ASSISTIVE DIGITAL PIANO

ECE 445: SENIOR DESIGN
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Requirements and Verification Table

Module	Points
Power	6
Input	16
Control	13
Indicator	7
Software	6
Audio	2
Total	**50**

POWER MODULE: 6 PTS

COMPONENT	REQUIREMENTS	VERIFICATION	POINTS
AC to DC Converter	Power from 120V AC and output a 9 ±0.5V DC	A. Connect one end of the AC-DC adapter to a 120V AC source and the other end to a DC Jack mounted on a breadboard B. Attach the Voltmeter to the DC Jack output C. Voltmeter Reading: 9 ±0.5V	2
Voltage Regulator 1 (3.3V)	The voltage across the output terminal and ground must be 3.3 ±0.5 V for a current load up to 3.4 ±0.5 mA when connected to a DC supply of 12V.	A. Connect a voltmeter across the VCC pin of the the color sensor and ground. The Voltmeter reading (measured voltage) should be around 3.3 ±0.5 V. B. Connect a multimeter across the VCC pin of the the color sensor and ground. The Multimeter reading (measure current)should be around 3.4 ±0.5 mA	2
Voltage Regulator 2 (5V)	The voltage across the output terminal and ground must be 5 ±0.5 V when connected to a DC supply of 12V.	A. Connect a voltmeter across the VCC pin of the the Photointerrupters and ground.The measured voltage should be 5 ±0.5 V. .The Voltmeter reading (measured voltage) should be around 5 ±0.5 V. B. Connect a voltmeter across the anode and cathode pins of the the LED . The Voltmeter reading (measure voltage) should	2

		be around 5 ±0.5 V.	

INPUT MODULE: 16 pts

COMPONENT	REQUIREMENTS	VERIFICATION	POINTS
Color Sensor	Must be able to identify 10 distinct colors, in the visible range	A. Take ten samples of different colors each in the visible range B. Connect the color sensor to arduino board. (VCC-3.3V, GND-GND, SDL-SDL,SCL-SCL) C. ADD the color sensor library into /arduino/libraries D. Read RGB data through the library function E. The intensities of these RGB data should be different for all the 10 colors	4
	Must no be able to identify a color beyond the area of the key (14±2 mm X 92 ±2 mm)	A.Take a color sample(red paper) of dimension 14±2 mm X 92 ±2 mm . Place it on a different color sample (blue paper) of dimension greater than 14±2 mm X 92 ±2 mm B. Repeat B to D from above by placing the color sensor 10mm above the centre color strip (red paper) The color sensor reads red color and not the blue color	3
	Must be able to register color changes in atmost 146 ms.	A. Make a color wheel of 10 distinct colors and of radius 10cm. B. Spin the wheel such that colors are changing at 145ms form a point where the color sensor is placed. C. Repeat steps 1-B to 1-D D. The intensities of the RGB data should change	3
Photointerrupters	Top sensor must be able to detect key press when a key is pressed 3 mm from its resting position, measured from above the sensor.	A. Supply 5V and 1.8V DC power to the power inputs of the photointerrupter PCB. B. Connect a digital multimeter across the output pin 2 of the photointerrupter and GND. C. The multimeter must show 0±.3V if the key is pressed by more than 3mm. It should show 5V±3V if the key is pressed any shallower.	3

COMPONENT	REQUIREMENTS	VERIFICATION	POINTS
	Bottom sensor must be able to detect key press when a key is pressed 9mm from its resting position, measured from above the sensor.	A. Supply 5V and 1.8V DC power to the power inputs of the photointerrupter PCB. B. Connect a digital multimeter across the output pin 1 of the photointerrupter and GND. C. The multimeter must show 0V±.3V if the key is pressed by 9mm .It should show 5V±.3% if the key is pressed any shallower.	3

CONTROL MODULE: 13 PTS

COMPONENT	REQUIREMENTS	VERIFICATION	POINTS
I/O Expander	Processes I^2C to the I/O expanders at a rate of 1.7 Mbps.	A. Connect two of the pins to a I^2C bus that is connected to a 16 bit I/O expander. B. Write 8 bits of data to port A of the I/O expander set at a rate of 1.7 Mbps. C. Read 8 bits of data from port A of the I/O expander set at a rate of 1.7 Mbps. D. Verify that the data does not change from reading/writing.	3
Microcontroller	Outputs signals to correct LEDs with 100% accuracy.	A. Connect VCC pin of the microcontroller to 5 ±5% V. B. Set the output bits of the microcontroller to identify all keys of the piano, one at a time. C. Ensure that the correct LEDs turn on.	4

	Outputs correct color codes to LEDs with 100% accuracy.	A. Connect VCC pin of the microcontroller to 5 ±5% V. B. Set the output bits of the microcontroller to identify one of the piano keys. C. Send all possible color codes to the LED. C. Ensure that the LED lights up as expected.	3
	Must be able to correctly identify at least 10 keys pressed within 1 ms of each other.	A. Connect the microcontroller to a computer through the USB interface. B. Press any 10 keys at the same time. C. Echo key data to the computer and display that information on the screen. D. Ensure that 10 key presses have been identified and that they correspond to the respective keys pressed.	3

Indicator Module: 7 pts

COMPONENT	REQUIREMENTS	VERIFICATION	POINTS
Indicator Module (7 pts)	Must be able to produce 10 distinct colors matching the colors on the provided gloves such that the RGB values are within 50 degrees of each other (per RGB component).	A. Take photos of one of the LEDs, one photo for each of the ten colors. B. Using a computer, find the RGB values of the color produced. C. Compare each component individually.	4
	Must be able to respond to microcontroller's signal and change which keys are lit within 10 ±0.5 ms.	A. Store two colors in the indicator module pcb by mimicking the microcontroller's signals with an Arduino. B. Set the indicator module to the address of the first color stored. C. Use the Arduino to increment the address and time the delay between sending the address and the output of the circuit changing.	3

Software Module : 6 pts

COMPONENT	REQUIREMENTS	VERIFICATION	POINTS
Software Module	Must be able to send a set of “next keys and fingers” to the microcontroller.	A. Send keypress data to the microcontroller. B. Verify that the microcontroller is processing the next note correctly with a rate of 99% accuracy.	3
	Must be able to download key press data from the control module	A. Send a sequence of keypress inputs from the microcontroller to the software. B. Verify that the software detected at least 99% of the keypress inputs.	3

Audio Module: 2 pts

COMPONENT	REQUIREMENTS	VERIFICATION	POINTS
Audio Module	Must be able to convert the key press code into the corresponding waveform.	A. Connect the output of the audio controller to an oscilloscope and press all keys on the piano, one at a time. B. Ensure that the frequency of the waveform matches the key pressed.	1
	Must be able to produce sound at volumes between 65 and 95 dB. The sound should be clearly audible from a distance of 1m.	A. Connect the speaker to a computer and play a song. B. Check manually by hearing the song if it is in the audible range of human hearing from at least 1m away from the Piano.	1