

Sensors & Touchdesigner

by Axel Mulder

- Intro: capturing human motion
- Overview of I-CubeX
- Connecting ioCube for TD
- Processing sensor signals
- Going wireless
- Controlling motors and more

<http://icubex.com/tds.pdf>

Schedule

- 👁 10:00 Intro + Overview
- 👁 10:20 Gear Check-in
- 👁 10:30 ioCube
- 👁 11:00 Break
- 👁 11:15 Sensor Examples
- 👁 12:15 Break
- 👁 12:30 Actuator Demos
- 👁 12:45 BLE/WIFI Demos
- 👁 13:00 Gear Check-out
- 👁 13:30 The End

[I-CubeX_TDS19.zip](#)

Detect, measure

- ① Presence or motion of a human
- ① Proximity of a human or hand
- ① 2D or 3D position of a finger, hand or human
- ① Hand or body posture
- ① Force applied by finger, hand or foot
- ① Facial features or expression
- ① Eye or gaze direction
- ① Heartbeat and body temperature

Motion capture tech

- Optical: Vicon, Optitrack, Motion Analysis, Qualisys, BTS, Kinect, iPiSoft, Blacktrax, Vyv, ...
- Inertial: Xsens, Polhemus, Ascension, Noitom, Nansense, Shadow, Notch, Chordata, ...
- Hand: Cyberglove, Avatar, Hi5, Senso, Leapmotion, 5DT, ...
- Eye: Tobii, ...

see also Axel G.E. Mulder (1994). Human Movement Tracking Technology.

Input devices

- Computer: keyboard, mouse, joystick, track ball, touchscreen, microphone, camera, ...
- Game: Pad, Kinect, Leapmotion, Wii, ...
- Music: keyboards, wind controllers (EWI), control panels (Roli, Push, Launchpad), foot pedals, ...

See also <https://www.billbuxton.com/InputSources.html>

Sensor technologies

- Piezo-resistance (FSR, strain gauge)
- Piezo-electricity (force, vibration)
- Pyro-electricity (PIR)
- Ultrasound and RF TOF (radar)
- Capacitive coupling (touch)
- Hall effect (magnetic field strength)
- Electro-optical (camera, LED)
- Bio-potentials (EMG, EEG, EOG)



An I/O toolkit for developing
interactive media applications

<http://ICubeX.com>

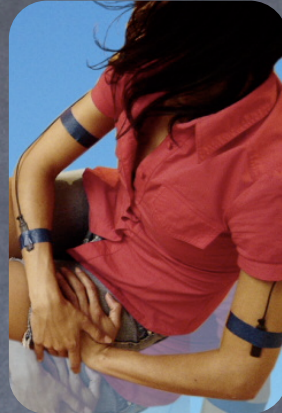
I-CubeX use cases

- Trigger sound/visual in sync with physical action on stage (TouchMini, <http://icubex.com/theatre>)
- Sync rotation of CG model with physical object in interactive retail experience (Orient4D)
- Create a basic control panel for QLab (TouchMiniOn)
- Use heart beat to control tempo in musical performance (BioBeat)
- Detect hand position in laserbeam to trigger sound (ReachFar, <https://youtu.be/BmWxUkhyedc?t=26>)
- Trigger sound upon tap on the chest (Bang, <https://www.youtube.com/watch?v=BmWxUkhyedc>)
- Add control for sound effects on a trumpet (Push3D, <https://www.youtube.com/watch?v=umBVBu6nFbI>)

I-CubeX applications



Music



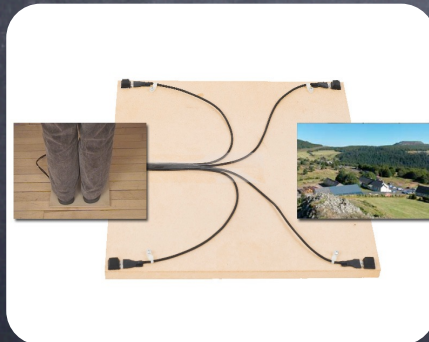
Dance



Installation Art



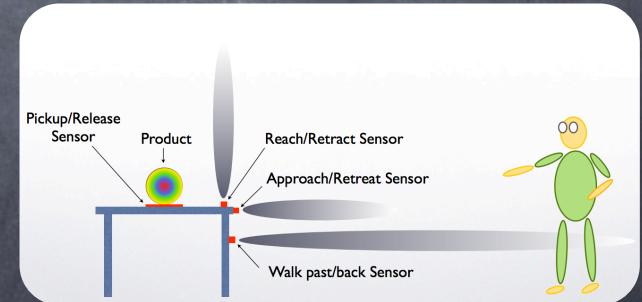
Exhibit Design



Game Dev

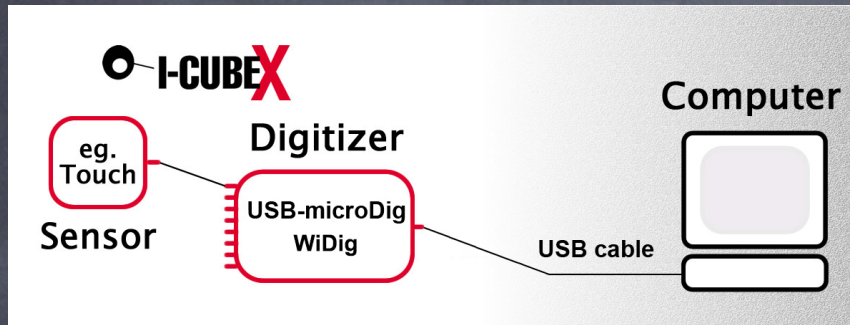


Biomechanics



Behaviour Research

I-CubeX basics



Mode of operation

- Host mode: raw
- Standalone mode: processed & mapped

<http://icubex.com/about>

Interfaces

- WiDig: USB & WiFi or BLE, 8 i/o ports



- USB-microDig: USB, 8 i/o ports



- PiShield: for Raspberry-Pi, 8 + 4 ports



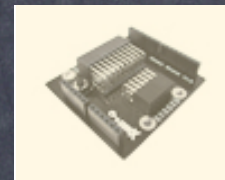
- Wi-microDig: Bluetooth, 8 inputs



- Digitizer: MIDI, 32 12bit inputs

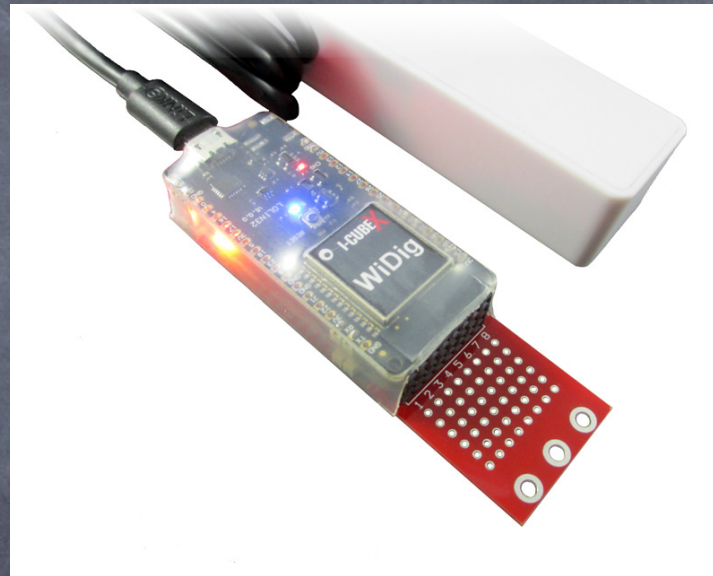


- ArduinoShield: for Arduino



WiDig

Wireless & USB sensor interface



8 input/output ports: 10bit ADC, I²C, TTL, 5760 Hz sample rate (max)

USB serial (MIDI), BLE (MIDI), WiFi (OSC/HTTP/WS)

WiDig Firmware v8.1

- Sensors -

- Digital (I²C) sensor support: Air2D, AngleD, BioBeat3D, BioAirD, HotSpot2D, Light2D, Magnetic3D, Orient4D, ReachCloseD, ReachFarD, ReachID, ReachOnD, Swipe3D, ..
- Analog sensor signal processing: lookup tables, rectifying, smoothing, threshold/peak detection, peak-peak time/frequency measurement, ..

WiDig Firmware v8.1

- Actuators -

- Digital (I2C) actuator support: FeelVibe, SeeRGB
- PWM output: servo/motor control, dimming of LEDs, ...
- Binary (TTL) output: turn actuators on/off
- Map (multiple) sensor input(s) to an actuator output

Application software

Software used in conjunction with I-CubeX:

• Max, Pd

• Unity

• TouchDesigner

• Resolume

• QLab

• Ableton Live

• Matlab

• Garageband

Software plugins

- Touchdesigner node: ioCube (MacOS/Windows)
- Max external: iCube, oCube (MacOS/Windows/Linux), digitizer (MacOS, Windows)
- openFrameworks ofxICubeX addon (MacOS/Windows/Linux)
- C/C++ API (MacOS/Windows/Linux)
- Processing interface (MacOS/Windows/Linux)
- Ableton Live plugin: Dig4Live (MacOS/Windows)
- EyesWeb plugin (Windows)

iCube/oCube

I-CubeX plugins for Max

Get started with iCube ! v4.0 © 2018 Infusion Systems Ltd.

The screenshot shows the iCube patch with the following callouts:

- Select both of the digitizer's MIDI ports.
- Retrieve the digitizer's configuration.
- Display what iCube knows about the currently connected digitizer.
- Turn on or off sensor input 1.
- Set which messages are displayed in the Max window.
- More help is on the web.
- Sensor data is output in physical units (Volt for analog sensors) in host or standalone mode.
- In edit mode, option-click the iCube object to open its help patch.
- Enable the print object patchcord on it and see even more iCube messages.

For the iCube object and its help patch to work they must be in the Max search path, which you can edit in the File Preferences under the Max Options menu.

iCube

Max object for I-CubeX digitizer configuration and sensor data processing

Get started with oCube !

The screenshot shows the oCube patch with the following callouts:

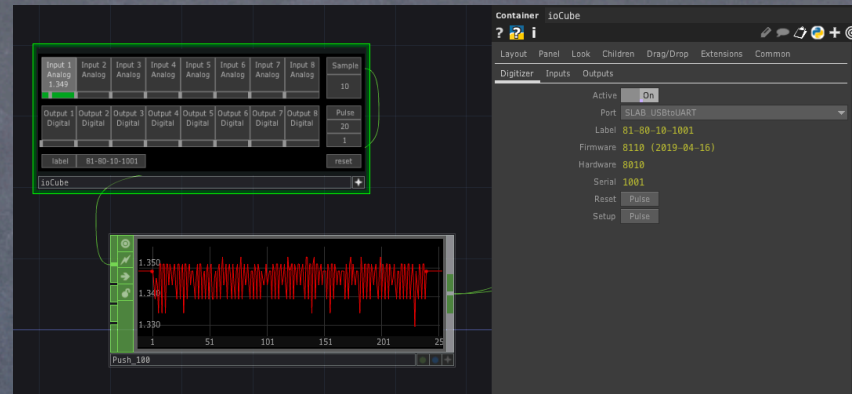
- Select both of the digitizer's MIDI ports.
- Retrieve the digitizer's configuration.
- Display what oCube knows about the currently connected digitizer and set which messages are displayed in the Max window.
- Pulse Width Modulated actuators: Set the digitizer's repeating pulse interval and maximum width. Switch between servo and general purpose repeating pulse presets.
- Number Input: When repeating pulse (RP) output is off, 0 or 1 turns the actuator on or off. Any number greater than 1 sets the duration of a single pulse. When RP is on, any number (0..127) sets the pulse width.
- Turn on or off and set width of repeating pulse of output 1.
- Set which actuator is connected to output 1.
- Emulated actuator level (digital binary or PWM actuators) or status (I2C actuators). The timing is not accurately displayed below approx. 50 ms.
- In patch edit mode, option-click the oCube object to open its help patch.
- Enable the print object patchcord by right-clicking on it (in patch edit mode) and see even more oCube messages.
- The digitizer's MIDI ports can also be selected by double-clicking on the midlin and midout objects.

For the oCube object and its help patch to work they must be in the Max search path, which you can edit in the File Preferences under the Max Options menu.

oCube

Max object for I-CubeX digitizer configuration and actuator output control

USB-microDig & ioCube



- Connect via USB serial port
- View status and data in the node
- Configure inputs for analog or digital I2C sensors
- Configure outputs for binary or digital I2C actuators

icube.toe

Sensors

- Contactforce, Buttons
- Knobs, Sliders
- Distance, Position
- Acceleration, Orientation
- Biometric
- Environment

<http://icubex.com/sensors>

MoveOn

Motion sensor



Outputs a short pulse when any movement of humans and warm-blooded animals is detected.

<http://icubex.com/moveon>

Orient4D

Orientation sensor



Use Wearability straps
to mount on body.

Orientation in quaternions or Euler
angles; acceleration, angular velocity,
magnetic field strength, temperature

<http://icubex.com/orient4d>

<http://icubex.com/wearability>

MoveOn signal processing



Process the MoveOn output to get a measure of human activity in a room.



MoveOn v1.4
Invert and
Smooth

[ioCube_example1_](#)
[MoveOn-14.toe](#)



MoveOn v1.8
Offset, Rectify
and Smooth

[ioCube_example2_](#)
[MoveOn-18.toe](#)

BioBeat signal processing



Use limit, count and peak detection for the BioBeat output to calculate the heartbeat rate

<http://icubex.com/biobeat>



ioCube_example3_
BioBeat-21.toe

Slide signal processing



Apply peak detection to the Slide output to hold the last touched value



Use a CHOP execute DAT to create an infinite slider

<http://icubex.com/slide050>

[ioCube_example4_Slide050-10.toe](http://icubex.com/ioCube_example4_Slide050-10.toe)

[ioCube_example5_Slide050-10.toe](http://icubex.com/ioCube_example5_Slide050-10.toe)

Actuator Control



Control motors, servos, LEDs, haptics and more.

[ioCube_example6_SwitchPower-10.to](#)

[ioCube_example7_SeeRGB-10.toe](#)

[ioCube_example8_SeeGreen-21.toe](#)

[ioCube_example9_Servo.toe](#)

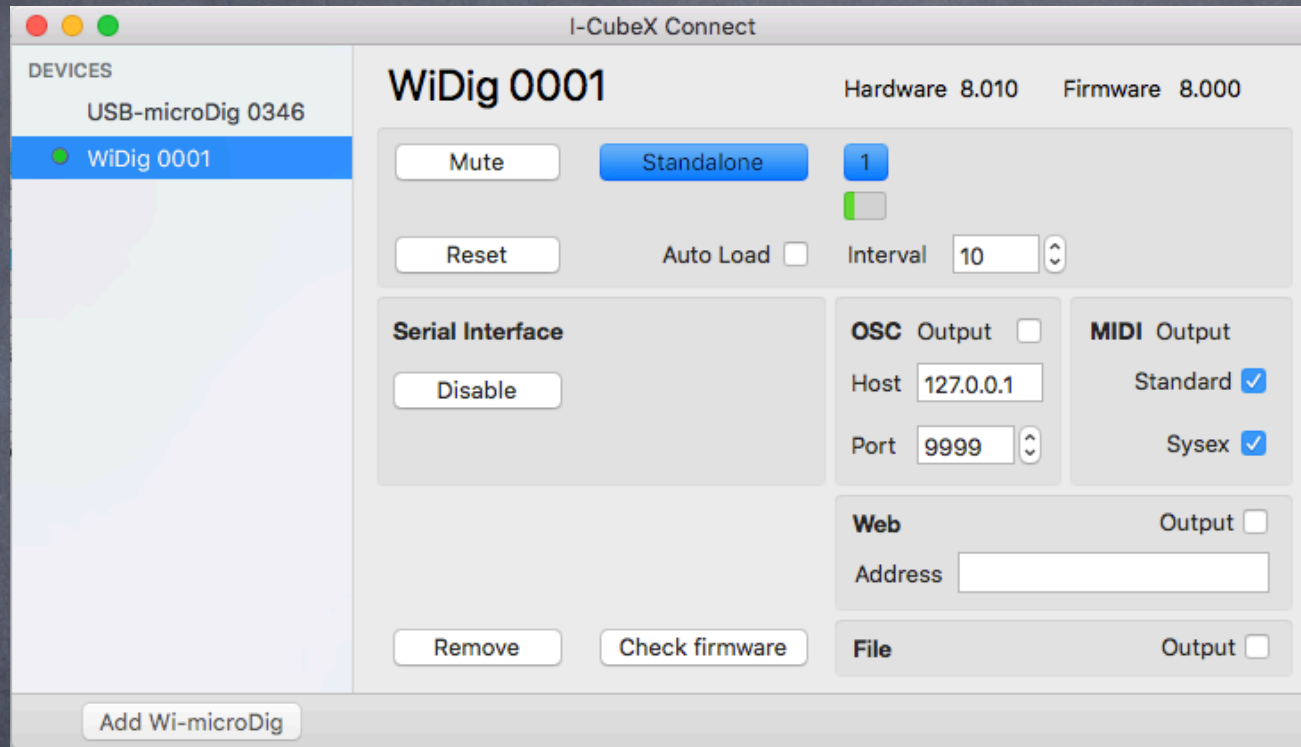
e

Software Apps

- Connect, WiConnect
- EditorX
- Link
- SensePlay
- SensorX, BioBeat3D, BioEmo, MuscleTrainer, GForce3D-6, Orient4D, Air2D, Light2D, PitchColor, TouchGloves, HotSpot2D, ..

see also <http://icubex.com/download>

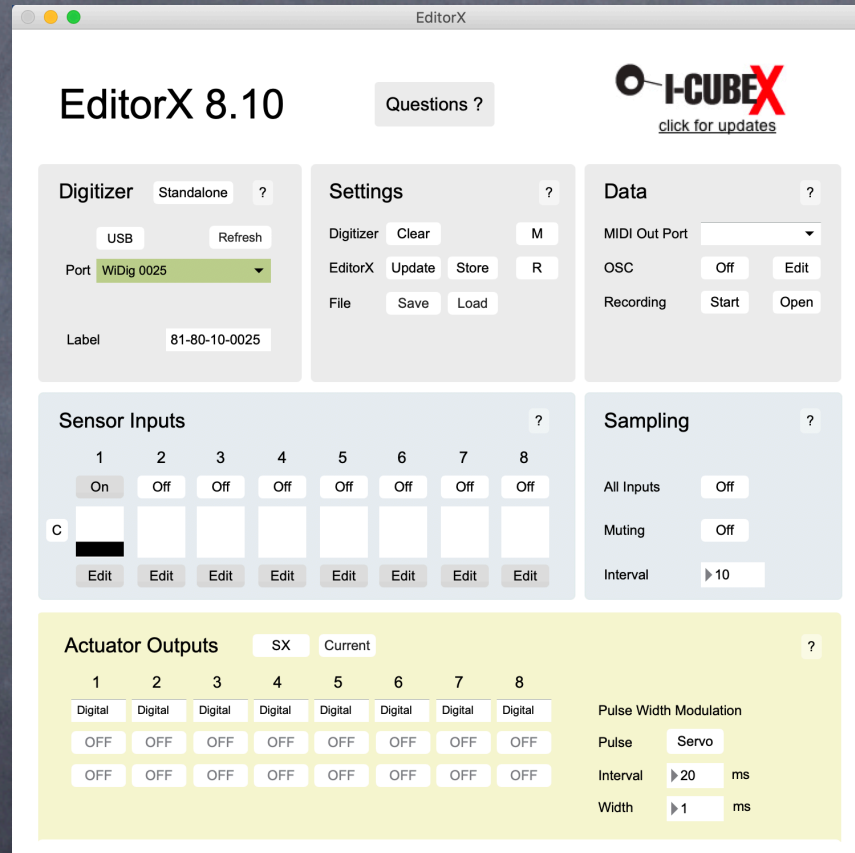
Connect



Serial to virtual MIDI / OSC / Webhook / file converter

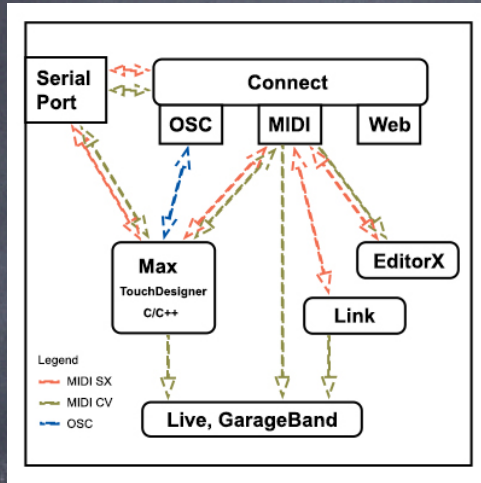
<http://icubex.com/connect>

EditorX Standalone mode editor

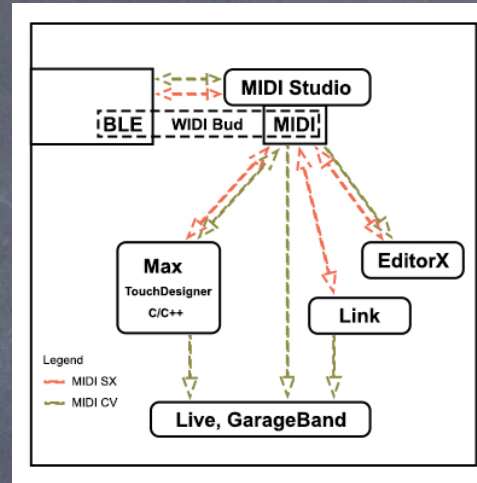


<http://icubex.com/editorx>

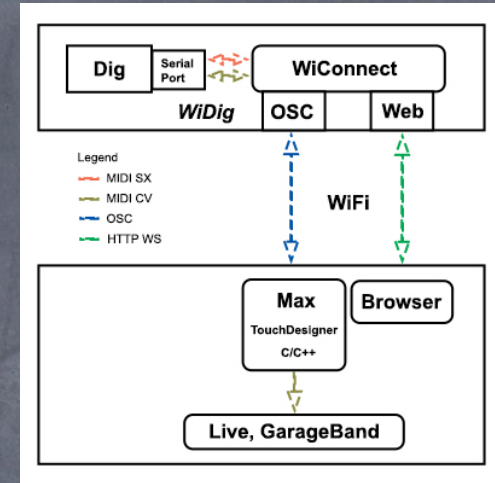
USB, (BLE) MIDI, (WiFi) OSC



Connect: MIDI
via USB serial
and as OSC



WiDig: MIDI
via BLE



WiDig: OSC
via WiFi

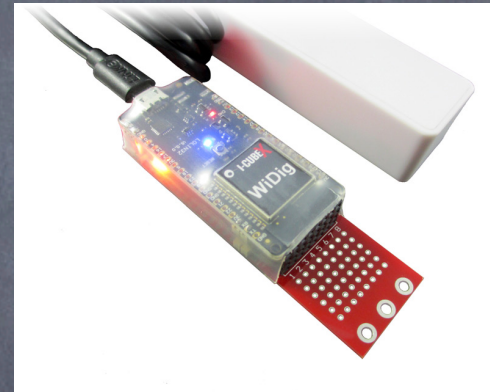
<http://icubex.com/about>

http://www.nime.org/proceedings/2019/nime2019_006.pdf

Wireless orientation sensing



Orient4D



WiDig

Via BLE-MIDI

The image shows a Pure Data patch and its MIDI Mapper interface. The patch includes objects for moviefilein1, displace1, chopto1, noise1, midiinmap1, select1, math1, angle1, and null1. The MIDI Mapper interface shows device mappings for a Bluetooth device and a MIDI console log.

MIDI Mapper - Device Mappings

ID	In Device	Out Device	MIDI Map	Ch
1.0	WD001 Bluetooth	none	User Device Map	2.0

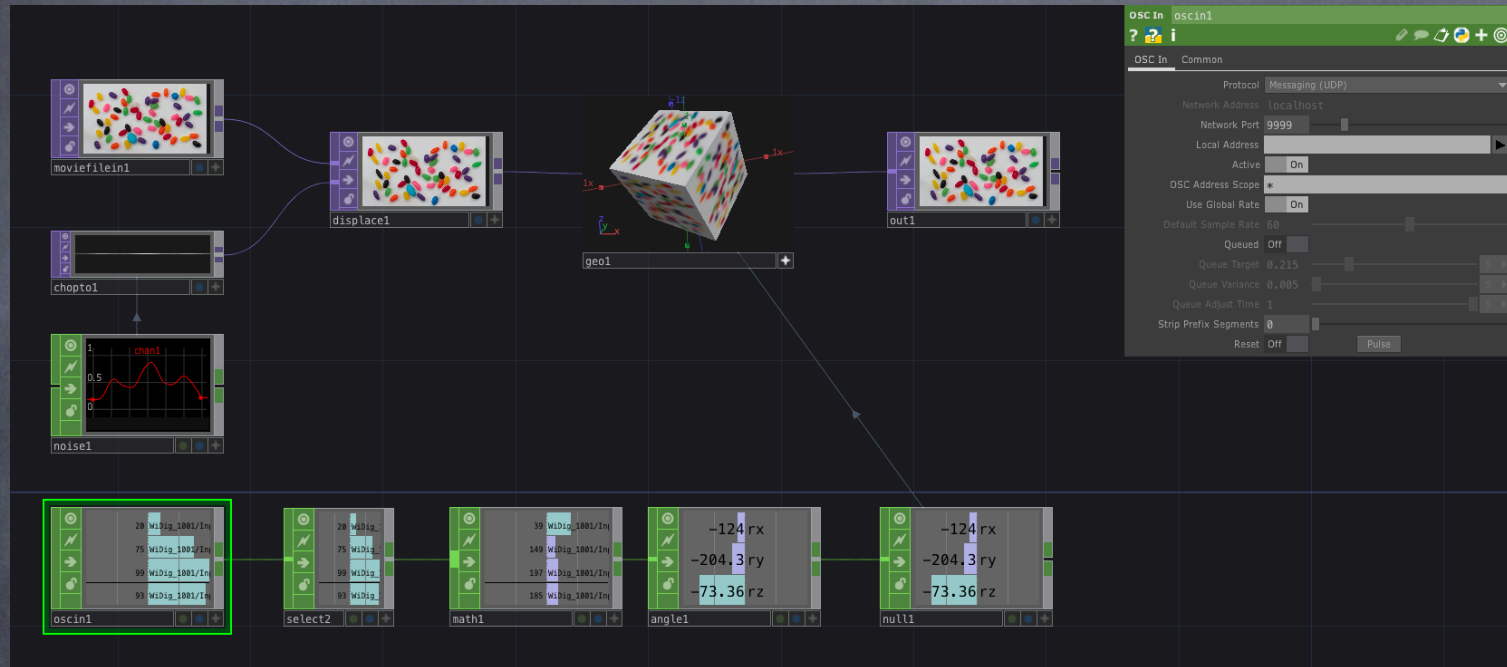
MIDI Console

ID	Type	Channel	Index	Value	Message
1	Control	1	4	73	b0 03 49
1	Control	1	3	121	b0 02 79
1	Control	1	2	89	b0 01 59
1	Control	1	1	55	b0 00 37
1	Control	1	4	73	b0 03 49
1	Control	1	3	121	b0 02 79
1	Control	1	2	89	b0 01 59
1	Control	1	1	55	b0 00 37
1	Control	1	4	73	b0 03 49
1	Control	1	3	121	b0 02 79
1	Control	1	2	89	b0 01 59
1	Control	1	1	55	b0 00 37

[WiDig_and_TouchDesigner_via_BLE-MIDI.toe](#)

<https://youtu.be/wGgp3Lzivgk>

Via OSC




see also [WiDig_and_TouchDesigner_via_OSC.toe](#)

see also <https://youtu.be/Z8JV8hqJNcA>

WiConnect

WiDig 0025



Range ms
Update Interval ms

Sensors

Raw Mute

Interval ms

Input 1	<input type="text" value="Orient4D"/>	<input type="text" value="0"/>	<input checked="" type="checkbox"/>	0.71, -0.28, 0.39, 0.51
Input 2	<input type="text" value="Analog"/>	<input type="text"/>	<input type="checkbox"/>	
Input 3	<input type="text" value="Analog"/>	<input type="text"/>	<input type="checkbox"/>	
Input 4	<input type="text" value="Analog"/>	<input type="text"/>	<input type="checkbox"/>	
Input 5	<input type="text" value="Analog"/>	<input type="text"/>	<input type="checkbox"/>	
Input 6	<input type="text" value="Analog"/>	<input type="text"/>	<input type="checkbox"/>	
Input 7	<input type="text" value="Analog"/>	<input type="text"/>	<input type="checkbox"/>	
Input 8	<input type="text" value="Analog"/>	<input type="text"/>	<input type="checkbox"/>	

OSC output

Address
Port
Status

Version 8.0 / 8.110 (20190317) / 1.914 (20190325)

Input 1 : Orient4D

— Qw — Qx — Qy — Qz

Web app for configuring a WiDig and viewing / saving data