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1. Summary Table

No.	Feature	Inputs	Description	Output Display
1	Real-time system	Mic, SW15, BTNC	**Real-time microphone-speaker system** SW15: Toggle on microphone-speaker function BTNC: reset both sound delay & pitch level to 0	7-segment left 2 digits display 0, 0
2A By: Terence Neo	1s Delay	Mic, SW15, BTNU	**Microphone-speaker system that delays the sound output by 1s** SW15: Toggle on microphone-speaker function BTNU/BTND: Adjust the time delay as displayed on left-most 7-segment digit to 1	7-segment left-most digit displays 1 to indicate 1s delay
2A By: Terence Neo	Delay Improvement: User friendly Microphone and Sound Recorder with adjustable sound delays and pitch levels	Mic, SW15, BTNU, BTND, BTNL, BTNR, BTNC	**Microphone Mode** SW15: Toggle on adjustable microphone-speaker function BTNU: Increase time delay by 1s BTND: Decrease time delay by 1s -Current time delay in seconds displayed on 7-segment -Time delay ranges from 0s to 4s BTNR: Increase pitch level BTNL: Decrease pitch level -5 different pitch levels displayed on 7-segment: 0: normal pitch, 1: high pitch, 2: higher pitch, 3: low pitch, 4: lower pitch BTNC: Reset time delay and pitch to 0 (0s delay and normal pitch)	7-segment displays time delay (Left-most digit) and pitch (Second from left digit)
		Mic, SW14, SW11, SW12, BTNL, BTNR, Musical Instrument	**Recording Mode** SW14: Toggle on sound recorder function BTNL: Record sound into sound memory (left) button while button is held down BTNR: Record sound into sound memory (right) while button is held down *Bonus: ability to record sound output from musical instruments	7-segment displays "REC" (left 3 digits) and octave number for musical instrument feature (right-most digit)
		SW12, SW11, BTNU, BTND, BTNL, BTNR, BTNC	**Playback Mode** SW12: Continuous playback from sound memory (left) SW11: Continuous playback from sound memory (right) BTNU: Extend time of playback by 1s BTND: Decrease time of playback by 1s BTNR: Increase pitch level of playback BTNL: Decrease pitch level of playback BTNC: Reset time extension and pitch to 0 (0s extension and normal pitch) *Bonus: ability to playback and record simultaneously, creating multi layered sounds	7-segment displays time extension (Left-most digit) and pitch (Second from left digit)
2B By: Clive Yuan	Musical Instrument	SW0 to SW6	**Plays piano notes just like a piano, multiple switches can be on to play chords** SW0, SW1, …, SW6 corresponds to notes of C, D, …, A, B respectively	N.A.

2B By: Clive Yuan	Musical Instrument Improvement	SW7	**Volume increase toggle between vol. 1 and vol. 2**	N.A.
		SW10	**Plays Fur Elise by Beethoven.**	N.A.
		BTNU, BTNC, BTND	**Change octave of the piano notes** BTNU: Increase octave (max. octave 5) BTNC: Reset to octave 1 BTND: Decrease octave (min. octave 1)	7-segment displays octave number on right-most digit
3 By: Both Students	**Extra Features**			
	Noise Filtering	SW13	Filters away unwanted background noises for clear and crisp voice sound (that doesn't hurt your ears, how useful and user-friendly is that!) (Noise cancellation is not required for Musical Instrument modes and disabled during Sound Merging)	7-segment displays "F" on third digit from left when noise cancellation is on and enabled
	Sound Merging	SW15, SW12, SW11, SW10, SW0 to 6	Simultaneous playback of an unlimited number of sounds created by the various features above when the various switches are toggled on at the same time *Bonus: timing, pitch, octave etc. adjustments can be done during sound merging	7-segment displays time (Left-most digit) and pitch (Second from left digit)
	Lightshow [1][2]	All switches and buttons	LED ripple effect and LED shift when switches or buttons are toggled	LEDs lighting up upon switches and buttons
	7-segment display [3]	N.A.	**User-friendly display indicators for various functions:** 1. Time delay/ extension 2. Pitch level 3. Recording mode enabled indicator 4. Noise filtering enabled indicator 5. Octave level	7-segment
	DJ Sound mixer	SW0 to 6, SW10 to 15, BTNU, BTND, BTNL, BTNR, BTNC	Finally, with all the features we have implemented above, we have a very useful and fully functional DJ sound mixer that is able to create remixes of voices, sounds and melodies!	7-segment displays various adjustable levels of time, pitch, octaves and modes

2. Feedback

1) What did you like most/least about the project?

It was an open ended project with that challenges us to explore and learn beyond the boundaries of the classroom. There is a certain sense of satisfaction when functions that we could only imagine at first finally works and our ideas come to fruition.

2) How would you suggest the overall project assignment be improved?

Perhaps more external components can be incorporated, like the usage of VGA and USB can be taught instead of self-learn.

3) Please include your experience on what made the project doable and enjoyable, and which parts caused unnecessary pressure during your learning journey.

As this is the first project we did on Verilog and Vivado, there were many times when we got stuck, baffled by lines of codes that works in other programming languages such as C but do not work in Verilog. Fortunately, we were able to readily consult the various teachers, lab staff, and graduate assistances who are not only very knowledgeable, spotting our errors instantly, but also extremely patient when explaining the concepts to us. And we are very grateful for you all!

3. References

[1]   https://electronics.stackexchange.com/questions/74277/what-is-this-operator-called-as-in-verilog (+: operator, indexed part select for LED bits isolation)

[2]   EE2026 tutorial 7, question 3 on shifting bits (LED moving effect)

[3]   http://www.fpga4student.com/2017/09/seven-segment-led-display-controller-basys3-fpga.html