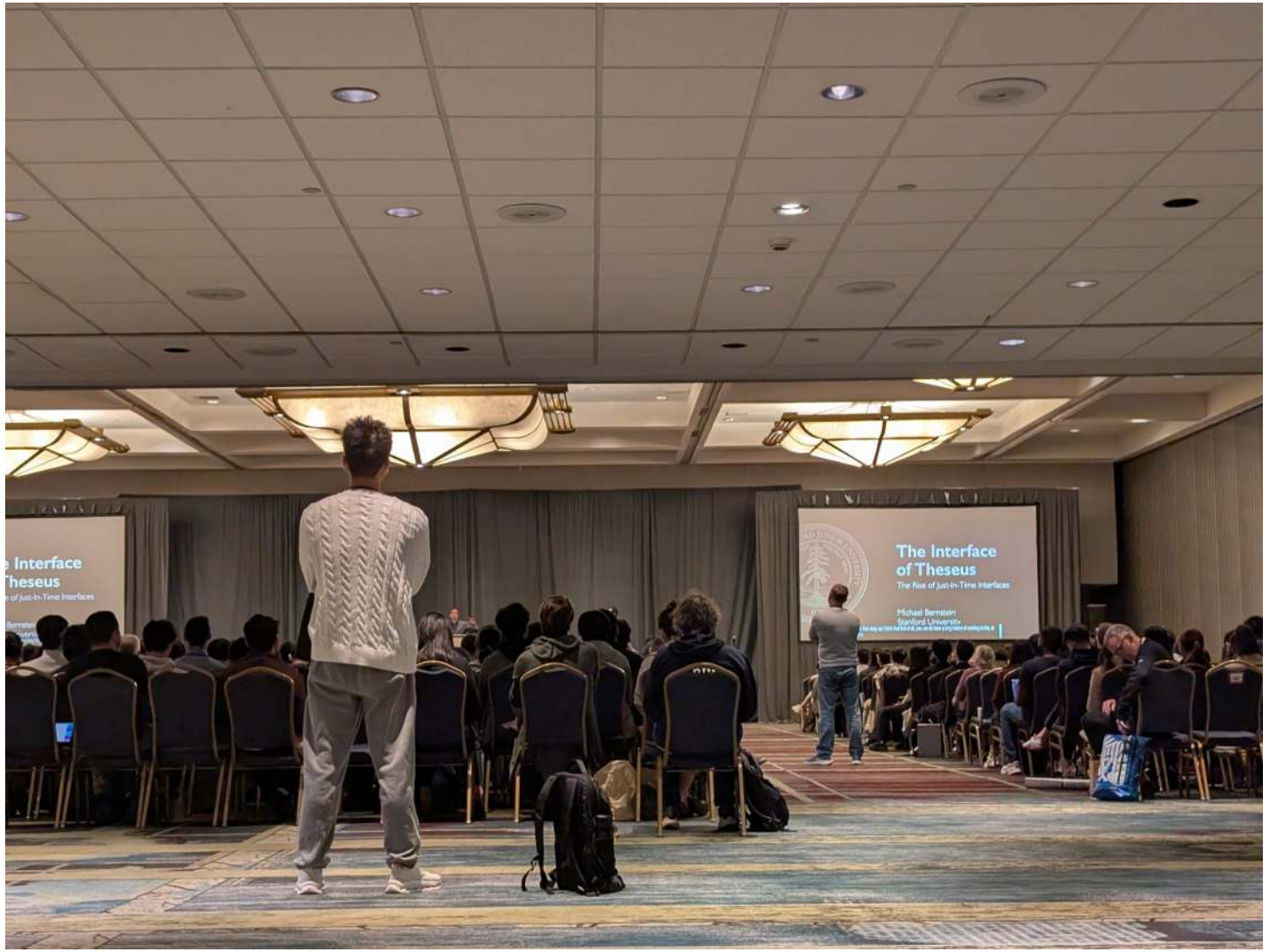


TangiMap

Context-Aware Generative Function Mapping for Tangible Input Devices

Yunyi Zhu, Chang Xiao

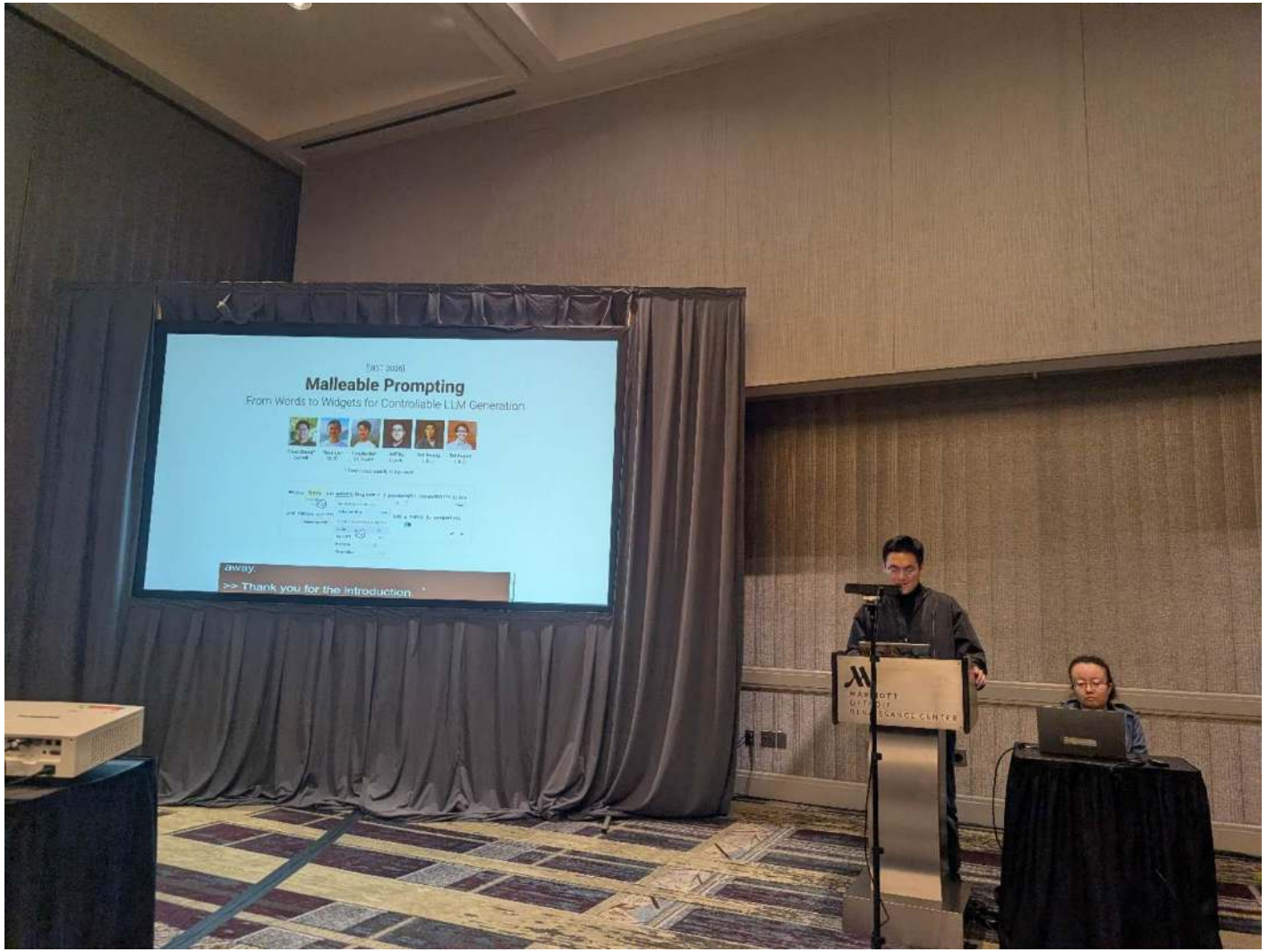
Just-in-time Interface



Direct Manipulation vs. Interface Agents



From Words to Widgets (just now)



Physical Controls



Physical Controls



Watch Repair



AEG Midinette 61 Radio

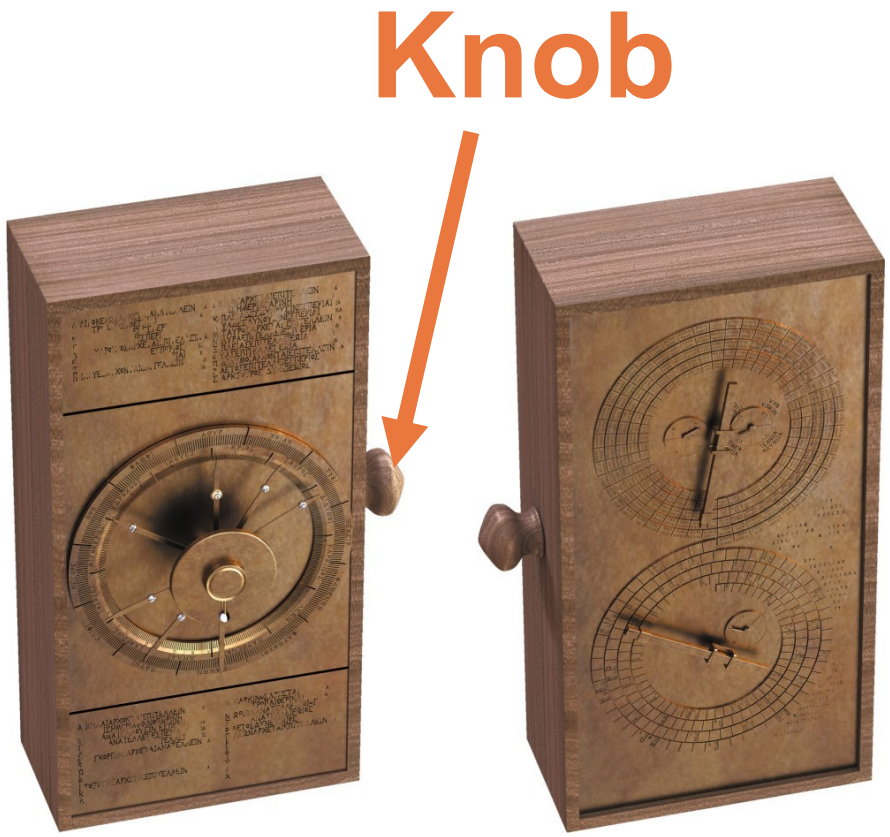


Plane Cockpit

Physical Controls



Antikythera Mechanism (~100 BCE)



reconstructed (2018)

Physical Controls



Blackmagic Design
DaVinci Resolve Advanced Panel



Toyota Prius

Single Purpose Hardware



TASCAM Model 16



Soundcraft Ui12 Web Interface

General Purpose Hardware

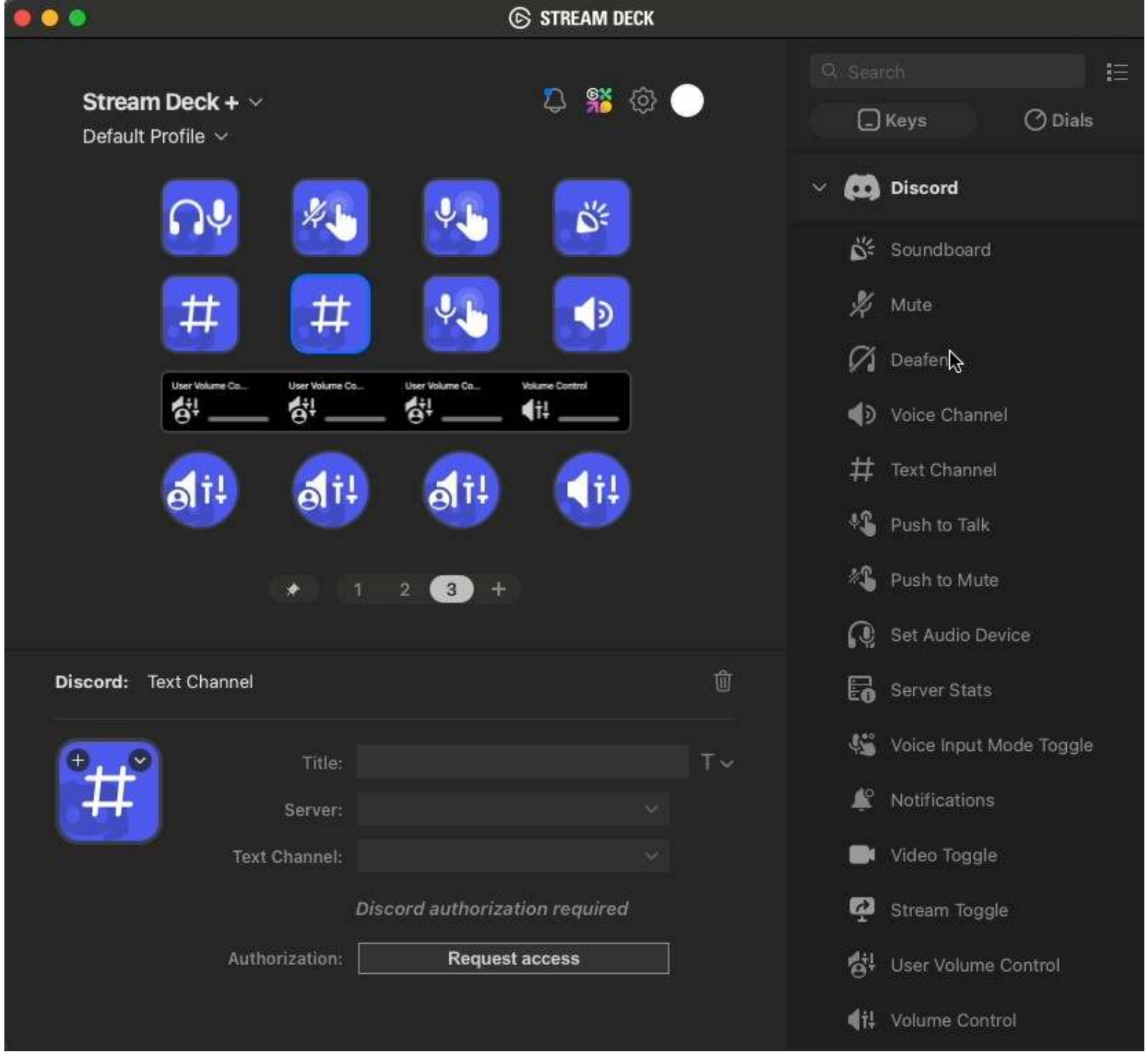


Loupedeck CT

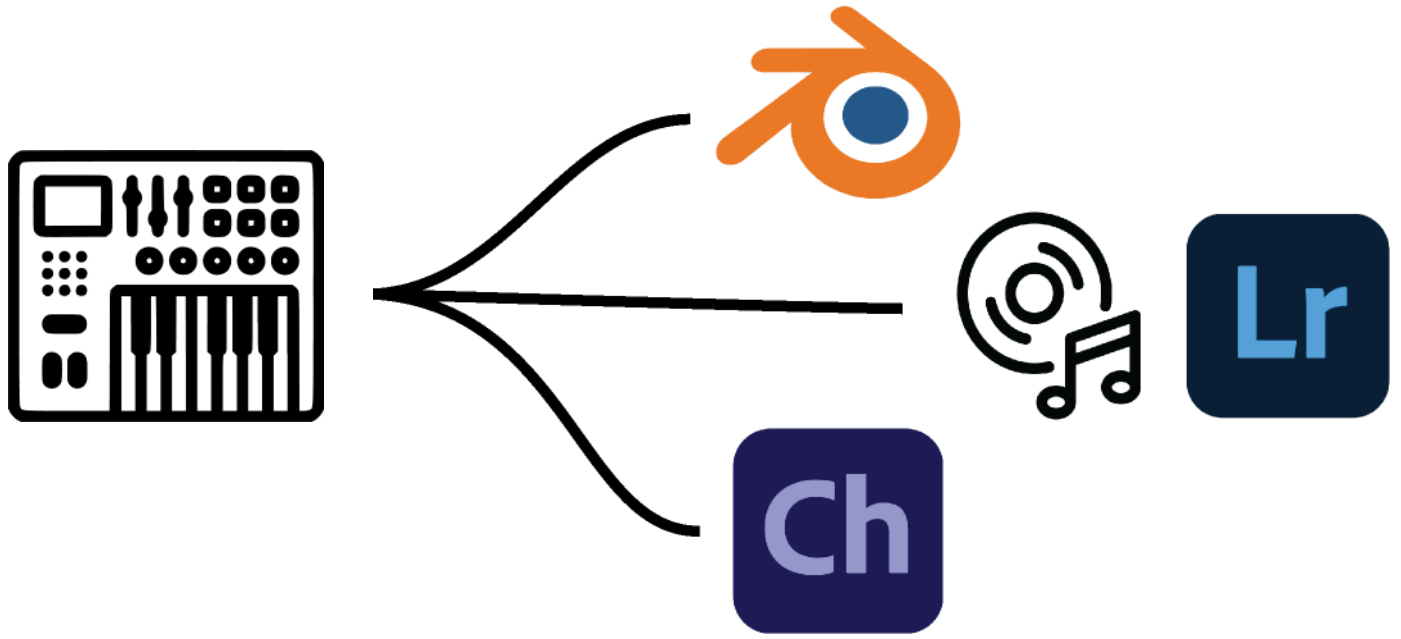


Tour Box


Photoshop File Edit Image Layer Type Select Filter 3D View Plugins Window Help
Wed Nov 16 11:58 AM
Adobe Photoshop 2023
Share
taylordragon3livedragon.tif @ 40.5% (Layer 42, RGB/8) *
Properties
Pixel Layer
Transform
Align and Distribute
Align:
Quick Actions
Remove Background
Select Subject
View More
Layers
Channels
Paths
Kind
Overlay
Opacity: 100%
Lock:
Fill: 100%
Layer 34
Layer 32
Smoke...opy 2
Layer 39
Layer 37
Layer 42
Layer 36 copy
Layer 36
Layer 38
LOUPEDECK
Flip Vertical
Flip Horizontal
Remove Background
Layer Properties Command
Layer Width
Layer Scale
Layer Rotate
Select Subject
Invert
Tab
Ctrl
Alt
Undo
A
B
C
D
E


STREAM DECK
Stream Deck +
Default Profile
User Volume Co...
User Volume Co...
User Volume Co...
Volume Control
1
2
3
Discord: Text Channel
Title:
Server:
Text Channel:
Discord authorization required
Authorization:
Request access
Search
Keys
Dials
Discord
Soundboard
Mute
Deafen
Voice Channel
Text Channel
Push to Talk
Push to Mute
Set Audio Device
Server Stats
Voice Input Mode Toggle
Notifications
Video Toggle
Stream Toggle
User Volume Control
Volume Control

TangiMap





Histogram

Blur Amount 50

Bokeh

Cat Eye 0

Boost 50

Focus Range

Near Far

Visualize Depth

Brush Refinement

Effects

Post-Crop Vignetting

Style Highlight Priority

Amount 0

Midpoint 50

Roundness 0

Feather 50

Highlights 0

Grain

Amount 0

Size 25

Roughness 50

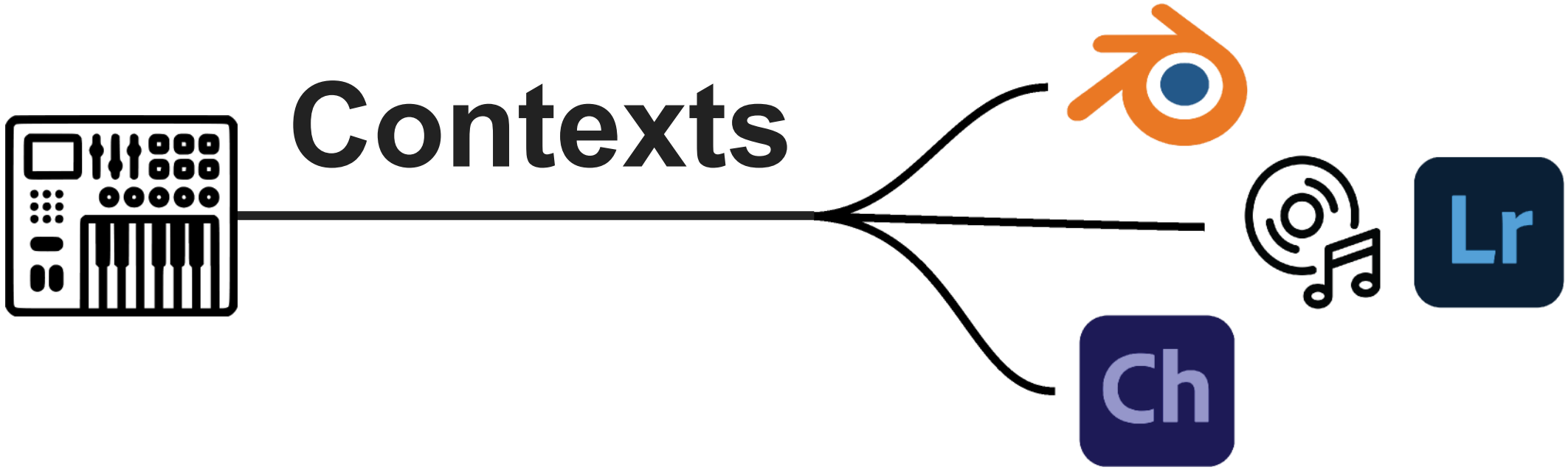
Calibration

Soft Proofing

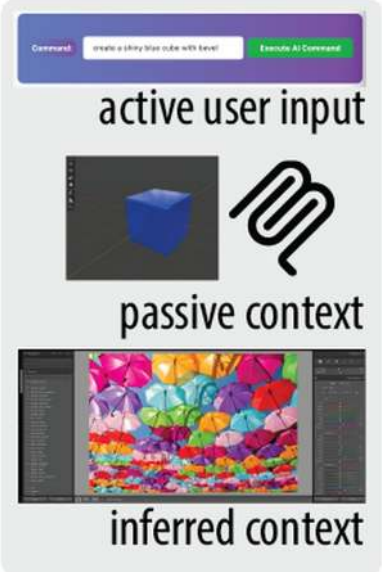
Previous Reset

oto / 1 selected / sample.png

Filter : Filters Off


Contexts
Lr
Ch

Contexts



User Context

What is the user trying to do?



Software Context

What are the software functions and adjustable parameters?



Device Context

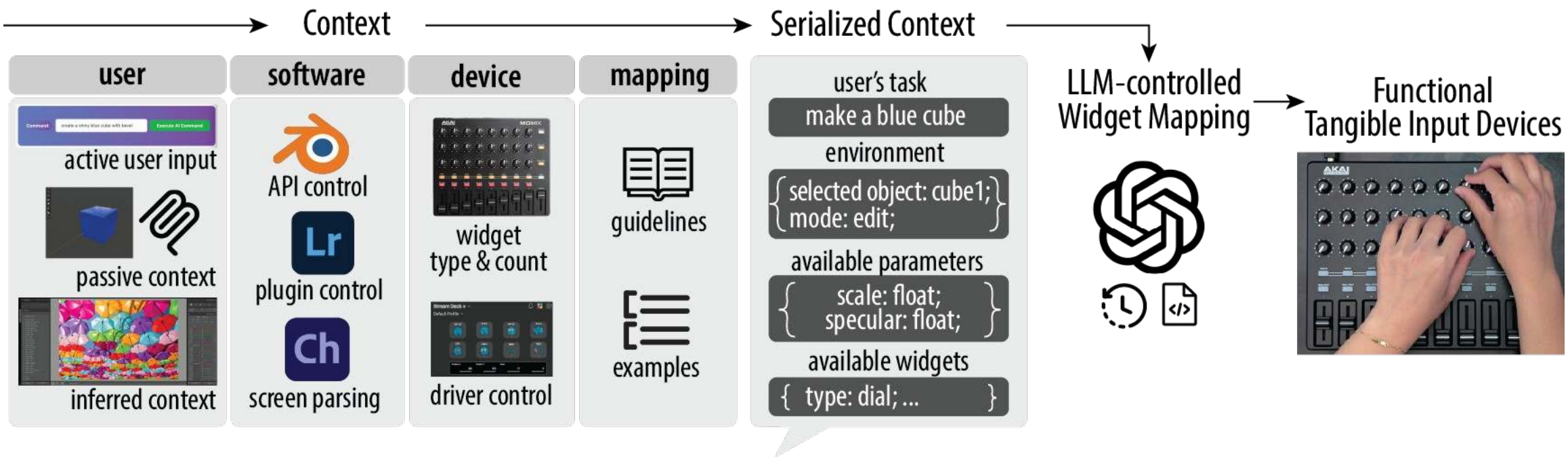
How does the device look like and work?



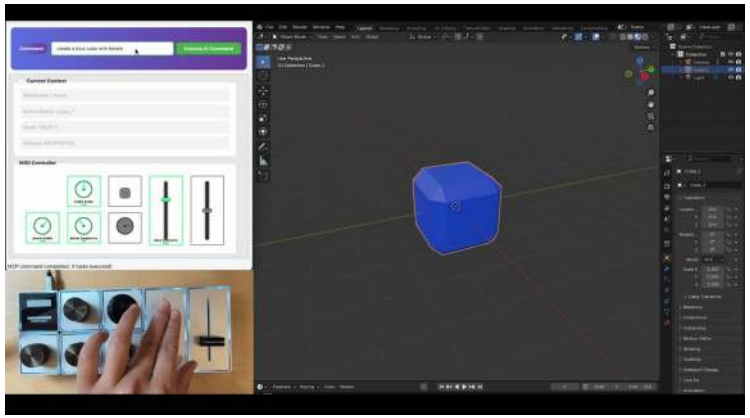
Mapping Guidelines

What type of functions would go well with which widget?

Contexts


Context
Serialized Context
user
software
device
mapping
active user input
passive context
inferred context
API control
plugin control
screen parsing
widget
type & count
driver control
guidelines
examples
user's task
make a blue cube
environment
{ selected object: cube1;
mode: edit; }
available parameters
{ scale: float;
specular: float; }
available widgets
{ type: dial; ... }
LLM-controlled
Widget Mapping
Functional
Tangible Input Devices

Applications



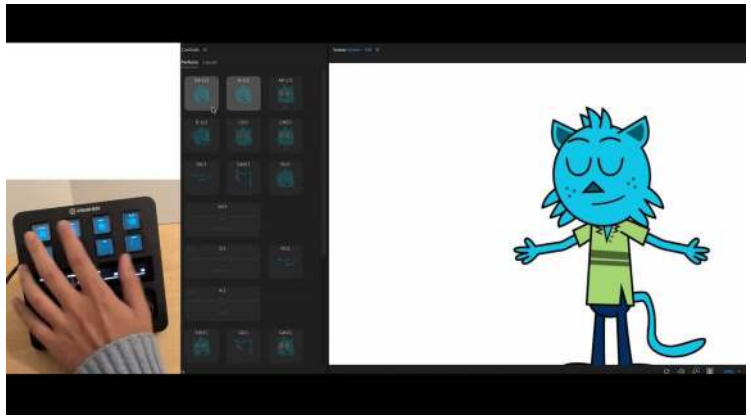
Tangible Control for Natural Language Interfaces

(Monogram Creative Console)



Repurposing Devices

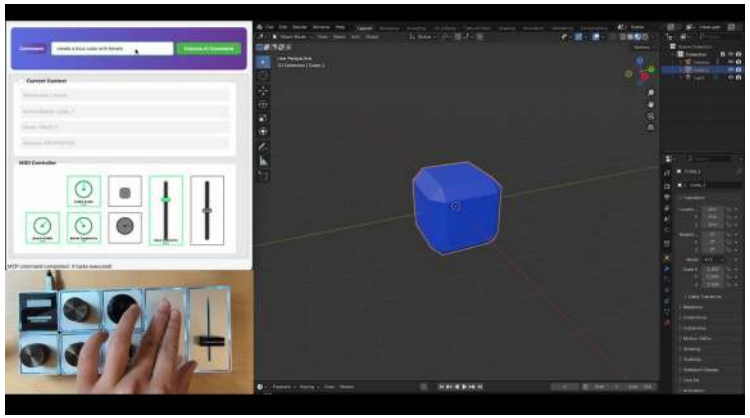
(Akai MIDIMix)



Puppeteering with Dynamic Hardware

(Stream Deck+)

Applications



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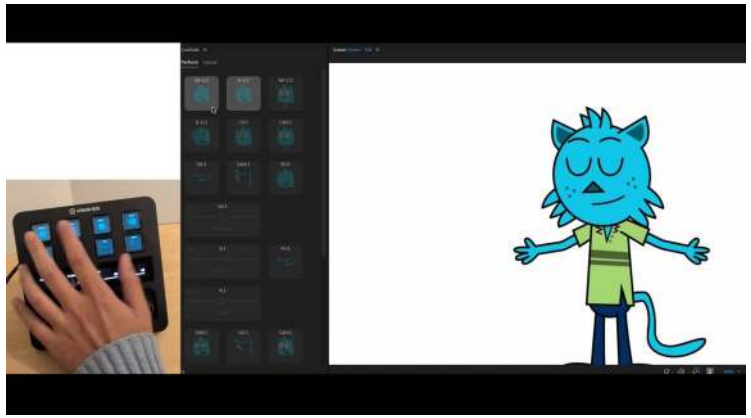
(Akai MIDIMix)



Puppeteering with Dynamic Hardware

(Stream Deck+)

Command: create a blue cube with bevels

Execute AI Command

Current Context

Workspace: Layout

Active Object: Cube_1

Mode: OBJECT

Window: PROPERTIES

MIDI Controller

Cube Scale

Monogram Creative Console



Blender

File Edit Render Window Help | Layout Modeling Sculpting UV Editing Texture Paint Shading Animation Rendering Compositing | Scene ViewLayer

Object Mode View Select Add Object | Global | Options

Scene Collection

Collection

Camera

Cube_1

Light

Cube_1

Cube_1

Transform

Location X 0 m

Y 0 m

Z 0 m

Rotation X 0°

Y 0°

Z 0°

Mode XYZ ...

Scale X 1.100

Y 1.100

Z 1.100

Delta Transform

Relations

Collections

Instancing

Motion Paths

Shading

Visibility

Viewport Display

Line Art

Animation

Playback Keying View Marker | 1 | Start 1 End 250

Command: create a blue cube with bevels

Execute AI Command

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Mode: OBJECT

Window: PROPERTIES

MIDI Controller

Cube Scale

Bevel Width

Bevel Segments

Blue Intensity

MCP command completed: 4 tasks executed!



File Edit Render Window Help Layout Modeling Sculpting UV Editing Texture Paint Shading Animation Rendering Compositing Scene ViewLayer

Object Mode View Select Add Object Global Options

User Perspective

(1) Collection | Cube_1

Scene Collection

Collection

Camera

Cube_1

Light

Cube_1

Cube_1

Transform

Location X 0 m

Y 0 m

Z 0 m

Rotation X 0°

Y 0°

Z 0°

Mode XYZ ...

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Y 1.100

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(1) Collection | Cube_1

Scene Collection

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Cube_1

Cube_1

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Y 0 m

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Light

Cube_1

Cube_1

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Z 0 m

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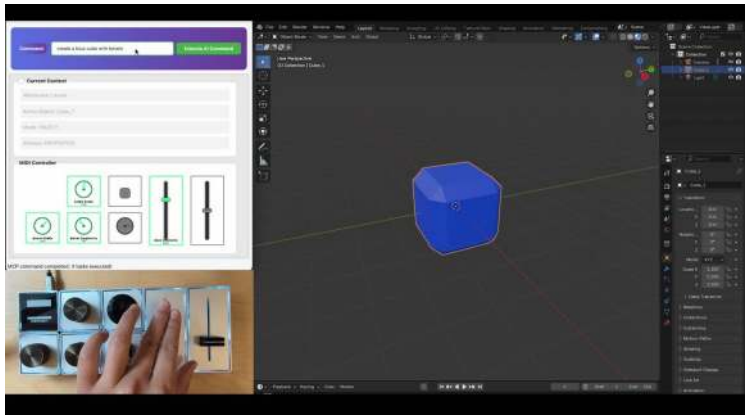
Playback Keying View Marker 1 Start 1 End 250

Applications



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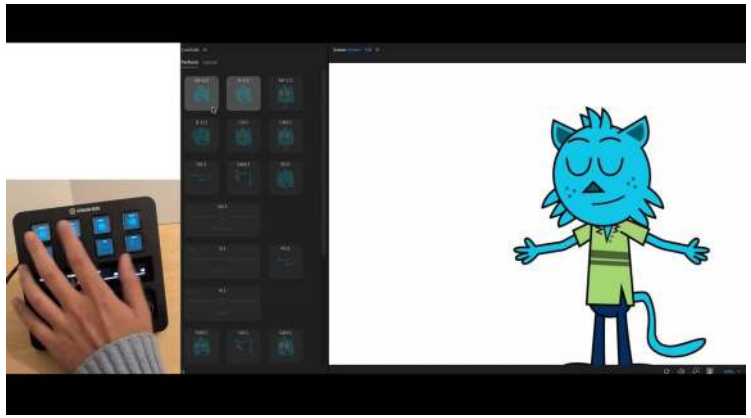
(Akai MIDIMix)



Puppeteering with Dynamic Hardware

(Stream Deck+)




AKAI
MIDIMIX


0.00
-1:12.0 left
Q
REV
LOAD
AUTO
TEMPO
±RNG
CUE 3
CUE 4
CUE 7
CUE 8
MIXER
CH 1
CH 2
TRIM
HI
0.00 dB
MID
LOW
CFX
0.00
1.00
VOL
CROSSFADER A B 0.00
MASTER 0.85
BOOTH 0.70
HP MIX 0.50
HP LVL 0.70
SYNC SRC
AUTO
DECK 2 128.0 BPM ♪ B
Demo Techno B 128bpm · TangiMap
0:00.0 elapsed
CUE
PLAY
SYNC
KEY
NUDGE
-4
IN
OUT
RELOOP
½
×2
CUE 1
CUE 2
CUE 5
CUE 6
ON
SAMPLER
KICK
CLAP
HAT
STAB
VOL 0.80
LIBRARY
SORT: TITLE
RESCAN
LOAD → 1
LOAD → 2
Artist Title BPM Key Len
1 TangiMap Demo House A 122bpm 122 A 1:12
2 TangiMap Demo Techno B 128bpm 128 B 1:12




AKAI
MIDIMIX

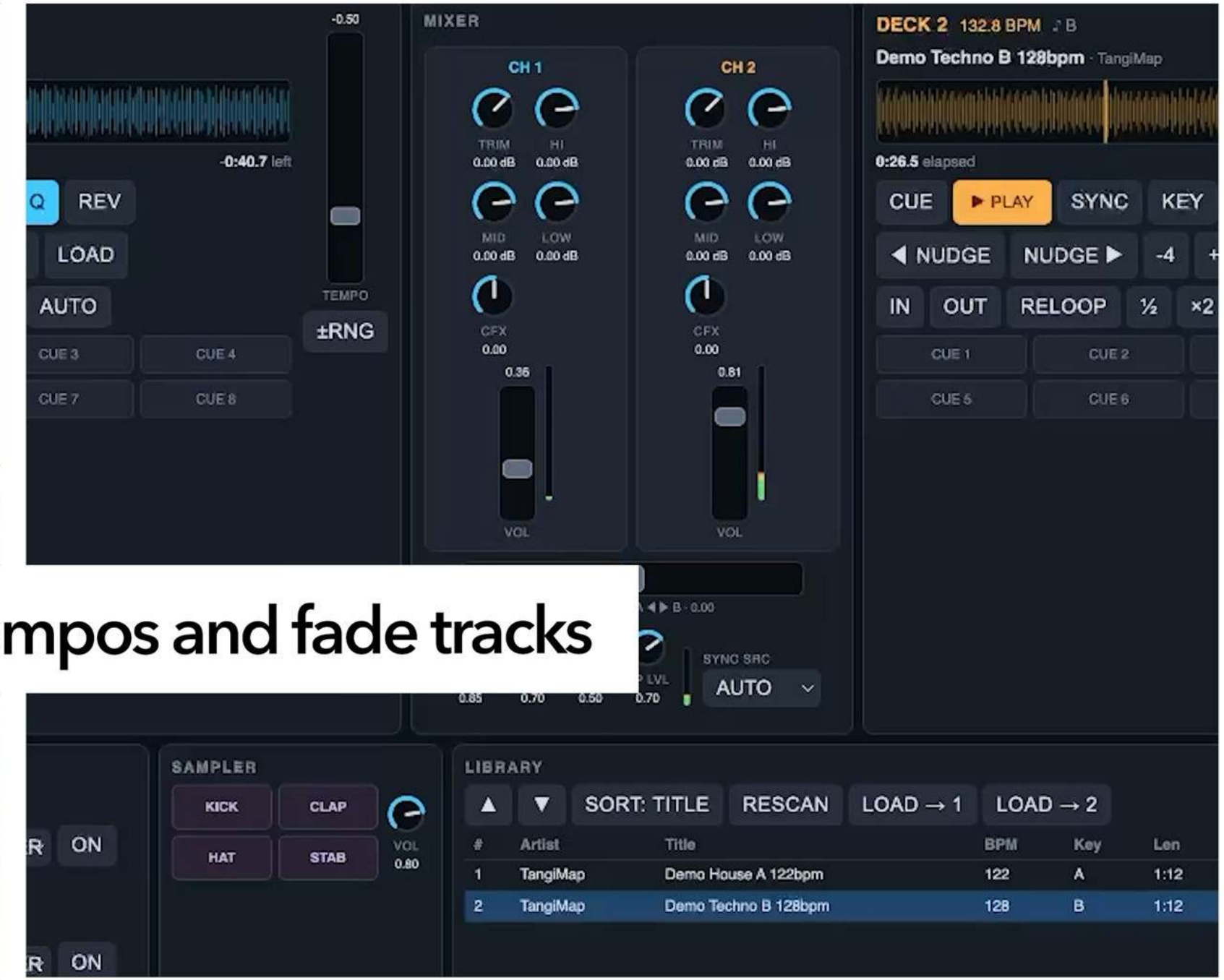

0.00
MIXER
DECK 2 128.0 BPM ♪ B
Demo Techno B 128bpm · TangiMap
-1:12.0 left
0:00.0 elapsed
CH 1
CH 2
TRIM
HI
MID
LOW
0.00 dB
CFX
0.00
1.00
VOL
REV
LOAD
AUTO
TEMPO
±RNG
CUE 3
CUE 4
CUE 7
CUE 8
CUE
PLAY
SYNC
KEY
NUDGE
-4
IN
OUT
RELOOP
½
×2
CUE 1
CUE 2
CUE 5
CUE 6
CROSSFADER A B 0.00
MASTER
BOOTH
HP MIX
HP LVL
0.85
0.70
0.50
0.70
SYNC SRC
AUTO
ON
SAMPLER
KICK
CLAP
HAT
STAB
VOL
0.80
LIBRARY
SORT: TITLE
RESCAN
LOAD → 1
LOAD → 2
Artist Title BPM Key Len
1 TangiMap Demo House A 122bpm 122 A 1:12
2 TangiMap Demo Techno B 128bpm 128 B 1:12


AKAI
MIDIMIX
play the track
MIXER
CH 1
CH 2
TRIM
HI
MID
LOW
CFX
VOL
CROSSFADER A ◀ ▶ B · 0.00
MASTER
BOOTH
HP MIX
HP LVL
SYNC SRC
AUTO
DECK 2 128.0 BPM
Demo Techno B 128bpm · TangiMap
0:00.0 elapsed
CUE
PLAY
SYNC
KEY
NUDGE
NUDGE
-4
IN
OUT
RELOOP
½
×2
CUE 1
CUE 2
CUE 5
CUE 6
-1:10.5 left
REV
LOAD
AUTO
TEMPO
±RNG
CUE 3
CUE 4
CUE 7
CUE 8
SAMPLER
KICK
CLAP
HAT
STAB
VOL
0.80
ON
LIBRARY
SORT: TITLE
RESCAN
LOAD → 1
LOAD → 2
Artist Title BPM Key Len
1 TangiMap Demo House A 122bpm 122 A 1:12
2 TangiMap Demo Techno B 128bpm 128 B 1:12





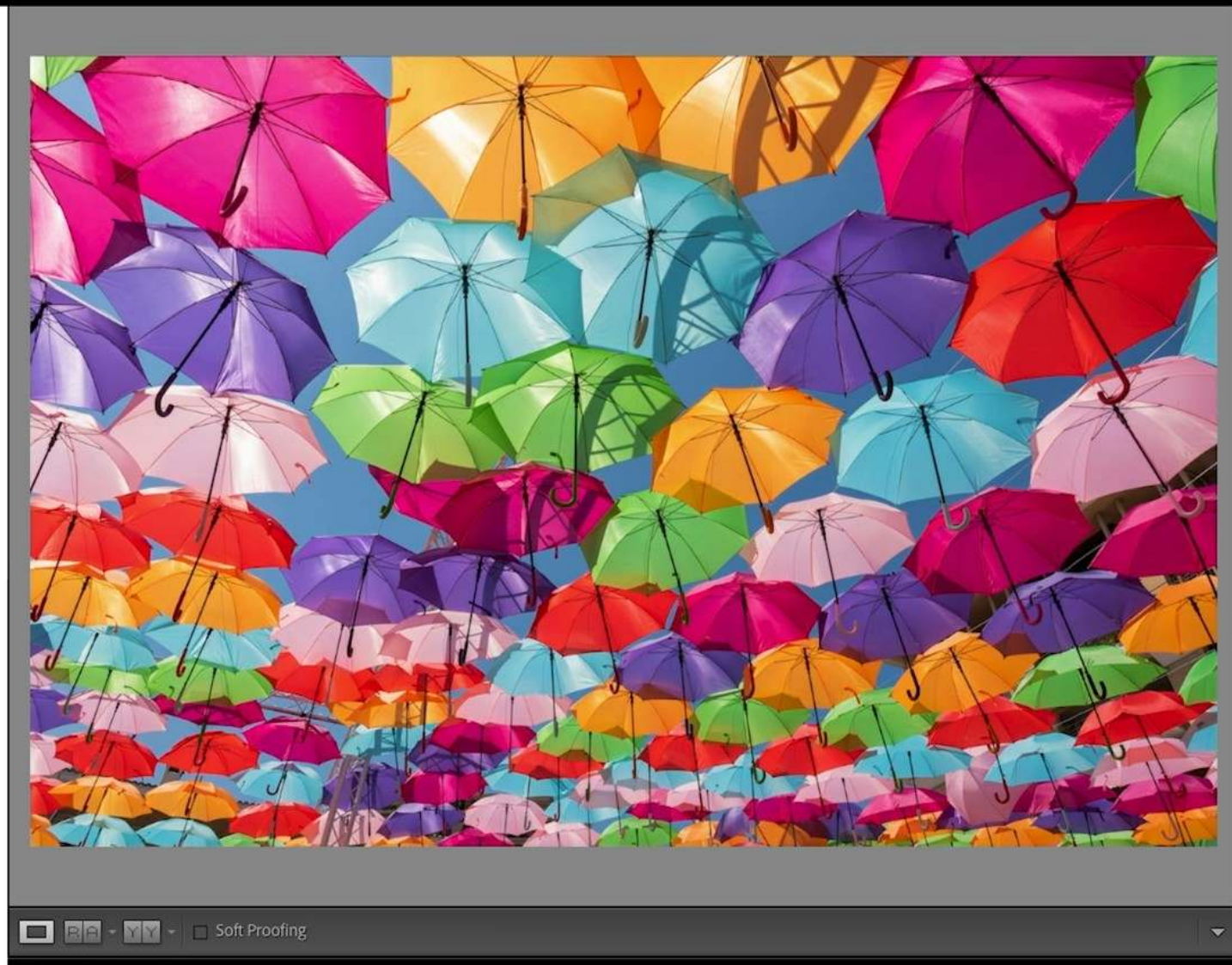
align tempos and fade tracks



Audio Mixer

AKAI MIDIMIX





Histogram

Basic

Auto B&W HDR

Profile : Color

WB : As Shot

Temp 0

Tint 0

Tone

Exposure 0.00

Contrast 0

Highlights 0

Shadows 0

Whites 0

Blacks 0

Presence

Texture 0

Clarity 0

Dehaze 0

Vibrance 0

Saturation 0

Tone Curve

Color Mixer

Color Grading

Detail

Lens Corrections

Profile Manual

Distortion

Amount 0

Soft Proofing

Previous Reset

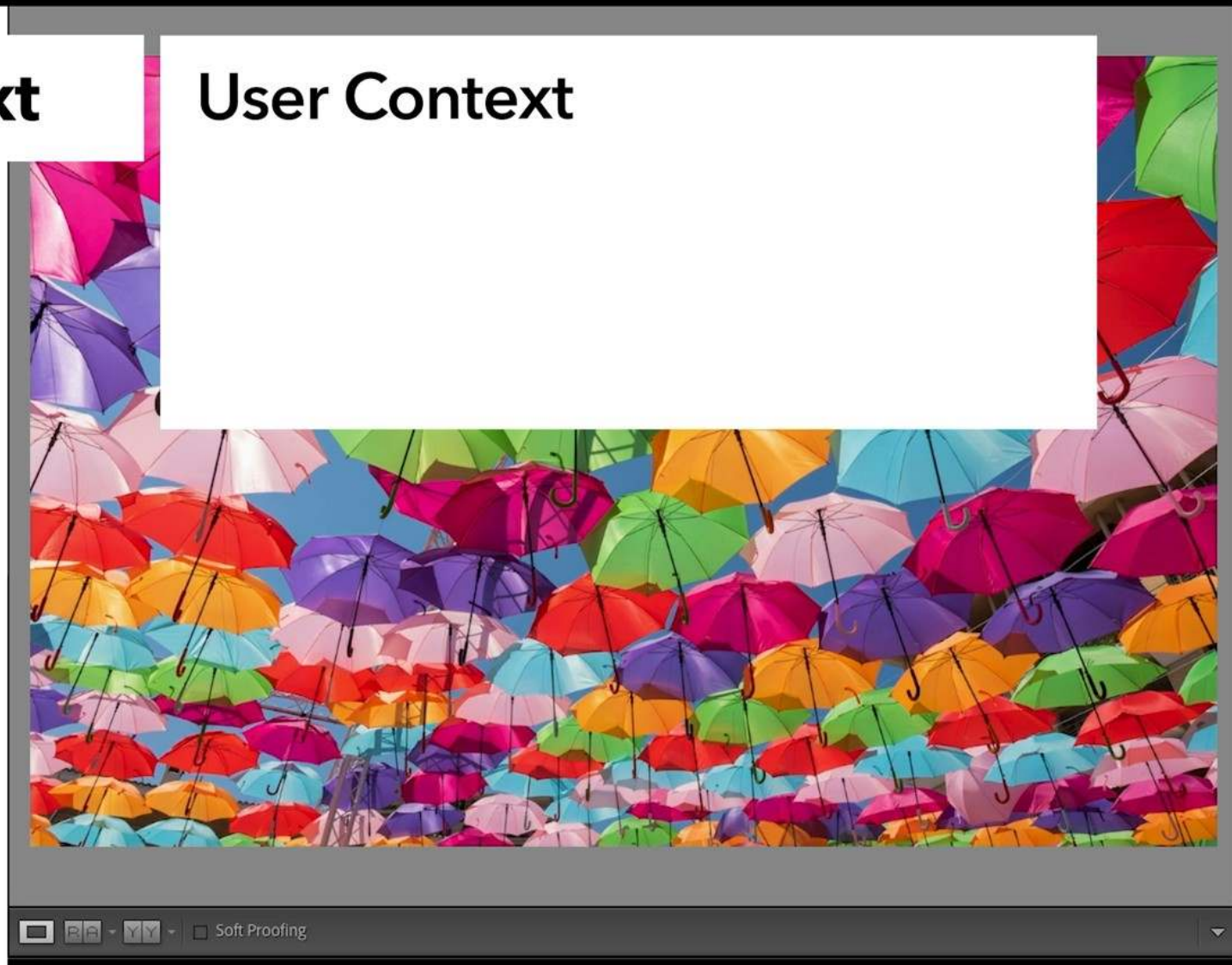
Previous Import 1 photo /1 selected / sample.png

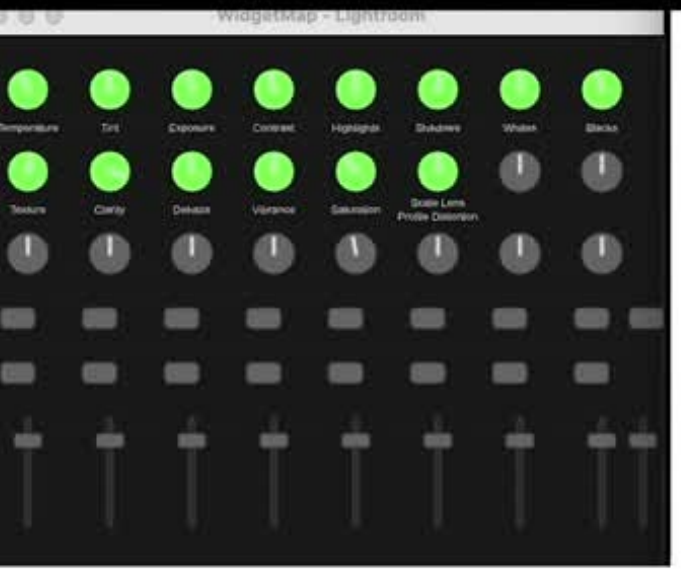
Filter : Filters Off

TangiMap Context

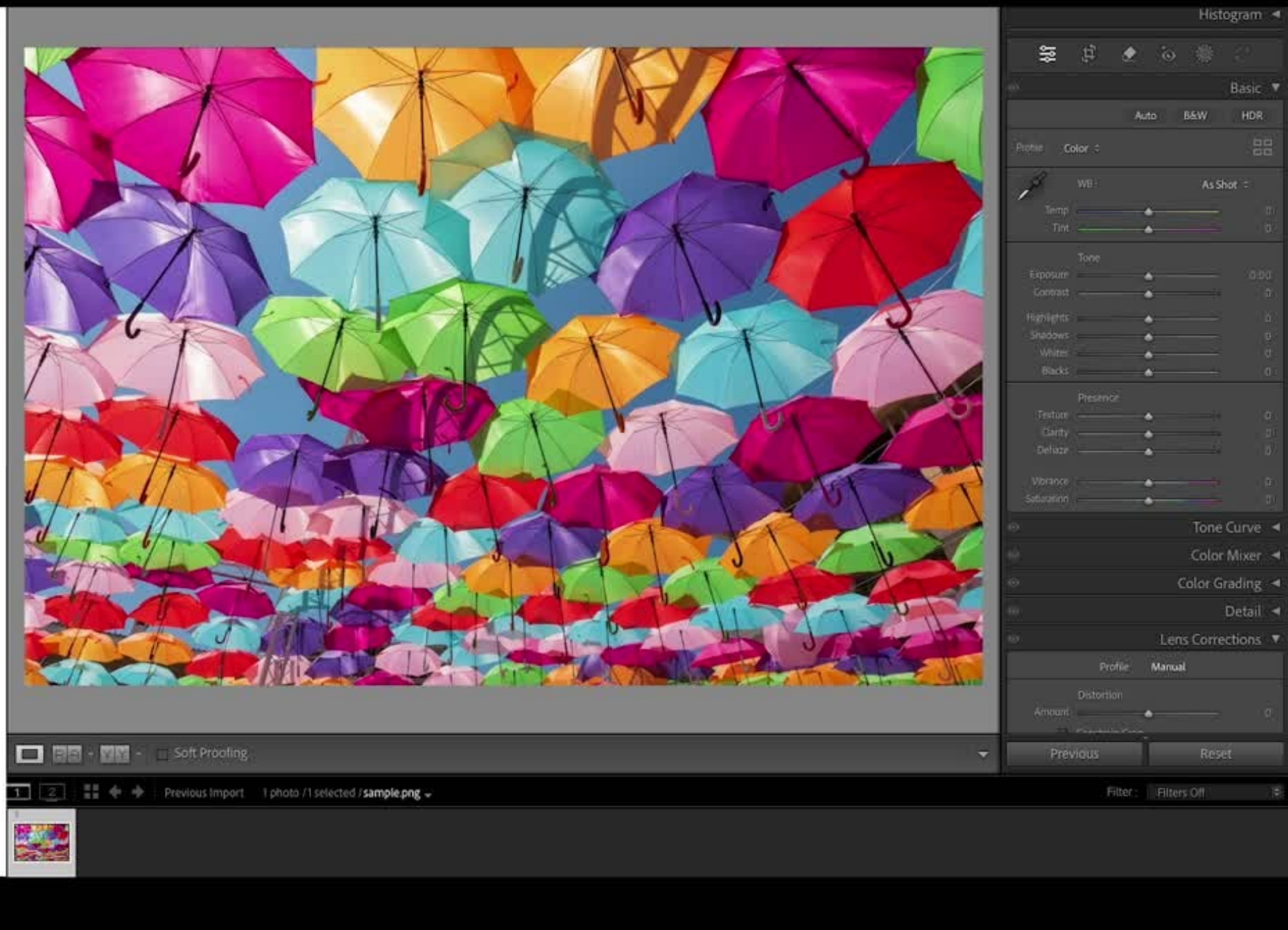


User Context

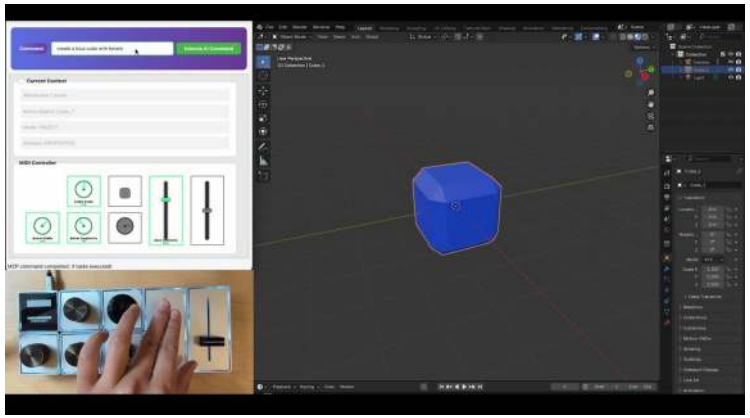



Temperature
Tint
Exposure
Contrast
Highlights
Shadows
Whites
Blacks
Texture
Clarity
Dehaze
Vibrance
Saturation
Scale Lens Profile Distortion


AKAI
MIDIMIX


Histogram
Basic
Auto
B&W
HDR
Profile
Color
WB
As Shot
Temp
Tint
Tone
Exposure
Contrast
Highlights
Shadows
Whites
Blacks
Presence
Texture
Clarity
Dehaze
Vibrance
Saturation
Tone Curve
Color Mixer
Color Grading
Detail
Lens Corrections
Profile
Manual
Distortion
Amount
Soft Proofing
Previous
Reset
Previous Import
1 photo / 1 selected / sample.png
Filter :
Filters Off

Applications



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(Monogram Creative Console)



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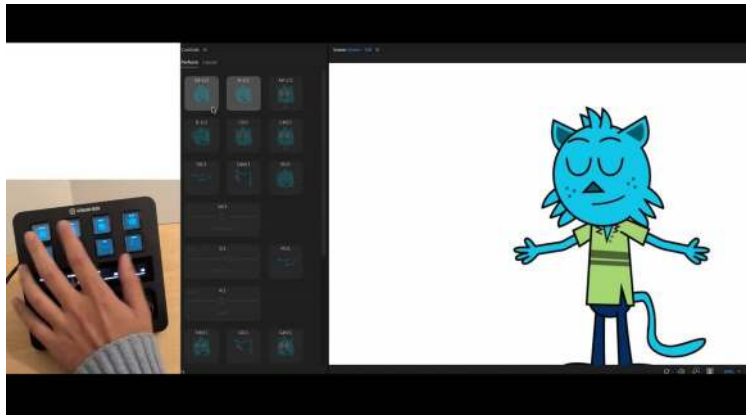

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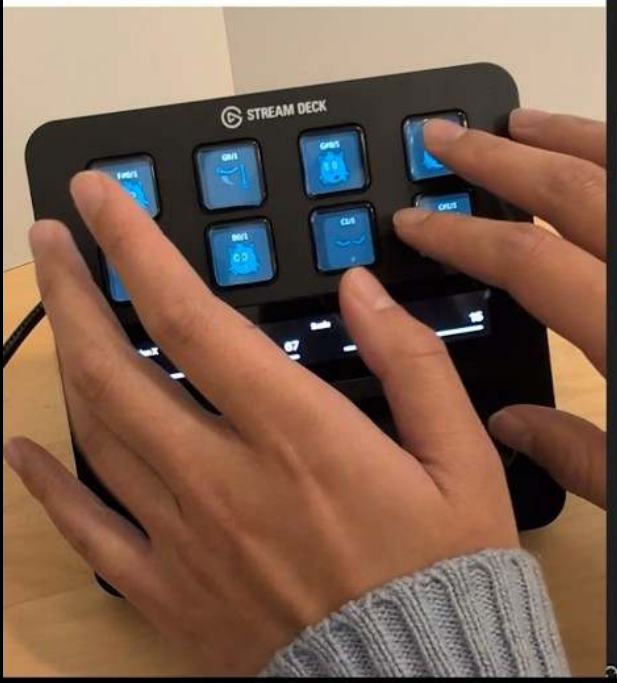
(Stream Deck+)



Controls

Perform Layout

16/1

Position X

3/1

Position Y

F0/1

4/1

Scale

F#0/1 G0/1 G#0/1

A0/1 A#0/1 B0/1

C1/1 C#1/1 D1/1

D#1/1 E1/1 F1/1

Scene: Scene - Tull



69%



STREAM DECK

G#-1/1

A-1/1

A#-1/1

B-1/1

C0/1

C#0/1

D0/1

D#0/1

Position X

65

Position Y

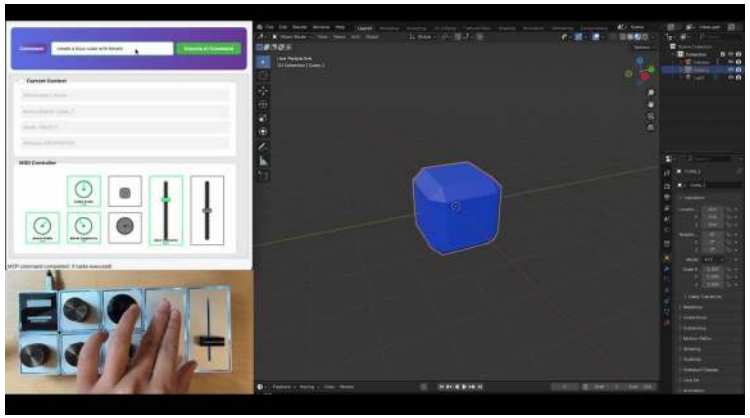
67

Scale

35

15

Applications



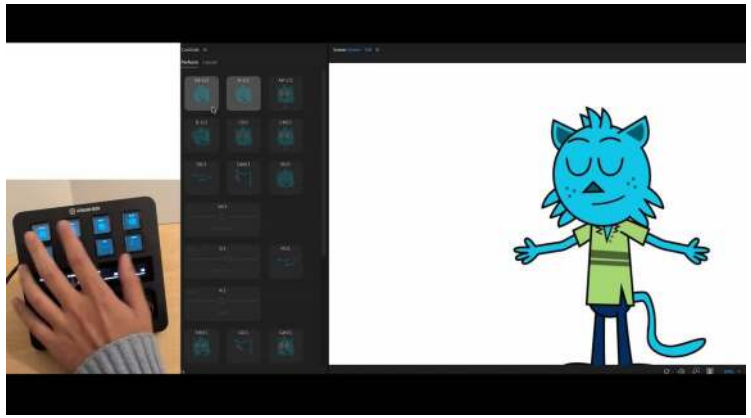
Natural Language
3D Modeling on Blender

(Monogram Creative Console)



Color Grading
and Music Editing

(Akai MIDIMix)



Character Animator

(Stream Deck+)

Technical Evaluation

Fixed-Layout Devices



ADJ HEX CON



Akai APC Key 25 MK2



DaVinci Resolve Mini Panel



Loupedeck+



Oberheim SEM



Teenage Engineering OP-Z



Pioneer DDJ-FLX4



Sony CCU-TX50

Configurable-Layout Devices



Xbox Controller



Monogram Creative Console



Elgato Stream Deck



Loupedeck CT



TourBox

99.1%

Widget-Type Agreement

Discussion

Learnability

Fixed

Muscle Memory

Dynamic

Large or Generated Parameter Spaces



Live Performance Puppeteering

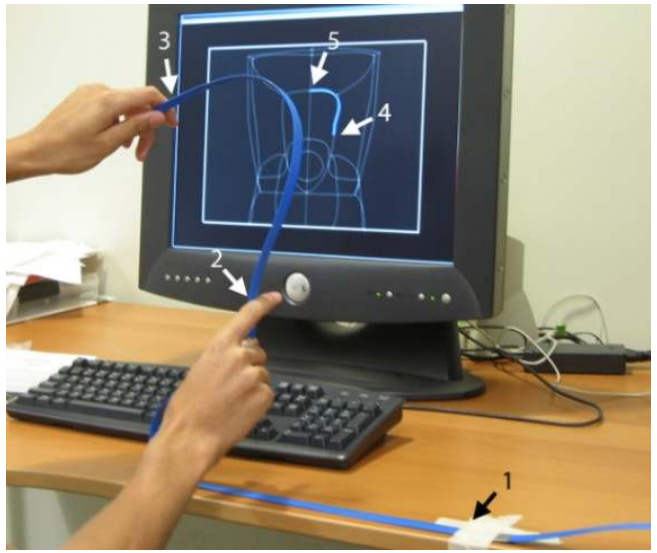
Lightroom

Blender

Limitations



Layout



Widget Type



On-screen Visualization

Future Work

Physical Controls for AI Agents



Codex Micro *(OpenAI and Work Louder, 2026)*

Physical Controls for AI Agents



Codex Micro *(OpenAI and Work Louder, 2026)*

Just-in-time Hardware

Just-in-case Hardware



Display Keys

Stream Deck+



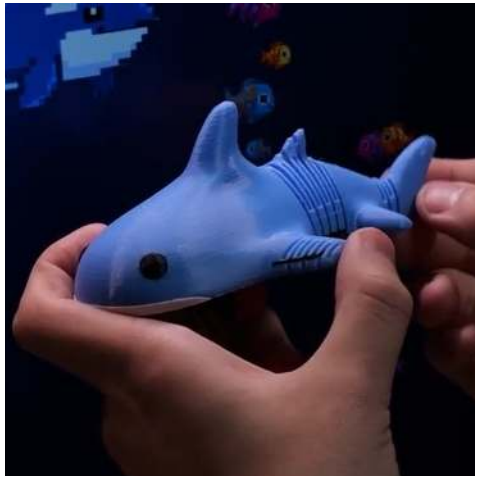
Modular Widgets

ClipWidgets, TEI 2022



Haptic Knobs

M5 Stack Haptic Knobs



Bespoke Input Devices

X-Hinges, UIST 2026


Tangible Game Controller
Score 4450
1X
DOF 1 - Rotate



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Yunyi Zhu, Chang Xiao

Paper and Video