

CVTILES

INTERNSHIP PROJECT

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Photron

CVTiles – Purpose

- ❖ **Goal:** utilize the Infinicam's high frame rate to **create high-definition scans, even for objects moving rapidly**
 - *By capturing just a single line of pixels at a time, we can stack these tiny images to make a single, large final image that shows movement over time in high detail*



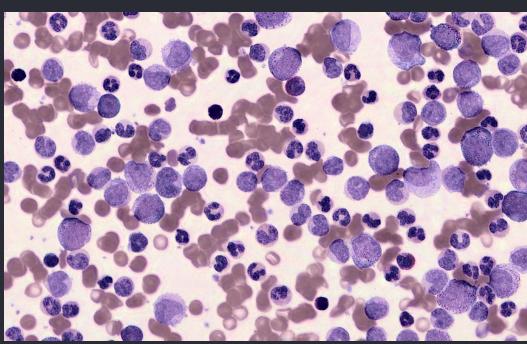
Photron

Example Use Case

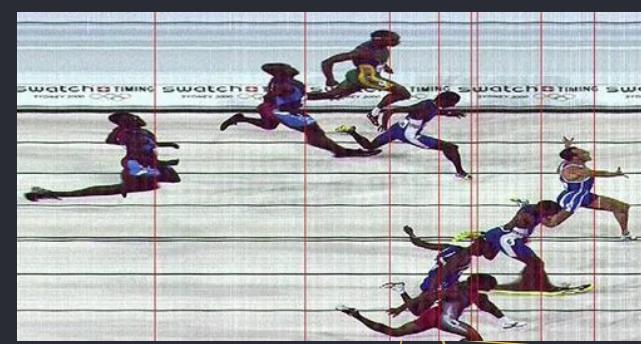
- ❖ **High-quality line scanning**
- ❖ **With the 1000s of images captured, the Infinicam can move across surfaces at fast speeds while still capturing high-quality images**



Museum Digitization



Blood Cell Scans



Sports

High Performance

- ❖ Dealing with 30K FPS requires high performance system design from beginning. CVTiles is Multi Threaded for high performance.

- ❖ **Capture Thread**

- FPS = 30,0000 => Must be Lightweight processing!
 - Decodes (also uses multiple threads) and then captures tile in ring buffer

- ❖ **UI Thread**

- FPS ~ 60 FPS
 - Draws the User Interface and Handles Keyboard and Mouse events

User Interface

The user interface diagram illustrates the layout of a Photron INFINICAM camera's control panel. It features several sections: a top header with the Photron logo, a central preview window, and various control panels for live video, histogram analysis, probe selection, trigger settings, and luminance controls.

LIVE CAM (Top Left): Includes a camera icon and a red-bordered "LIVE" button.

PROBE (Orange Box): A placeholder for probe selection.

HISTOGRAM (Green Box): Two histogram displays.

STATISTICS (Green Box): Displays Counter, Dropped Frames, and Avg Luminance values.

PREVIEW (Large Blue Box): The main video preview window with zoom controls (+, -, (s), and a clear button).

MANUAL SCAN (Left): Includes "SCAN" and "EXIT" buttons.

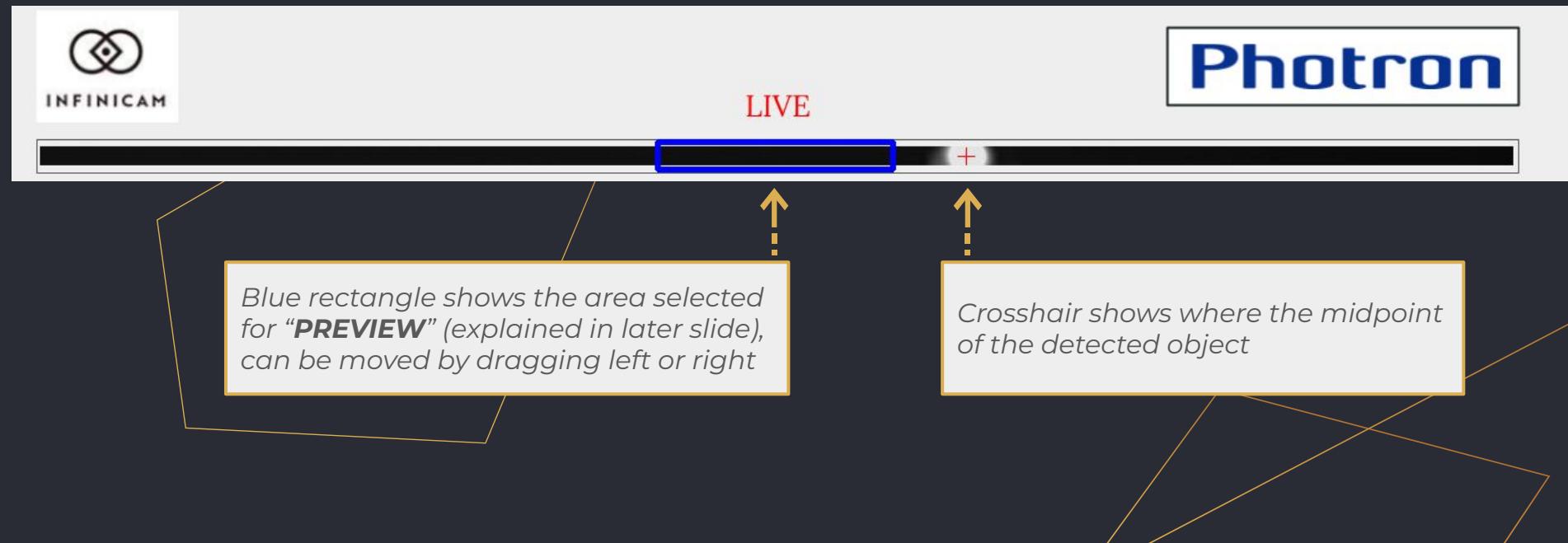
TRIGGER (Purple Box): Includes a green rectangular button, "Detect Mode" radio buttons (Light, Dark, Range), "Threshold" input, and "Time" input.

TRIGGER CONTROLS (Purple Box): Includes "LUMINANCE" checkboxes for Full Frame Average, Preview Only Average, and Noise Cancellation.

LUMINANCE CONTROLS (Pink Box): Located at the bottom right.

LIVE

- ❖ The **Live Cam** window displays a 1024 x 16 live feed straight from the Infinicam



PROBE

The red chart represents a probe across the centerline of the tile

Average luminance of middle row of pixels displayed as black line

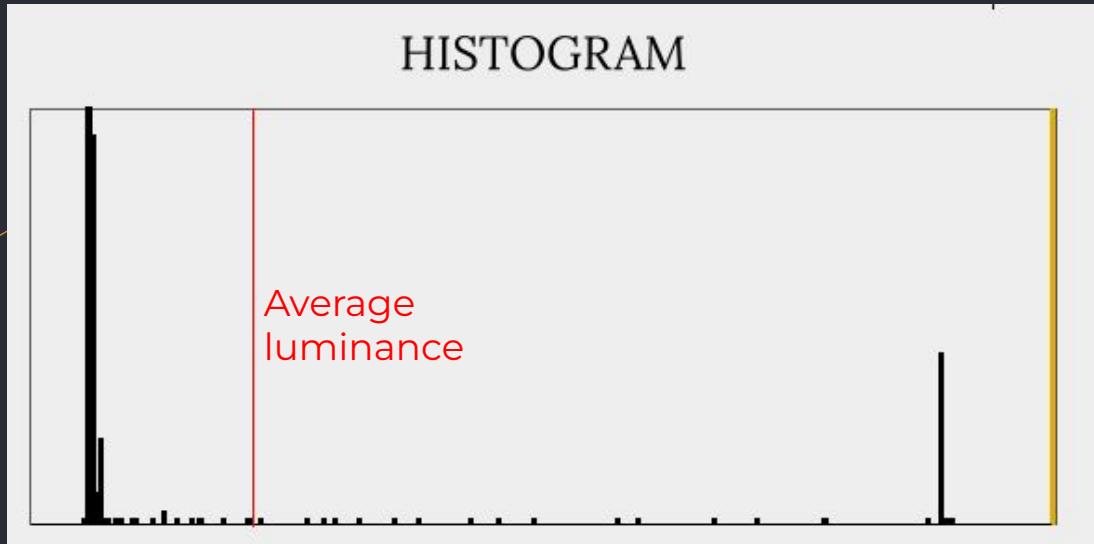


The Left Edge of
Object Detected

The Right Edge of
Object Detected

HISTOGRAM

❖ **Histogram** displays the distribution of luminance values across the center row of pixels from the Live Cam



STATISTICS

- ❖ **Statistics** box updates to show relevant info as camera moves / different controls are activated



Counter: **26821** [REDACTED]

Dropped Frames: **4.264662**

Avg Luminance: **13.200642**

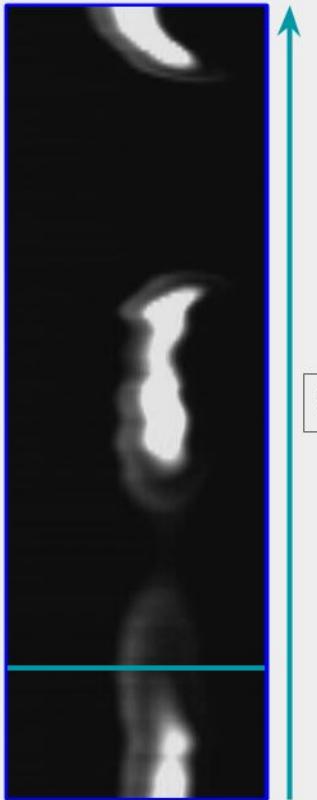
Displays the INFINICAM frame sequence number

Average # of dropped frames

Avg luminance across middle row of pixels from Live Cam

PREVIEW

PREVIEW



- ❖ The **Preview** window shows what has been captured by the Infinicam from the past 3 seconds
 - Window can be adjusted to show between the last 1-5 seconds
- ❖ *The purpose of the Preview window is to give the user a rough idea of what the final saved image will look like*

The preview window only displays 200 pixels of the full 1024 pixels captured by Infinicam; we can adjust which part of the feed is shown by sliding the blue box in the Live Cam.

Above are videos showcasing the Preview window in action.

LUMINANCE

The **Luminance** box allows users to control how luminance from the live feed is determined.

- 3 options: *Full Frame Avg.*, *Preview Only Avg.*, & *Noise Cancellation*

Given the same input from the live feed:

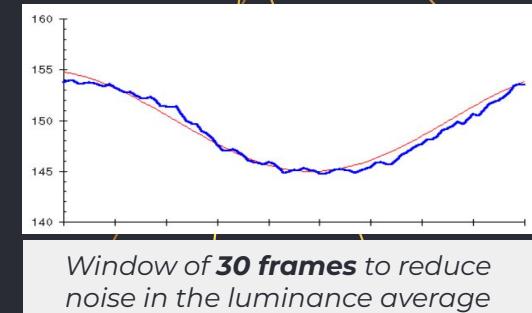
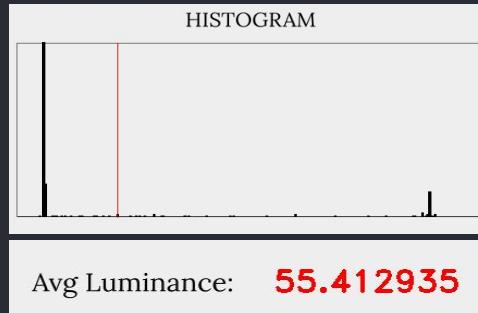
Mode selected:

- LUMINANCE**
- Full Frame Average
- Preview Only Average
- Noise Cancellation

- LUMINANCE**
- Full Frame Average
- Preview Only Average
- Noise Cancellation

- LUMINANCE**
- Full Frame Average
- Preview Only Average
- Noise Cancellation

Effect:



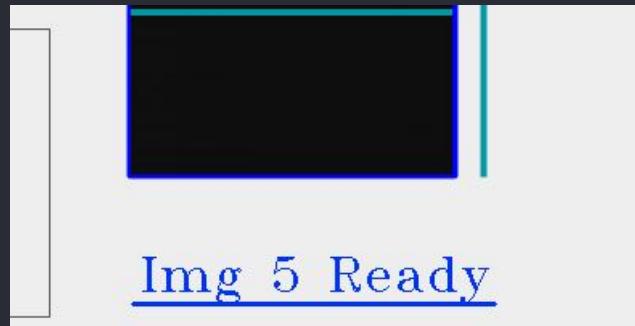
Manual Scanning

Clicking the “SCAN” button will immediately take a single row of pixels from the following 30,000 frames and stack them to create one large final image.

1.) Click “SCAN”



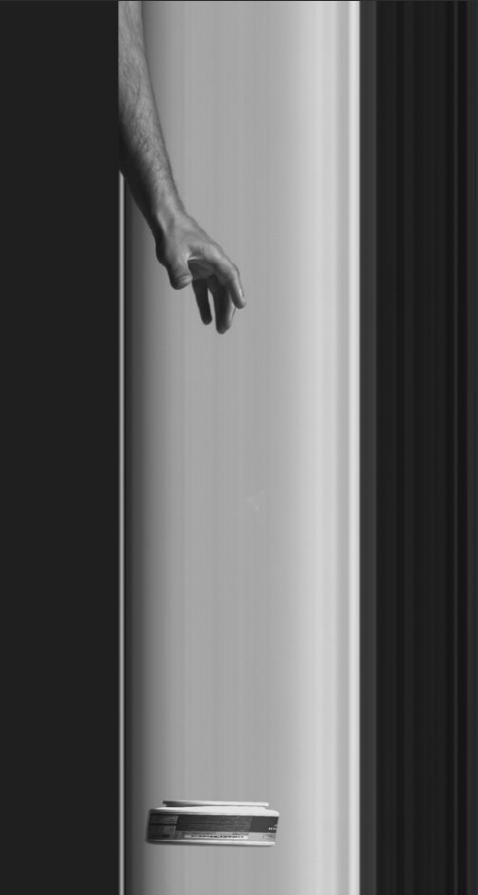
2.) Text will appear on the bottom right of UI. **Click “Img Ready” to view scan.**



3.) Scan will be displayed on screen. All previous scans are saved to files and automatically named as *test##*.

Name	Date
x64	6/3/2022 9:13 AM
cvtiles.cpp	6/3/2022 9:13 AM
cvtiles.vcxproj	6/3/2022 9:13 AM
cvtiles.vcxproj.filters	6/3/2022 9:13 AM
cvtiles.vcxproj.user	5/30/2022 7:33 PM
cvtiles_background	7/7/2022 11:26 AM
test0	7/12/2022 10:08 PM
test1	7/12/2022 10:08 PM
test2	7/12/2022 10:08 PM
test3	7/12/2022 10:08 PM
test4	7/12/2022 10:08 PM

Manual Scanning – Results & Pitfalls

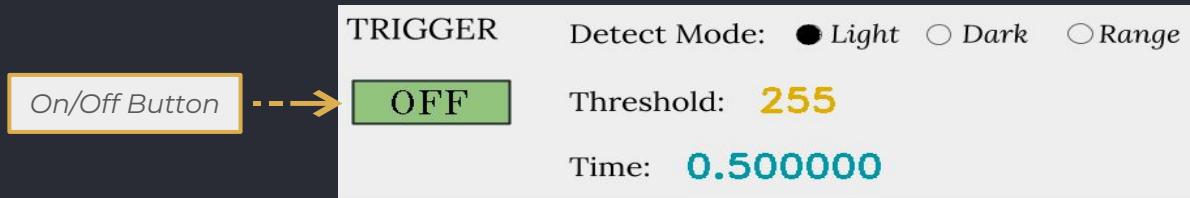


Issue: Manually clicking the “SCAN” button exactly when needed, especially when scanning fast-moving objects, is very difficult. This is addressed through the **Trigger**.

Trigger

The **Trigger** will automatically create a scan when it detects that an object has passed in front of the Infinicam.

How this is determined can be changed with the following settings:



It would be preferable to not always have the scan begin when the object is detected (as the object would always be at the very bottom).

Thus, the **Time** gives a delta value in the past for when the scan will begin from.

The bullet would get scanned when it first passes the turquoise line.



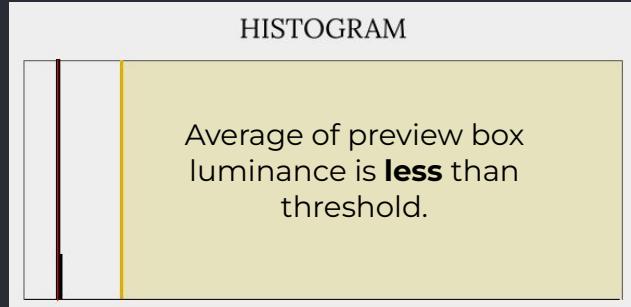
Light Trigger

When Detect Mode is on “LIGHT”, **the Trigger only activates when the average luminance crosses above the set threshold.**

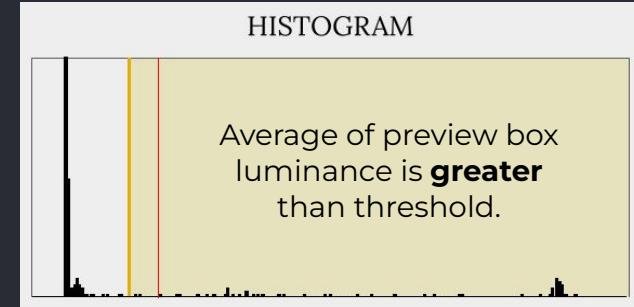
Light trigger works best when **a bright object is going to pass through a dark background.**



on a dark background...



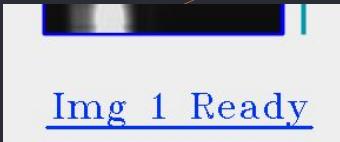
if we bring in a bright object...



With the following settings...

TRIGGER	Detect Mode:	<input checked="" type="radio"/> Light	<input type="radio"/> Dark	<input type="radio"/> Range
ON	Threshold:	41		
	Time:	0.500000		

...trigger will be set off and we will have a scan ready!



Dark Trigger

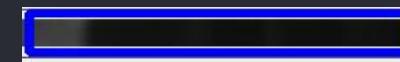
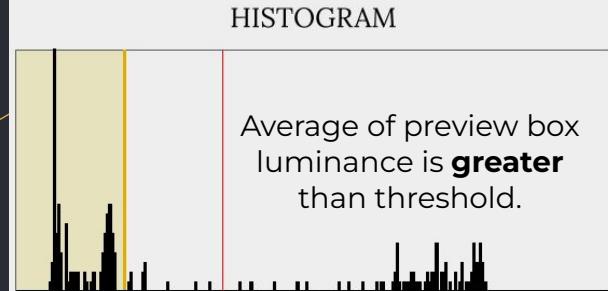
When Detect Mode is on “DARK”, **the Trigger only activates when the average luminance crosses below the set threshold.**

Dark trigger works best when **a dark object is going to pass through a light background.**



on a light background...

HISTOGRAM



if we bring in a dark object...

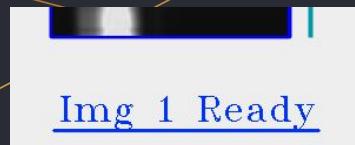
HISTOGRAM



With the following settings...

TRIGGER	Detect Mode:	<input type="radio"/> Light	<input checked="" type="radio"/> Dark	<input type="radio"/> Range
	Threshold:	46		
	Time:	0.500000		

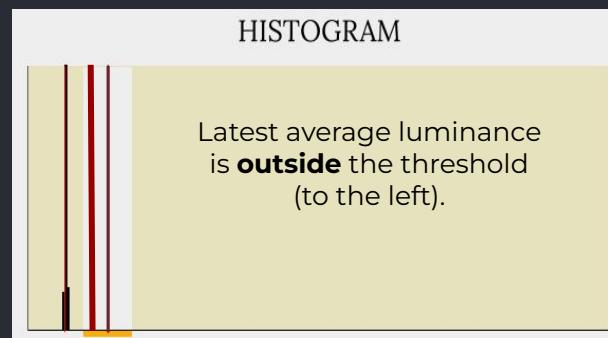
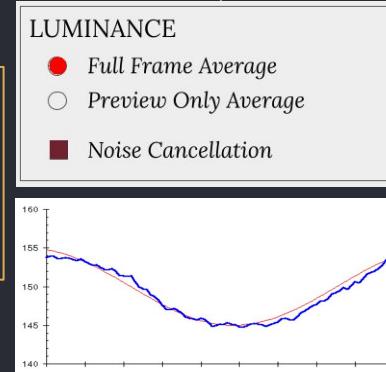
...trigger will be set off and we will have a scan ready!



Range Trigger

When Detect Mode is on “RANGE”, **the Trigger only activates when the average luminance rapidly changes** (either increases or decreases) **above or below the given threshold range**.

- In order for “RANGE” mode to be able to work, we need to know what the previous luminance averages were, on average, to determine when the current luminance average changes.
- This process is done via Noise Cancellation, an option in the **Luminance** box
 - This option **CANNOT** be deselected when in “RANGE” mode
- Thus, the **Histogram** shows both the LATEST average (fast-moving) and the average calculated by Noise Cancellation (slow-moving, in dark red).

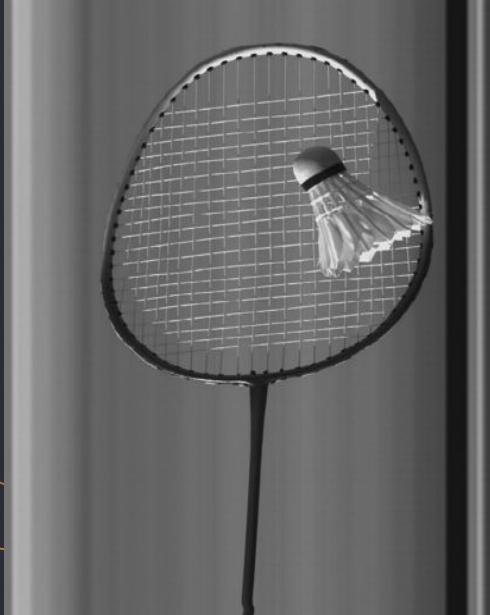


Final Result - Experiments



Final Results

Badminton



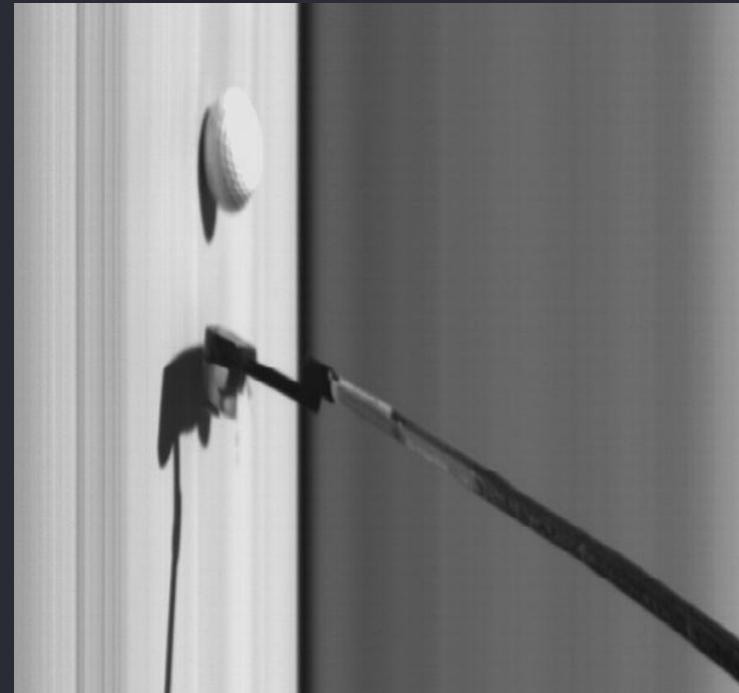
Final Results

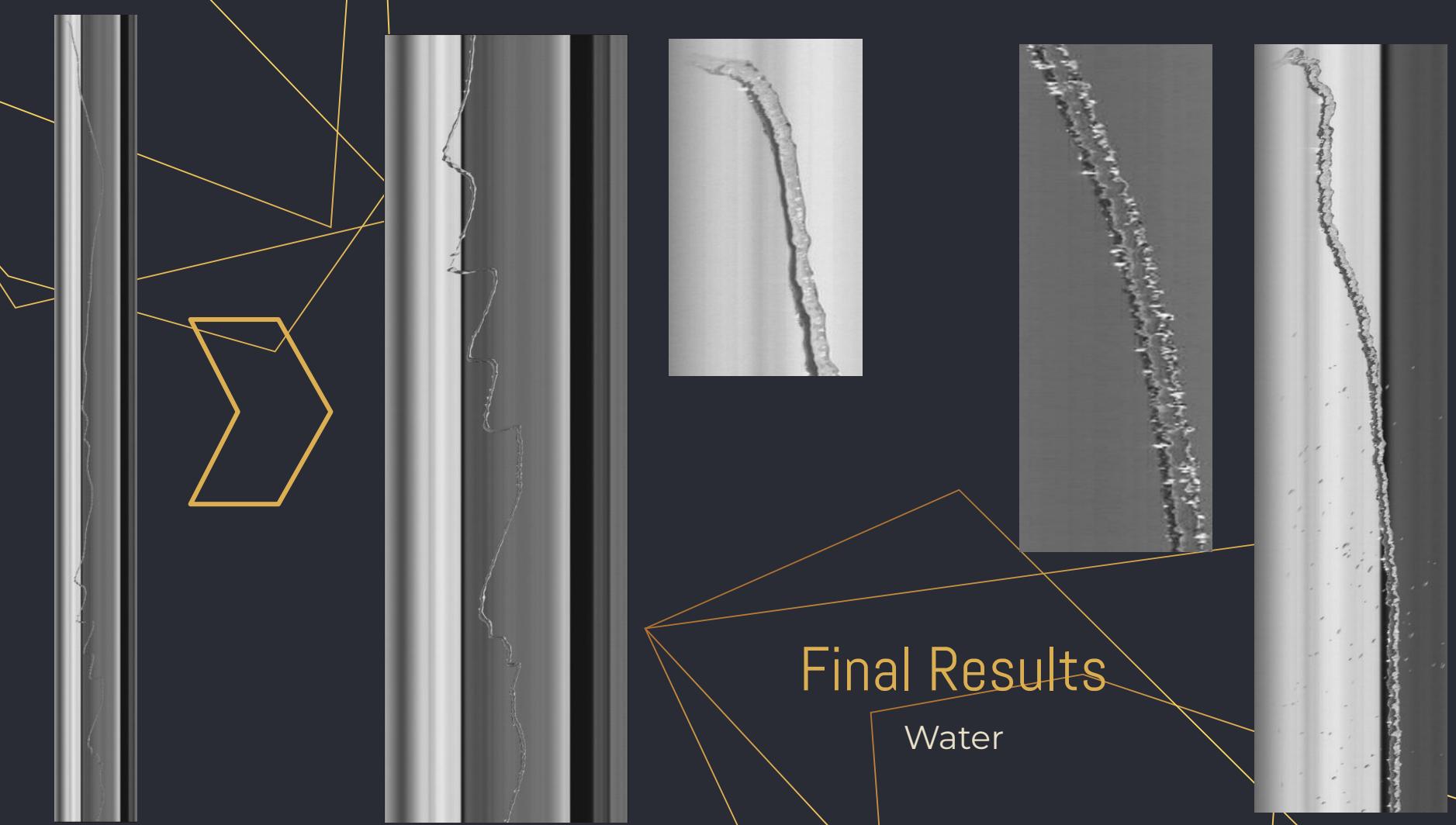
Tennis



Final Results

Golf





Final Results

Water

Potential Future Work

30K x 30K Images

Combine Horizontal (1k x 30k) and Vertical Scans (30K x 1k) into Scan (30k x 30k)

OpenGL

*Viewing large scale images using OpenGL similar to the Imagica app, **Infinite Pixel Viewer***

Optimization

Other quick algorithms that can be done in 30K FPS - traditional approach is not possible as it would be too slow, so use simple algorithms.

- Consider using GPUs; batching tiles into larger images and processing batches together

Info

https://github.com/photonrondev/infinicam-sdk/tree/mehar_internship/src/cvtiles

The screenshot shows a GitHub repository page for the 'infinicam-sdk' repository, specifically the 'cvtiles' branch. The URL in the address bar is https://github.com/photonrondev/infinicam-sdk/tree/mehar_internship/src/cvtiles. The page title is 'photonrondev / infinicam-sdk' (Private). The main navigation menu includes Code, Issues, Pull requests, Actions, Projects, Security, and Insights. The 'Code' tab is selected. The breadcrumb navigation shows 'mehar_internsh... / infinicam-sdk / src / cvtiles /'. A message indicates that 'This branch is 28 commits ahead of main.' Below this, a commit titled 'mehar-samra trigger now operational for Range mode' is shown, along with other files like README.md and cvtiles.sln. At the bottom, there is a link to 'README.md'.

photonrondev / infinicam-sdk Private

Code Issues Pull requests Actions Projects Security Insights

mehar_internsh... / infinicam-sdk / src / cvtiles /

This branch is 28 commits ahead of main.

mehar-samra trigger now operational for Range mode

cvtiles trigger now operational for Range mode

README.md updated README

cvtiles.sln added cvtiles

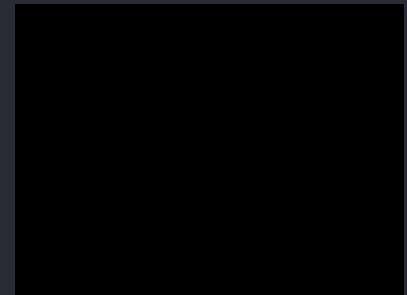
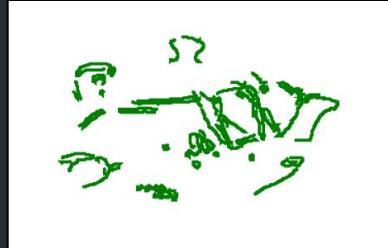
README.md

cvtiles

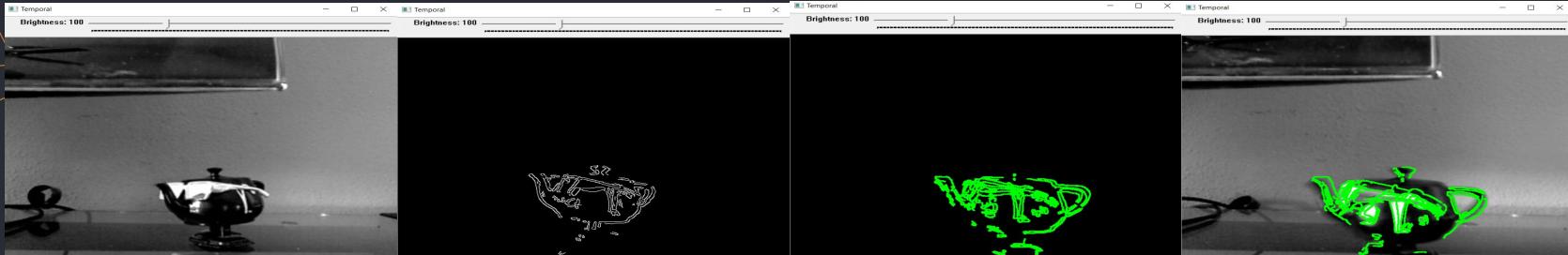
EXTRAS

OTHER PROJECTS FROM THIS INTERNSHIP

Temporal Project



- ❖ The primary goal is to send high speed camera data across the Internet by vectorizing the images from the high speed camera and sending vector data across the Internet via a simple websocket server
 - Specifically sends polyline “edges” by using contour detection.



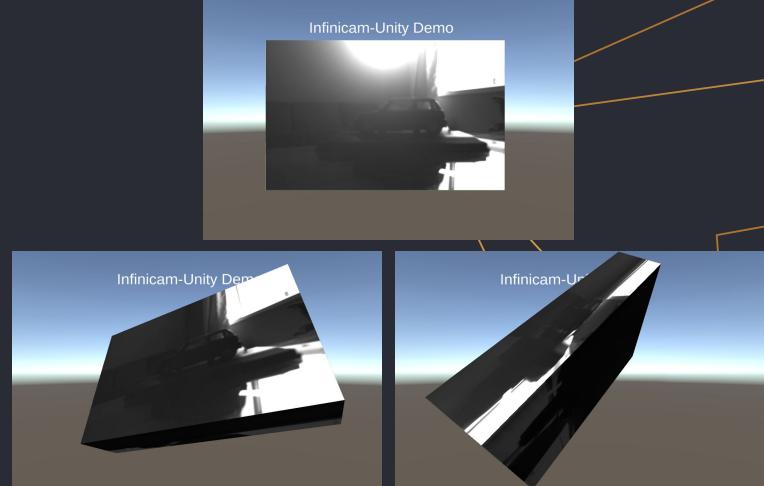
Unity Project

❖ Display the feed from Infinicam onto GameObjects in Unity

➤ *The resulting object would be completely interactable within the game project, just like any other object in the scene.*



*Video would show in
real-time on texture
mapped to a polygon.*



Thank you!

Mehar Samra

Thank you for an amazing
opportunity to be a part of Photron
and the Imagica team!