Project conclusion & user manual

Looking at this project beeing an audio exercise, we have learned a lot by designing this gadget. The project idea was aimed big, looking at the time available. We could get the audio part working, which became overwhelming, meaning that the focus switched a bit. The distance sensor became a musical instrument, featured with a four state cube compained by a joystick and some buttons and switches for settings filled up with jazz inside, while the MIDI part and capacitive sensing are not handled by now. A connection to the ESP32 µC was priorized for network inclusion.

Joystick

The dual axes joystick offers quick changing of root note, osc2 offset and waveshapes. See current configuration table.

LED switches

In cube mode 1 oscilllator 1 and 2 can be switched on and off. The current state is indicated by a white LED. We used rugged metal switches to get some quality feel on the prototype. They are ready for an even more professional built version.

Buttons

The 3 multi-purpuse momentary buttons are used for settings and tests. The functions vary depending on cube and settings mode. See current configuration table.

4 state cube

Detects four orientations of a cube by using two KY-027 Magic Light Cup sensor modules. This helped us a lot for testing new functions since we always had two or three test modes available without touching working routines. The cube can be used musically as a note off command by turning to cube mode 2 or turning the device into a speaker tester by letting it run a frequency sweep in mode 0. The jazz theremin can be found on main mode 1. The modes are indicated as binary on the two module LEDs. See current configuration table.

Cube Modes

1: theremin plays many jazz scales
2: stop sound, play single notes on buttons [note off and test mode]
3: button 1: play notes sweep up | button 2: play frequency sweep down
4: [test mode]

Distance echo control

The HC-SR04 ultrasonic distance sensor module measures the distance to any reflecting solid object sending a 40 kHz trigger and waiting for the echo. The module sends the distance value via a pulse with varying width. On the rising edge of the pulse, a timer gets enabled. The timer value is read and reset on the falling edge interrupt of the echo pulse. The distance controls the pitch in jazz theremin mode. By default the increment is chromatically. If a scale is selected, only notes which are represented by that scale will sound.

Since we wanted to try out the idea of connecting to different µCs we skipped the MIDI part as fast UART responder and priorized a ESP32 connection for handling the display and possible further inputs via ESPNOW and webserver control. Combing stable, lossless MIDI and other fast UART connections while reading an interrupt based distance sensor is not achieved yet.

I2C OLED display

The 1.3 inch OLED display is connected to the ESP32 via I2C and makes use of the faster u8x8 library which is part of u8g2 by Oli Kraus (https://github.com/olikraus/u8g2). The OLED display is great for showing settings such as root note, scale names etc. but the downside with these I2C modules is always the speed. So we decided to outsource this task to the ESP32 for now. We had an 0.96 inch OLED running on the PsoC by using an adapted SSD1306 OLED driver by Derk Steggewentz (https://github.com/derkst/Cypress-PSOC-OLED) but it went slow and did not work well while using distance echo control.

Low Pass Filter

We added a simple passive 4 stage analog LPF for sound experiments since the output sounded quite harsh in many configurations.

Current configuration table

Cube Mode 0 [test sweeps]	
Button 1	chromatic notes up
Button 2	frequency sweep down
Button 3	
Switch 1	
Switch 2	
Joystick Switch	
Joystick Up	
Joystick Down	
Joystick Left	
Joystick Right	

Cube Mode 1 [jazz theremin]	**Settings Mode 1**	**Settings Mode 2**
Button 1	note delay cycling up	octaves cycling up
Button 2	scale group cycling up	scale group cycling up
Button 3	scale cycling up	scale cycling up
Switch 1	osc 1 on / off	osc 1 on / off
Switch 2	osc 2 on / off	osc 2 on / off
Joystick Switch	toggle settings mode	toggle settings mode
Joystick Up	osc 1 root note up	osc 2 offset up
Joystick Down	osc 1 root note down	osc 2 offset down
Joystick Left		
Joystick Right	cycle waveshapes osc 1	cycle waveshapes osc 1

Cube Mode 2 [wedding surprise] – starts playing if mode 2 is selected

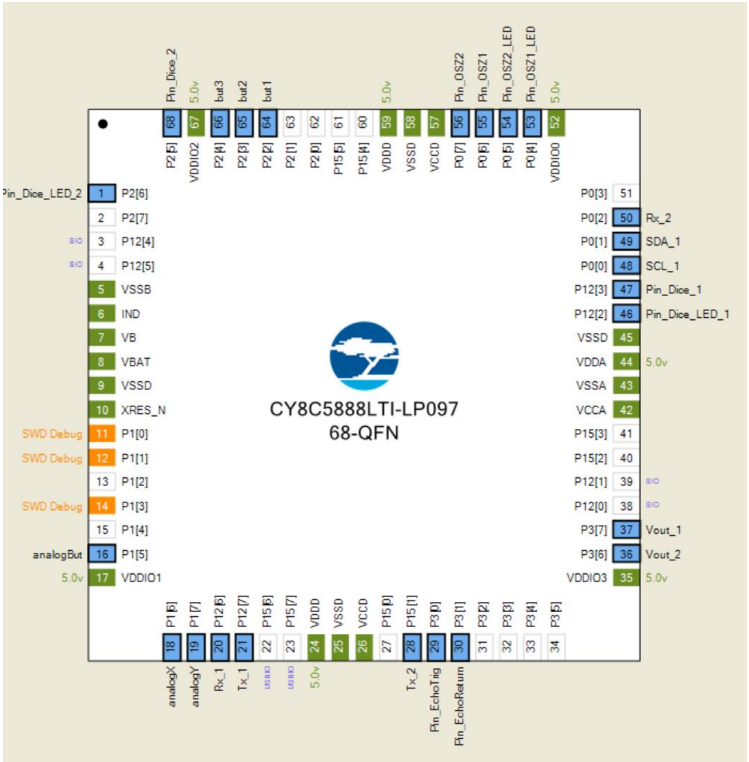
Cube Mode 3 [Note Test]	
Button 1, 2, 3	Play notes

Pinouts

Psoc Pinout

The PSoC is powered via USB leaving the KitProg unsnapped for now.

	analogBut	P1[5]	16	☑
	analogX	P1[6]	18	☑
	analogY	P1[7]	19	☑
	but1	P2[2]	64	☑
	but2	P2[3]	65	☑
	but3	P2[4]	66	☑
	Pin_Dice_1	P12[3]	47	☑
	Pin_Dice_2	P2[5]	68	☑
	Pin_Dice_LED_1	P12[2]	46	☑
	Pin_Dice_LED_2	P2[6]	1	☑
	Pin_EchoReturn	P3[1]	30	☑
	Pin_EchoTrig	P3[0]	29	☑
	Pin_OSZ1	P0[6]	55	☑
	Pin_OSZ1_LED	P0[4]	53	☑
	Pin_OSZ2	P0[7]	56	☑
	Pin_OSZ2_LED	P0[5]	54	☑
	Rx_1	P12[6]	20	☑
	Rx_2	P0[2]	50	☑
	SCL_1	P0[0]	48	☑
	SDA_1	P0[1]	49	☑
	Tx_1	P12[7]	21	☑
	Tx_2	P15[1]	28	☑
	Vout_1	P3[7]	37	☑
	Vout_2	P3[6]	36	☑



ESP32 Pinout

The ESP is powered using the PSoC's 5V on the VIN pin. For debug and programming purposes it can also be powered via USB.

VIN	Voltage Shifter VB [5V]
GND	Common Ground
3V3	Voltage Shifter VA [3.3V]
RX2 [16]	Voltage Shifter A1
TX2 [17]	Voltage Shifter A2
D22	Display SCL
D21	Display SDA

Part Info & Datasheets

HC-SR04 Ultrasonic Distance Sensor

https://cdn.sparkfun.com/datasheets/Sensors/Proximity/HCSR04.pdf

1.3 inch OLED I2C 128 x 64 Pixel Display

https://cdn.shopify.com/s/files/1/1509/1638/files/1_3_Zoll_Display_Datenblatt_AZ-Delivery_Vertriebs_GmbH_rev.pdf?v=1606164520

Steel Push Buttons 0.63 inch flat LED Ring White

https://www.led-taster.de/mediafiles/Sonstiges/Datenblatt/16/P16-RF-X.pdf

B3F-1 Tactile Button Switches

https://cdn-shop.adafruit.com/datasheets/B3F-1000-Omron.pdf

KY-023 Dual Axis Joystick Module

https://arduinomodules.info/ky-023-joystick-dual-axis-module/

8 Ohm Speaker

https://components101.com/sites/default/files/component_datasheet/8%20ohm%20speaker.pdf

KY-027 Magic Light Cup Module

https://arduinomodules.info/ky-027-magic-light-cup-module/

TXB0108 Bidirectional Voltage Shifter

https://www.adafruit.com/product/395#technical-details

https://cdn-shop.adafruit.com/datasheets/txb0108.pdf

ESP32 DevKit C

https://www.espressif.com/en/support/download/documents/development-board