Real-Time Sensing and Artificial Intelligence for Live Performative Arts

Live Performers Meeting, March 2024, M'Hamid El Ghizlane, Morocco. March 7, 2024

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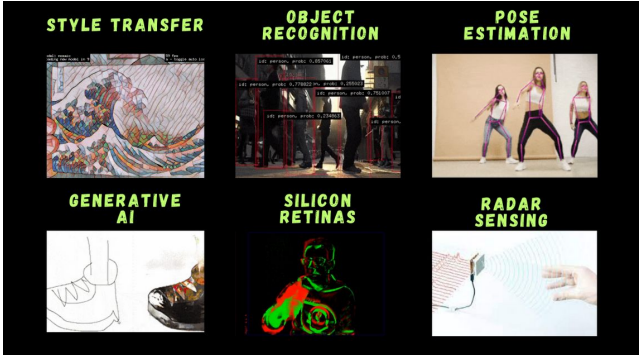
Real-Time Sensing and Artificial Intelligence for Live Performative Arts

Date	Lectures	Notes
Session 1	Creative coding, OpenFrameworks, the basic of programming, interactivity.	OFX docs, slides, code examples
Session 2	OpenFrameworks, creating add-ons in OFX, and sensors.	OFX docs, slides, OFX addons
Session 3	Neural networks basics, working with data, neural networks in OFX.	OFX docs, slides, code examples
Session 4	Using Neural Networks for data analysis, interpretation, and augmentation.	NN models, slides, OFX addons



Outline

Session 1 Recap

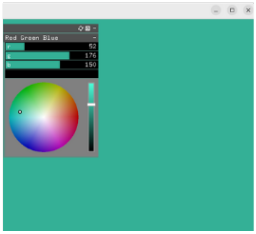
OFX Addons

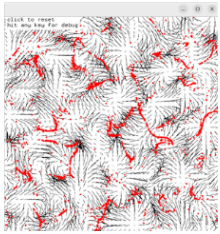
Sensors and Interfaces
- Kinect Xbox Sensor
- Event-Based Camera
- MIDI

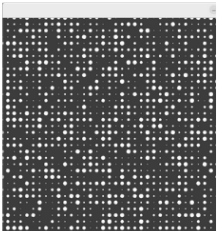
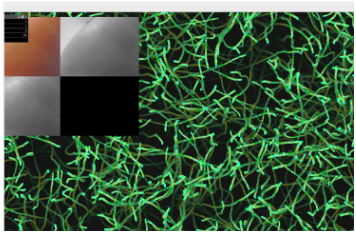
Recap from last time

Main topics

- OpenFrameworks (project, folder, compilation, IDE setup)
- The basic of programming:
  - Shapes and colors, variables, functions, conditions, animate shapes, loops, arrays, vectors, c++ classes
- Particle system
- Computer vision and interactivity





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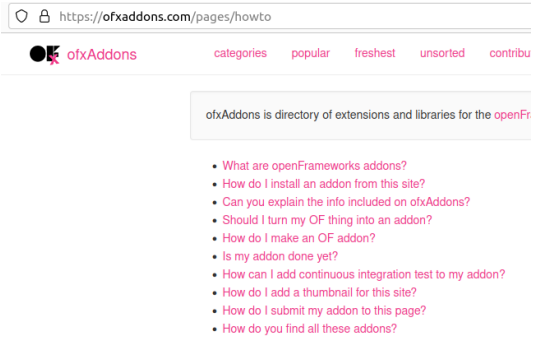
Openframeworks add-ons

Add-on

An addon is code that extends openFrameworks in some way. There are usually two main reasons to make an addon:

- Bring in an external C/C++ library or piece of code to OFX (e.g. OpenCV)
- Bring in sensors (e.g. ofxKinect for using the kinect in openFrameworks, or ofxMidi for sending midi commands)

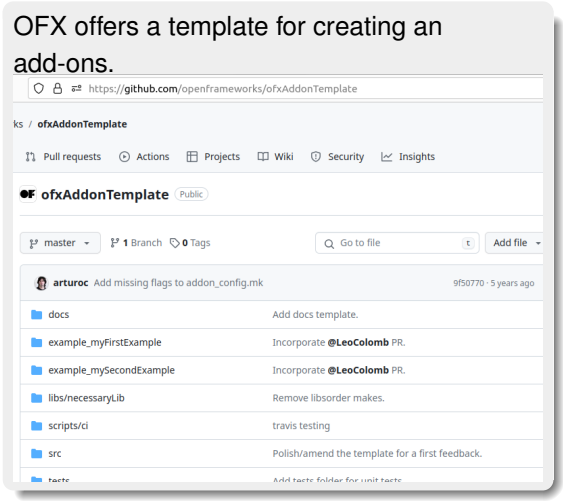
OFX design style makes it easy to customize the frameworks to your own needs. Currently there are more than 2000 add-ons.



https://ofxaddons.com/categories

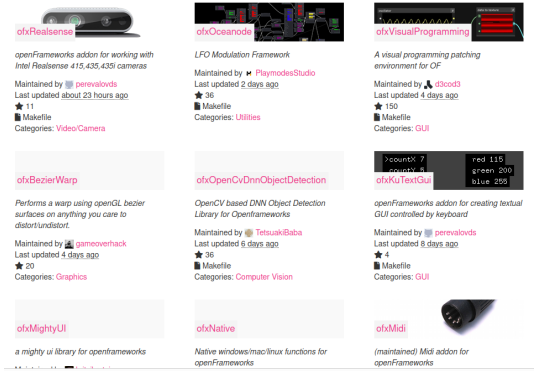
Openframeworks add-on template

OFX offers a template for creating an add-ons.



https://github.com/openframeworks/ofxAddonTemplate

Page visited on Jan. 20 2024



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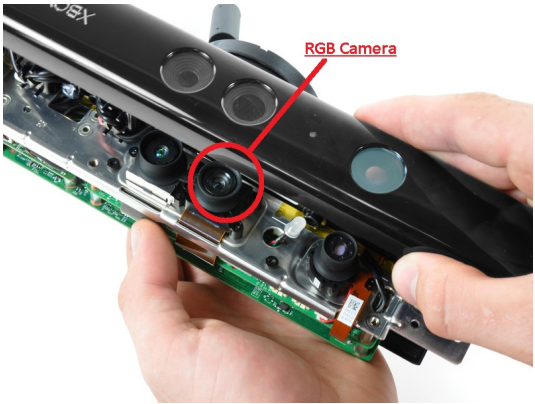
Kinect Sensor

Kinect teardown

Kinect Specs

Kinect Sensor

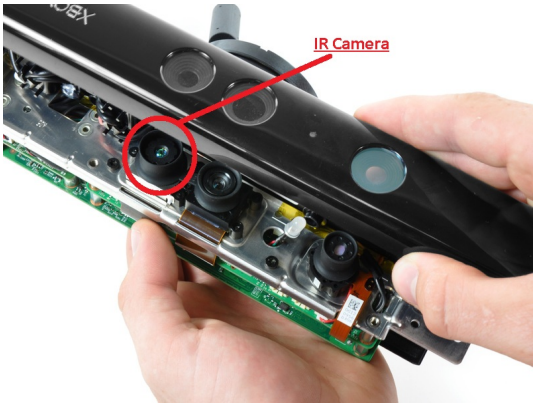


Kinect teardown

Kinect Specs

- Colour VGA Motion Camera: 640x480 pixel resolution @30FPS.

Kinect Sensor

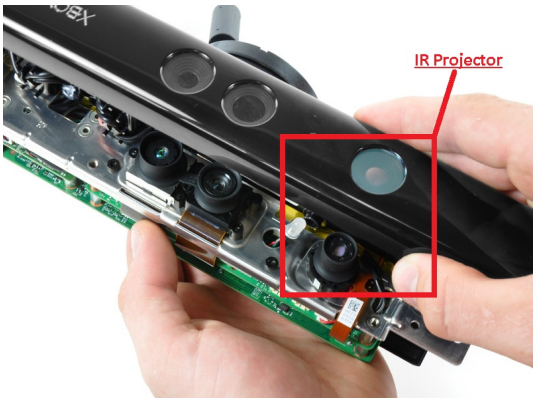


Kinect teardown

Kinect Specs

- Colour VGA Motion Camera: 640x480 pixel resolution @30FPS.
- Depth Camera: 640x480 pixel resolution @30FPS (resolution: 1.5 cm to 5 cm).

Kinect Sensor



Kinect teardown

Kinect Specs

- Colour VGA Motion Camera: 640x480 pixel resolution @30FPS.
- Depth Camera: 640x480 pixel resolution @30FPS (resolution: 1.5 cm to 5 cm).
- Range distance between 1.2 and 3.5 meters
- Horizontal field of view is 57deg wide, max range can scan a scene 3.8 meters wide (resolution: 0.75 mm to 3 mm per pixel).

Kinect Sensor

Kinect teardown

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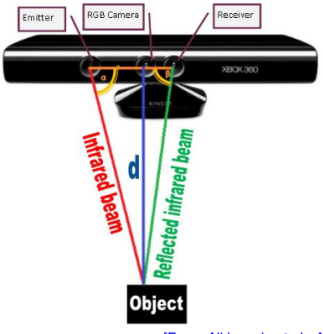
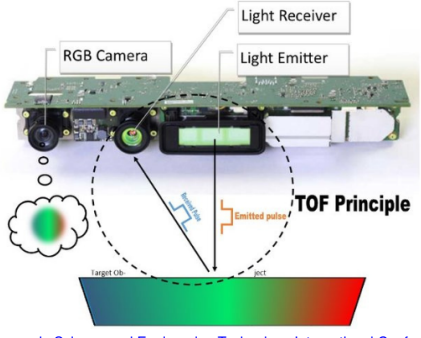
- Array of four microphones.
- Total Power 2.25W

Kinect Xbox Sensor

How does it work?

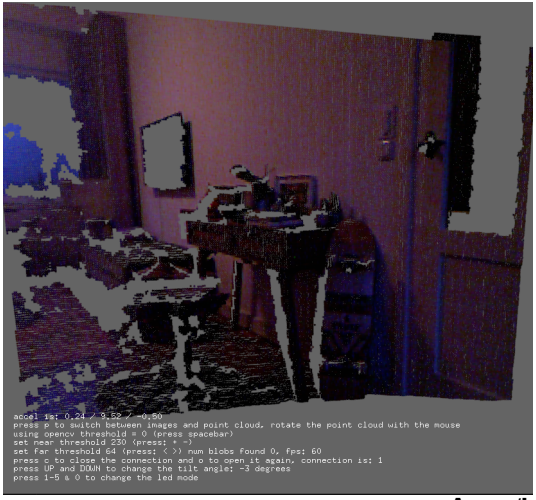
The Kinect uses an infrared projector and camera to create a 3D depth map by detecting how emitted infrared light is distorted by objects. It also includes a standard RGB camera for visual imaging and facial recognition.

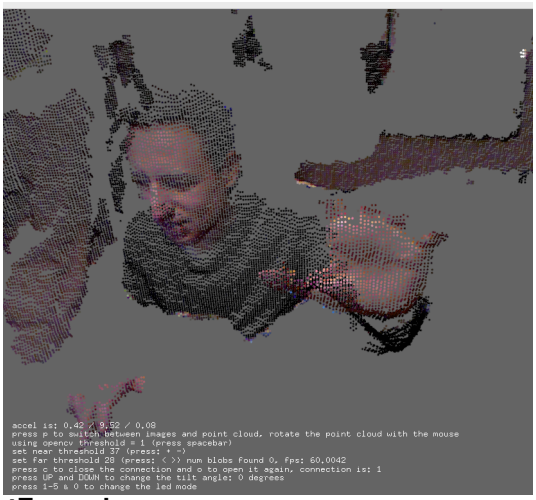




[Fares Alkhawaja et al., Advances in Science and Engineering Technology International Conferences (ASET), 2019]

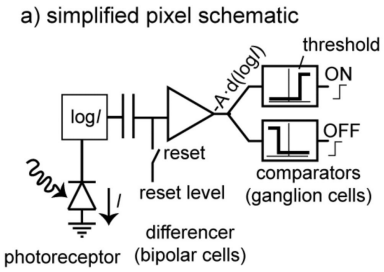
Kinect in OpenFrameworks

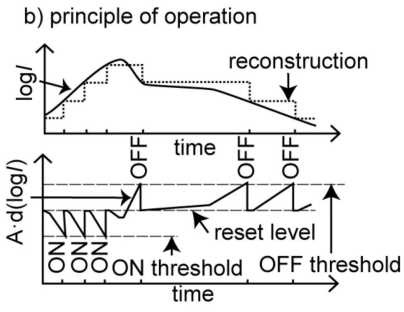




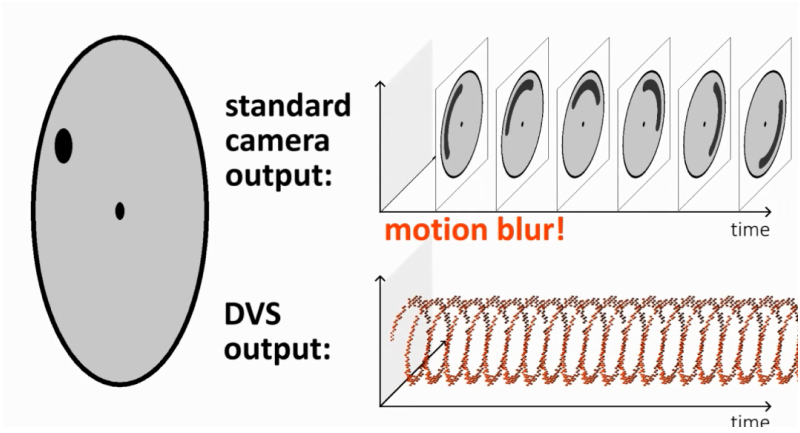
myApps/kinectExample

Silicon Retina or Event Cameras or Dynamic Vision Sensors





Silicon Retina vs. Frame Camera

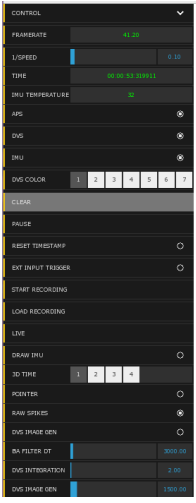


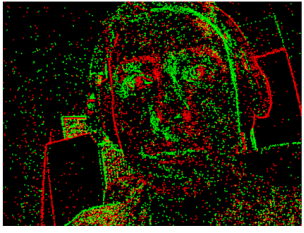
[Video Event-Based Camera]

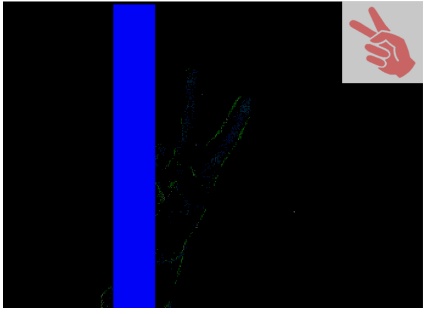
Silicon Retina

- Sparse quick, output [Video Youtube 1]
- High-speed resolution [Video Youtube 2]
- Surveillance applications [Youtube Video 3]
- Robo Goalie [Youtube Video 4]
- Example applications [Video Youtube 5]

Silicon Retina in Open Frameworks



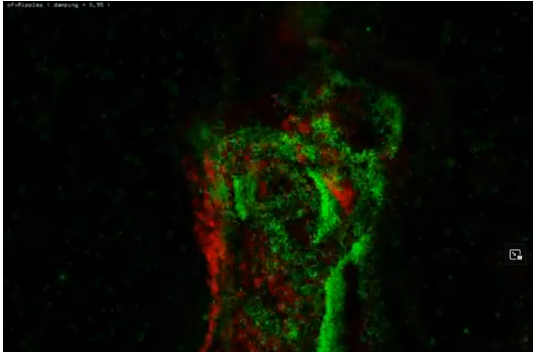




- ofxSiliconRetina
- Add-on with examples

addons/ofxDVS

Silicon Retina: Intensity & Colors



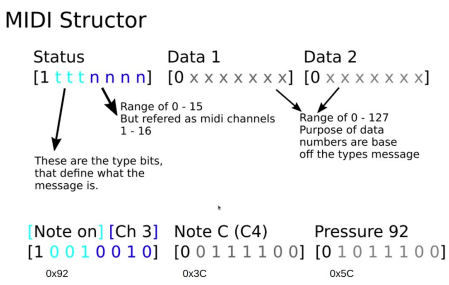
addons/ofxSiliconRetina/example_siliconretinaIntensity Dynamic Bulerias - G. Hazi

MIDI

What is MIDI ?

- MIDI = Musical Instrument Digital Interface
- Introduced as a standard in 1983
- Allows different instruments, computers and other devices to communicate with one another
- Transmits and receives notes, timing and other parameters
- It does not transmit the sound itself (waveform) but messages

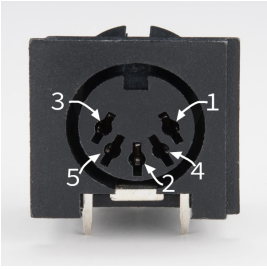
MIDI messages



Detail description of MIDI messages

Status	Explanation	Msg Size	Byte 1	Byte 2
0x8c	Note Off	2	pitch	velocity
0x9c	Note On	2	pitch	velocity
0xAc	Key Pressure	2	key	pressure
0xBc	Controller Change	2	controller	value
0xCc	Program Change	1	preset	
0xDc	Channel Pressure	1	pressure	
0xEc	Pitch Bend	2	bend LSB	bend MSB
0xF0	System Exclusive	*n*	vendor ID	anything
0xF2	Song Position	2	position LSB	position MSB
0xF3	Song Select	1	song number	
0xF5	*Unofficial Bus Select*	*1*	*bus number*	
0xF6	Tune Request	0		
0xF7	End of SysEx	0		
0xF8	Timing Tick	0		
0xFA	Start Song	0		
0xFB	Continue Song	0		
0xFC	Stop Song	0		
0xFE	Active Sensing	0		
0xFF	System Reset	0		

MIDI connectors

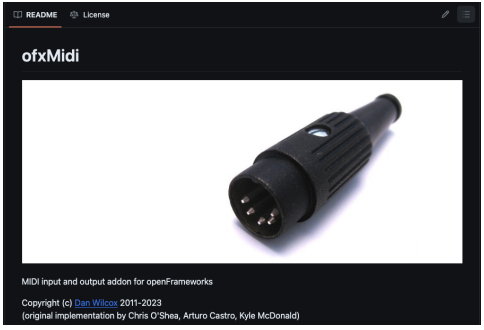


Pin 1	No Connection
Pin 2	Shield
Pin 3	No Connection
Pin 4	Voltage Reference Line
Pin 5	Data Line

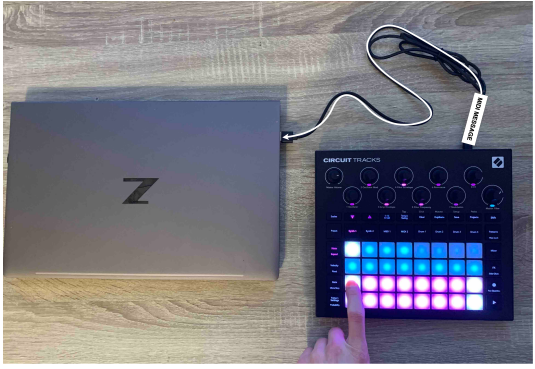
Which connectors are used by MIDI ?

- Conventional 5-pin MIDI connector
- Conventional USB connector
- Bluetooth
- WIFI

MIDI with OpenFramework



Link to github repository



That’s all for this session

Summary

- OpenFrameworks add-ons
- The basic of sensor interfaces:
  - Kinect
  - Event-based cameras
  - MIDI

Next Time

We will learn how to process sensor data with neural networks! Stay tuned!