snake or a ladder.

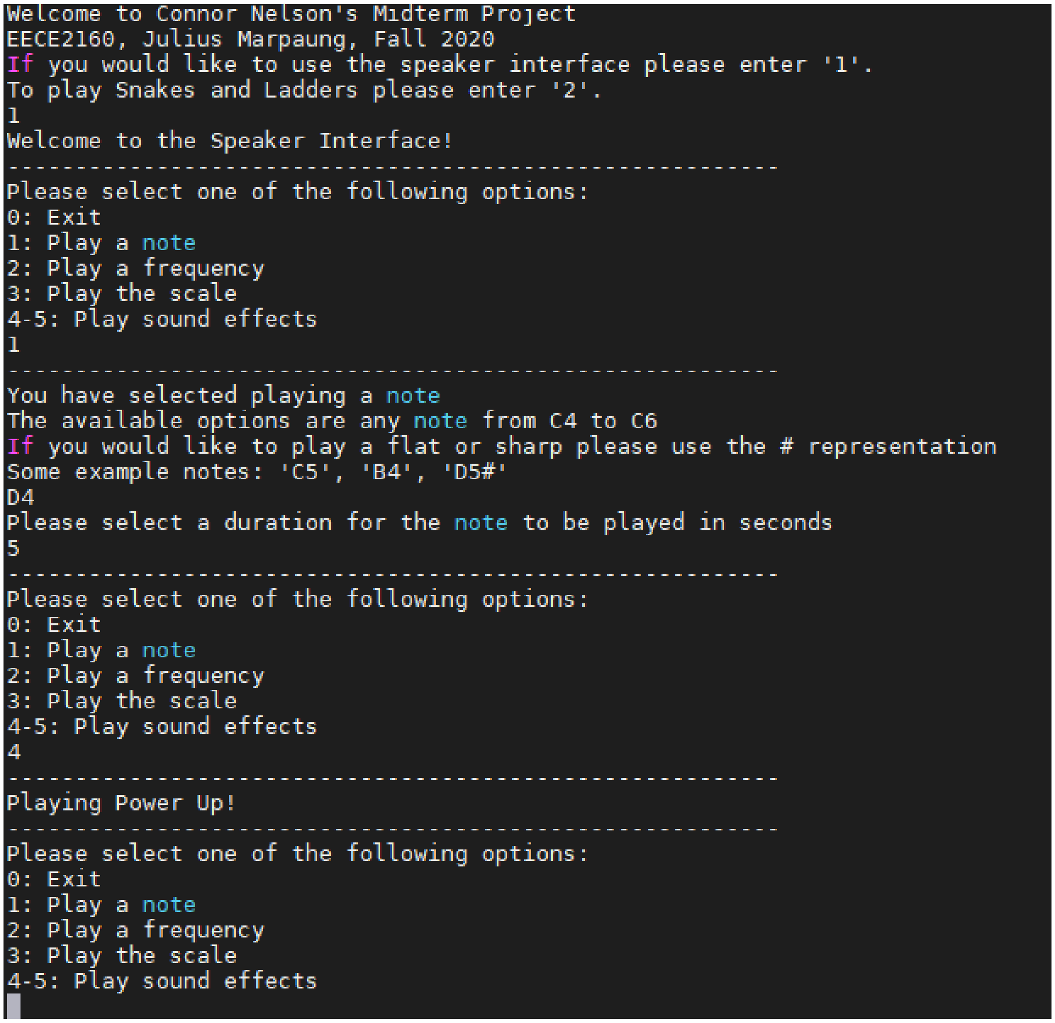
These sounds were created by playing a series of notes. The sounds themselves were gathered from common video game sound effects transposed into piano music. This was since we could only play a single note at a time and needed a simple set of sheet music. Implementing them using the functions that we had created for the speaker was fairly simple. These sounds can be found in the Speaker.cpp file (appendix C).

Results

My final project can be viewed at the link: https://youtu.be/tnu0B1JXle8

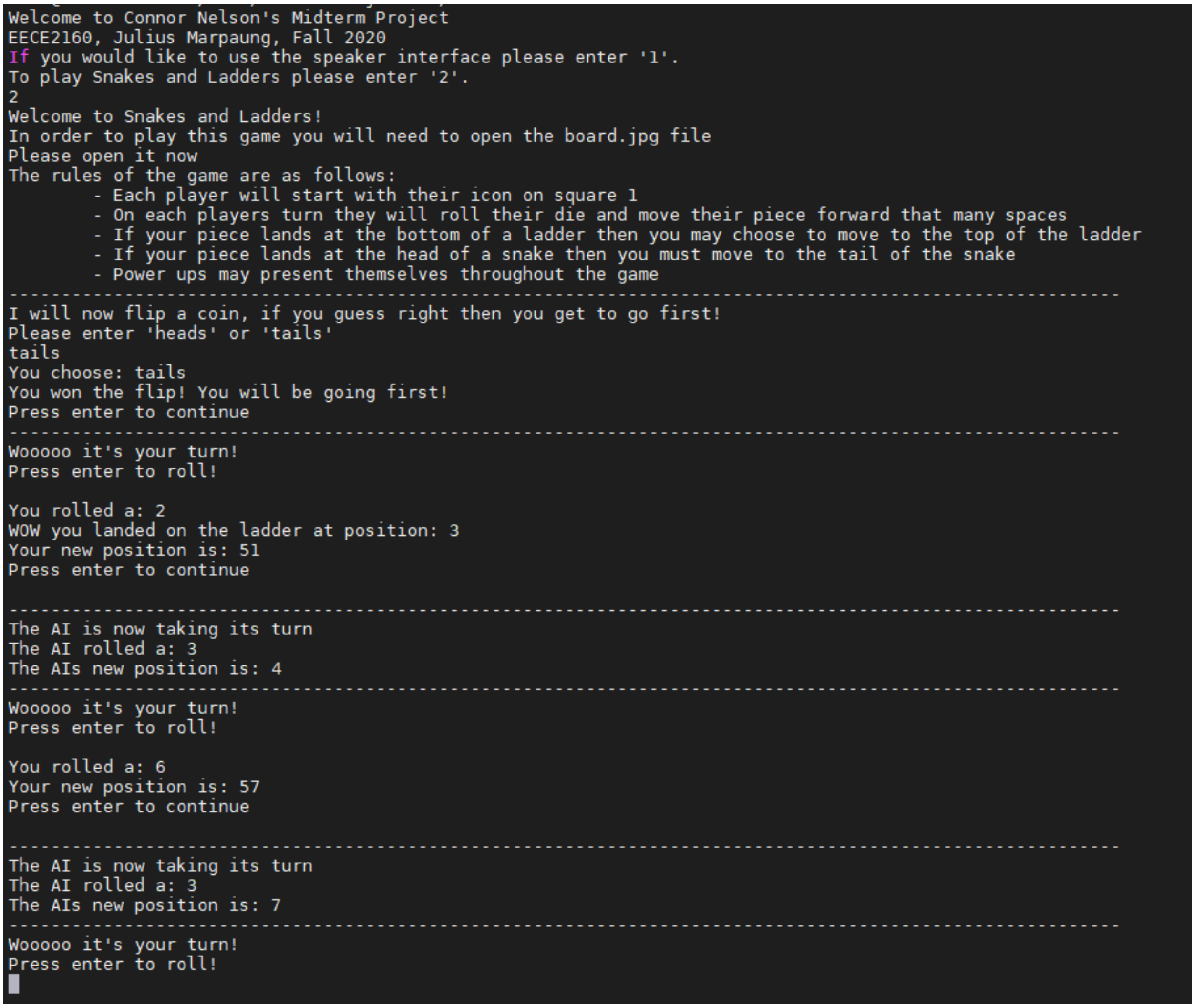
We were successfully able to play a variety of tones on the speaker as well as implement a snakes and ladders game. To see the full implementation please watch the video above.

Below you will see some screen shots of the text based interfaces created. In addition see appendix A for the image used for the board.



```
Welcome to Connor Nelson's Midterm Project
EECE2160, Julius Marpaung, Fall 2020
If you would like to use the speaker interface please enter '1'.
To play Snakes and Ladders please enter '2'.
1
Welcome to the Speaker Interface!
---------------------------------------------------------
Please select one of the following options:
0: Exit
1: Play a note
2: Play a frequency
3: Play the scale
4-5: Play sound effects
1
---------------------------------------------------------
You have selected playing a note
The available options are any note from C4 to C6
If you would like to play a flat or sharp please use the # representation
Some example notes: 'C5', 'B4', 'D5#'
D4
Please select a duration for the note to be played in seconds
5
---------------------------------------------------------
Please select one of the following options:
0: Exit
1: Play a note
2: Play a frequency
3: Play the scale
4-5: Play sound effects
4
---------------------------------------------------------
Playing Power Up!
---------------------------------------------------------
Please select one of the following options:
0: Exit
1: Play a note
2: Play a frequency
3: Play the scale
4-5: Play sound effects
```

Figure 1: Speaker Interface Example



```
Welcome to Connor Nelson's Midterm Project
EECE2160, Julius Marpaung, Fall 2020
If you would like to use the speaker interface please enter '1'.
To play Snakes and Ladders please enter '2'.
2
Welcome to Snakes and Ladders!
In order to play this game you will need to open the board.jpg file
Please open it now
The rules of the game are as follows:
        - Each player will start with their icon on square 1
        - On each players turn they will roll their die and move their piece forward that many spaces
        - If your piece lands at the bottom of a ladder then you may choose to move to the top of the ladder
        - If your piece lands at the head of a snake then you must move to the tail of the snake
        - Power ups may present themselves throughout the game
----------------------------------------------------------------------------------------------------------
I will now flip a coin, if you guess right then you get to go first!
Please enter 'heads' or 'tails'
tails
You choose: tails
You won the flip! You will be going first!
Press enter to continue
----------------------------------------------------------------------------------------------------------
Wooooo it's your turn!
Press enter to roll!

You rolled a: 2
WOW you landed on the ladder at position: 3
Your new position is: 51
Press enter to continue

----------------------------------------------------------------------------------------------------------
The AI is now taking its turn
The AI rolled a: 3
The AIs new position is: 4
----------------------------------------------------------------------------------------------------------
Wooooo it's your turn!
Press enter to roll!

You rolled a: 6
Your new position is: 57
Press enter to continue

----------------------------------------------------------------------------------------------------------
The AI is now taking its turn
The AI rolled a: 3
The AIs new position is: 7
----------------------------------------------------------------------------------------------------------
Wooooo it's your turn!
Press enter to roll!
```

Figure 2: Example Snakes and Ladder Output

Analysis

There are not real results for this lab as nothing was tested, but this section will touch on the efficiency of the algorithms developed and possible sources of error. In terms of efficiency there were no real algorithms to analyze, but there are more memory efficient ways to build snakes and ladders.

The midterm project was more of a research project and lacked a so called “correct” answer. The final product of my lab was beyond the scope of the requirements and implemented extra features.

Conclusion

This lab demonstrates our proficiency with the DE1-SoC board and C++. Its completion and lack of problems shows our self sufficiency with the resources at our disposal.

If I were to continue this project in the future, I would want to add a real graphical user interface to the Snakes and Ladders game. The current implementation mirrors the era MDOS era and it would be relatively easy to implement a real snakes and ladder game. If I had to choose, I would implement it in another language which I am more familiar with the graphics libraries. I would also like to implement multiple boards for the user to select from.

References

[1] Prof. Julius Marpaung, “*Lab Report Guide*”, Northeastern University, January 6 2020.

Appendix A: Board Image

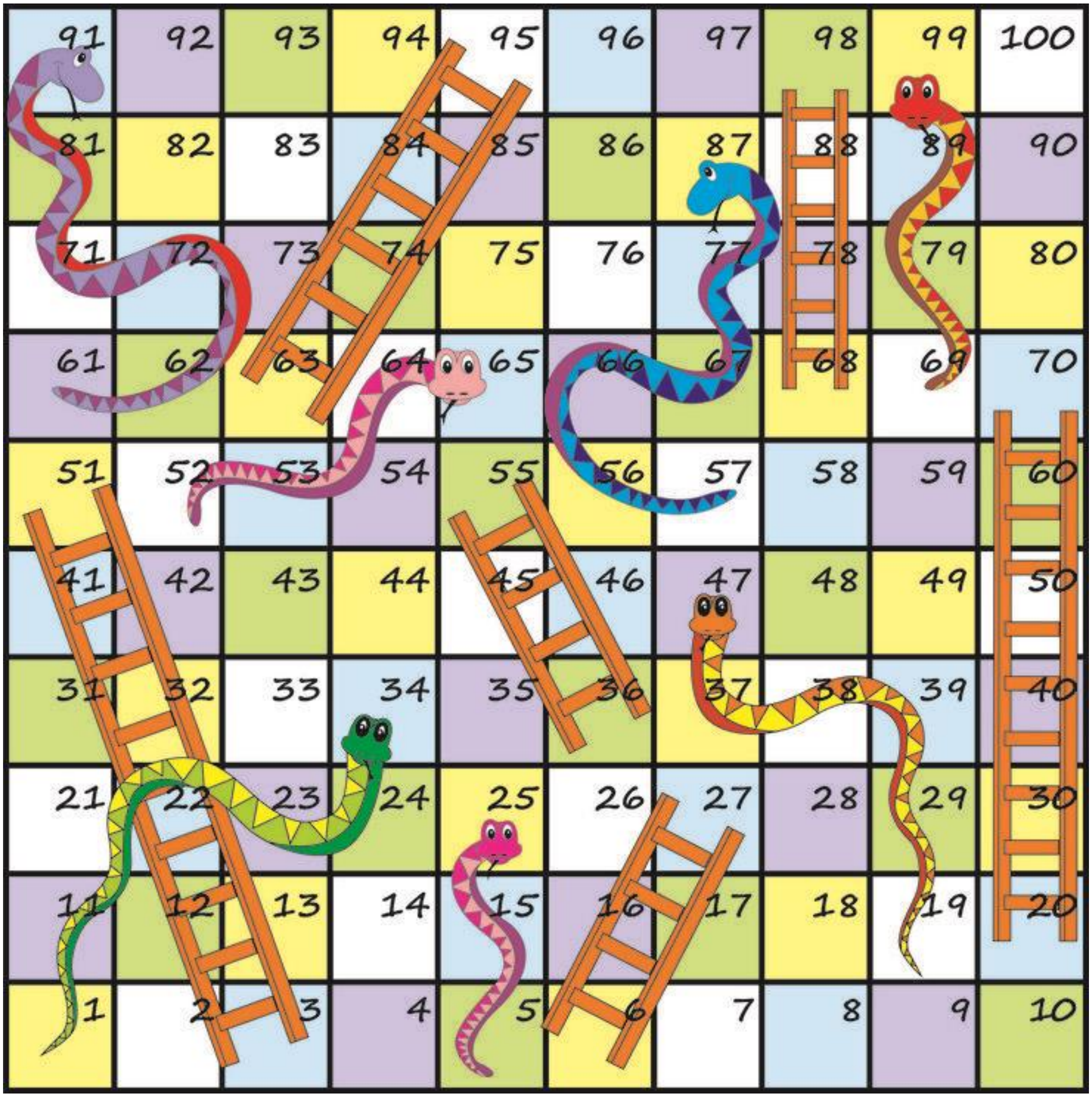


Figure 3: Image used for Representing Board State

The code in the appendices has been removed for plagiarism reasons. Please reach out of you would like a sample or watch the video included in the repo if you would like to see the functionality of my code.

Thank you for reading!