UiO : Department of Technology Systems
University of Oslo

Introduction to TEK5030 – Computer Vision

19.01.2024

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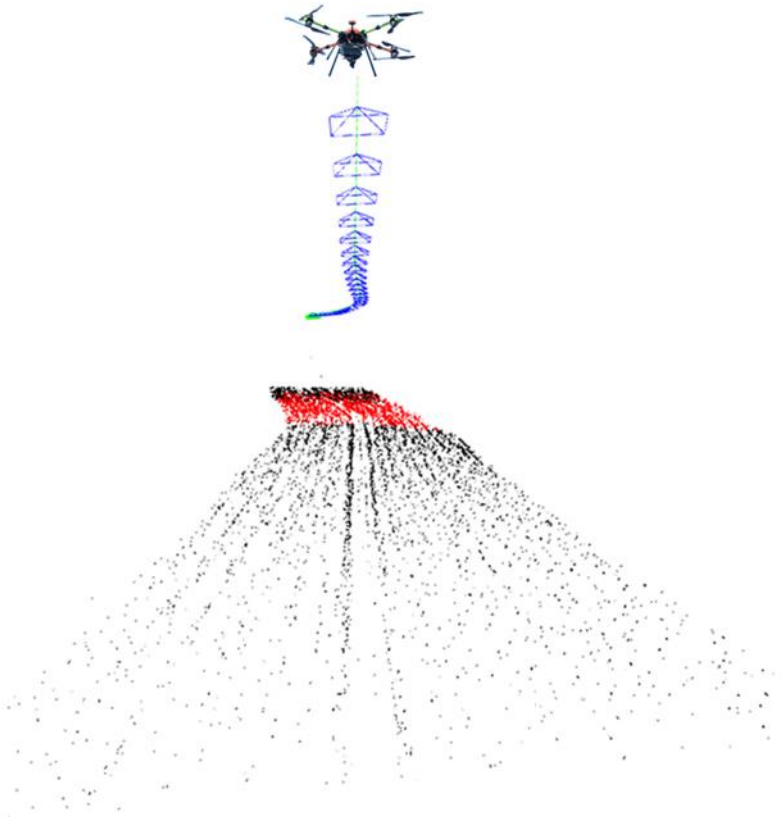

Today

- A quick introduction to computer vision
- About the course

- Lab: An introduction to OpenCV
  - Processing live video streams with OpenCV!

Illustration: Generated by Midjourney

«An image is worth more than a thousand words»

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How can we extract
this information?

Images and pixels

Images and pixels

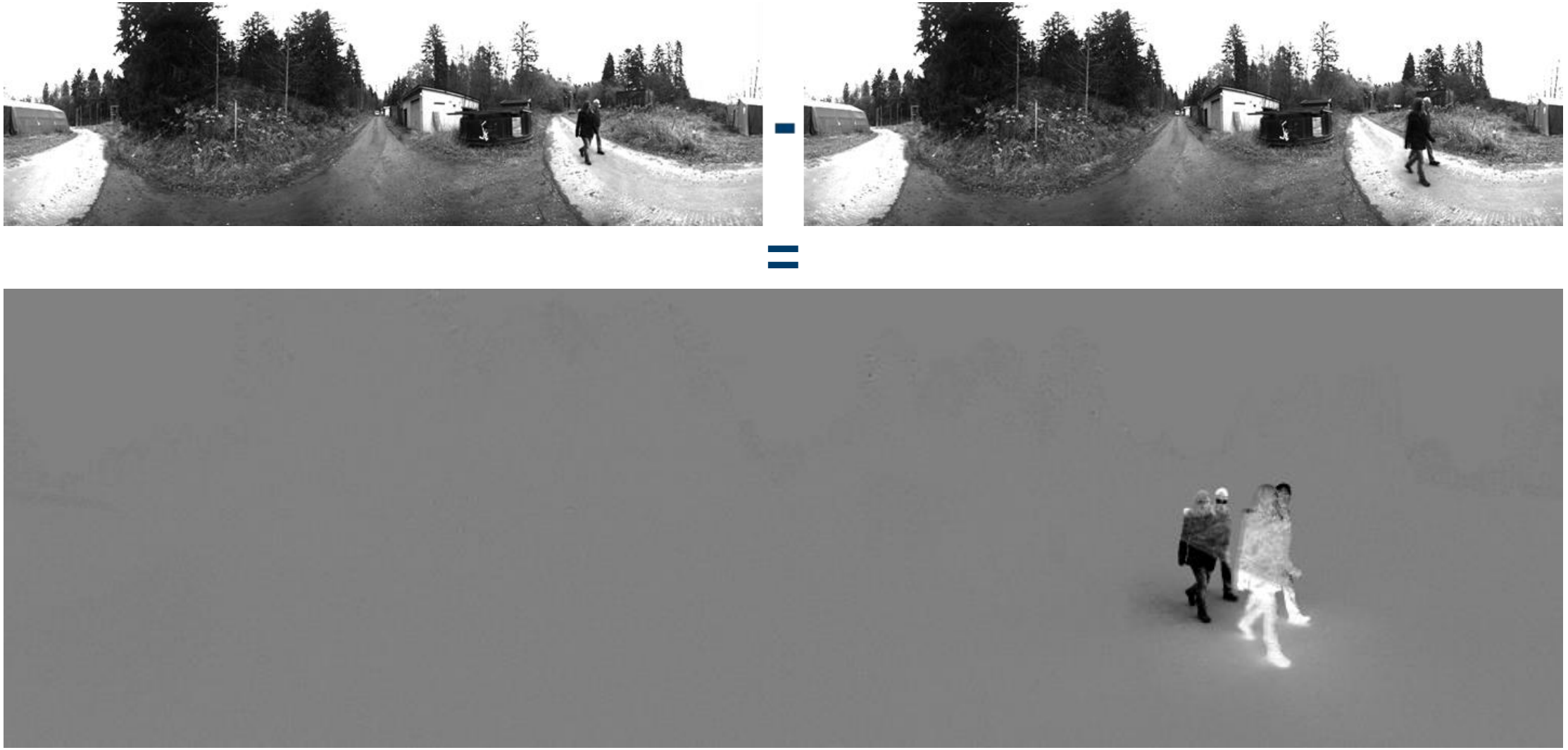
Images and pixels

Images and pixels

Images and pixels

It is easy to calculate with images!

It is easy to calculate with images!



How fast can a machine crunch pixel values?

Illustration: Generated by Midjourney

Floating point operations (FP32) per second (FLOPS)

Photo: Miiicihiaieil Hieinizilieir (CC BY-SA 4.0)

Raspberry PI 4B
48 GFLOPS

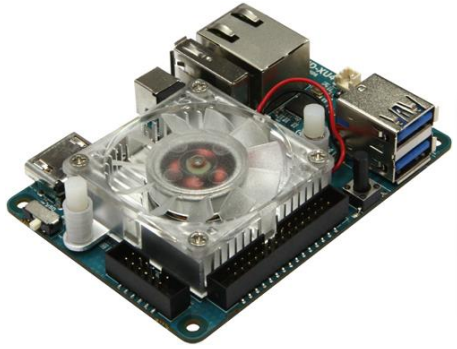


Photo: Alexandre.willame (CC BY-SA 4.0)

Odroid XU-4
214 GFLOPS

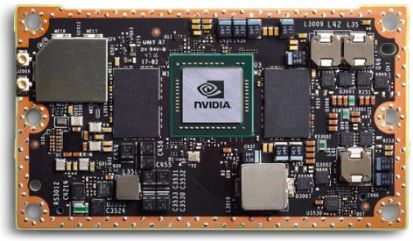


Photo: NVIDIA

Jetson TX2
782 GFLOPS

Photo: HP

My laptop
3 TFLOPS

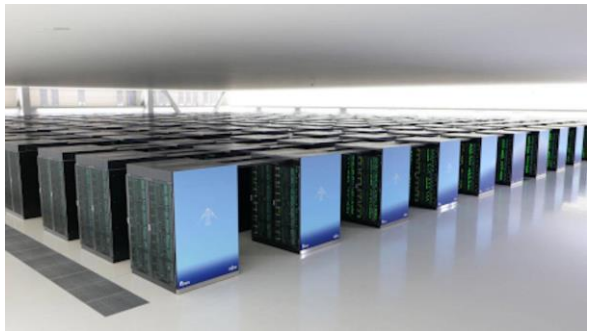
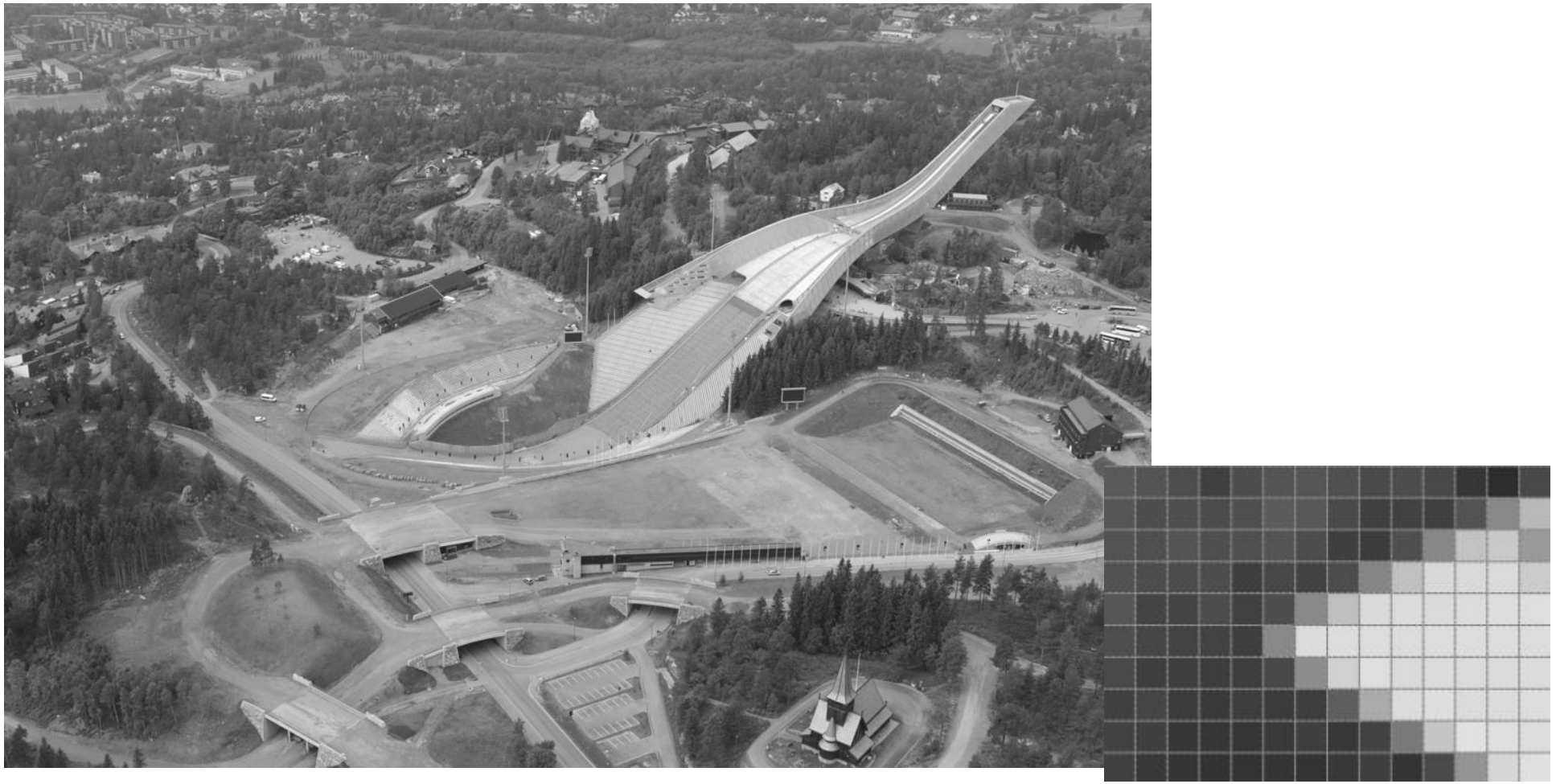


Photo: RIKEN

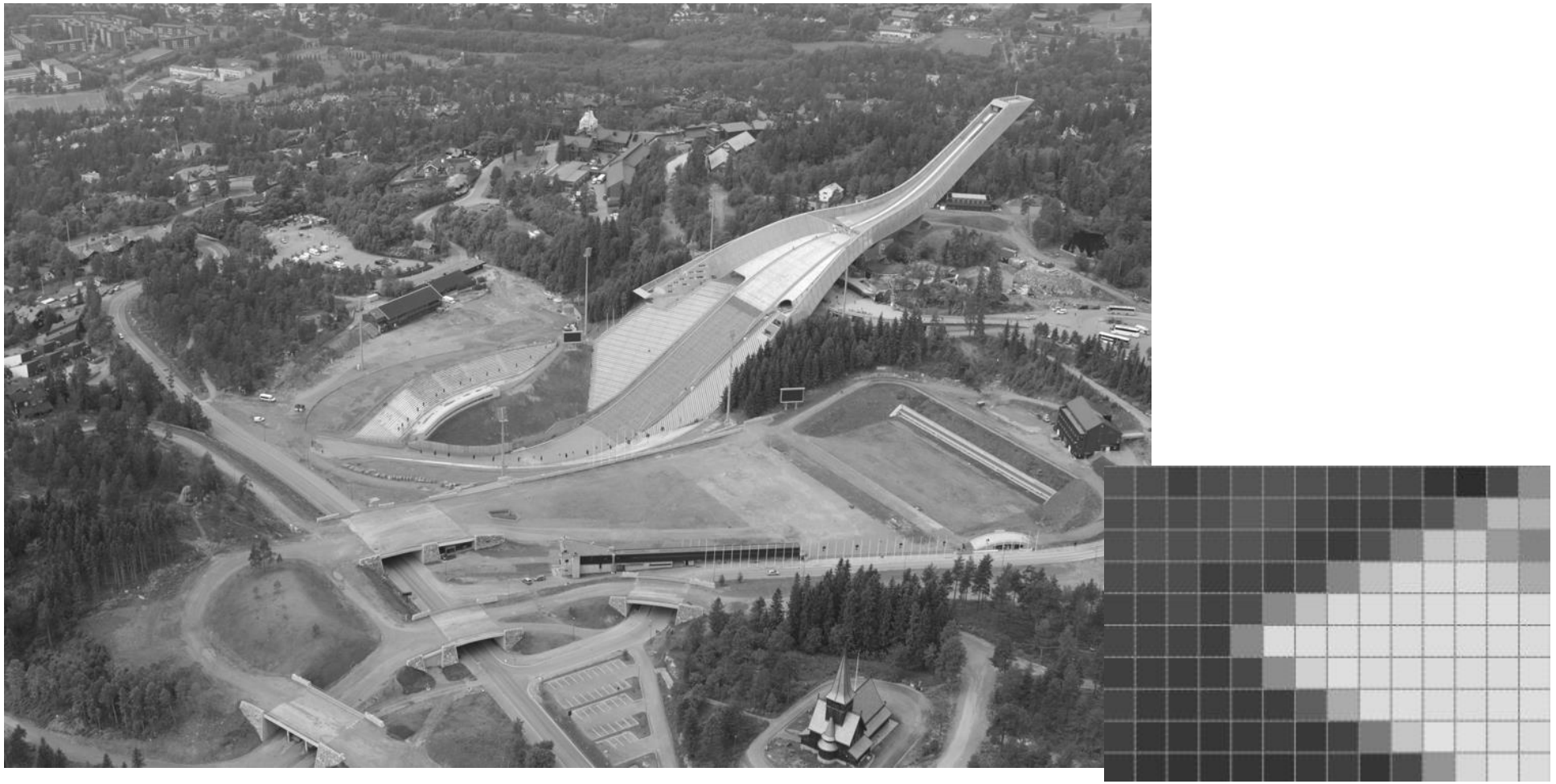
Fugaku supercomputer
>1000 PFLOPS

(theoretical *peak*)

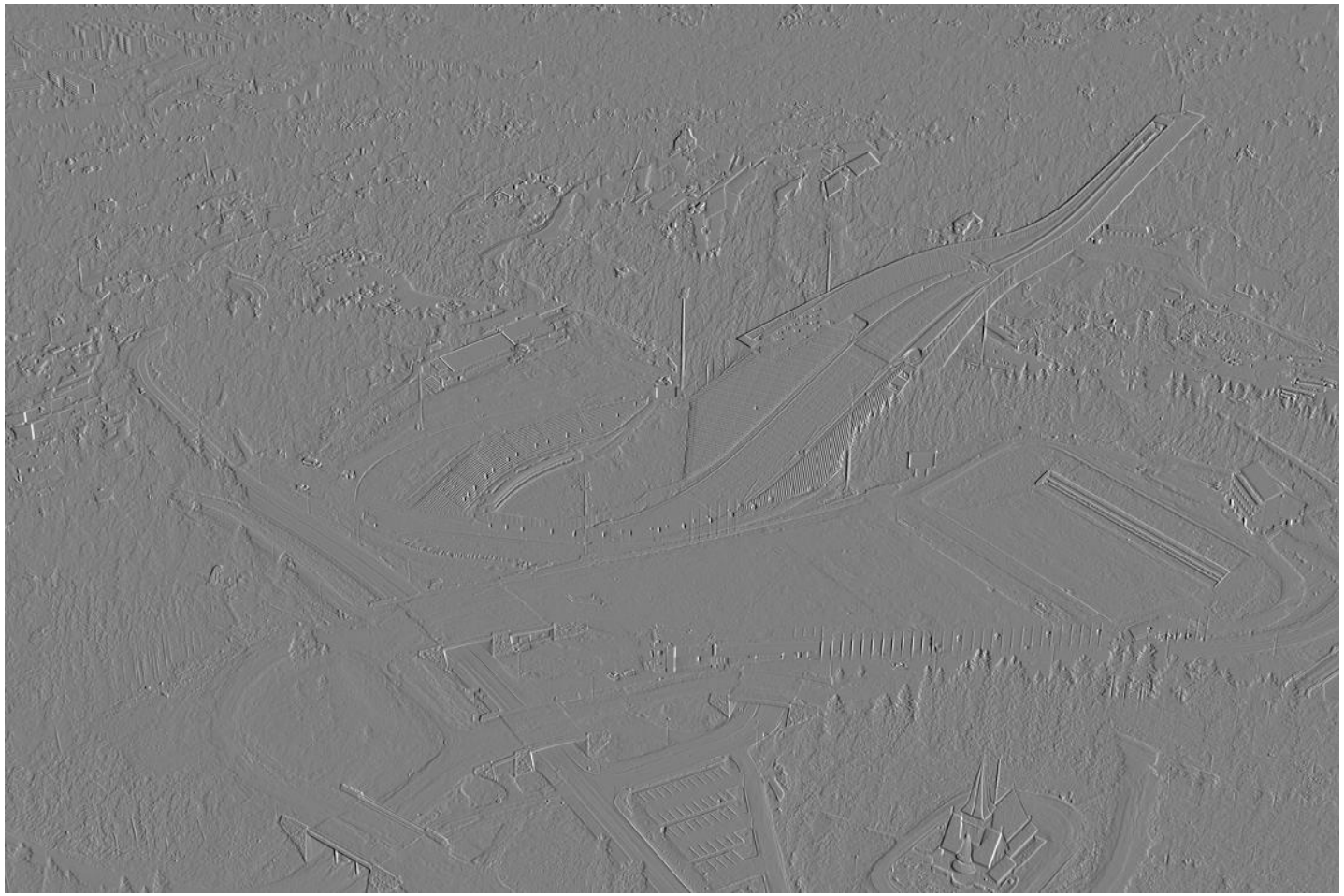
The difference between neighbouring pixels



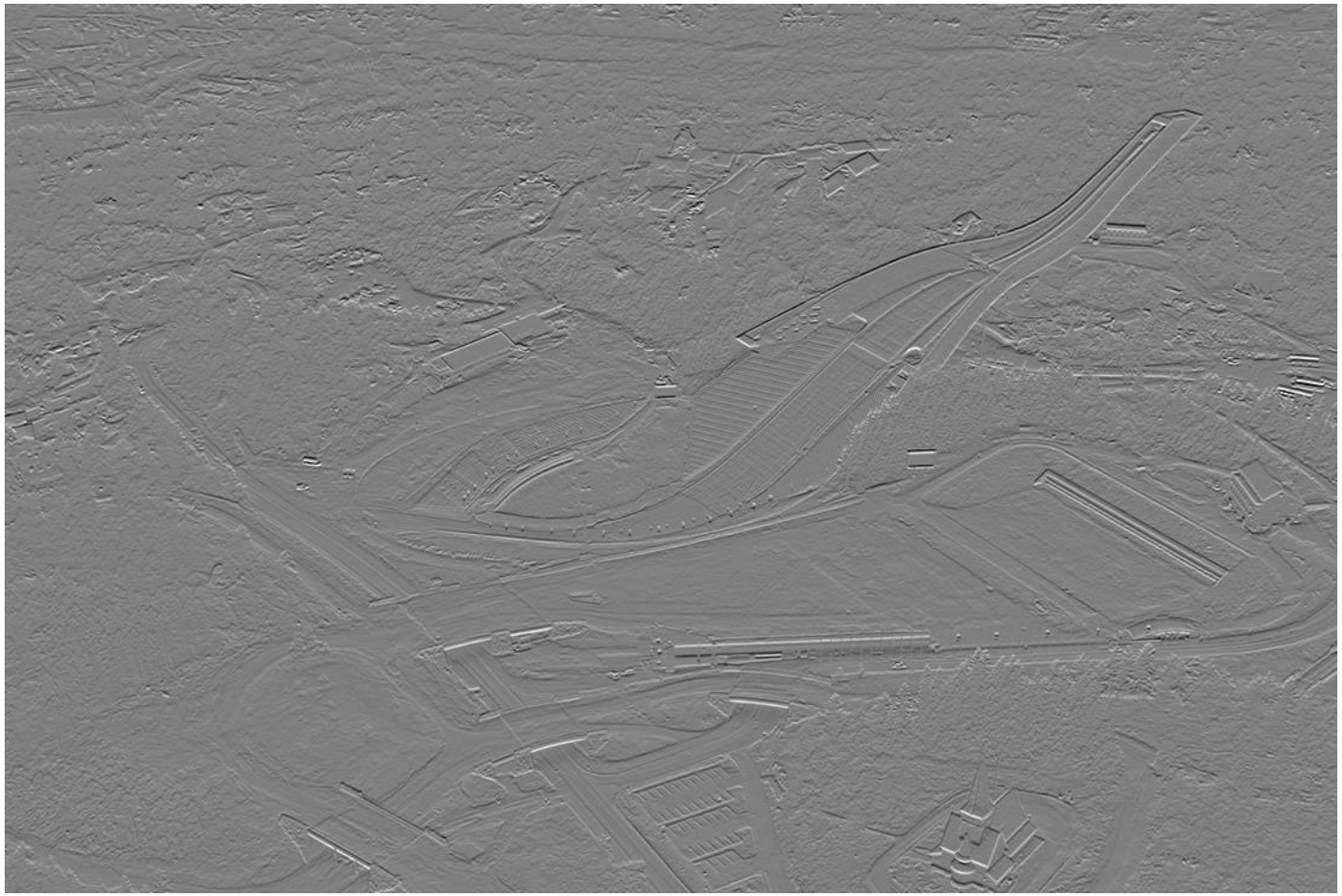
The difference between neighbouring pixels



Horisontal differences



Vertical differences



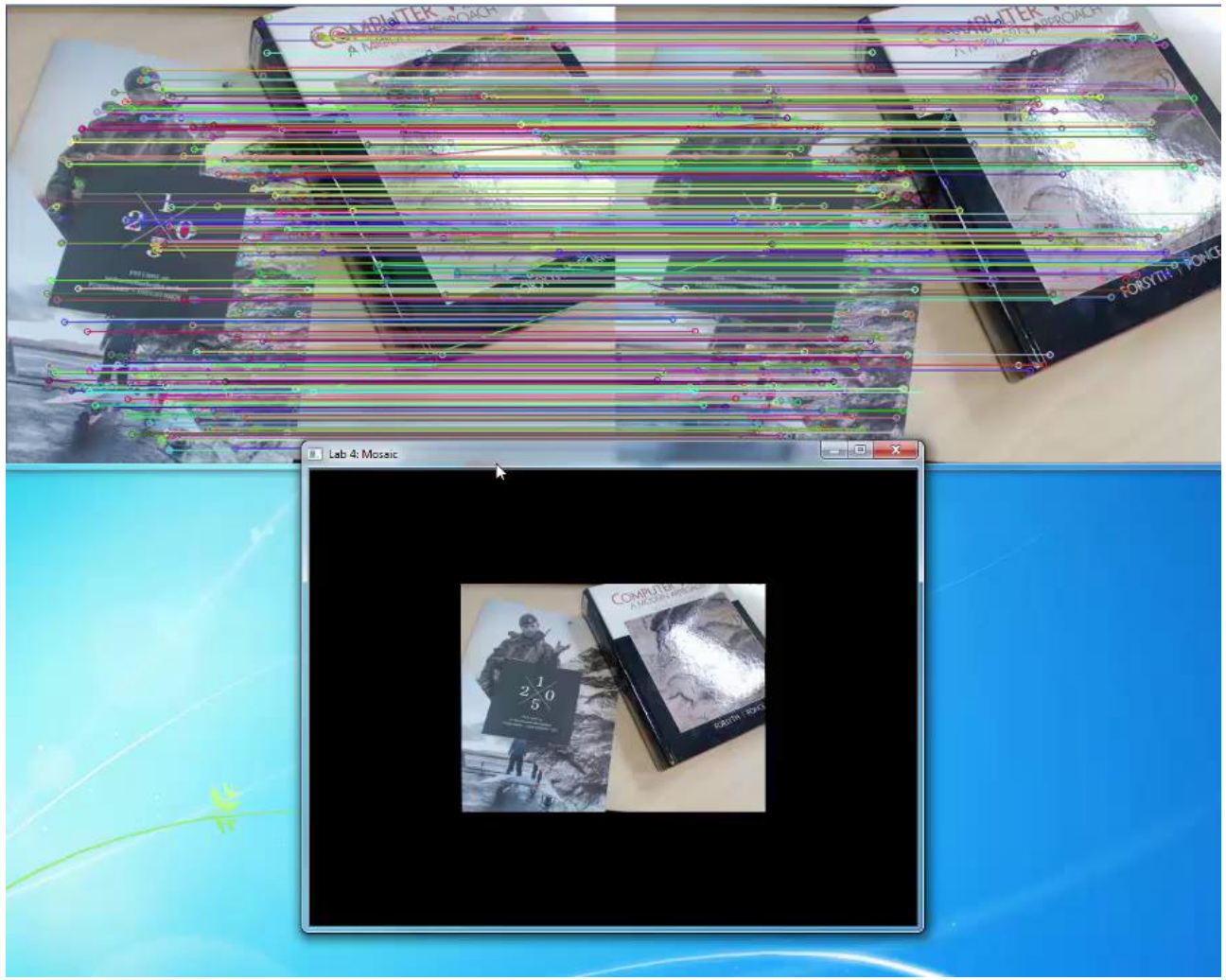
Edges and corners

Significant corners

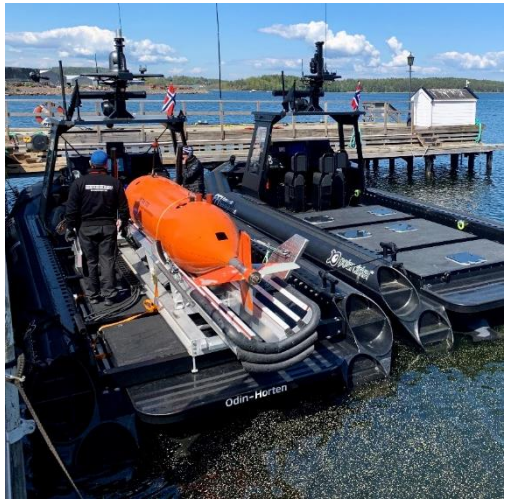
Significant corners

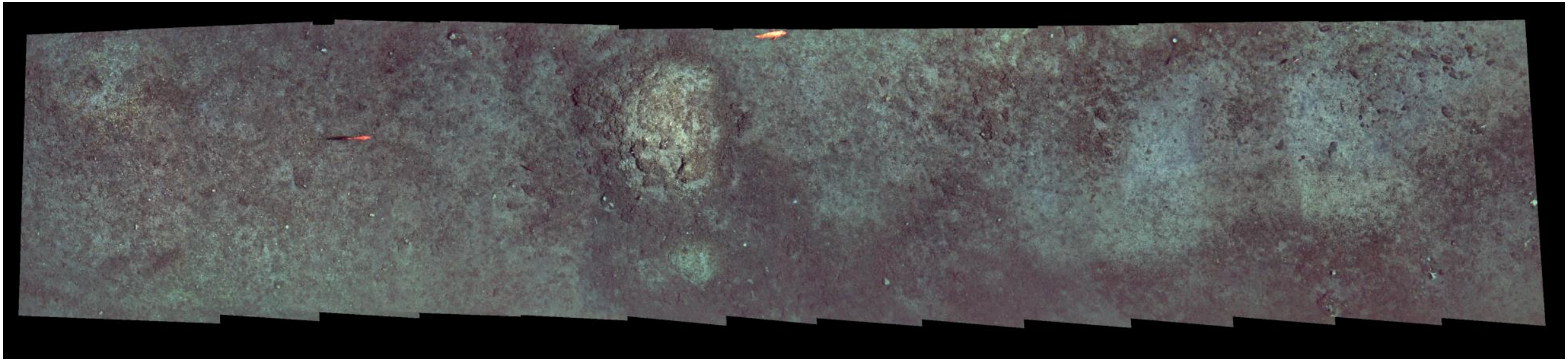
Significant corners

Example: Coregistering images

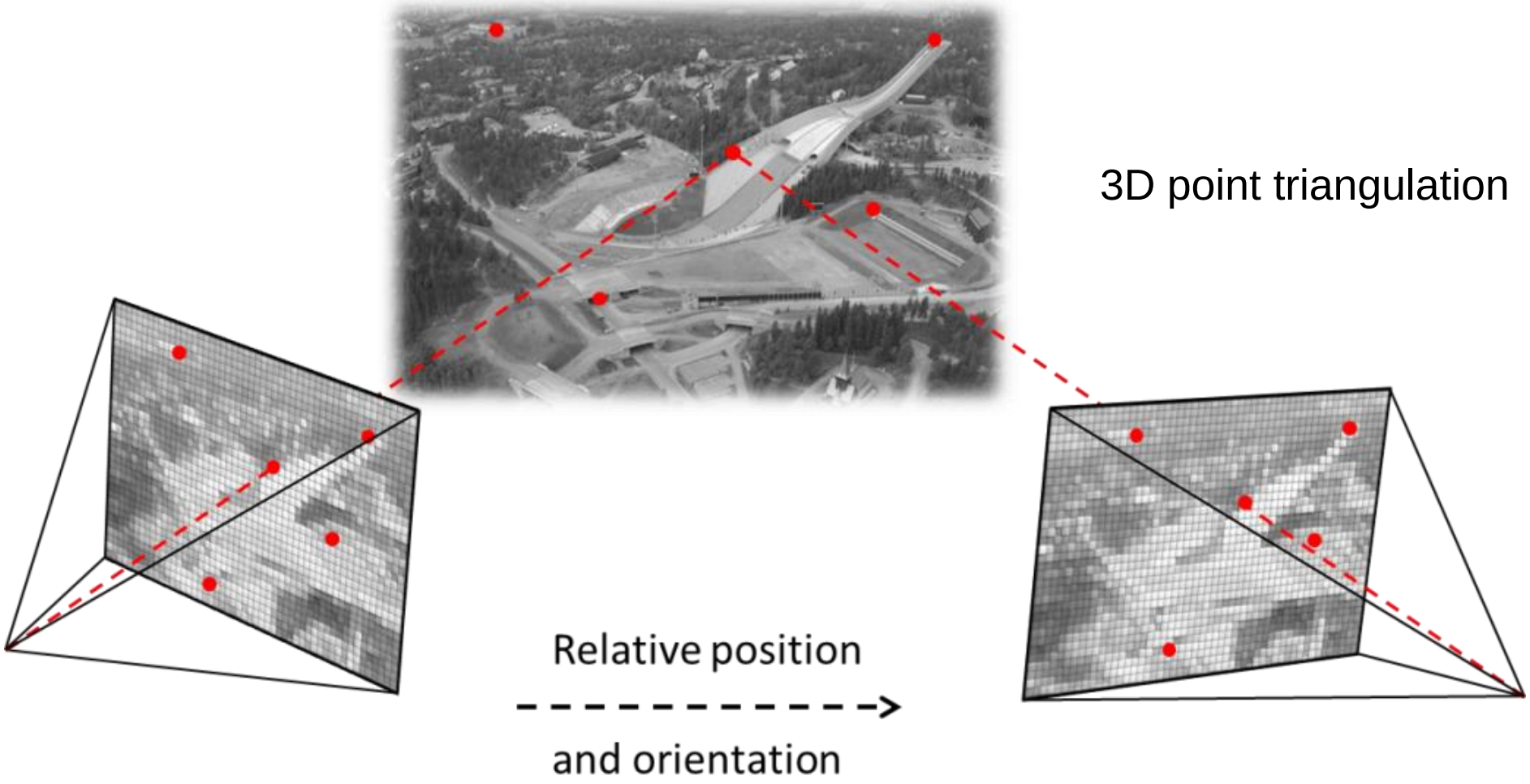


Application: Underwater visual mapping from HUGIN AUV

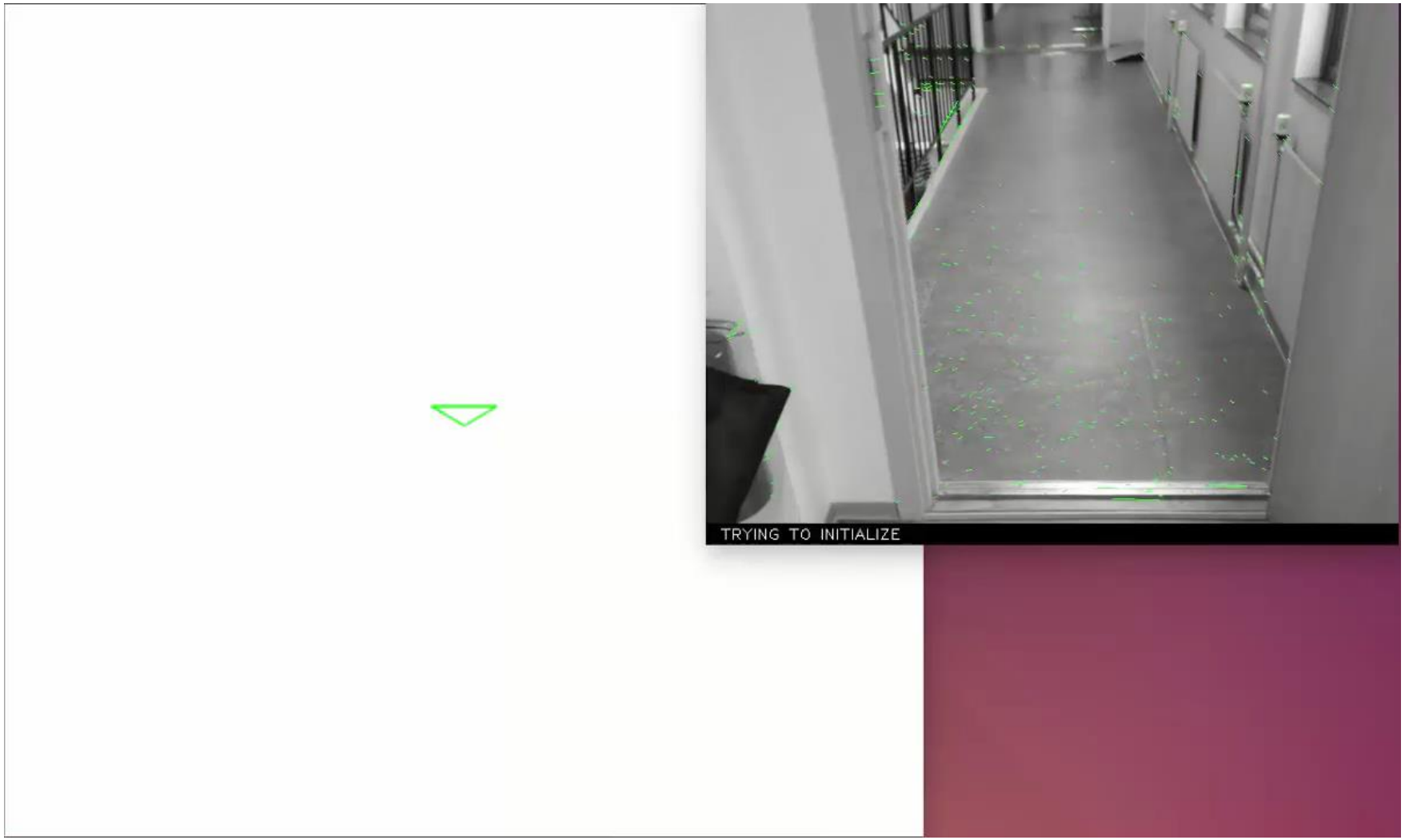




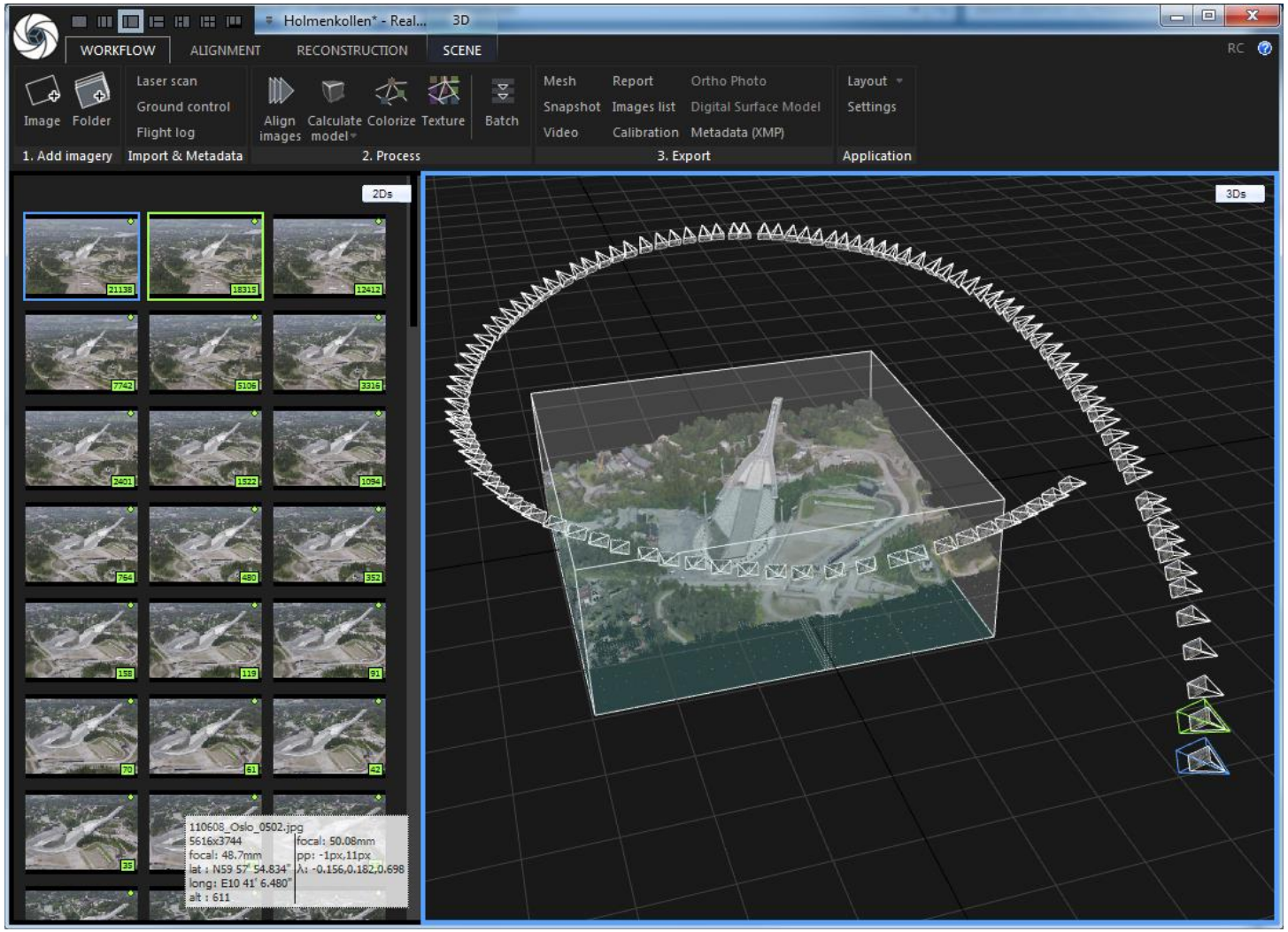
Extracting geometric information from images



Visual navigation

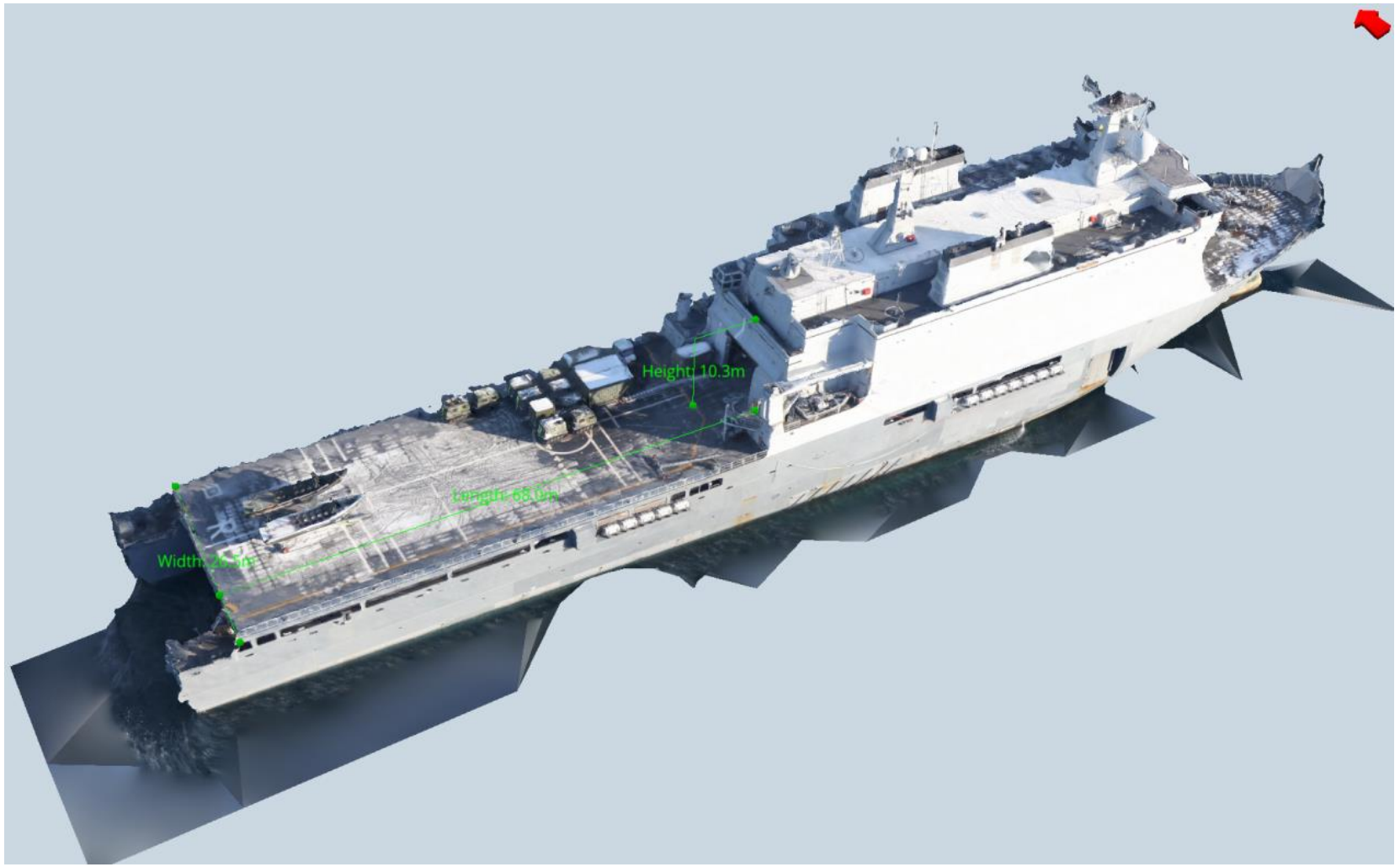


3D reconstruction from images

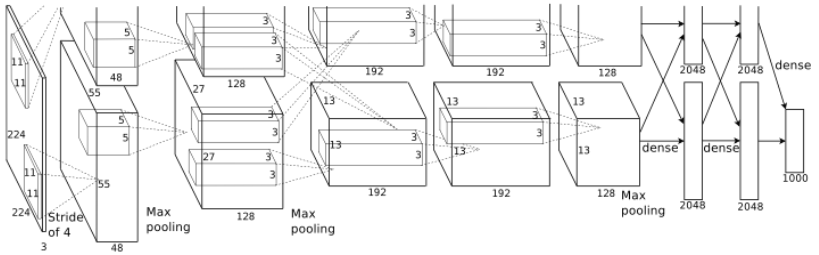


A detailed 3D surface in colors!

Recognise the shape of a ship

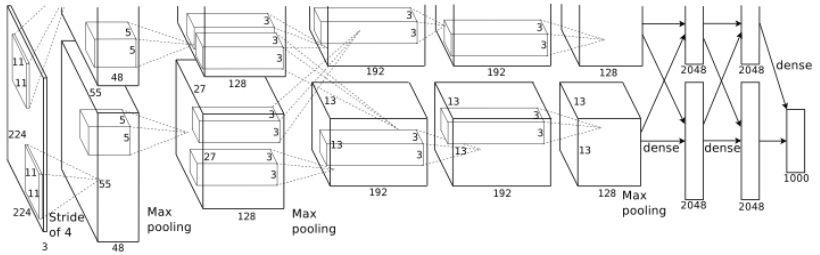


Let the machine learn a better representation itself!



«Warship»

Let the machine learn a better representation itself!



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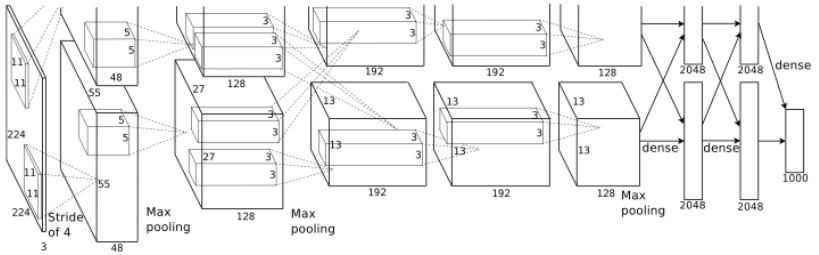
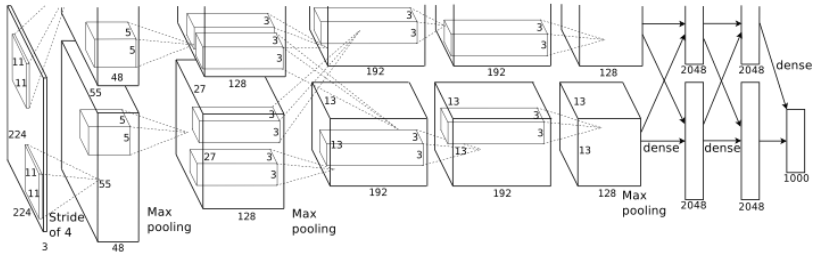


«CV90»

Let the machine learn a better representation itself!

Many millions of
learned parameters

Millions
of images



Millions
of labels

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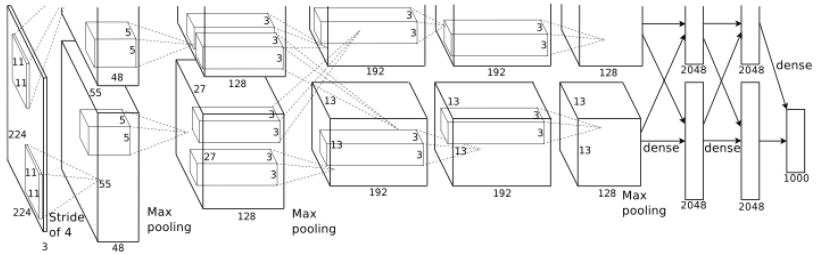

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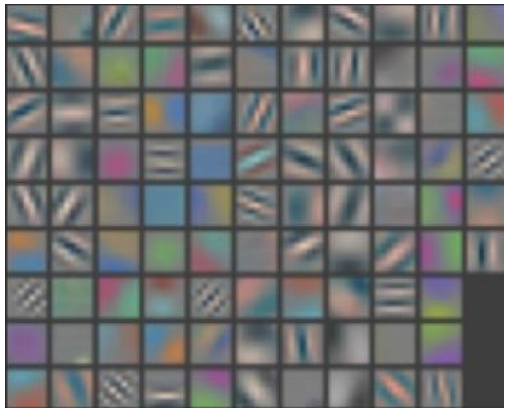

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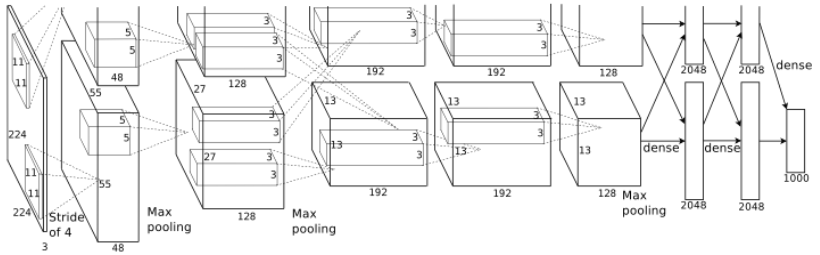

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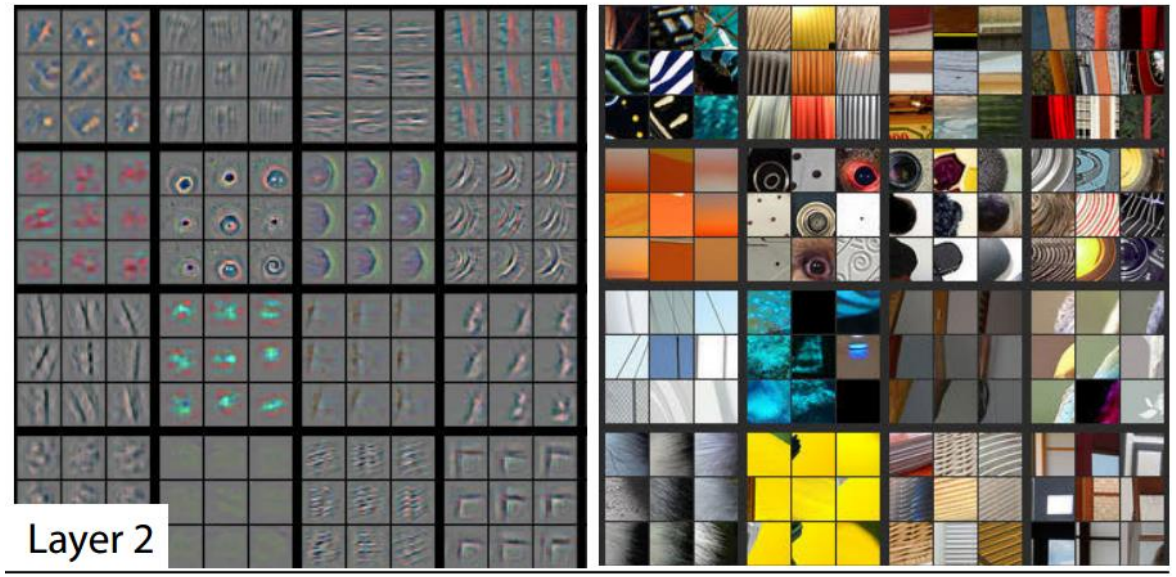

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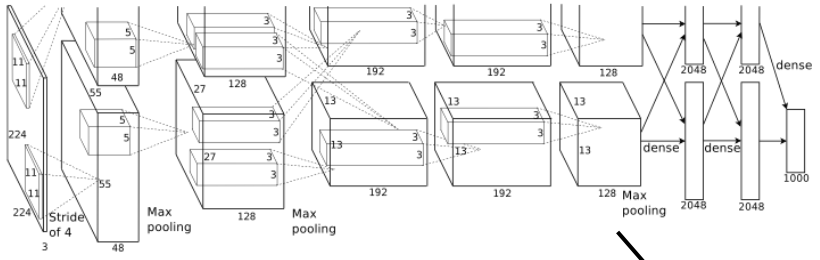

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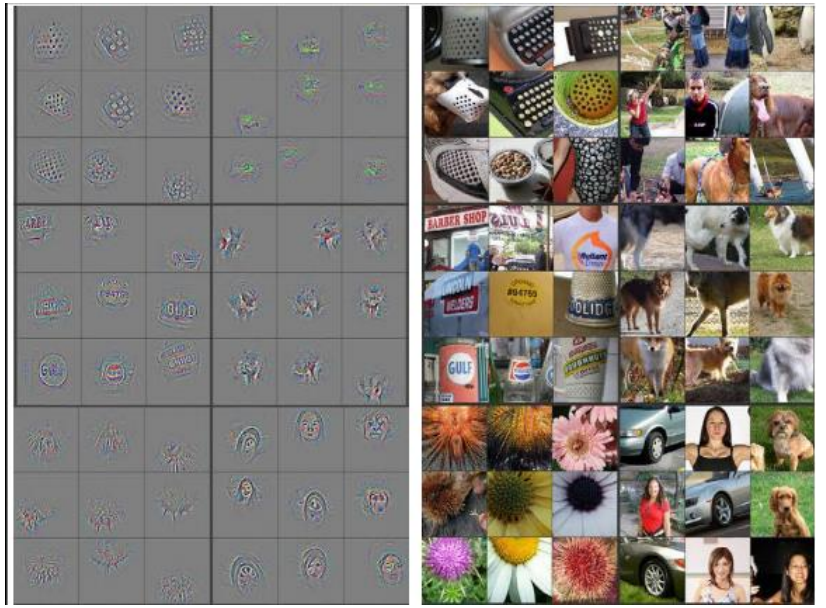
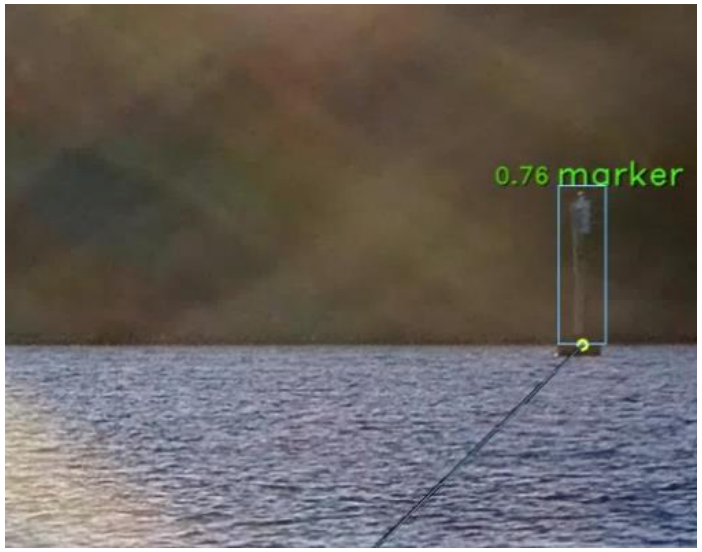
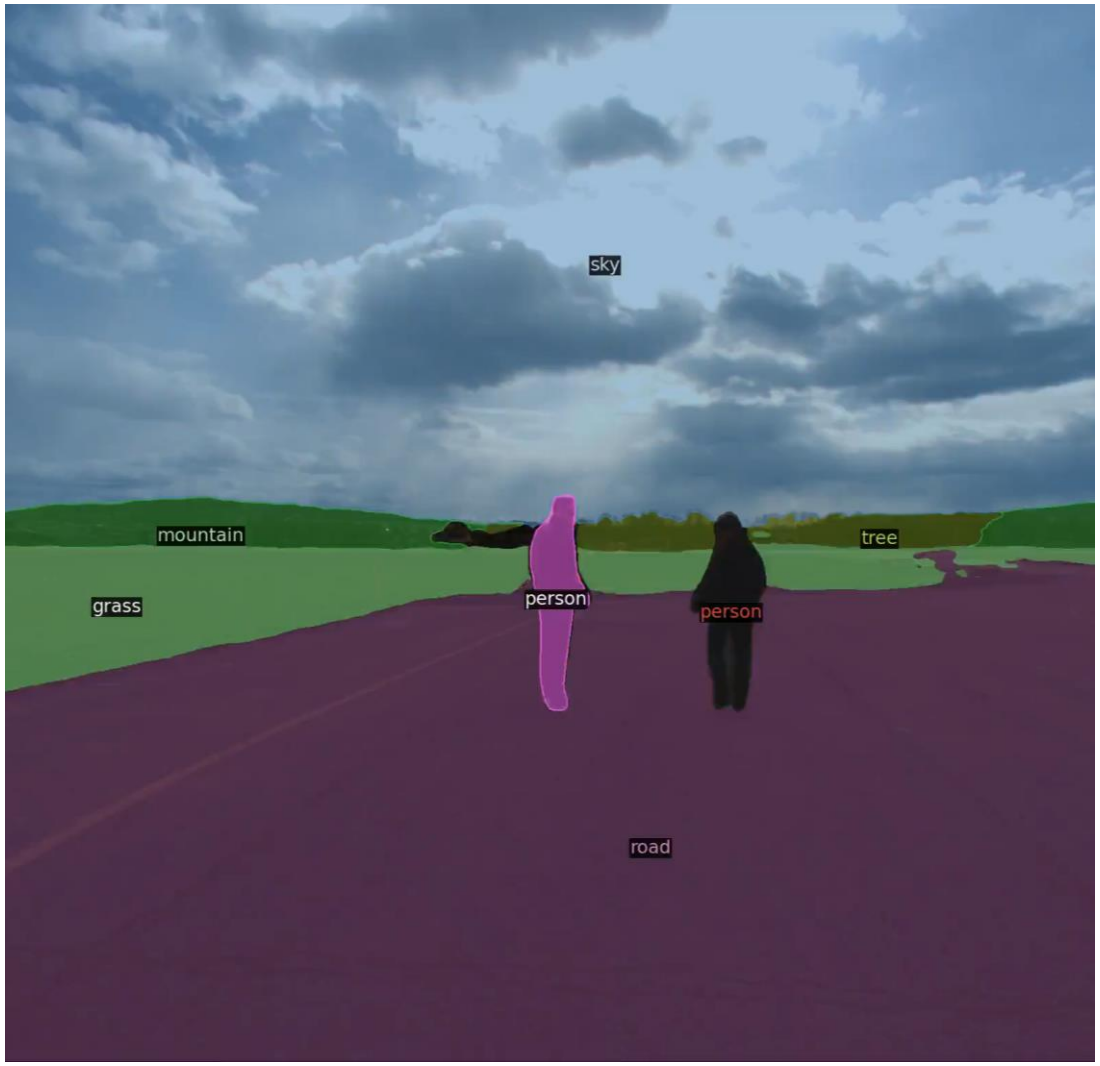
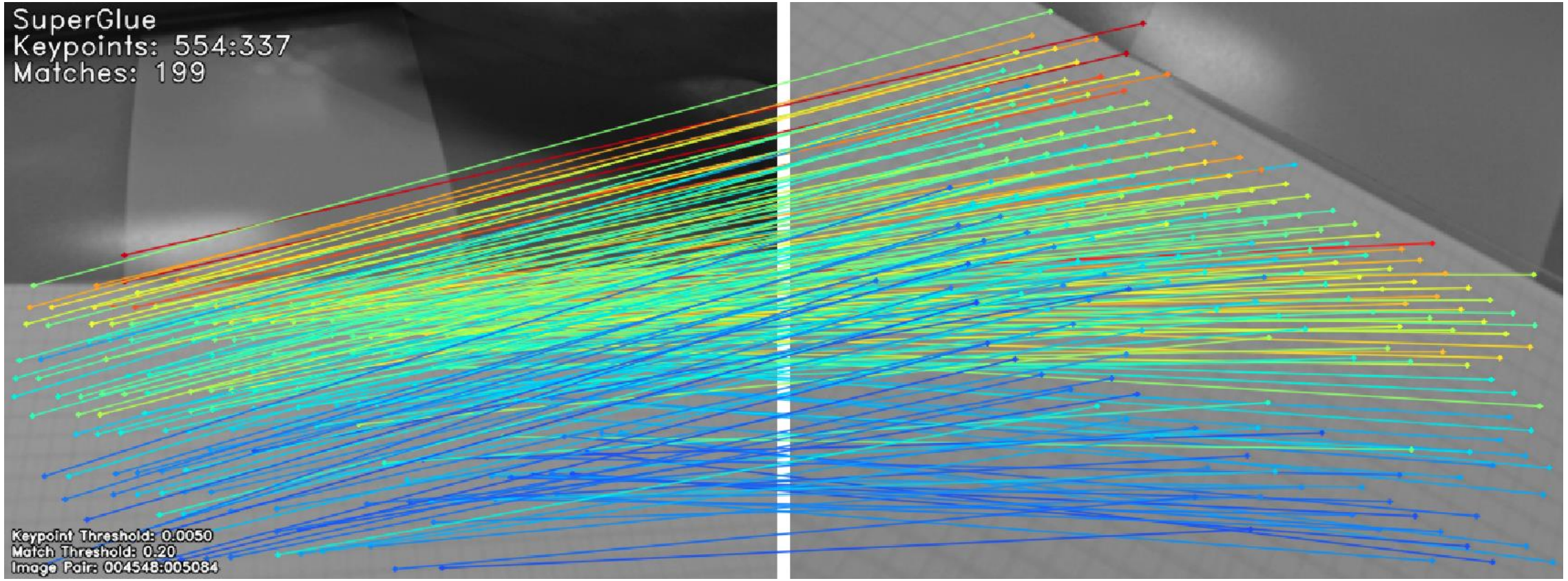
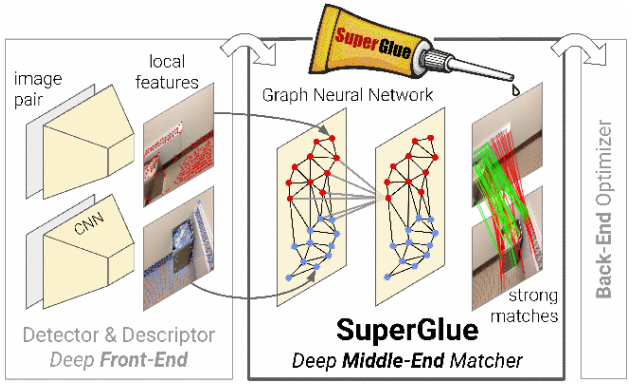



0.76 marker


mbt: 0.99

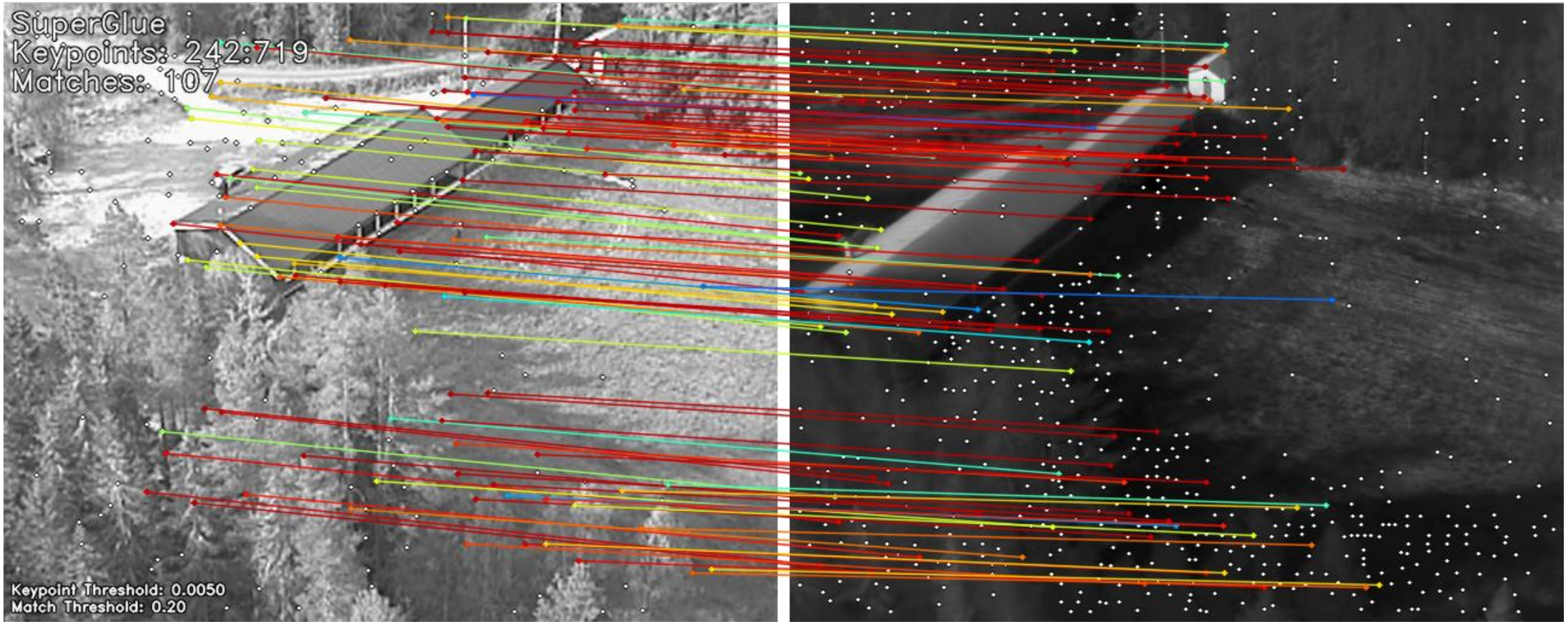

sky
mountain
tree
grass
person
person
road

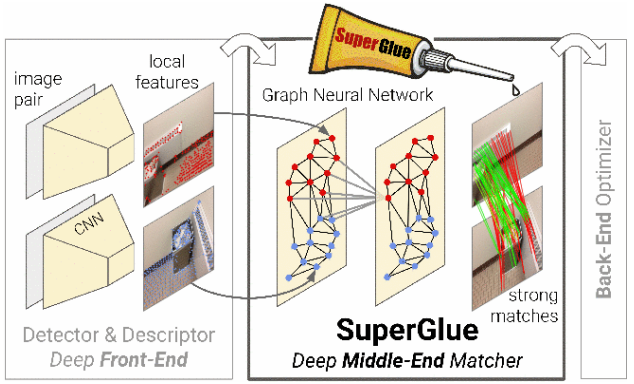




Sarlin, P. E., Detone, D., Malisiewicz, T., & Rabinovich, A. (2020).
SuperGlue: Learning Feature Matching with Graph Neural Networks.
Proceedings of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 4937–4946.

https://psarlin.com/superglue/





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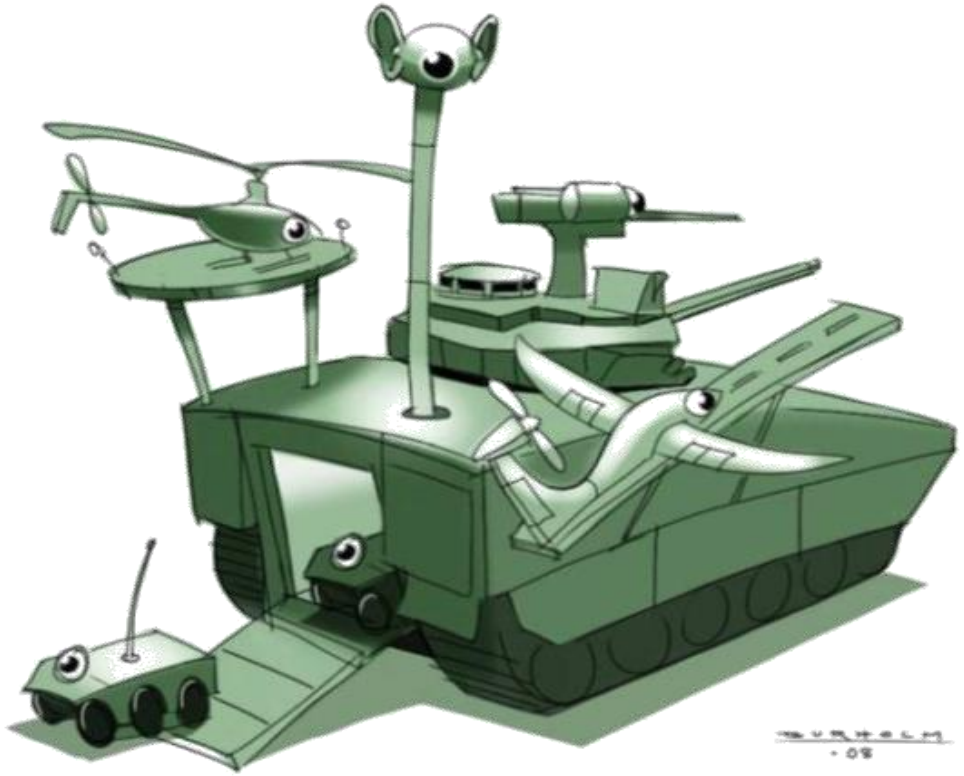
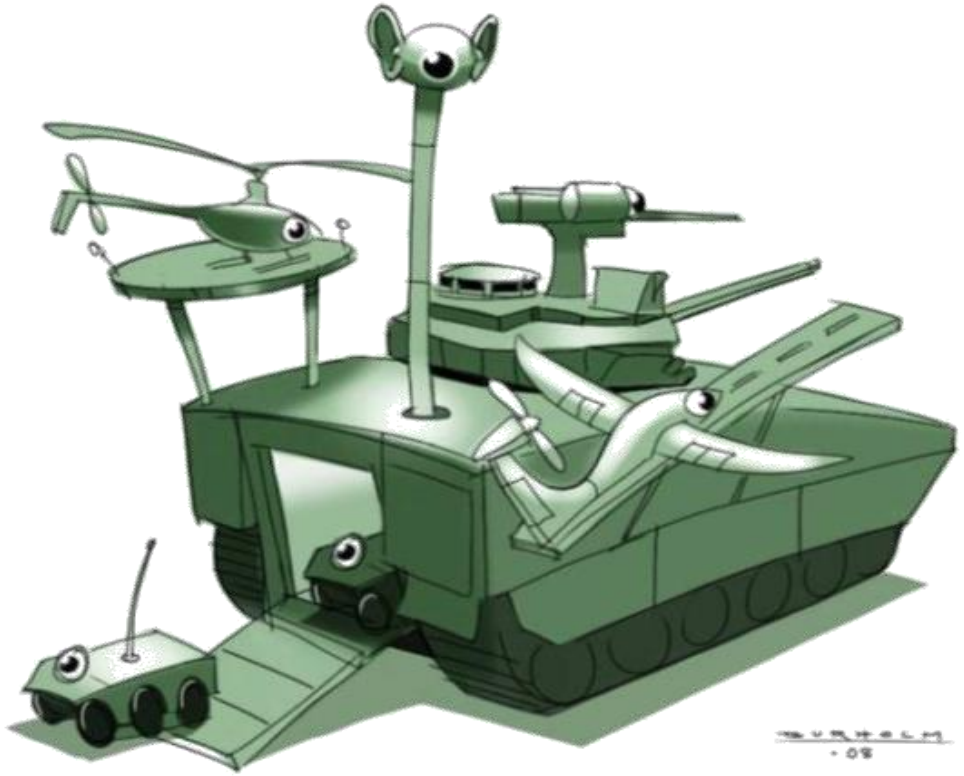
What is computer vision?



What is computer vision?

The study of how a machine
can interpret and understand its surroundings
from images



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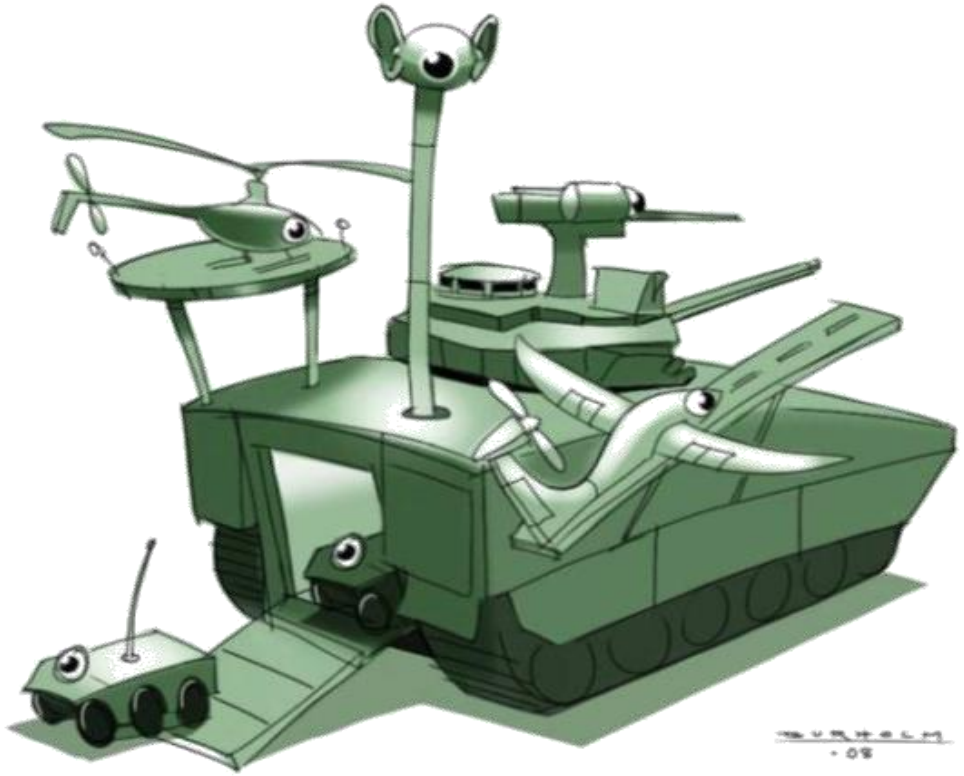
- “Enabling computers to see”



What is computer vision?

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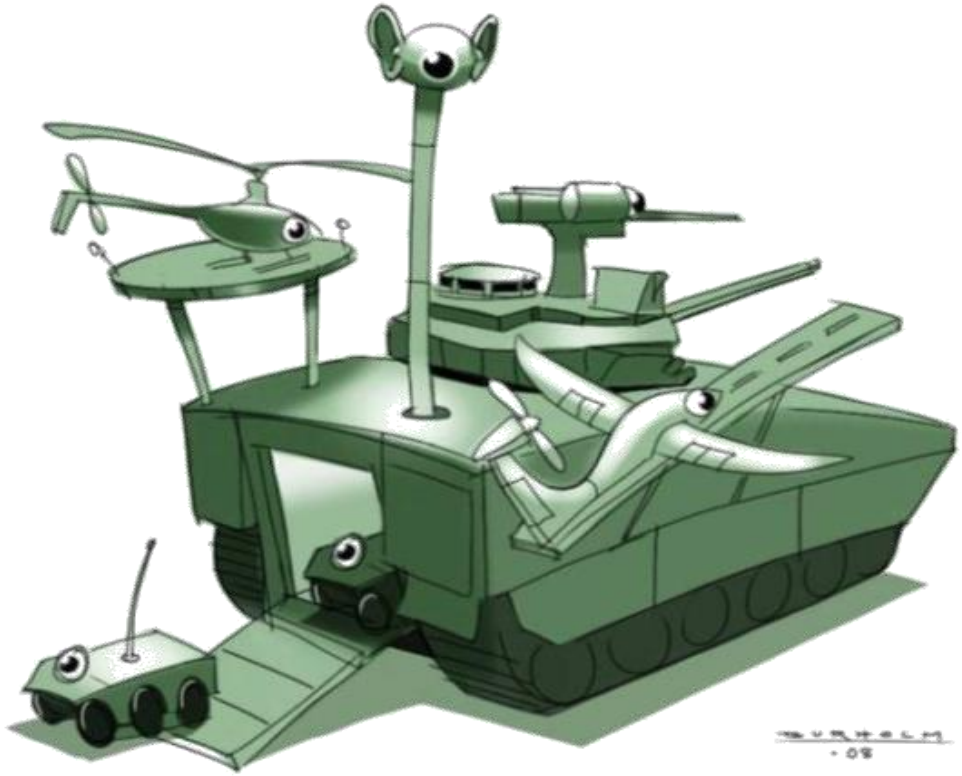
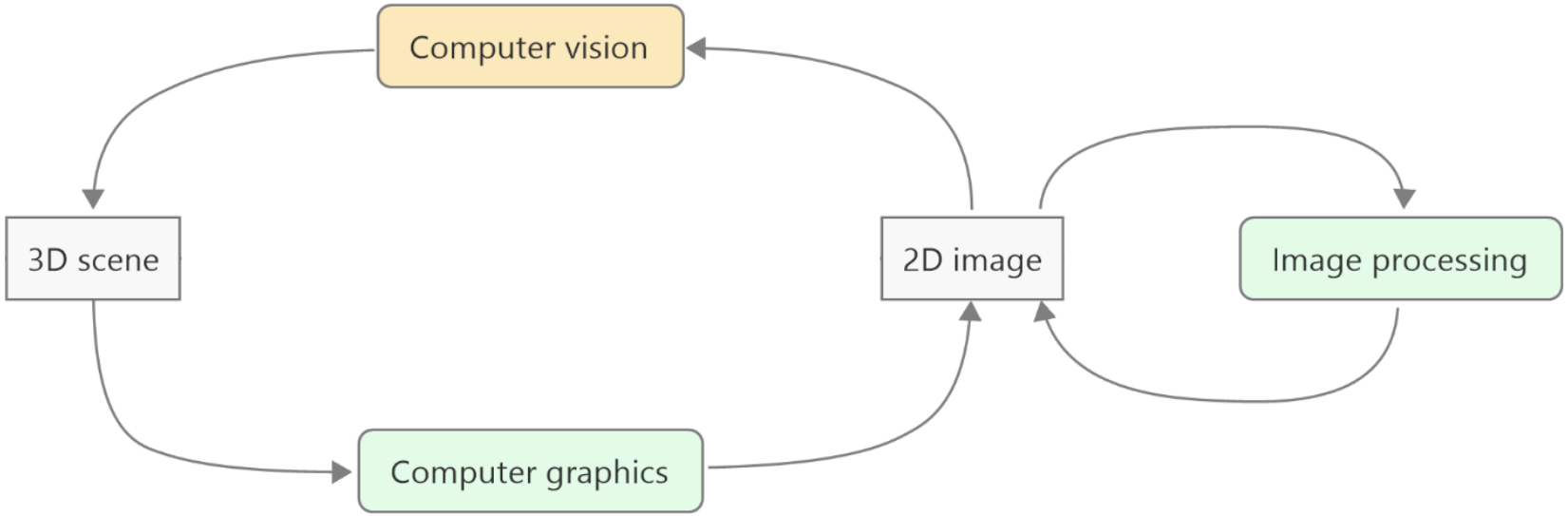
from images

- “Enabling computers to see”

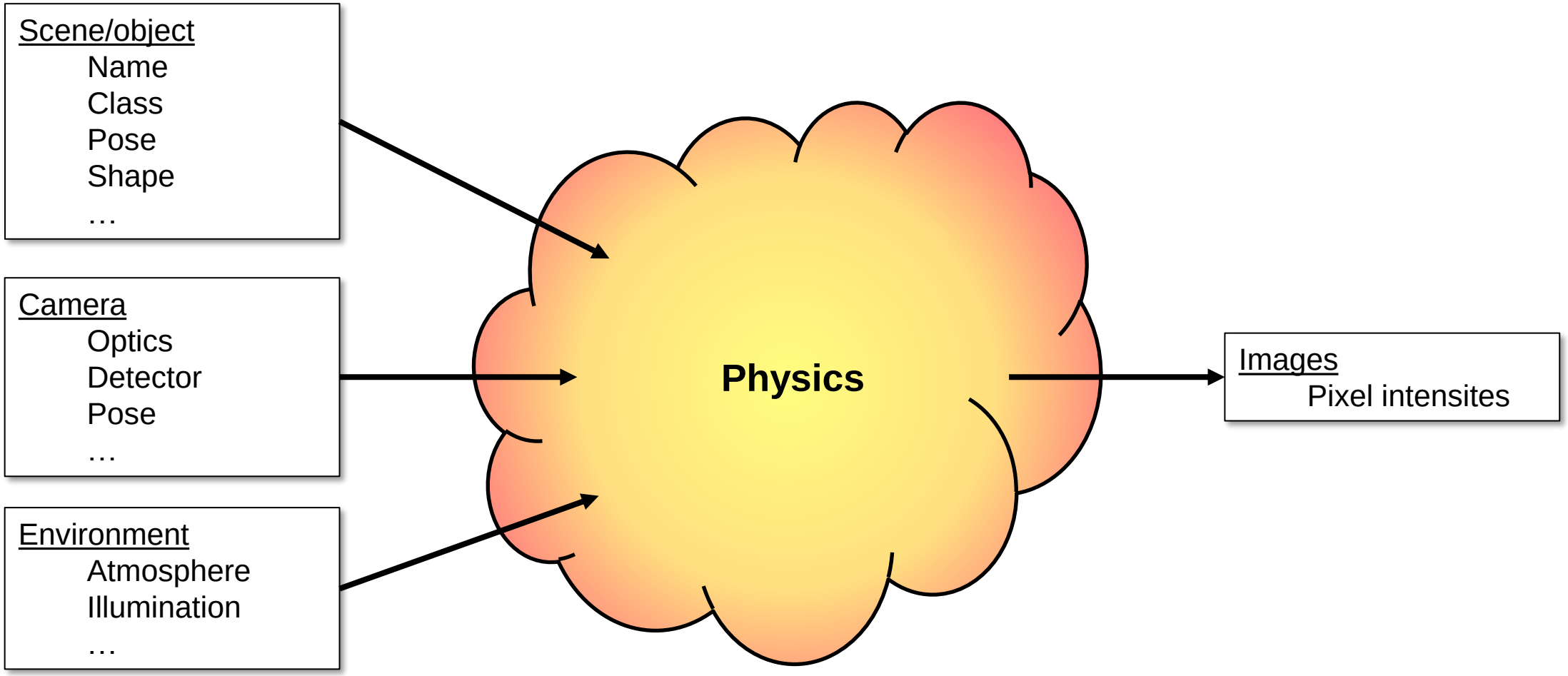
- Image analysis
- Robotic vision
- Perception
- Spatial AI



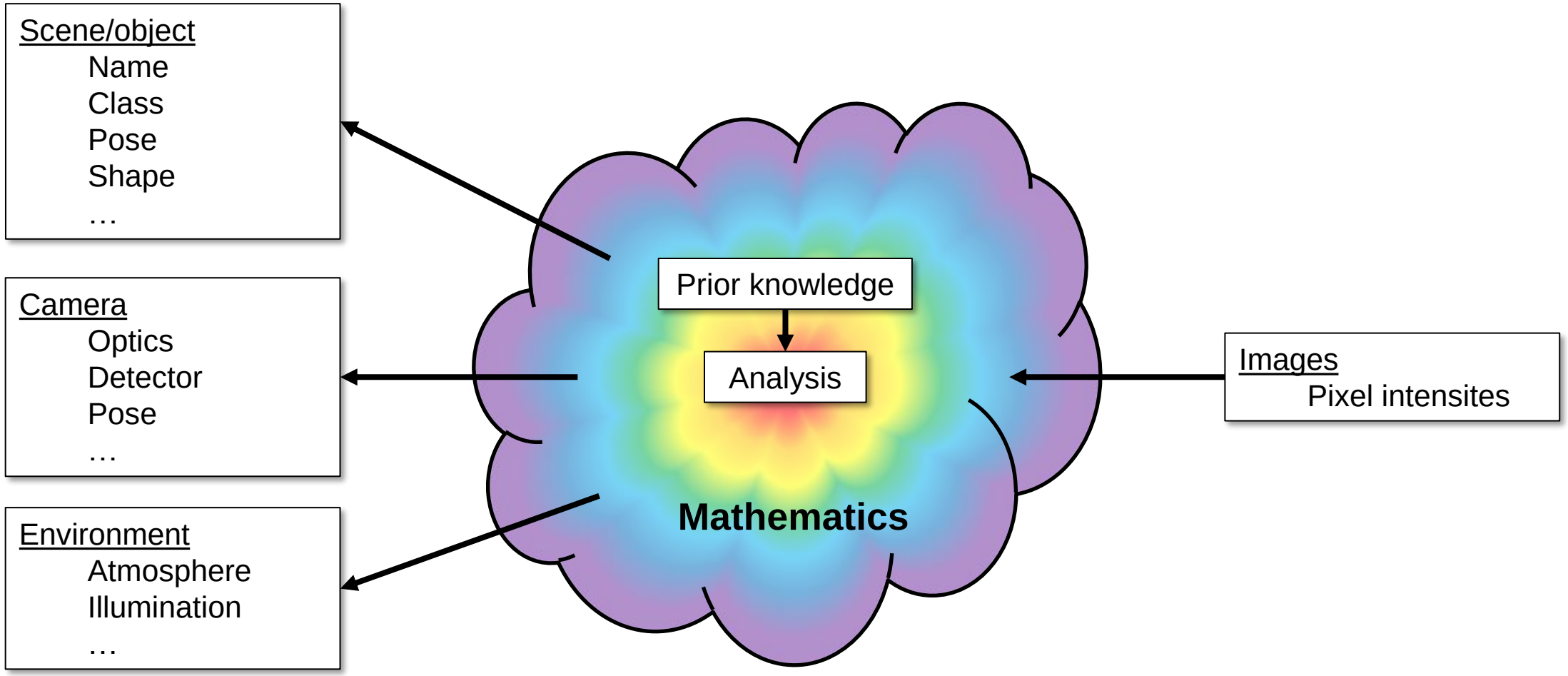
Computer vision is an *inverse problem*!



The *forward* imaging process



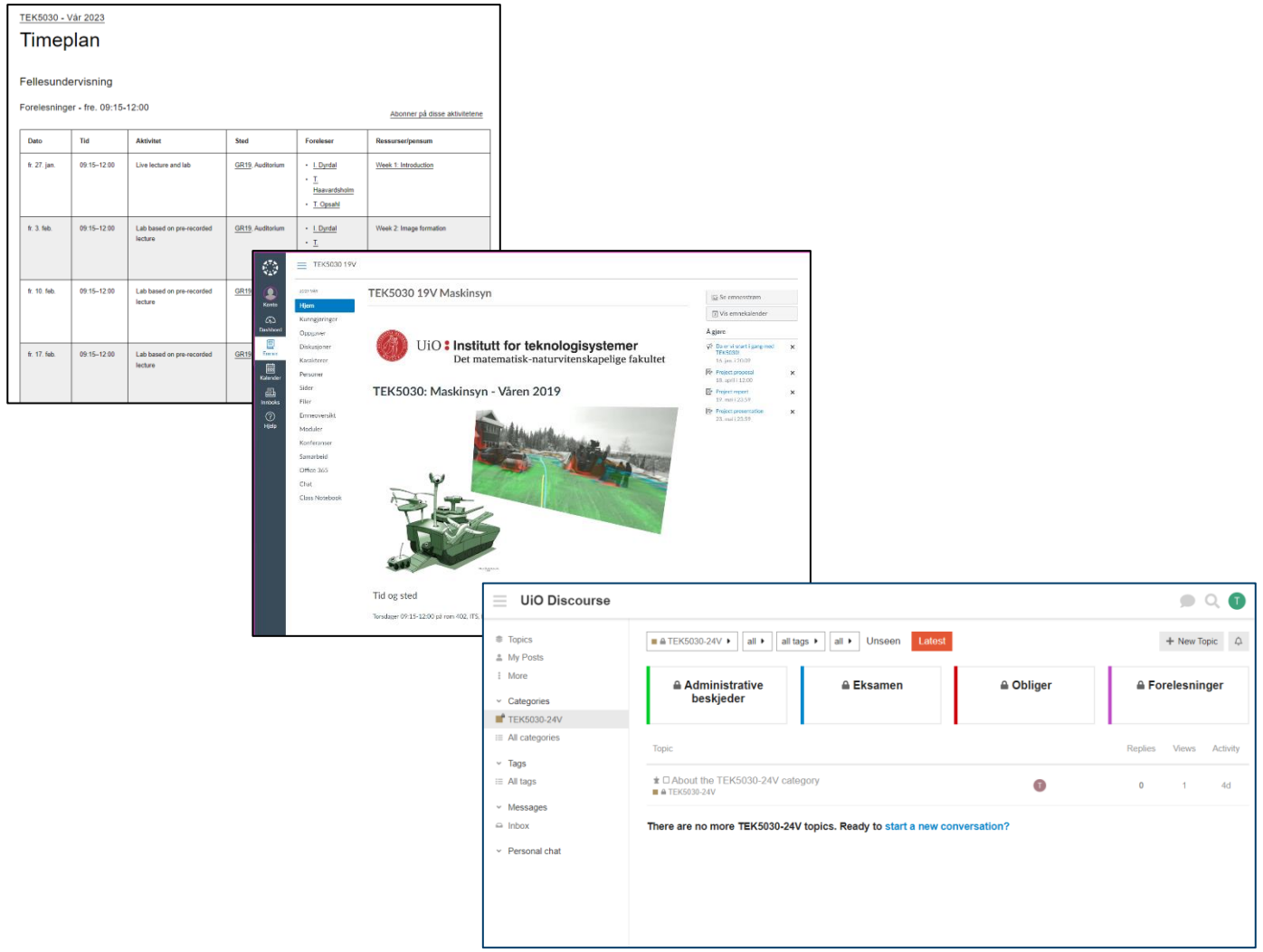
The *inverse* analysis process



About the course

Course sites

- The semester page
  - Course plan
  - Lecture slides and videos
  - Lab exercises
- Canvas
  - Course overview
  - Zoom links
  - Project deliveries
- Discourse
  - Announcements
  - Questions
  - Discussions



«Flipped classroom»

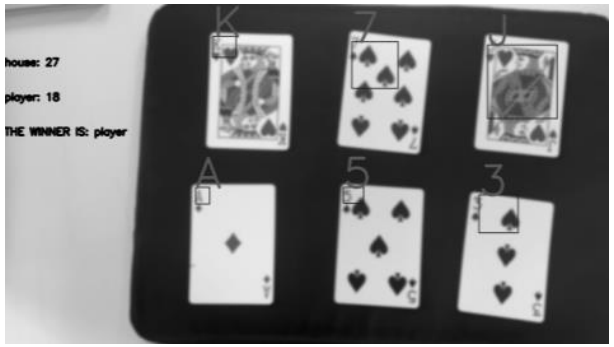
- Purpose
  - Get as much as possible out of a day at Kjeller
- Online
  - Pre-recorded lectures most weeks
- Fridays 09:15-12:00
  - ~20 min lecture summary and questions
  - ~2.5 hours programming lab

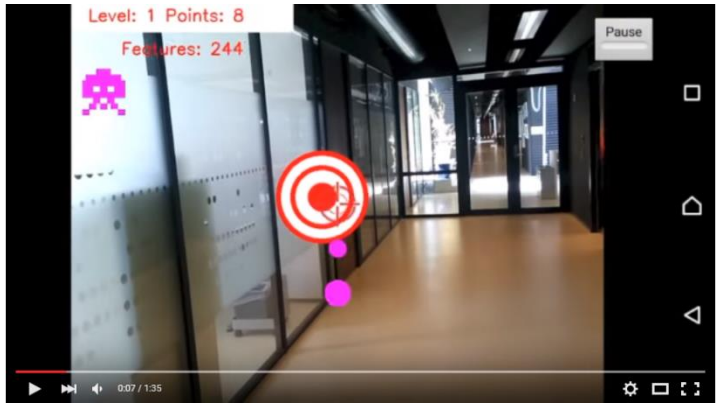

```cpp
#include "opencv2/highgui.hpp"
#include <iostream>

int main()
{
    cv::VideoCapture input_stream(0);

    if (!input_stream.isOpened())
    {
        std::cerr << "Could not open camera\n";
        return EXIT_FAILURE;
    }

    const std::string window_title = "Lab 0: Introduction to OpenCV";
    cv::namedWindow(window_title, cv::WINDOW_NORMAL);

    cv::Mat frame;

    while(true)
    {
        input_stream >> frame;

        if (frame.empty())
        { break; }

        cv::imshow("cam", frame);

        if (cv::waitKey(15) >= 0)
        { break; }
    }

    return EXIT_SUCCESS;
}
```

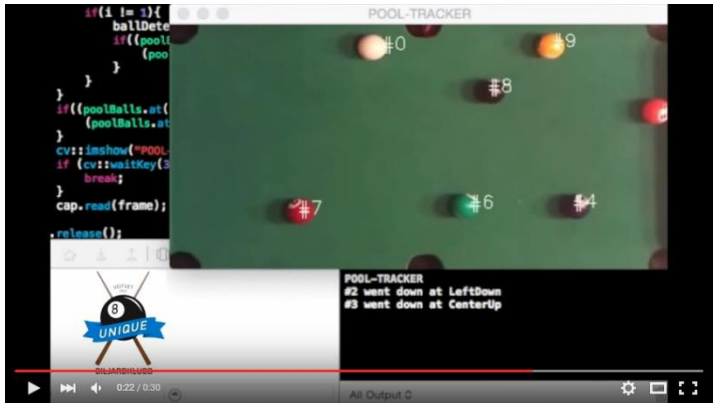
Student projects

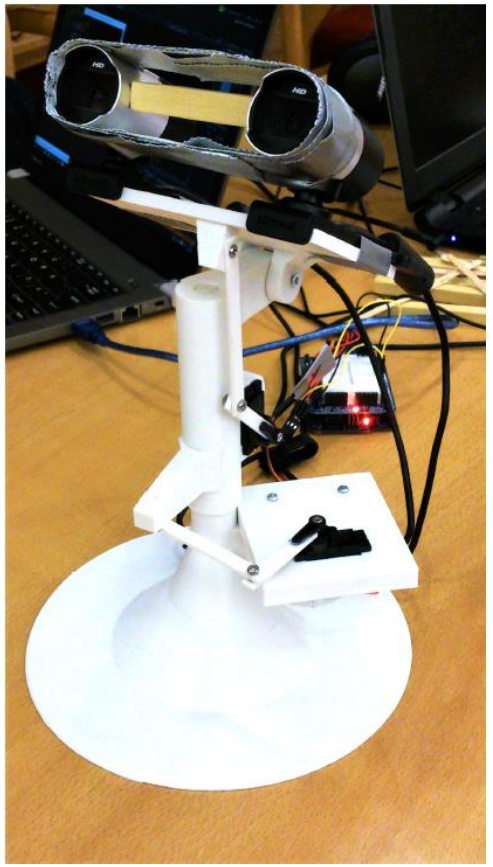
- Develop a working computer vision system that does something interesting
  - Big: More than a month
  - Approved/Not approved

- Project topic of your own choice
- Preferably in groups of up to 3 persons

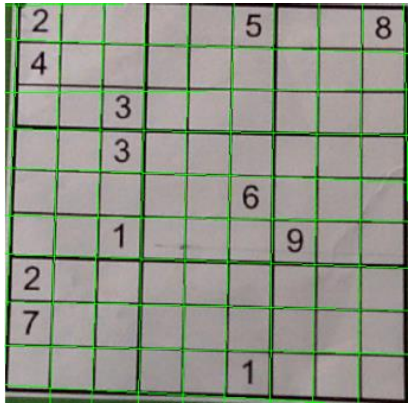








Student projects



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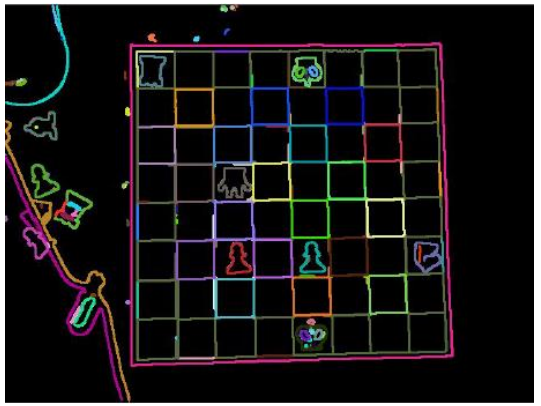

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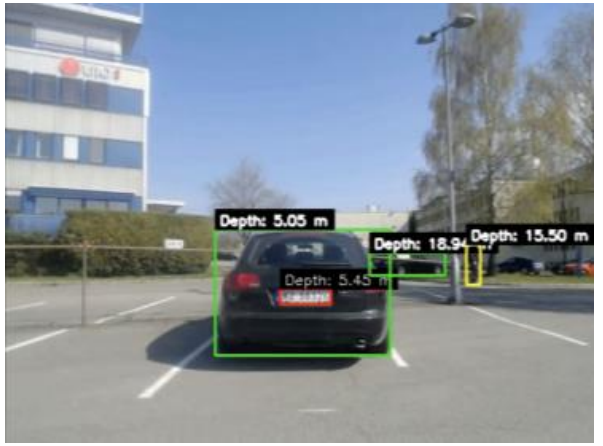

Exam

- Written or oral exam
- Mid-June

Feedback

- We encourage feedback during the course
  - We are open to making adjustments!
- Please fill out and deliver
  the course evaluation form after the course!
- Any feedback or questions now?