EE2026 FPGA Design Project: Real-Time Audio Visualizer

Name	Mohamed Riyas	Tan Chin Khang
Matriculation No.	A0194608W	A0180296Y
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1. Features of the Audio Visualizer

No.	Features	Owner	FPGA Input Used	Features	Figure
1	Menu Page	Team	BTNU, BTND, BTNC buttons	User will be be directed to a menu page displaying two options, 'Graphs' and 'Pong' respectively. User will have to press up or down button to toggle between the options and press the centre button to access the option that the user wants	Fig. 1
2	Pong Game	Team	SW[2], SW[3], SW[4], SW[14], SW[15]	Upon clicking the 'Pong' option in the menu display, user will be directed to the game. User needs to flip SW[2] to 'on' to start playing the pong game.To restart the game, player can flip SW[2] off then on. Player 1(P1) uses SW[15] while Player 2(P2) uses SW[3]. The game is a ordinary pong game with a twist: the ball size is tied to the mic input, therefore, to "kill" your opponent, you need to clap when the ball reaches the player paddle. The opponent can defend by clapping right before it reaches the paddle to deflect the ball. If one is unable to clap and defend, he/she can let the computer take over by flipping SW[4] and SW[14] for P1 and P2 respectively. However, note that the paddle moves faster when controlled by player.Game ends when one of the player's score reaches 30. The user can flip SW[2] at this point to reset the game.	Fig. 2

3	Side Menu	Chin Khang	BTNC button	When BTNC is pressed, a side menu will pop up, allowing the user to exit whichever option they are currently in and directing them back to the menu display stated above in (1). This side menu is in both pong game and graph. For graph there is an additional option for color select and the current graph selected.	Fig. 3 & 4
4	Basic Voice Visualizer	Team	SW[0] BTNU, BTND button	Upon clicking the 'Graphs' option in the menu display, user will be directed to the page displaying the real time voice waveform. When SW[0] = 1, the VGA displays the test wave. To display other visual representations of the input waveform(which will be discussed in greater details between (8) and (16)), user will have to press either the BTNU or BTND button to toggle between the different visual representations of the input signal until he/she has reach the desired visual representation that he/she wants.	Fig. 5
5	Volume Indicator	Riyas	Nil	The LEDs from LD0 to LD11 light up with respect to the intensity of the input audio sample.	Fig. 6
6	Seven Segment Display	Riyas	Nil	The last two segments (AN1 & AN0) will display a numeric value between 0 and 12 with respect to the intensity of the input audio sample.	
7	VGA	Chin Khang	SW[7], SW[8] SW[9], SW[10]	SW[7] hides axis SW[8] hides ticks SW[9] hides grid SW[10] hides waveform Pressing left and right on the main waveform would scroll through the 5 default color schemes. Note that this option is only available if user is in the page in (4).	-

8	Colour Select	Chin Khang	BTNL, BTNR, BTNC, SW[11], SW[12], SW13]	In the unlikely event that the users do not like the color scheme, they are able to change it. SW[13:11] determines which part of the graph is changed. 0 - bg, 1 - grid, 2 - waveform, 3 - axis,4 - ticks. To change the color, press the BTNC to open up the side menu and select color sel. Once inside, you can preview the selected color on the box next to the side menu, the user can then press the BTNC to confirm the change.	Fig. 7
9	Voice Indicator Display	Riyas	BTND & BTNU Buttons	Upon pushing the BTND button, user will be directed from the display page from (4) to the page which displays the waveform in (4) together with the volume indicator boxes which increases in sizes and changes in colour with respect to the input voice waveform. Pushing the BTNU button will direct to the display page in (4).	Fig. 8
10	Amplify Voice SIgnal	Riyas	BTND & BTNU Buttons	10a) Upon pushing the BTND button, user will be directed from the page in (9) to the page displaying the same voice waveform depicted in (4) but now with input signal and grids amplified 2 times to give users a ‘zoom in’ view of the waveform. Pushing the BTNU button will direct to the page in (9). 10b) Pushing the BTND button again displays the same voice waveform in (4) with the input signal amplified 4 times instead. Pushing the BTNU button will direct back to the earlier version of ‘zoom in’ view in (10a).	Fig. 9
11	Bar Graph	Riyas	BTND & BTNU Buttons	11a) Upon pushing the BTND button, user will be directed from the page in (10b) to the page displaying a bar graph representation of the input audio sample (see Fig 10). Pushing the BTNU button will direct to the page in (10b). 11b) Pushing the BTND button again will lead to the page representing the same bar graph with different configuration (see Fig 11). Pushing the	Fig. 10 & 11

				BTNU button will direct to the earlier version of bar graph in (11a).	
12	Circular graph	Riyas	BTND & BTNU Buttons	Upon pushing the BTND button, user will be directed from the page in (11b) to the page displaying a circle which increases in size with respect to the input audio sample. Pushing the BTNU button will direct to the page in (11b).	Fig. 12
13	Line Graph	Team	BTND & BTNU Buttons	13a) Upon pushing the BTND button from the page displayed in (12), user will be directed to the page displaying a line graph representation of the input audio sample. Pushing the BTNU button will direct to the page in (12). 13b) Pushing the BTND button again will lead to the page representing the same line graph with different configuration. Pushing the BTNU button will direct to earlier version of line graph in (13a).	Fig. 13
14	Slow Waveform	Team	BTND & BTNU Buttons	14a) Upon pushing the BTND button, user will be directed from the page in (13b) to the page displaying the same waveform in (4) but now with the input signal fluctuating and changing slowly. Pushing the BTNU button will direct to the page in (13b). 14b) Pushing the BTND button again displays another variation of the same slow waveform. Pushing the BTNU button will direct to the earlier version of slow waveform in (14a).	Fig. 14 & Fig. 15

15	2 Graphs Display	Riyas	BTND & BTNU Buttons	15a) Pushing the BTND button from the page in (14b) displays the normal waveform in (4) and line-graph representation of the waveform in (13) side by side. Pushing the BTNU button will direct to the page in (14b). 15b) Pressing the BTND button again displays the normal waveform in (4) and bar-graph representation of the waveform in (11) side by side. Pushing the BTNU button will direct to the earlier version of 2 graphs in (15a).	Fig.16 & Fig.17
16	4 Graphs Display	Riyas	BTND & BTNU Buttons	16a) Pressing the BTND button from the page in (15b) displays the normal waveform in (4), line-graph representation of waveform in (13), bar-graph representation of waveform in (11) and circle representation of the waveform in (12) side by side. Pushing the BTNU button will direct to the page in (15b). 16b) Pressing the BTND button displays the normal waveform in (4), line-graph representation of waveform in (13), bar-graph representation of waveform in (11) and volume indicator of the waveform in side by side. Pushing the BTNU button will direct to the page in (16a).	Fig.18 & Fig.19.

2. Feedback

	Riyas	Chin Khang
1) What did you like most / least about the project?	I liked displaying various displays of the waveform. It was challenging but fun. I disliked the time required to generate bitstream.	I liked most about the project is that we get to play with the vga display. It is very fun. The EE2026 wiki is also quite useful. I would have preferred more material given regarding the syntax of verilog.

2) How would you suggest the overall project assignment be improved?	Each of us could have been given individual sets of microphone and VGA cable so that we can accelerate the project.	The EE2026 wiki although useful, could have more material regarding verilog syntax.

3. Appendix

Fig. 1

Fig. 2

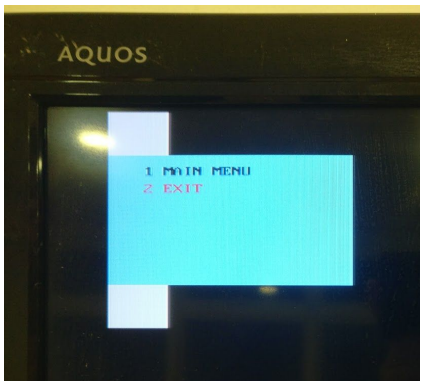

Fig. 3

Fig. 4

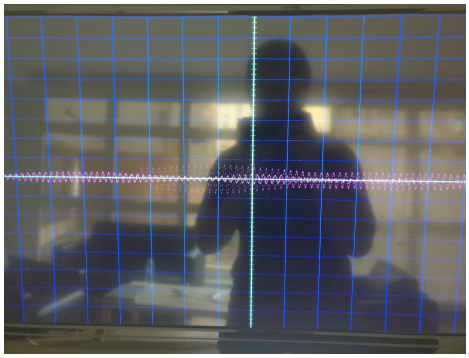
Fig. 5

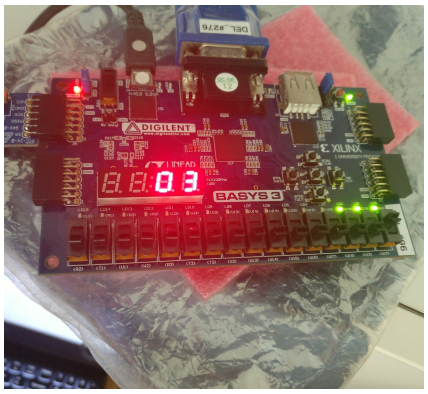

Fig. 6

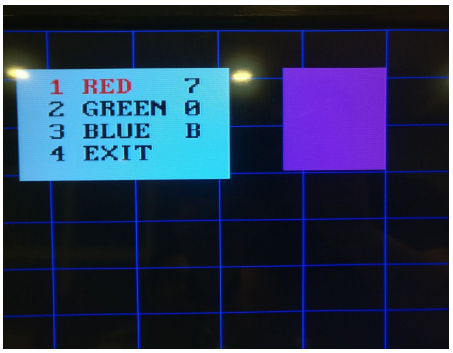

Fig.7

Fig. 8

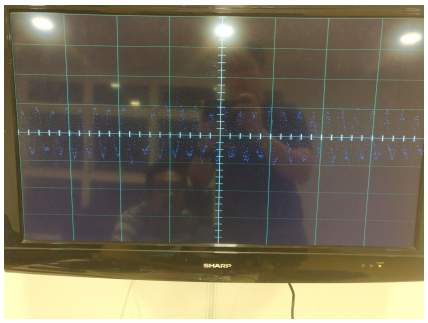
Fig. 9

Fig. 10

Fig. 11

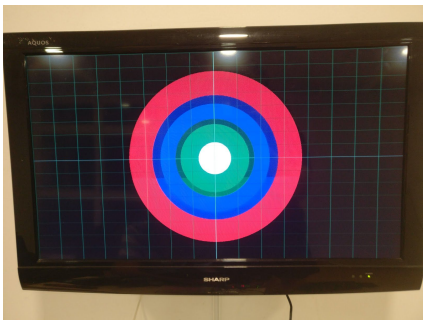

Fig 12

Fig. 13

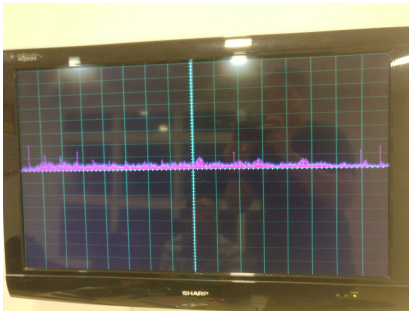

Fig. 14

Fig. 15

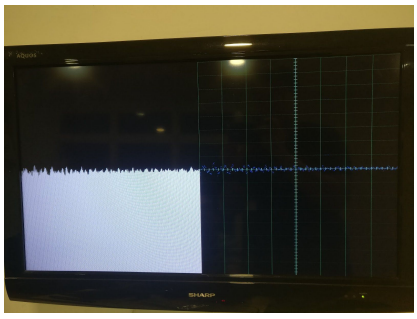

Fig. 16

Fig. 17

Fig. 18

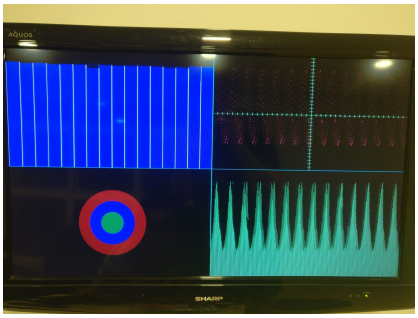

Fig. 19