

The background image shows a vast desert landscape with large sand dunes. The sky is filled with dramatic, colorful clouds, ranging from deep blues to bright yellows and oranges, suggesting a sunset or sunrise. The sand dunes are illuminated by the warm light of the setting sun, appearing in shades of orange and yellow.

Real-Time Sensing and Artificial Intelligence for Live Performative Arts

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

March 7, 2024

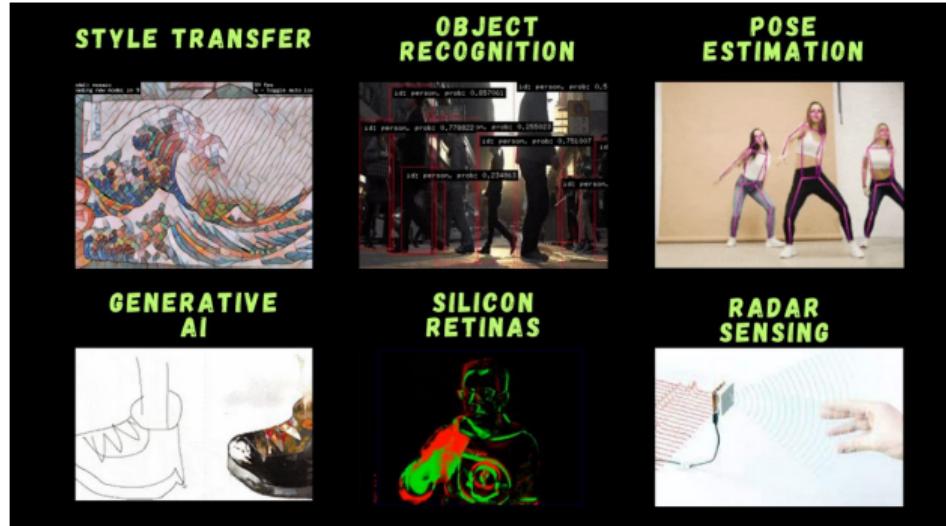
Federico Corradi - federico.corradi@gmail.com

FC

Federico Corradi

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

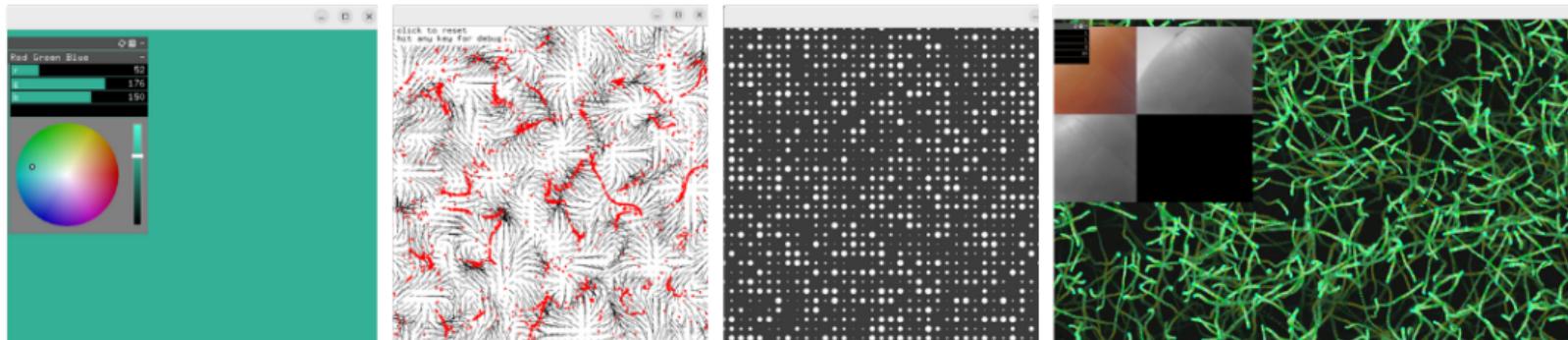
Event-Based Camera

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.

The screenshot shows a web browser window displaying the URL <https://ofxaddons.com/pages/howto>. The page title is "ofxAddons". Below the title, there are navigation links for "categories", "popular", "freshest", "unsorted", and "contrib". A sidebar on the left contains the text: "ofxAddons is directory of extensions and libraries for the openFr". The main content area lists several "How to" topics:

- What are openFrameworks addons?
- How do I install an addon from this site?
- Can you explain the info included on ofxAddons?
- Should I turn my OF thing into an addon?
- How do I make an OF addon?
- Is my addon done yet?
- How can I add continuous integration test to my addon?
- How do I add a thumbnail for this site?
- How do I submit my addon to this page?
- How do you find all these addons?

<https://ofxaddons.com/categories>

Openframeworks add-on template

OFX offers a template for creating an add-ons.

The screenshot shows the GitHub repository page for 'ofxAddonTemplate'. The repository has 1 branch and 0 tags. There are 7 pull requests listed:

- arturoc** Add missing flags to addon_config.mk · 9f50770 · 5 years ago
- docs** Add docs template.
- example_myFirstExample** Incorporate **@LeoColomb** PR.
- example_mySecondExample** Incorporate **@LeoColomb** PR.
- libs/necessaryLib** Remove libsortorder makes.
- scripts/ci** travis testing
- src** Polish/amend the template for a first feedback.

At the bottom, there is a note: "Add tacte folder for unit tacte".

<https://github.com/openframeworks/ofxAddonTemplate>

Page visited on Jan. 20 2024



openFrameworks addon for working with Intel Realsense 415,435,436i cameras
Maintained by **perevalovds**
Last updated about 23 hours ago
★ 11
Makefile
Categories: Video/Camera



LFO Modulation Framework
Maintained by **PlaymodesStudio**
Last updated 2 days ago
★ 36
Makefile
Categories: Utilities



A visual programming patching environment for OF
Maintained by **d3cod3**
Last updated 4 days ago
★ 150
Makefile
Categories: GUI



Performs a warp using openGL bezier surfaces on anything you care to distort/undistort.
Maintained by **gameoverhack**
Last updated 4 days ago
★ 20
Categories: Graphics



OpenCV based DNN Object Detection Library for Openframeworks
Maintained by **TetsuakiBaba**
Last updated 6 days ago
★ 36
Makefile
Categories: Computer Vision



openFrameworks addon for creating textual GUI controlled by keyboard
Maintained by **perevalovds**
Last updated 8 days ago
★ 4
Makefile
Categories: GUI



a mighty ui library for openframeworks



Native windows/mac/linux functions for openFrameworks



(maintained) Midi addon for openFrameworks

<https://ofxaddons.com/fresthest>

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Kinect Sensor



Kinect teardown

Kinect Specs

Kinect Sensor

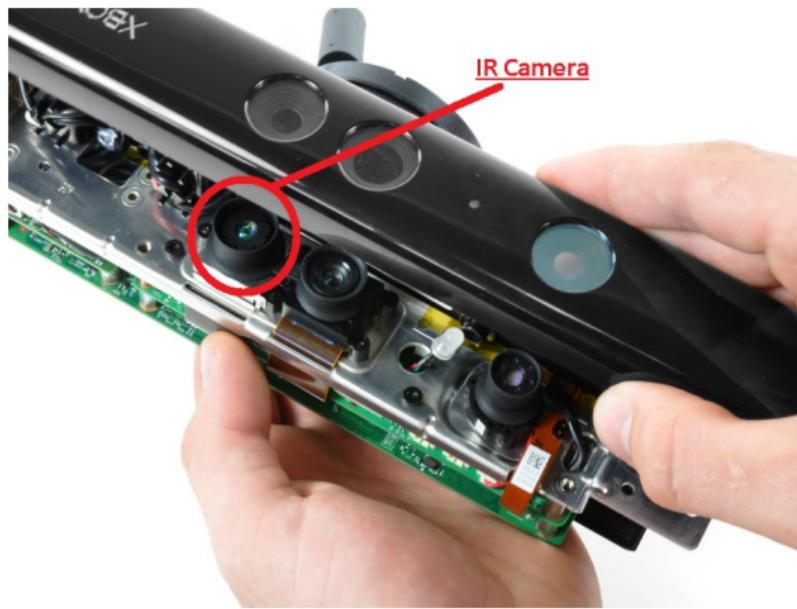


Kinect teardown

Kinect Specs

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

Kinect Sensor

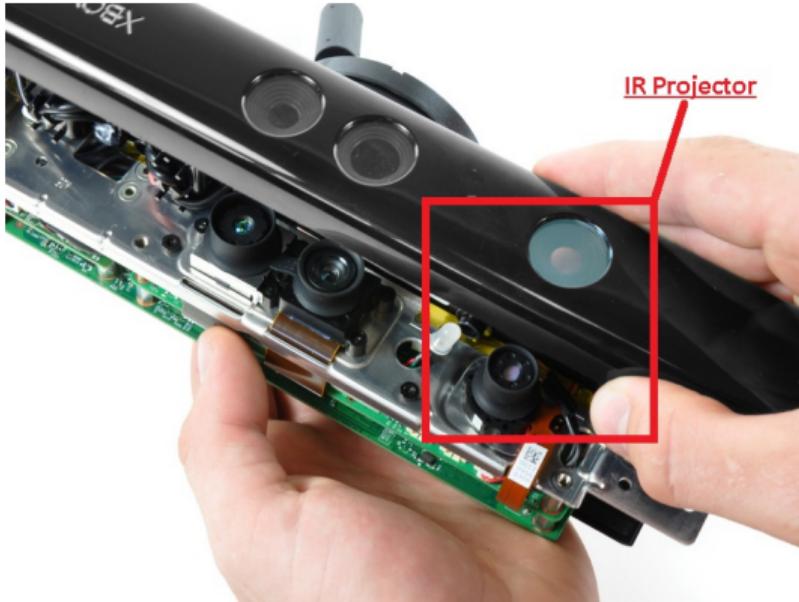


Kinect teardown

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

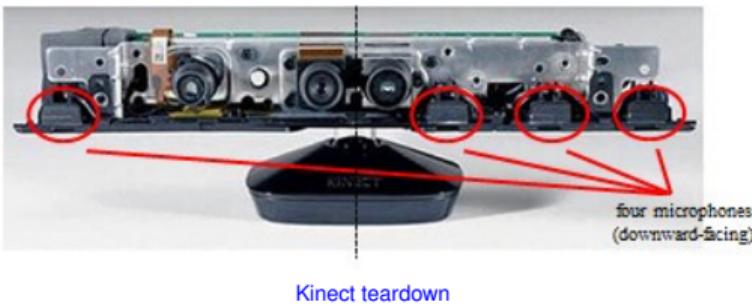


Kinect teardown

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



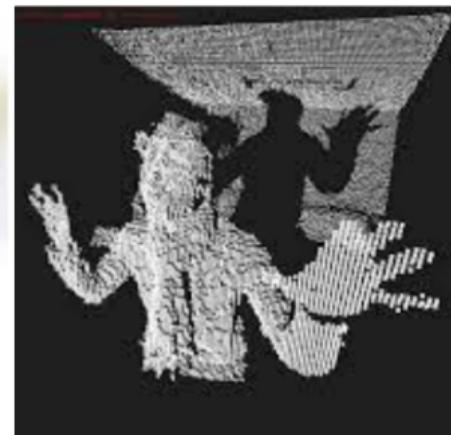
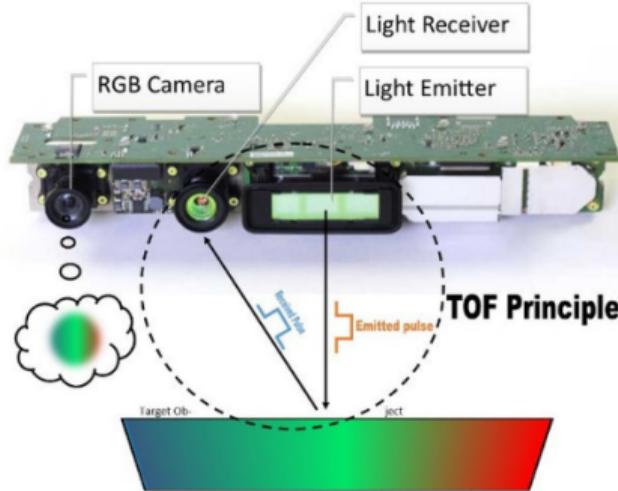
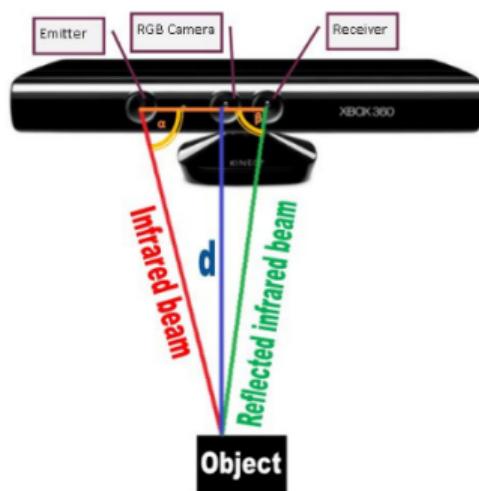
Kinect Specs

- Colour VGA Motion Camera: 640x480 pixel resolution @30FPS.
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- 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).
- Array of four microphones.
- Total Power 2.25W

Kinect Xbox Sensor

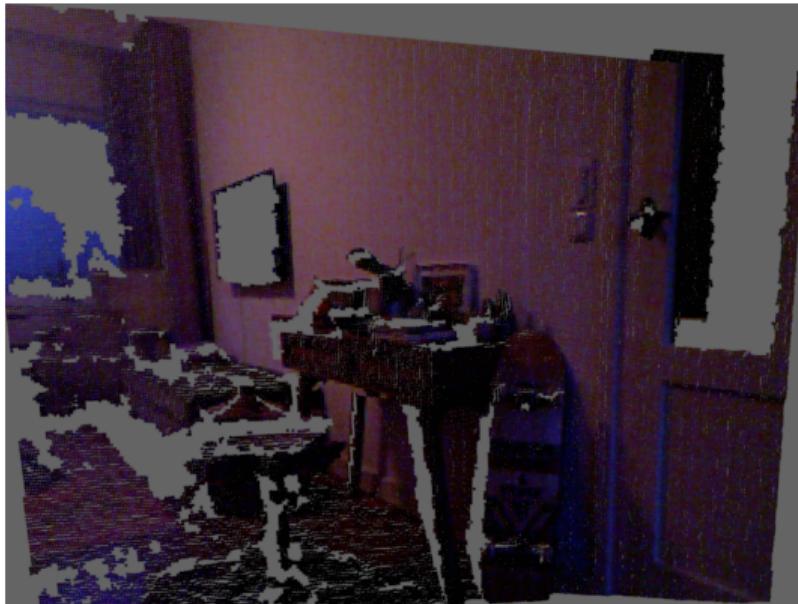
How does it work?

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.

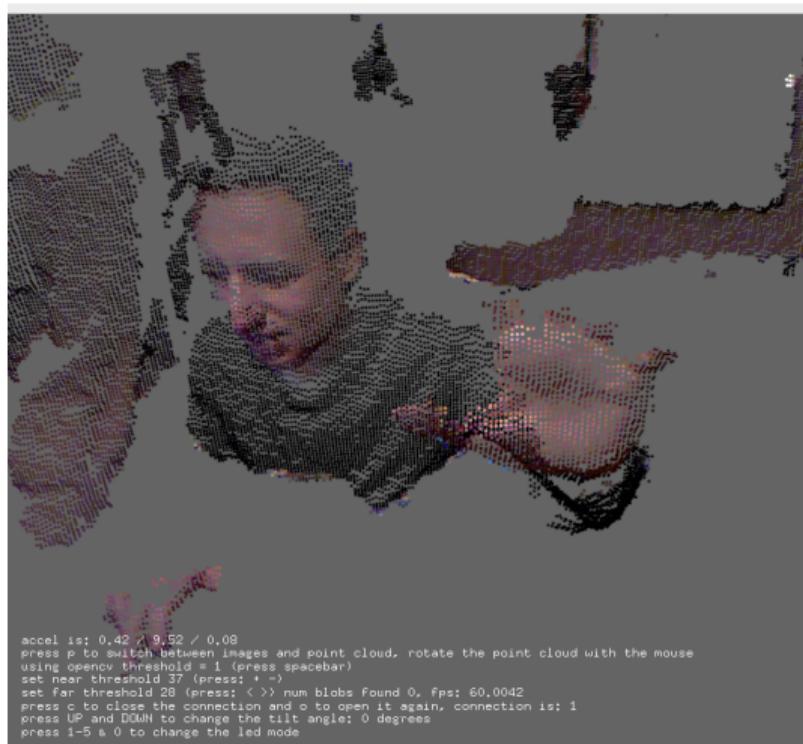


[Fares Alkhawaja et al., Advances in Science and Engineering Technology International Conferences (ASET), 2019]

Kinect in OpenFrameworks



```
accel is: 0.24 / 9.52 / -0.50  
press p to switch between images and point cloud, rotate the point cloud with the mouse  
using opencv threshold = 0 (press spacebar)  
set near threshold 230 (press: + -)  
set far threshold 64 (press: < >) num blobs Found 0, Fps: 60  
press c to close the connection and o to open it again, connection is: 1  
press UP and DOWN to change the tilt angle: -3 degrees  
press 1-5 & 0 to change the led mode
```

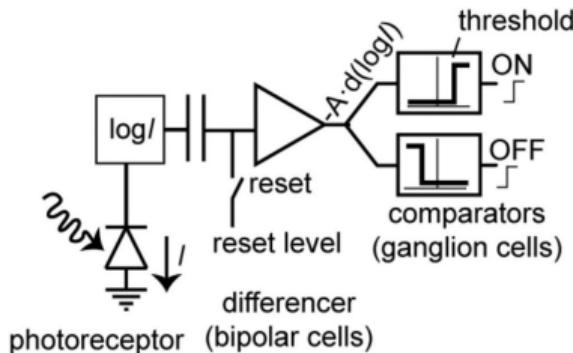


```
accel is: 0.42 / 9.52 / 0.08  
press p to switch between images and point cloud, rotate the point cloud with the mouse  
using opencv threshold = 1 (press spacebar)  
set near threshold 37 (press: + -)  
set far threshold 28 (press: < >) num blobs Found 0, Fps: 60.0042  
press c to close the connection and o to open it again, connection is: 1  
press UP and DOWN to change the tilt angle: 0 degrees  
press 1-5 & 0 to change the led mode
```

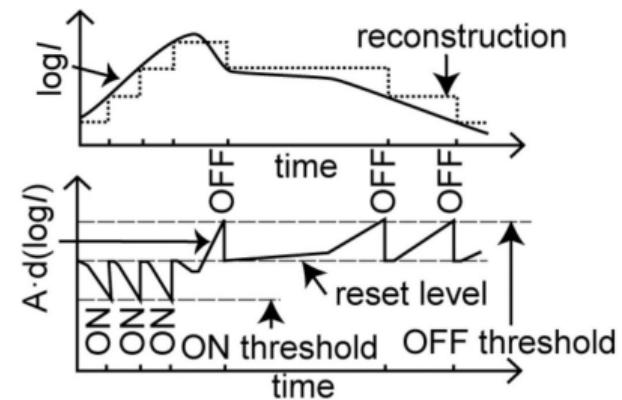
myApps/kinectExample

Silicon Retina or Event Cameras or Dynamic Vision Sensors

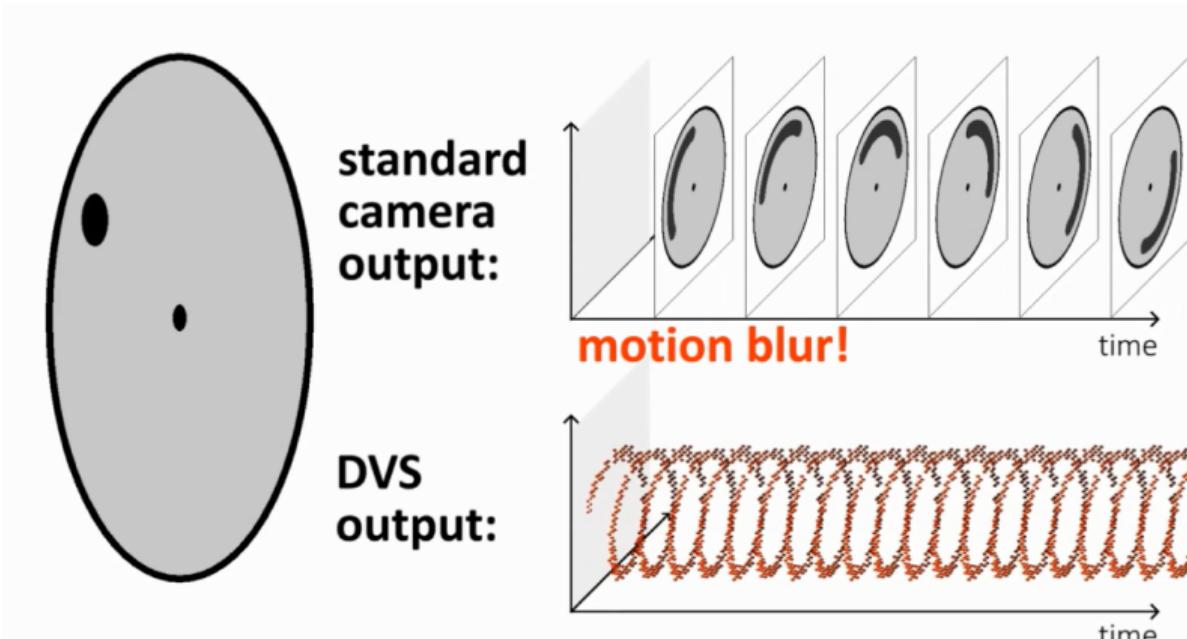
a) simplified pixel schematic



b) principle of operation



Silicon Retina vs. Frame Camera

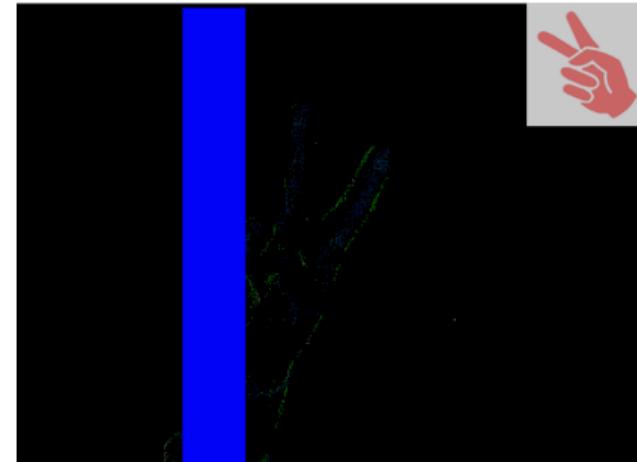
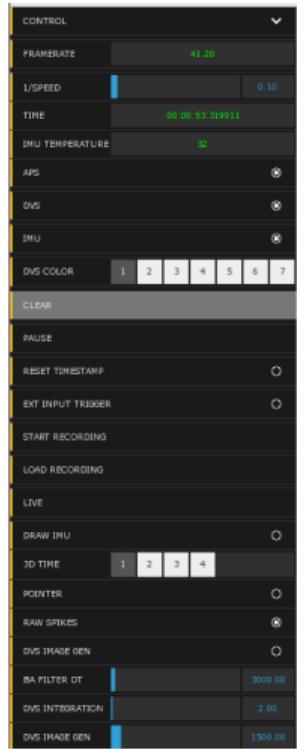


[Video Event-Based Camera]

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](#)]

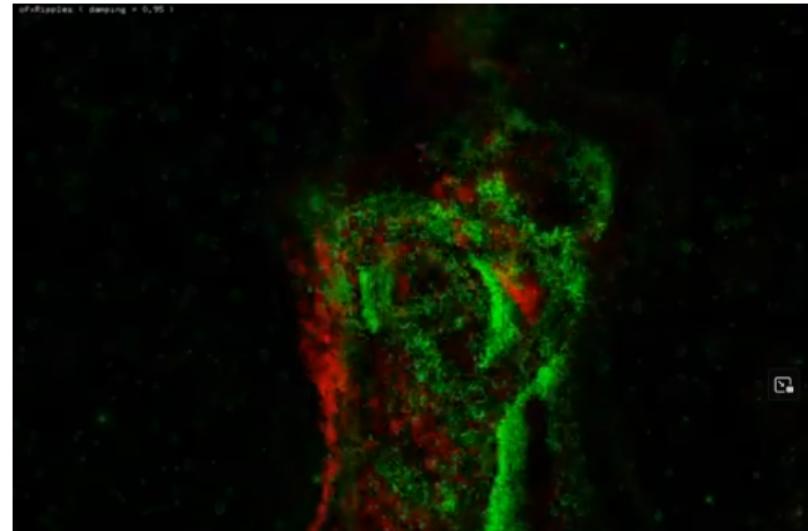
Silicon Retina in Open Frameworks



- [ofxSiliconRetina](#)
- Add-on with examples

addons/ofxDVS

Silicon Retina: Intensity & Colors



`addons/ofxSiliconRetina/example_siliconretinalIntensity` Dynamic Bulerias - G. Hazi

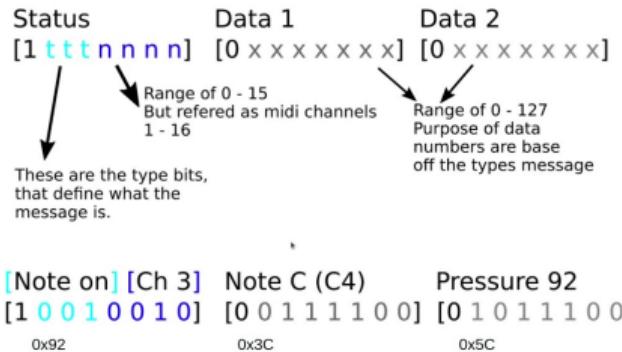


What is MIDI ?

- 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

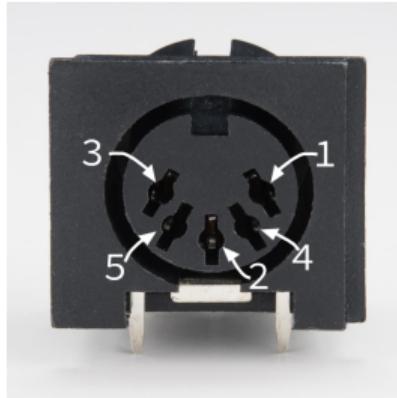
MIDI Structor



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		

Detail description of MIDI messages

MIDI connectors

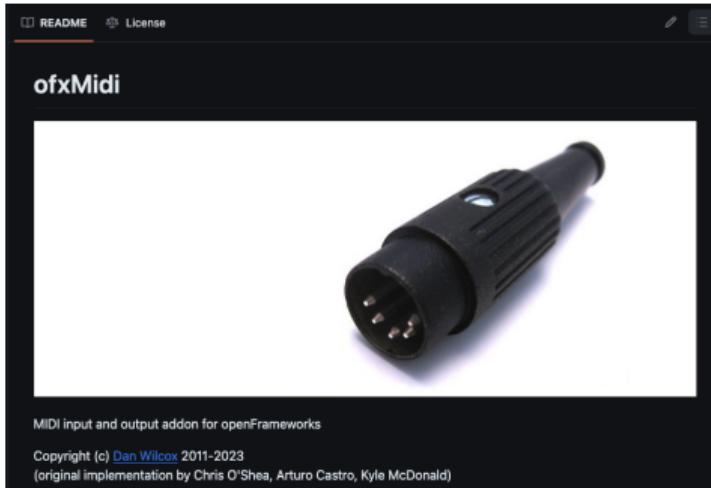


Pin 1	No Connection
Pin 2	Shield
Pin 3	No Connection
Pin 4	Voltage Reference Line
Pin 5	Data Line

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!