

EE2026 FPGA Design Project

Sound Display and Entertainment System

Feature		Input Device(s)	Feature Description	Images / Photos
Real-time audio volume indicator <i>Synopsis: After extracting the amplitudes, our real-time audio volume indicator employs the 7-segment displays and the LED array to represent different amplitude ranges (from 0 to 4095) from the audio signal linearly and refresh at an observable rate.</i>		SW0 LED[15:0] Seg[6:0]	<p>SW0 is 1: mic_in is shown on LEDs 0 - 11. The 12 LEDs are able to light up and flicker.</p> <p>SW0 is 0: 1 to 16 LEDs light up as a bar to show the corresponding level of peak intensity of mic_in (0 corresponds to LED 0 lighting up, 1 corresponds to LEDs 0 and 1 lighting up etc).</p> <p><u>Additionally, the 7-segment displays, despite SW0 being 0 or 1, always display the level of peak intensity of mic_in, from 0 to 15 (except when improvement feature 1 or 5 is enabled).</u></p>	1a, 1b, 1c
Graphical visualisations and configuration <i>Synopsis: The volume captured by mic_in can be graphically represented as a volume bar on the OLED screen containing 96 * 64 pixels. The linear volume bar has 16 levels, ranging from 0 to 15. The bars are made in 3 different colours to indicate when volume is low (0 - 4), medium (5 - 10) or high (11 - 15).</i>		SW1 SW2 SW3 SW4 SW5 SW6	<p>SW5 and SW6 are 0 enables the original colour theme, with border being white, background being black, low volume bar being green, medium volume bar being yellow and high volume bar being red.</p> <p>SW1 is 1 / 0: The border is turned on / off.</p> <p>SW2 is 1 / 0: The volume bar is shown / hidden.</p> <p>SW3 is 1 / 0: The volume bar is freezed / unfreezed.</p> <p>SW4 is 1 / 0 (with SW1 = 1): The thickness of the border is 3 * 3 pixels / 1 * 1 pixel.</p> <p>SW5 is 1 and SW6 is 0 enables the first additional complimentary colour theme, with border being green, background being dark blue, low volume bar being light blue,</p>	2a, 2b, 2c, 2d, 2e, 2f

			<p>medium volume bar being purple and high volume bar being orange.</p> <p>SW6 is 1 and SW5 is 0 enables the second additional complimentary colour theme, with border being yellow, background being purple, low volume bar being light green, medium volume bar being light pink and high volume bar being light yellow.</p> <p><u>* Do not turn on SW5 and SW6 together because the output is invalid. *</u></p>	
<p>Improvement Feature 1: Snellen (Eye) Chart</p> <p><i>Synopsis: Students and staff from the Department of Electrical and Computer Engineering are usually and inevitably exposed to blue light from computers and other digital devices in the laboratory. Thus, it is imperative that we conduct regular eye tests to check our visual acuity. In our eye chart, the OLED screen displays an English letter "E" facing a random direction with smaller size each time for the user to identify. There are in total 6 tests and we give 7 different bands for measurement of relative visual acuity, namely, Distinction (A), Excellent (B), Very good (C), Good (D), Pass (E), Sub-pass (S) and Unsatisfactory (U). The direction facing the smallest symbol that can be reliably identified is considered the person's visual acuity. In the case when the user cannot identify the direction facing the first (largest) symbol, he or she will receive the lowest band, Unsatisfactory, (U). The details on the requirements to attain different bands is as follows:</i></p> <p><i>Distinction (A): The user can identify the direction facing all 6 symbols.</i></p>	<p>SW10 BtnL BtnR BtnU BtnD BtnC Seg0 Seg1 Seg2 Seg3 Seg4 Seg5 Seg6</p>	<p>SW10 is 0 means the eye chart feature is not enabled. SW10 is 1 means the system is initiated.</p> <p>Step 1: The user is to place the OLED screen at a standardised distance of 30cm away from him or her while making the OLED screen in the upright position.</p> <p>Step 2: The tester then proceeds to identify the direction which the English letter "E" on the chart is facing towards, by pressing a corresponding pushbutton.</p> <p>Step 3: After correctly identifying where the symbol is facing, the user continues with progressively smaller symbol until the person wrongly identify the direction or when the direction facing the smallest symbol is correctly identified. At the end, the result of the user's visual acuity will be displayed.</p> <p><u>* The user can press the central pushbutton if he or she wants to take another series of tests. *</u></p> <p>Display of Visual Acuity: On the 7-segment Display: A letter grade will be displayed, with A (Distinction) being the highest, followed by B (Excellent), C (Very good), D (Good), E (Pass), S (Sub-pass) and U (Unsatisfactory).</p> <p>On the OLED Screen (All Letters Displayed are Capitalised): Four portions of content will be displayed. The first portion is: "Please look left and below for your grade and comment respectively..." The second portion is: "Press the central pushbutton to try again."</p>	<p>3a, 3b, 3c, 3d, 3e, 3f, 3g</p>	

<p><i>Excellent (B): The user can identify the direction facing the first 5 symbols.</i></p> <p><i>Very good (C): The user can identify the direction facing the first 4 symbols.</i></p> <p><i>Good (D): The user can identify the direction facing the first 3 symbols.</i></p> <p><i>Pass (E): The user can identify the direction facing the first 2 symbols.</i></p> <p><i>Sub-pass (S): The user is only able to identify the direction facing the first symbol.</i></p> <p><i>Unsatisfactory (U): The user is unable to identify the direction facing the first symbol.</i></p>		<p>The third portion is the grade given to the user, with Distinction being the highest and Unsatisfactory being the lowest.</p> <p>The fourth portion is the comment given to the user. Please refer below for the details:</p> <p>Distinction: U r the best!</p> <p>Excellent: Impressive!</p> <p>Very good: Not bad!</p> <p>Good: You are fine!</p> <p>Pass: Take breaks from screen time!</p> <p>Sub-pass: Obtain regular eye examinations!</p> <p>Unsatisfactory: Go for a general eye consultation!</p>	
<p>Improvement Feature 2: Varying bubble and Xiao-Chuan (Sound detection and entertainment system)</p> <p><i>Synopsis: The volume captured by mic_in can also be represented in more creative and interactive forms. Specifically, our sound display and sound entertainment system includes the design of a virtual bubble which varies its sizes and colours when a voice with different loudness is detected. When the highest possible range of audio signal is captured by the microphone for some time, a picture of Sun Xiao-Chuan, a popular internet celebrity among the younger generation in mainland China with his famous quote of "why do you shout so loudly?", is shown. The emoji stickers of a red pepper and a horse are demonstrated as well because "pepper" and "horse" rhyme with some Chinese words in his quote.</i></p>	SW7	<p>SW7 is 0: The sound detection and entertainment system is not enabled.</p> <p>SW7 is 1: The sound detection and entertainment system is initiated. A circular bubble appears at the centre of the OLED screen with varying sizes and colours depending on the loudness of the sound read by the microphone. Specifically, the bubble expands in size when the value of mic_in increases and changes colour when the values of mic_in changes from one amplitude range to another. The range of sound levels remains to be from 0 to 15. Thus, there are in total 16 different sizes and colours of the bubble. When the volume reaches the highest level possible, the largest bubble appears and after a short delay, a picture containing Sun Xiao-Chuan, an internet celebrity from China with his famous quote of "why do you shout so loudly?", is presented.</p> <p><u>Sun Xiao-Chuan's picture will remain there as long as SW7 is 1 because the noise was too anger-inducing to him. The user can first turn off the system and then turn it on to interact with the system again.</u></p>	4a, 4b, 4c, 4d, 4e
<p>Improvement Feature 3: SpongeBob and his friends (Noise detection and entertainment system)</p>	SW12	<p>SW12 is 0: The noise detection and entertainment system is not enabled.</p>	5a, 5b, 5c, 5d

<p><i>Synopsis: While Improvement Feature 3 might only appeal to Chinese nationals, we decide to make a noise detection and entertainment system that caters to the rest of the users. Specifically, we make use of 4 carefully selected pictures from SpongeBob SquarePants that interact with the user when the level of sound is different.</i></p>		<p>SW12 is 1: The noise detection and entertainment system is initiated.</p> <p>If the amplitude range is between 0 and 3, a smiling SpongeBob is displayed on the OLED screen.</p> <p>If the amplitude range is between 4 and 9, the OLED screens shows SpongeBob and his friend Patrick Star laughing and having fun together.</p> <p>If the amplitude range is larger than 9, Squidward Q. Tentacles cannot sleep and hence the OLED shows him telling SpongeBob to lower the volume.</p> <p>If the amplitude range is larger or equal to 13 for a while, the noise makes Eugene Harold Krabs mad and thus there is a picture displaying his negative feeling on the OLED screen.</p> <p><u>This system is tolerant of any noise pollution made earlier. Hence, after about 2.5 seconds of sound with amplitude range between 0 and 3, the smiling SpongeBob will be displayed on the OLED screen again :)</u></p>	
<p>Improvement Feature 4: Welcome to NTU! (Sound-related orientation game)</p> <p><i>Synopsis: We design this game to make students learn more about loudness of their voices, so that they are better prepared for University life where they are encouraged to have fun shouting and screaming when playing orientation games and should be quiet in the classroom. In this game, there are two tasks to be accomplished. Students need to raise their voice to the loudest in one task and remain silent in the other. After completing these two tasks, there will be a picture congratulating them on their readiness for University. All the pictures on the OLED screen are colour coded.</i></p>	SW8 SW9 LED0 LED1 LED2 LED3 LED4 LED5 LED6 LED7 LED8 LED9 LED10	<p>Both SW8 and SW9 are 0: The sound-related orientation game is not enabled.</p> <p>SW8 is 1 and SW9 is 0: The first task of the sound-related orientation game is initiated. On the OLED screen, the instruction that "Make some noise!!" is displayed. The user is required to be as loud as possible for a while because he or she is considered to successfully finish task 1 if and only if the microphone reads in an amplitude range that is greater than or equal to 13 for a while. If he or she is successful, "Well done!!" will be displayed on the OLED screen. If not, nothing happens.</p> <p>SW9 is 1 and SW8 is 0: The second task of the sound-related orientation game is initiated. On the OLED screen, the instruction that "Be quiet!!" is displayed. The user is required to remain silent because he or she is considered to successfully finish task 2 if and only if the microphone reads in an amplitude range that is lower than or equal to 3. If he or she is</p>	6a, 6b, 6c, 6d, 6e, 6f

<p><i>If the user completes both tasks, the LED bar shows 2026 in binary, that is, 1111100100. Otherwise, the LED bar will be off.</i></p>		<p>successful, "Good Job!!" will be displayed on the OLED screen. If not, nothing happens.</p> <p><u>SW8 is 1 and SW9 is 1:</u> The system checks if the user has successfully completed both tasks 1 and 2. If so, a picture showing "You are ready for NTU!!" will be displayed. We would like to pilot test this game at NTU before the full deployment of the system in other higher institutions. If the user fails to accomplish either one of the tasks, the OLED screen will display the message that "Please finish the 2 given tasks first!!"</p> <p>* <u>Once the user finishes both tasks, the LED bar displays 2026 in binary.</u> *</p> <p>* <u>During the game, do not turn off SW8 and SW9 at the same time at any instant because it will reset the whole game!</u> <u>Instead, turn on the other switch before turning off the current switch.</u> *</p> <p>* <u>All Letters Displayed on the OLED Screen are Coloured Coded and Capitalised</u> *</p>	
<p>Improvement Feature 5: Dr Wong and Dr Chua's fans! (OLED Display of teachers, 7-segment displays of password and words)</p> <p><i>We take this opportunity to thank Dr Chua and Dr Wong who are our lecturers for EE2026 and CS1231 respectively :)</i></p>	<p>SW11 BtnL BtnR BtnU BtnD BtnC Seg0 Seg1 Seg2 Seg3 Seg4 Seg5 Seg6</p>	<p><u>SW11 is 0:</u> The system is not enabled.</p> <p><u>SW11 is 1:</u> The system is initiated. A question mark is displayed on the OLED screen. The user needs to input a password onto the 7-segment displays using the pushbuttons. When BtnU / BtnD is pressed once, the change is exactly one character in the forward /reverse direction. If BtnR / BtnL is pressed, the number selection goes to the right / left by one exactly position. (The forward cycle starts from three dashes, followed by 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and then three dashes again. The reverse cycle is the opposite.)</p> <p>If the password is 2026 and the central pushbutton is pressed, Dr Chua's picture will be displayed. In addition, the 7-segment displays "Dr.Chua'sfans" in a loop continuously. There is a blank space between any consecutive loops.</p> <p>If it is 1231 and the central pushbutton is pressed, the picture of Dr Wong Tin Lok, our previous lecturer for CS1231, will be displayed. In addition, the 7-segment displays</p>	<p>7a, 7b, 7c, 7d,</p>

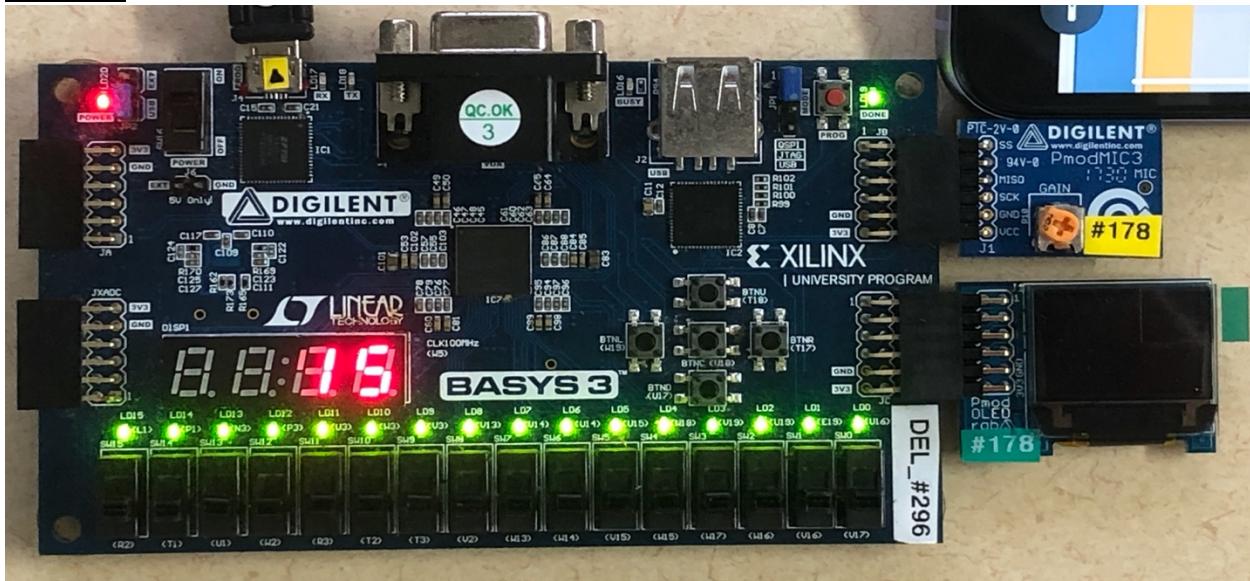
		<p>"Dr.Wong'sfans" in a loop continuously. There is a blank space between any consecutive loops.</p> <p>If the password entered is any other number and the central pushbutton is pressed, a picture of NUS will be displayed. The 7-segment displays do not show anything.</p> <p>In addition, when Dr Chua or Dr Wong is displayed, the user has 2 ways to interact with the system. The user can cheer for his or her teacher by producing a loud sound that is greater or equal to the amplitude range of 13 for a while and the whole system will be reset and a question mark will appear and wait for the user's password input again. If the user presses the central pushbutton, the 7-segment displays will display either Dr.Chua'sfans" or Dr.Wong'sfans" from the start again.</p> <p><u>* All Letters Displayed on the OLED Screen are Coloured Coded and Capitalised *</u></p>	
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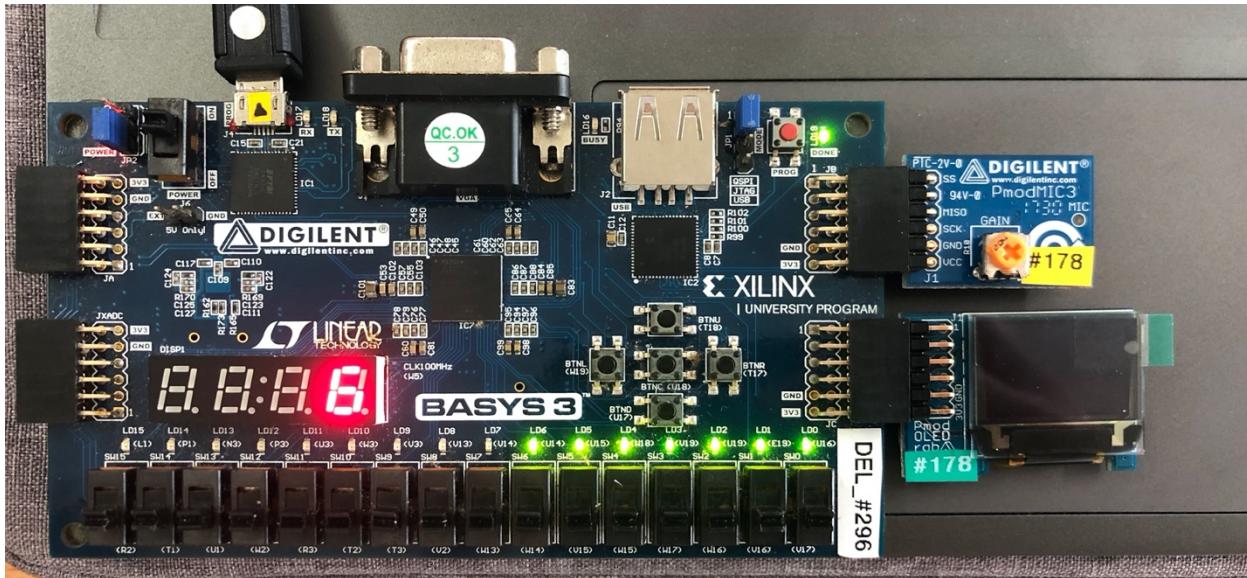
Appendix:

* Please note that for some pictures, the colour for certain part is homogenous to human eyes
but my phone camera is unable to show that. *

Real-time audio volume indicator:

SW0 is 1: 1a

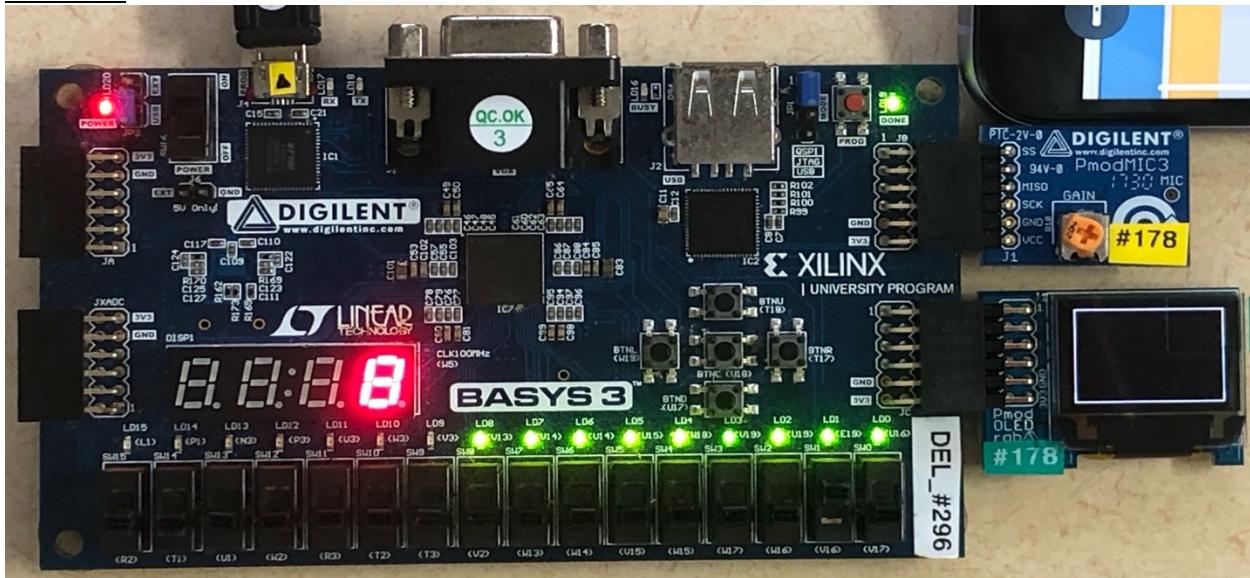




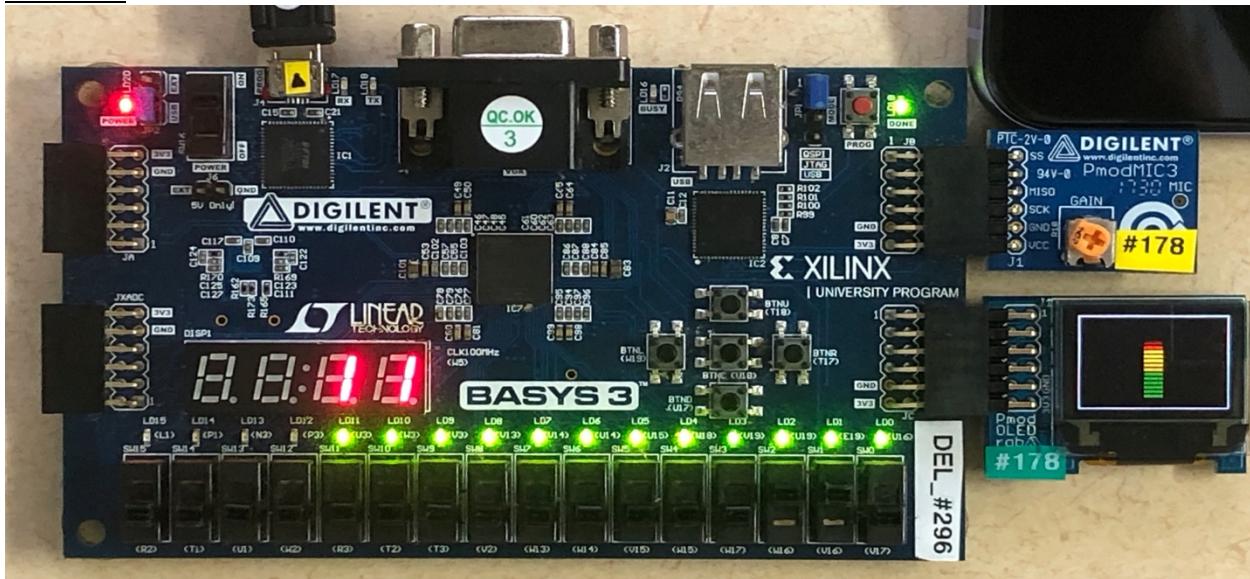
Graphical visualisations and configuration:

SW5 and SW6 are 0:

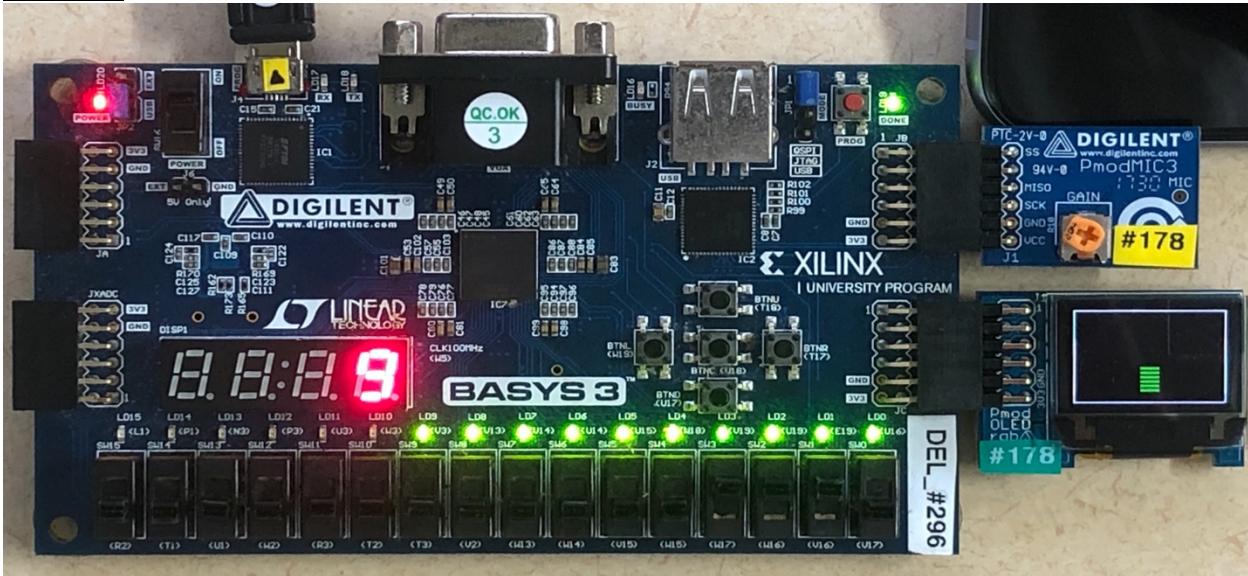
SW1 is 1: 2a



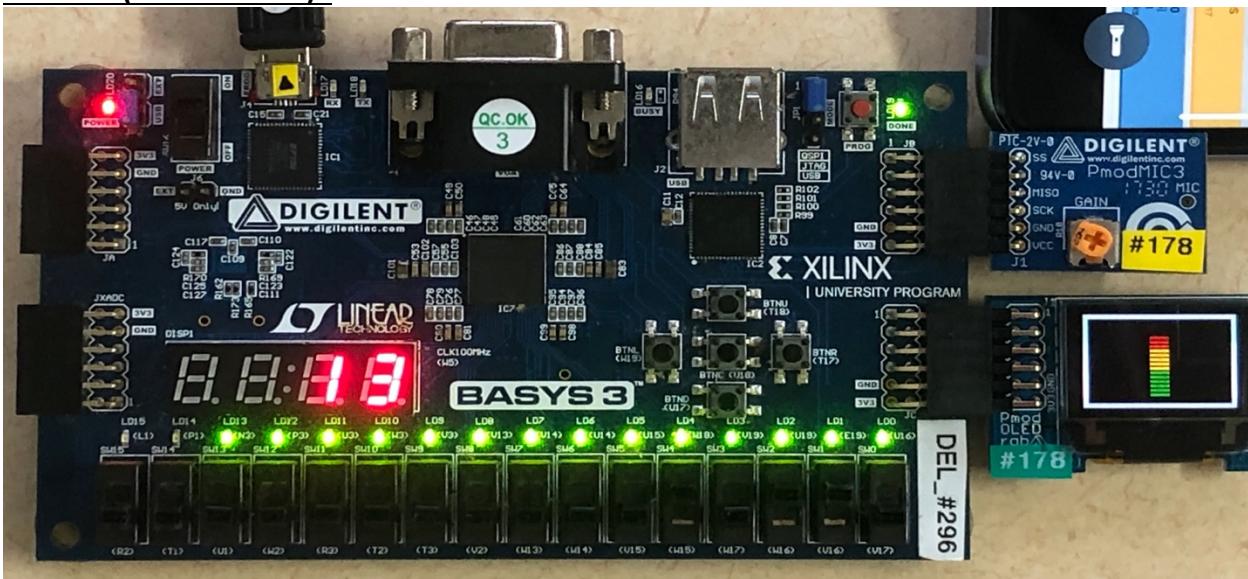
SW2 is 1: 2b



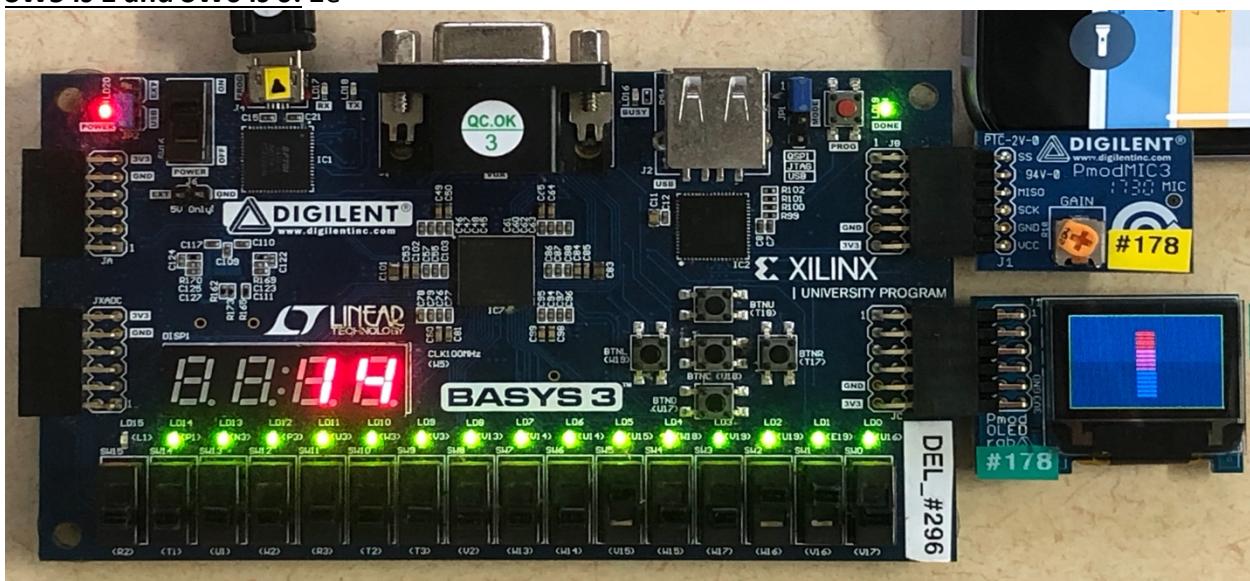
SW3 is 1: 2c



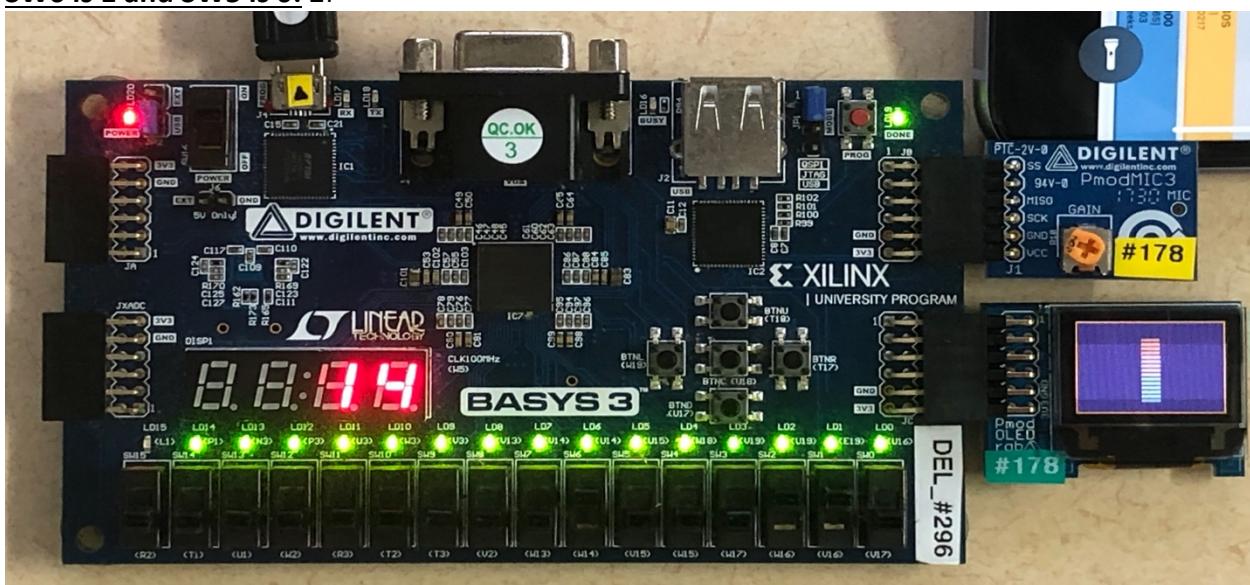
SW4 is 1 (with SW1 = 1): 2d



SW5 is 1 and SW6 is 0: 2e

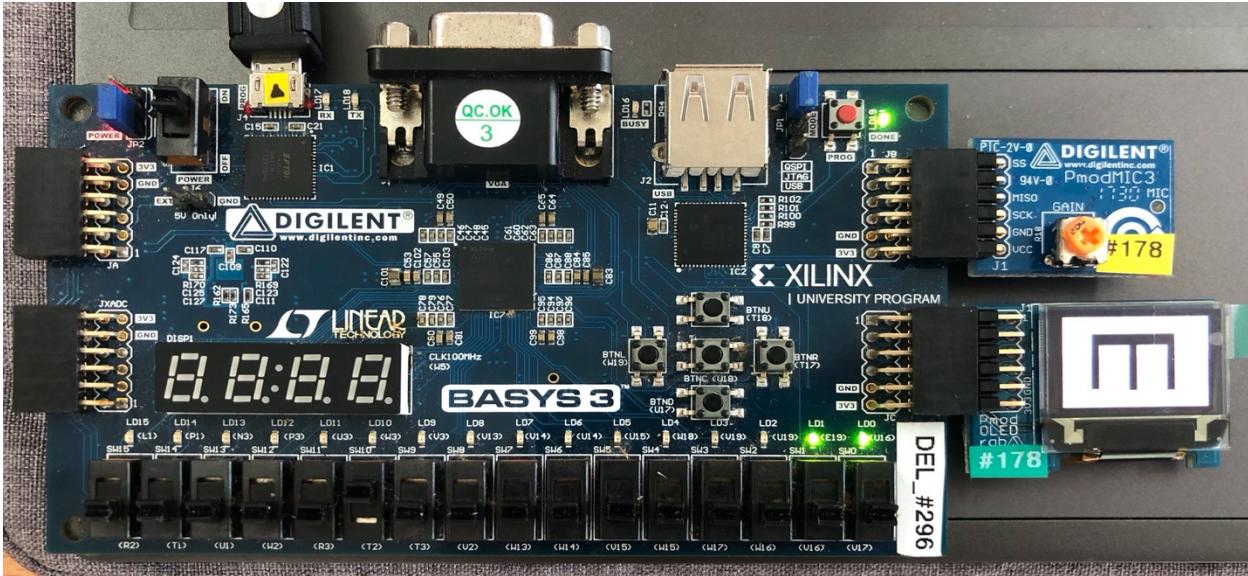


SW6 is 1 and SW5 is 0: 2f

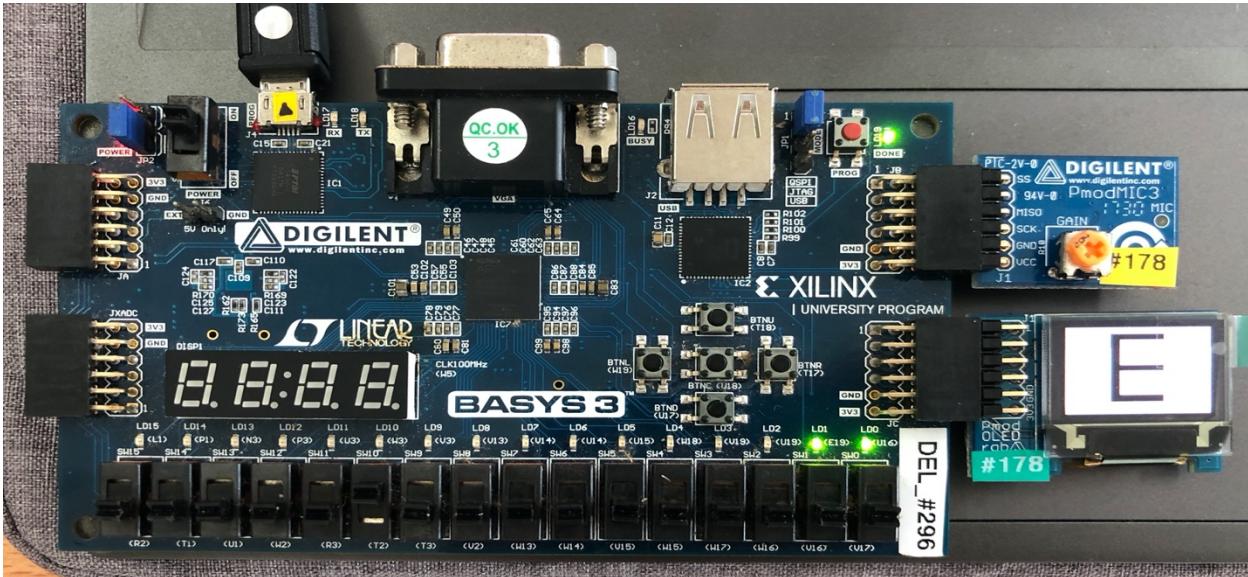


Improvement Feature 1: Snellen (Eye) Chart

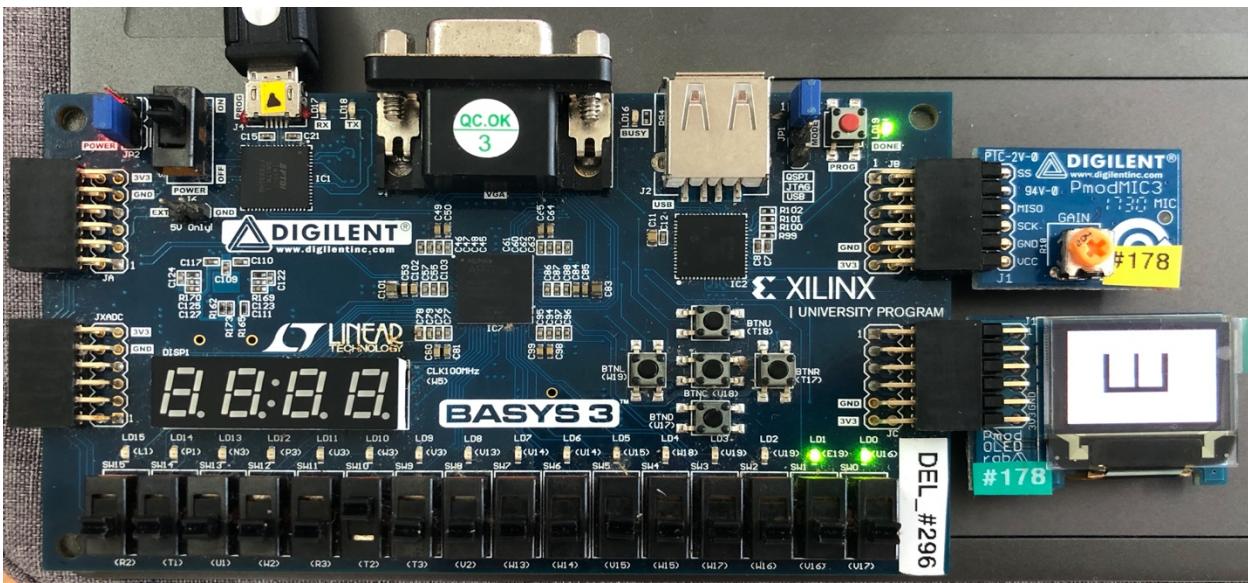
3a



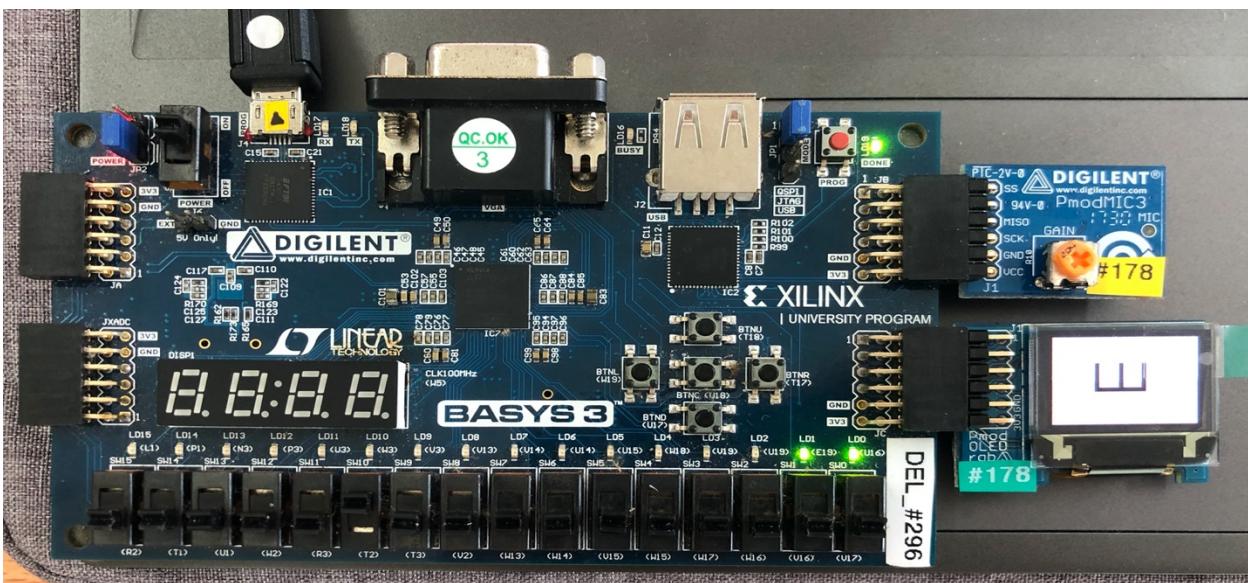
3b



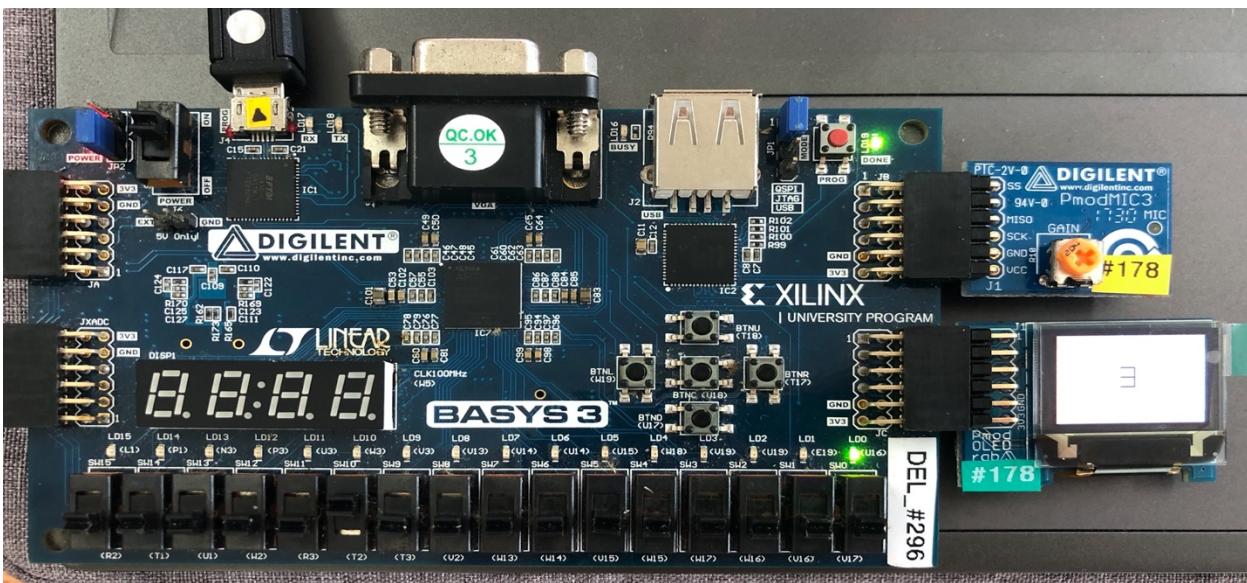
3c



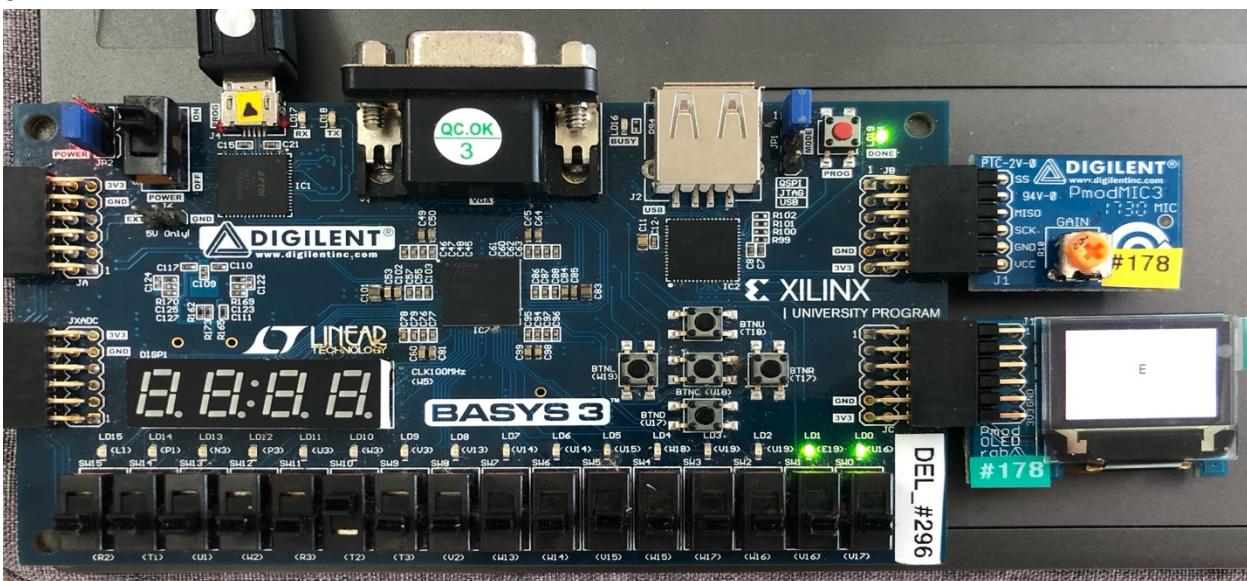
3d



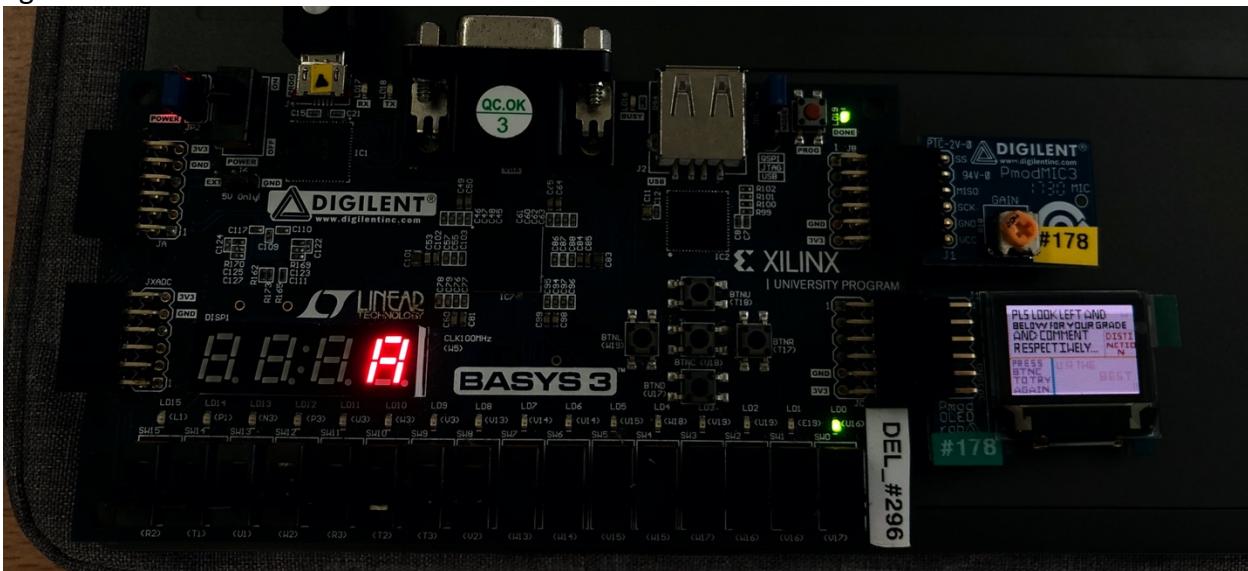
3e



3f

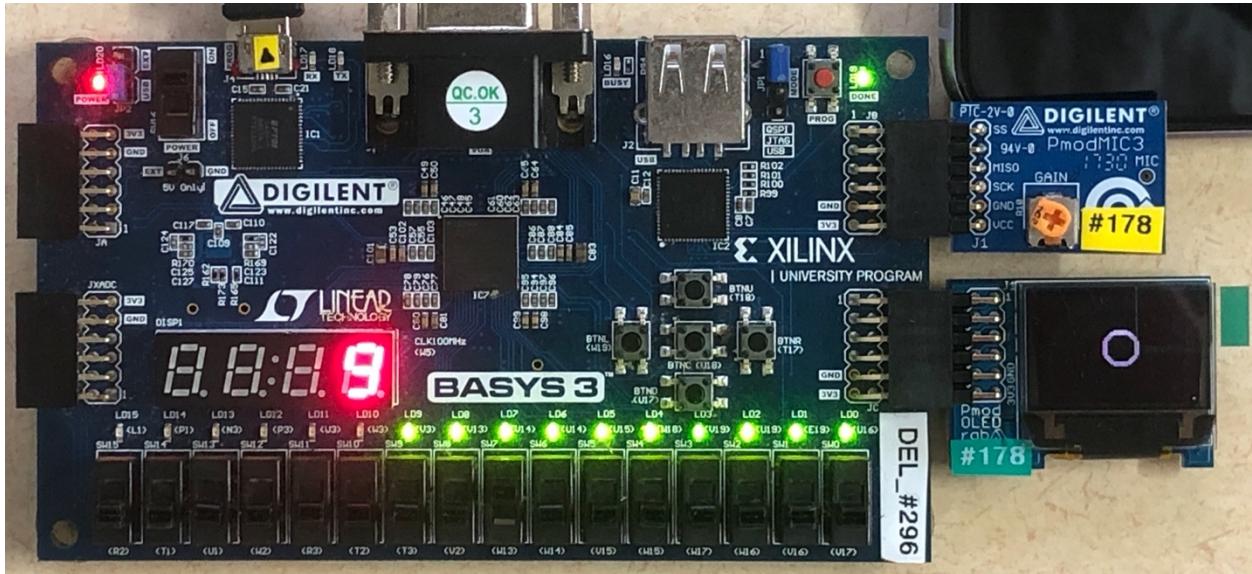


3g

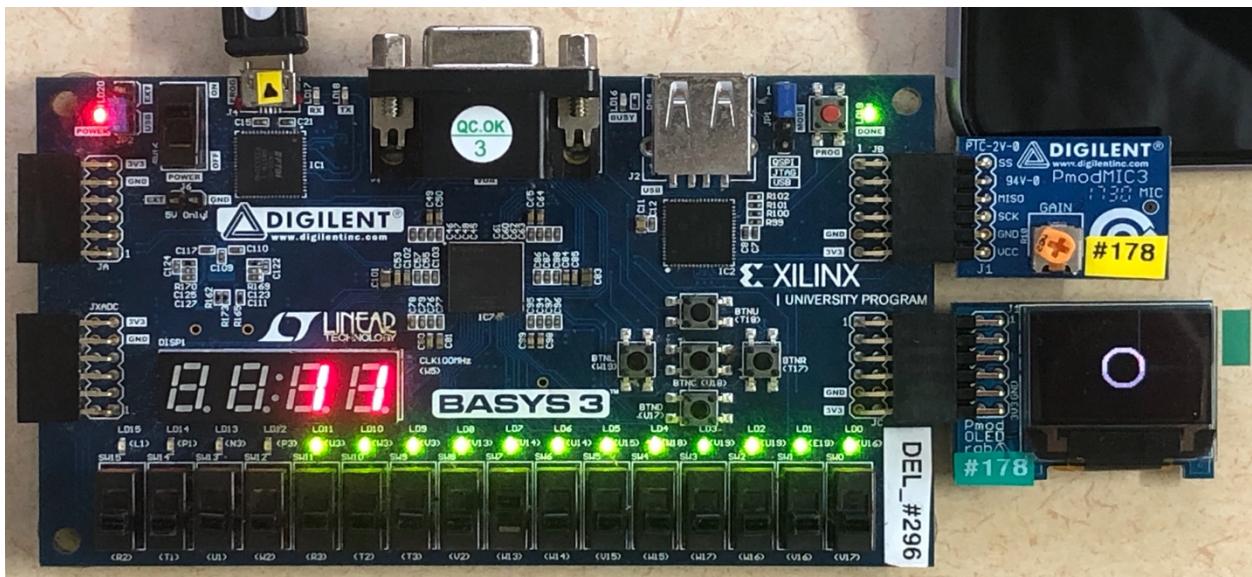


Improvement Feature 2: Varying bubble and Xiao-Chuan (Sound detection and entertainment system)

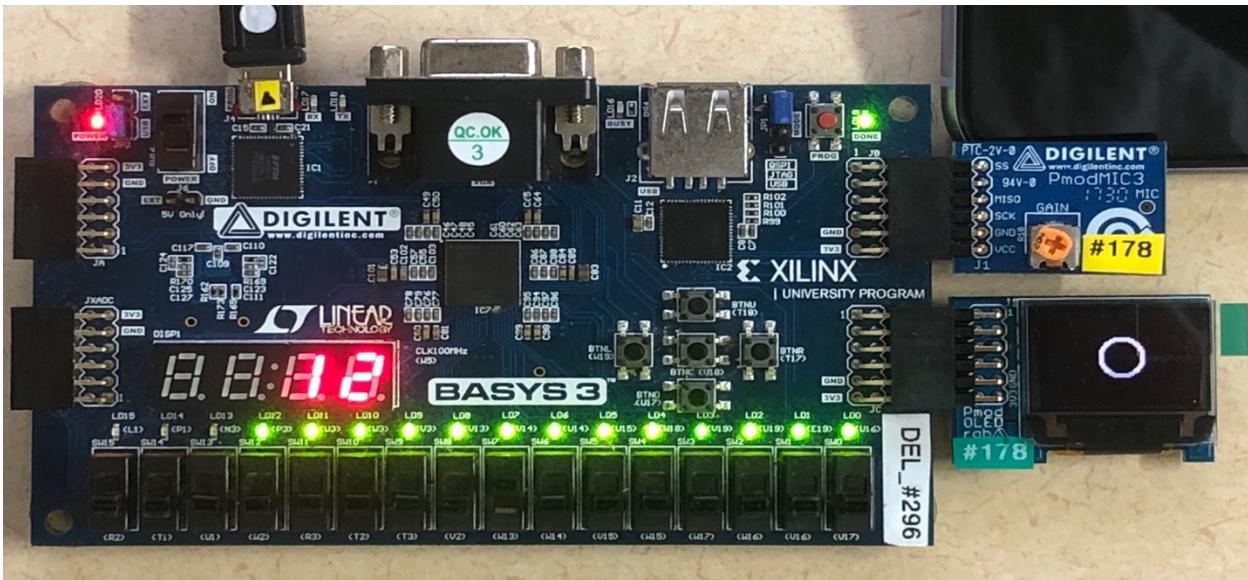
4a



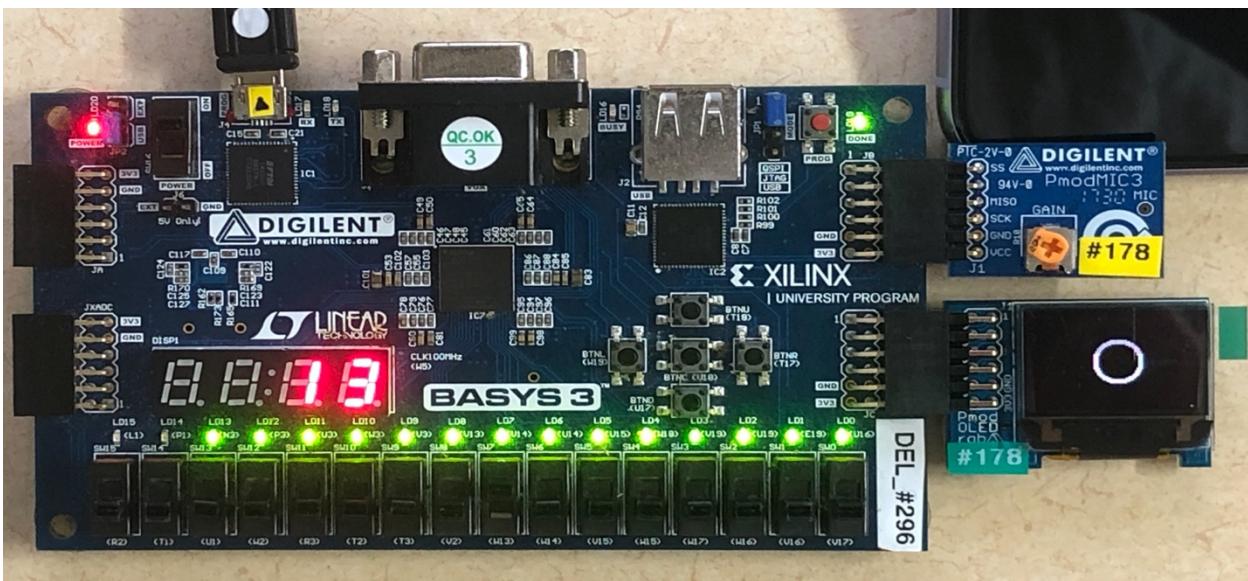
4b



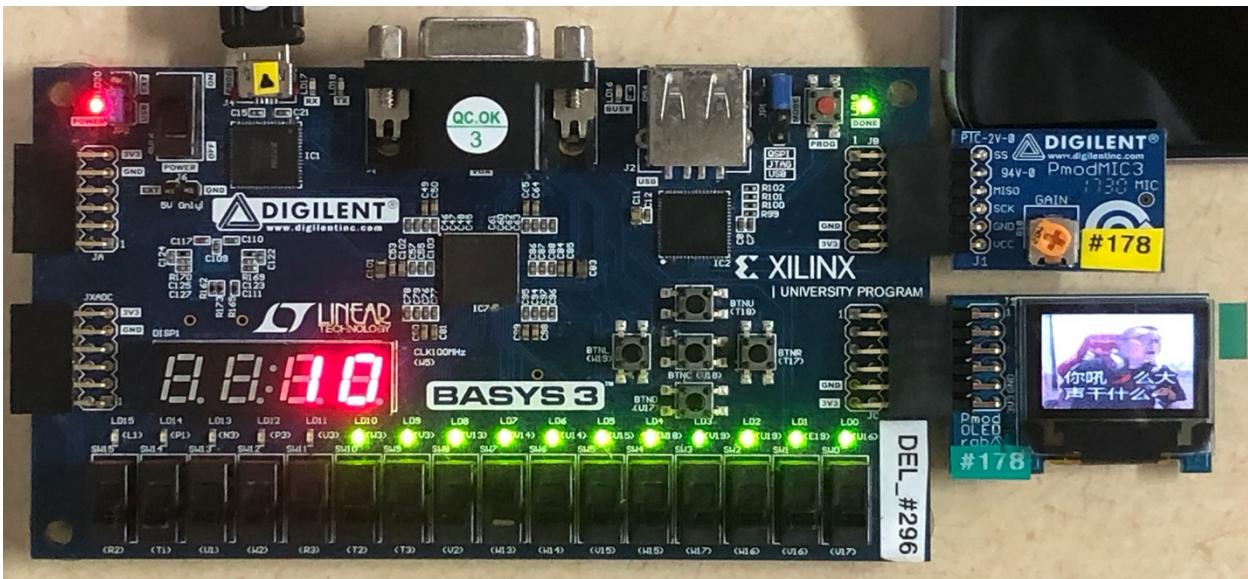
4c



4d

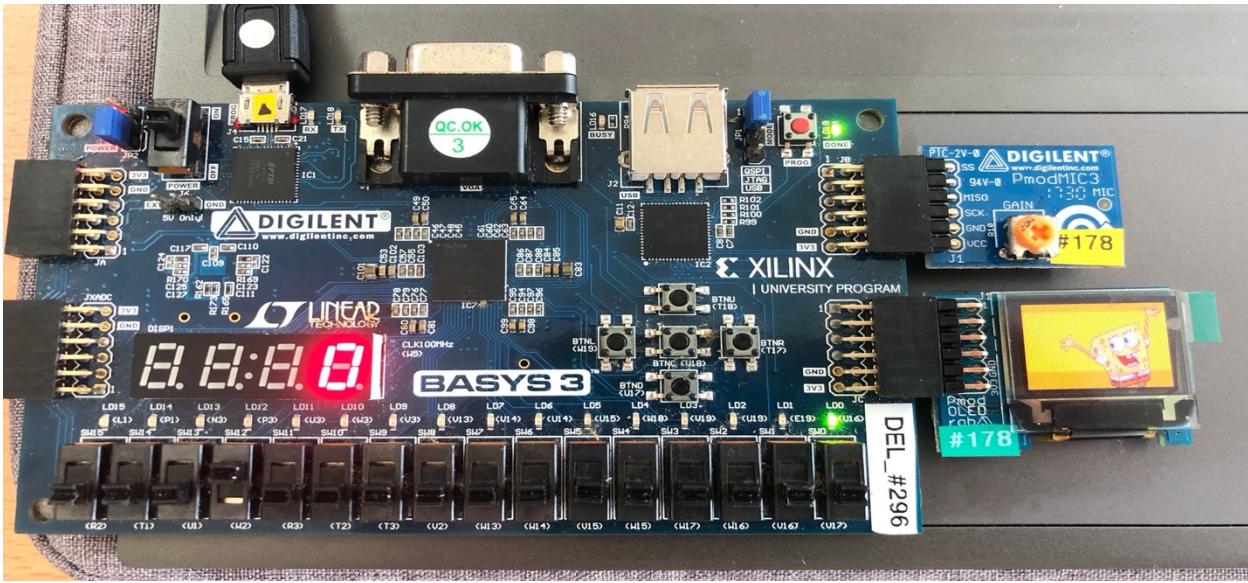


4e

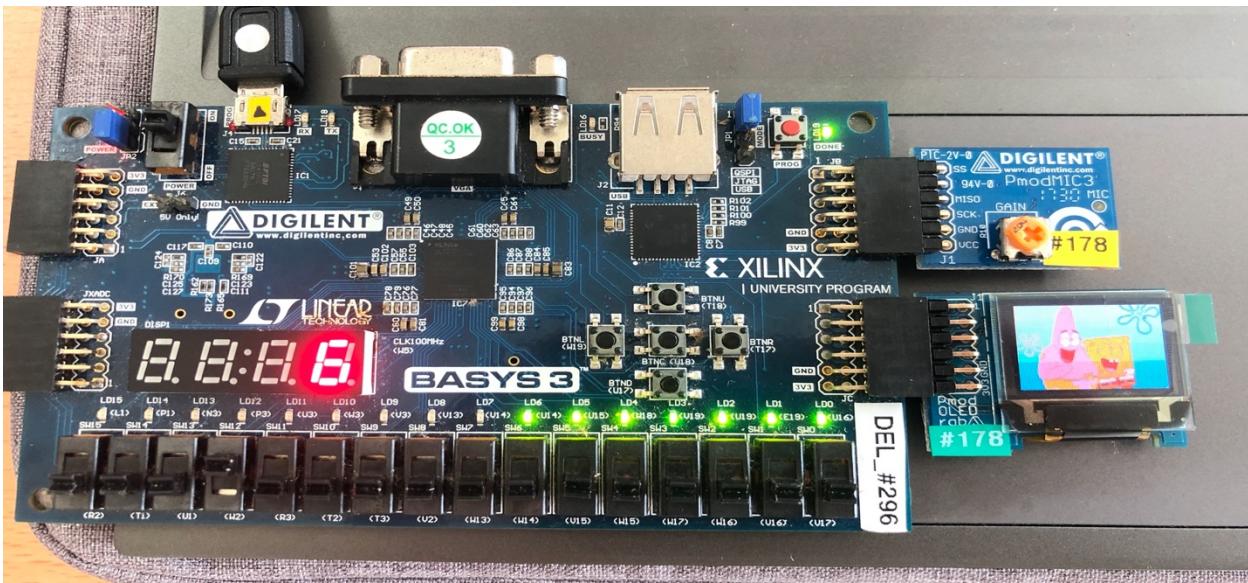


Improvement Feature 3: SpongeBob and his friends (Noise detection and entertainment system)

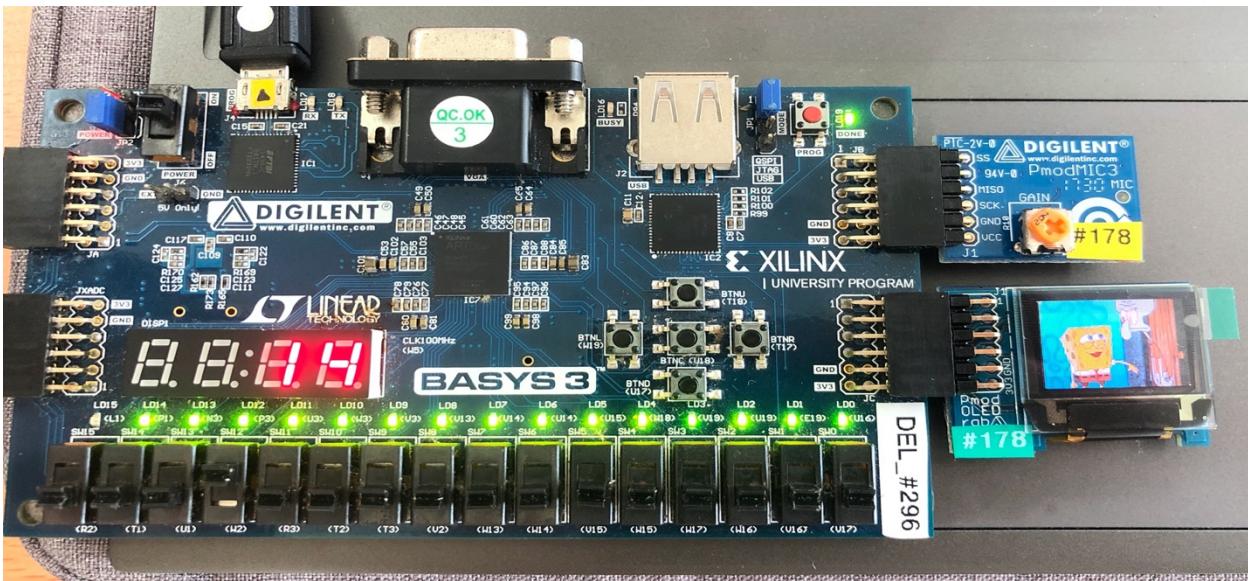
5a



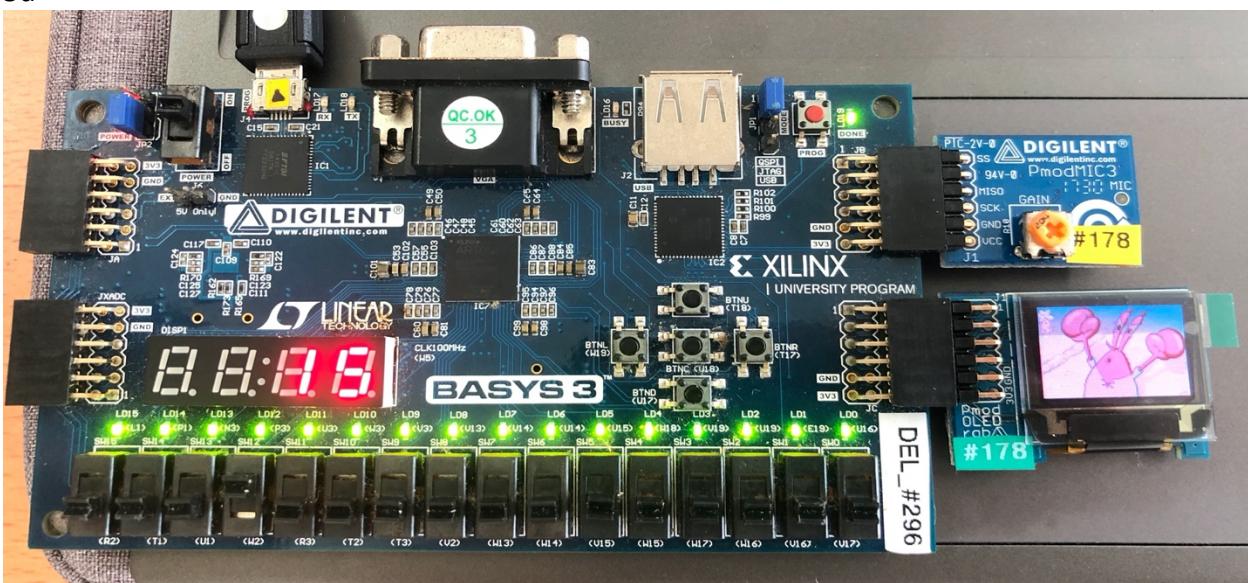
5b



5c

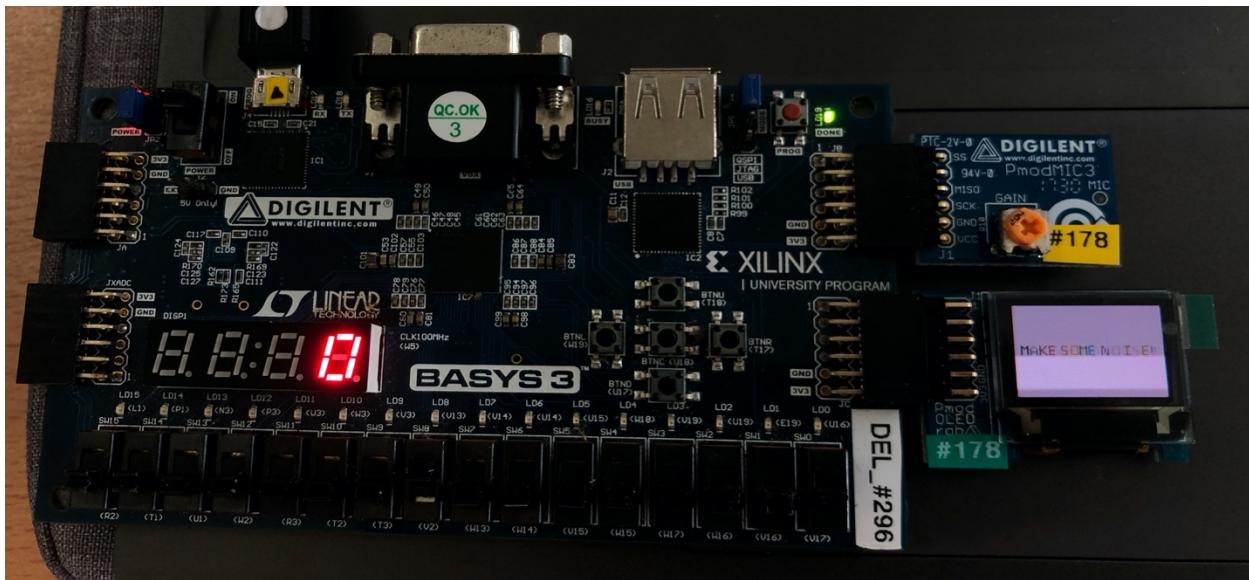


5d

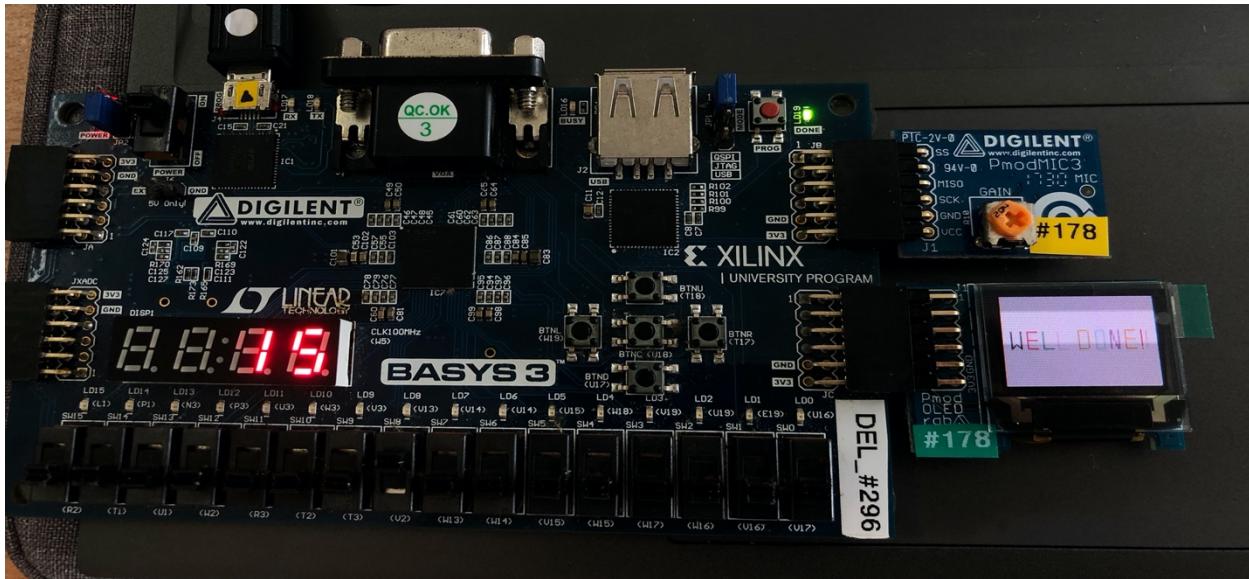


Improvement Feature 4: Welcome to NTU! (Sound-related orientation game)

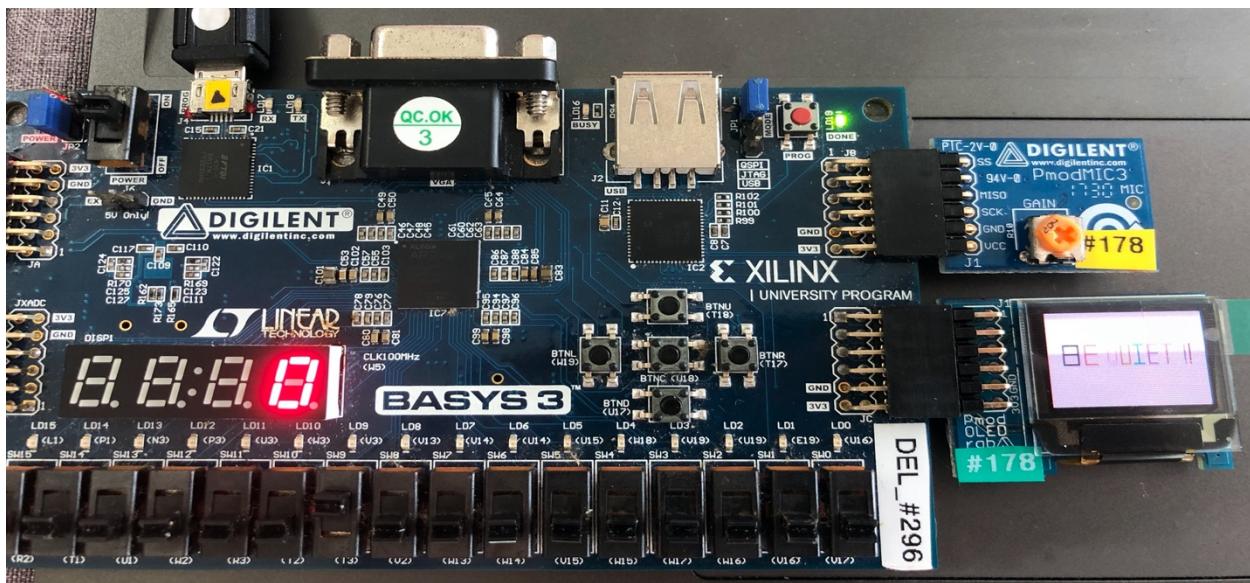
6a



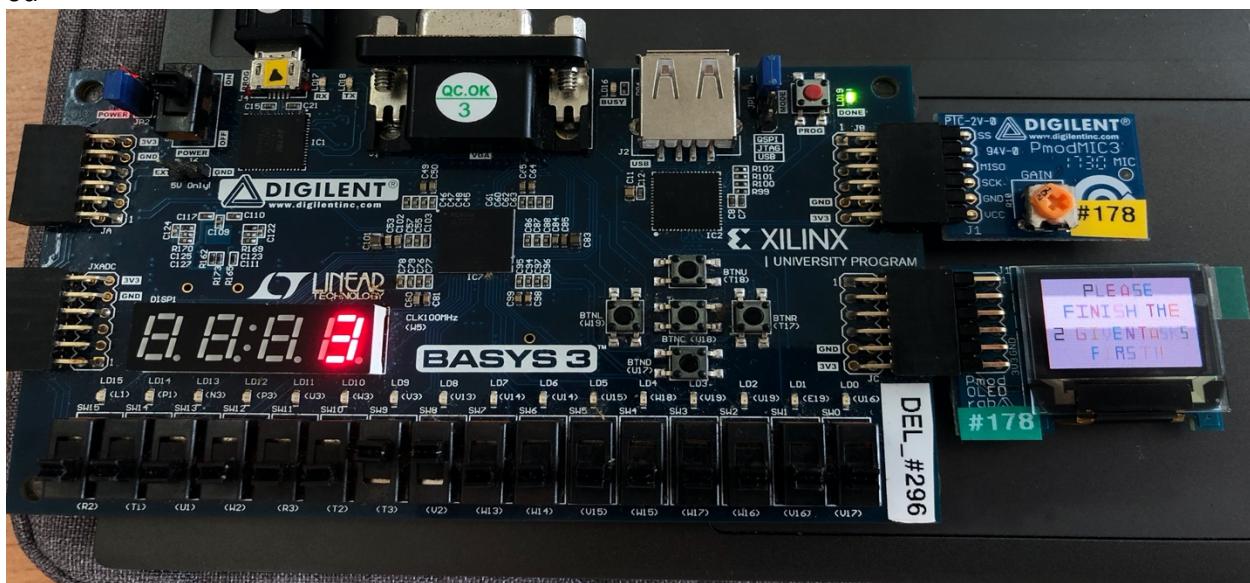
6b



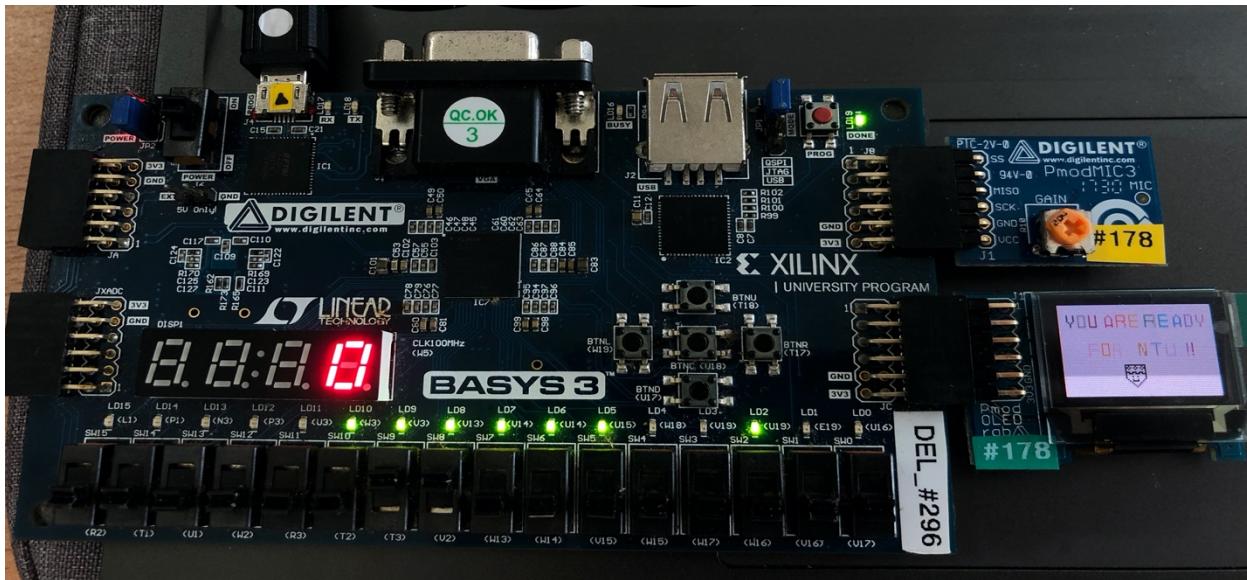
6c



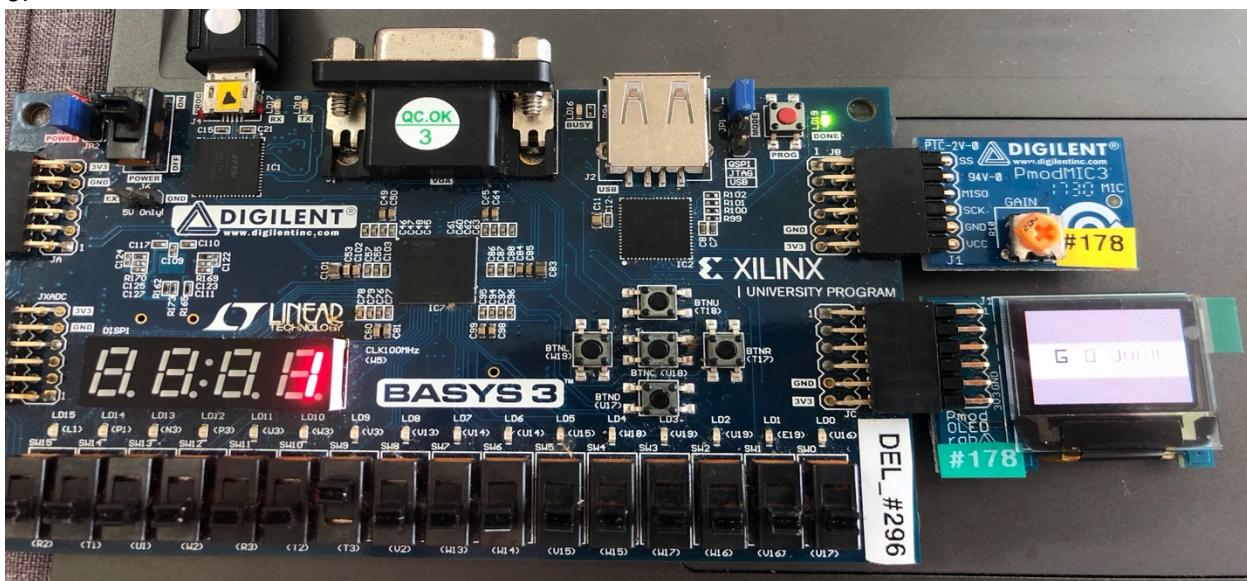
6d



6e

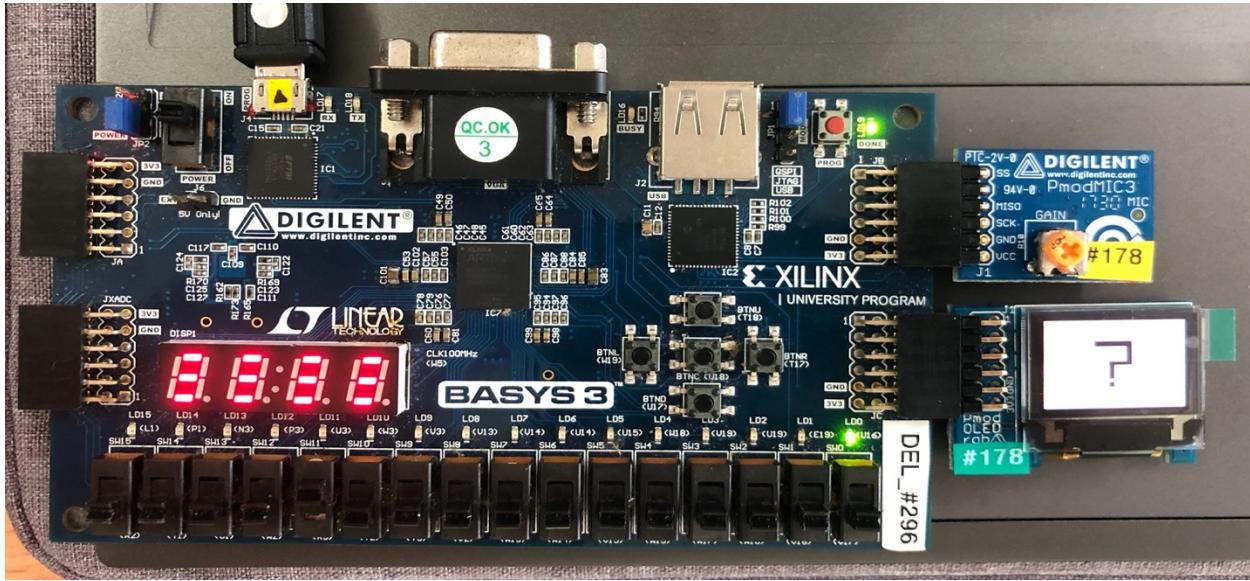


6f

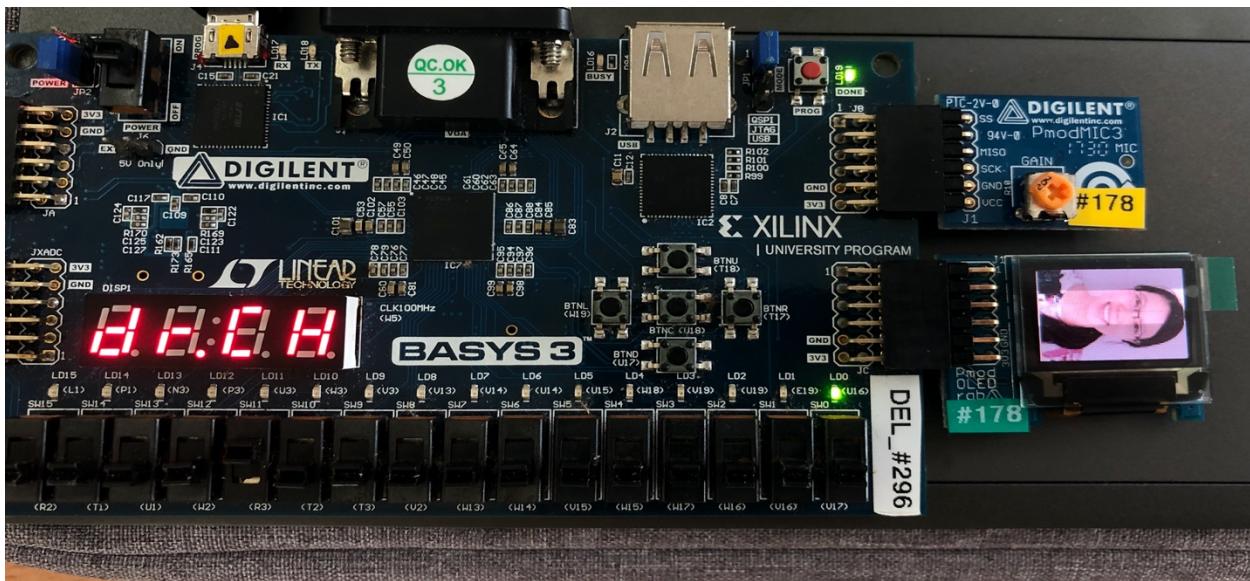


Improvement Feature 5: Dr Wong and Dr Chua's fans! (OLED Display of teachers, 7-segment displays of password and words)

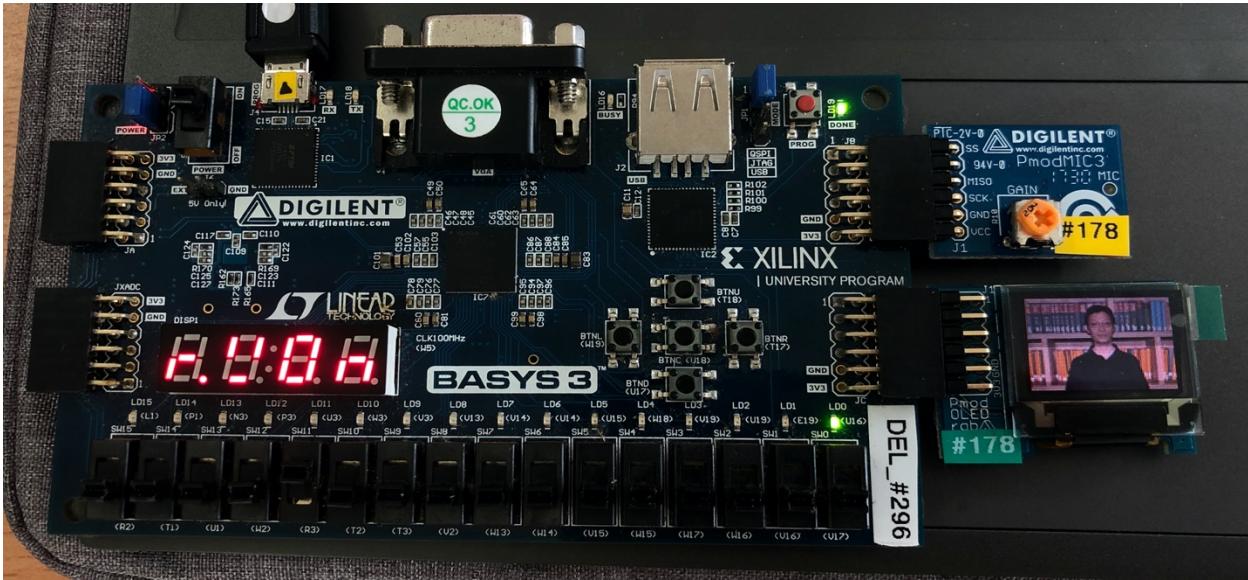
7a



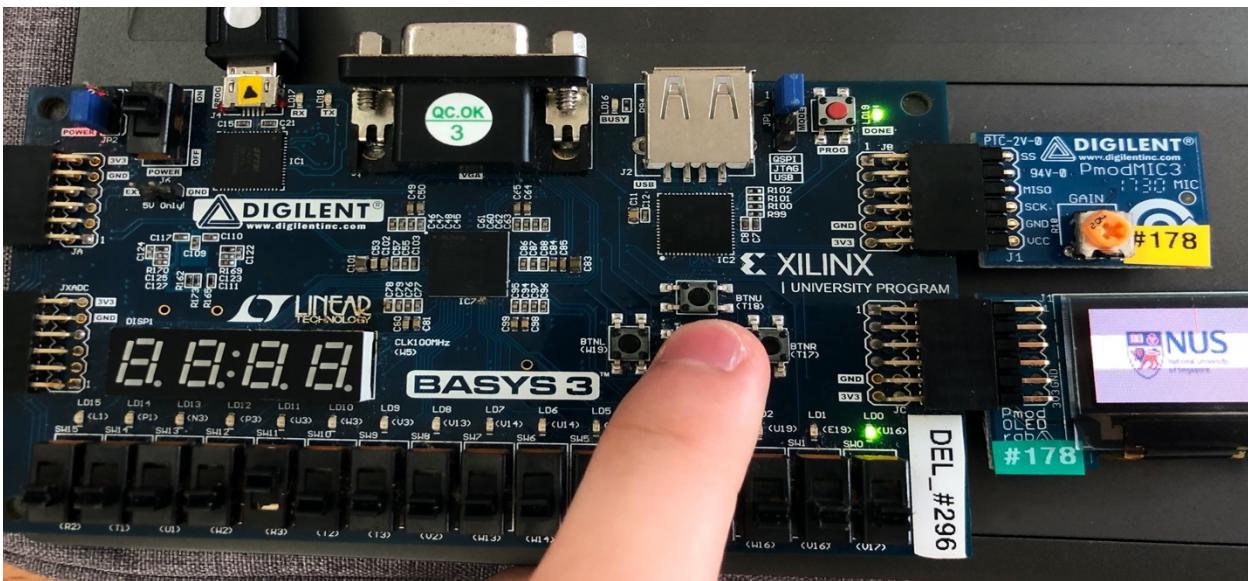
7b



7c



7d



Reference: None

Feedback: None