

Introduction to TEK5030 – Computer Vision

14.01.2021

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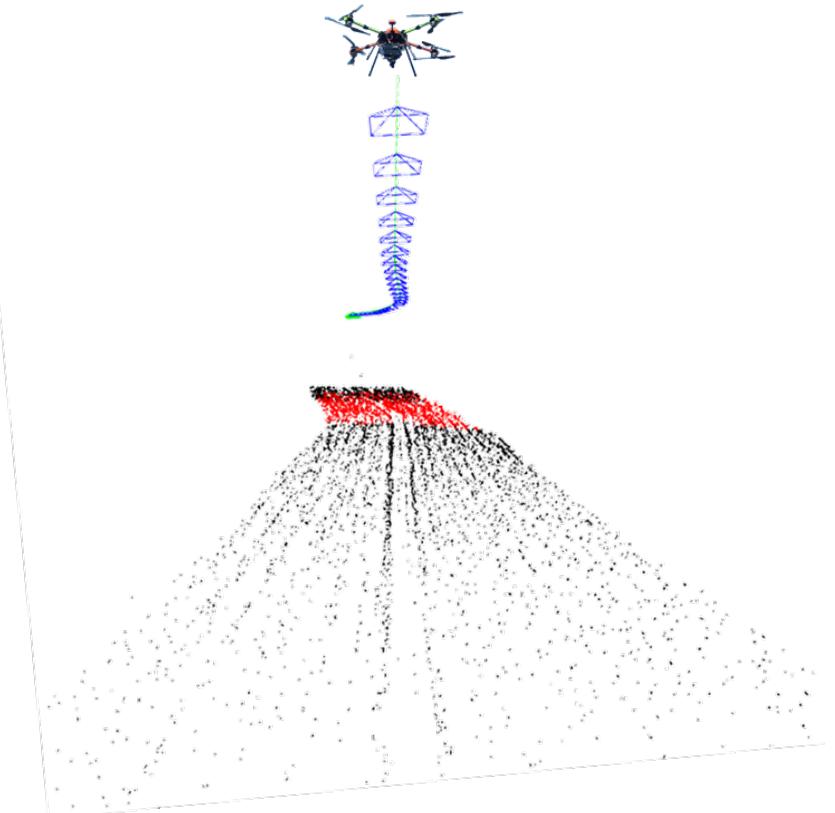
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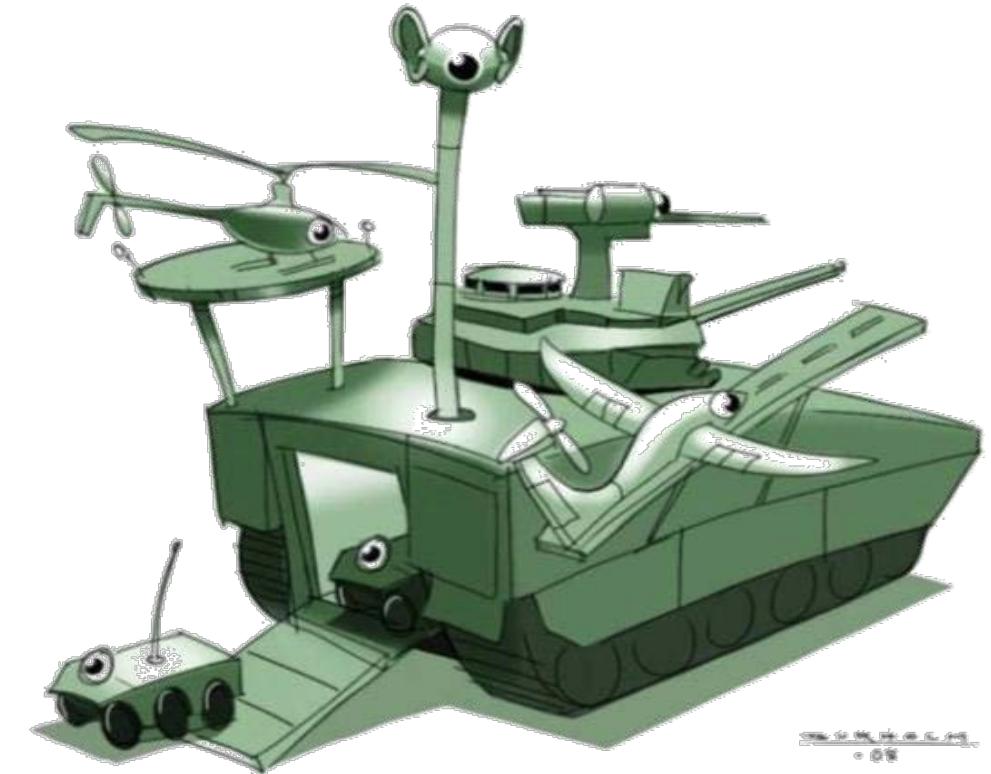
TEK5030



Today

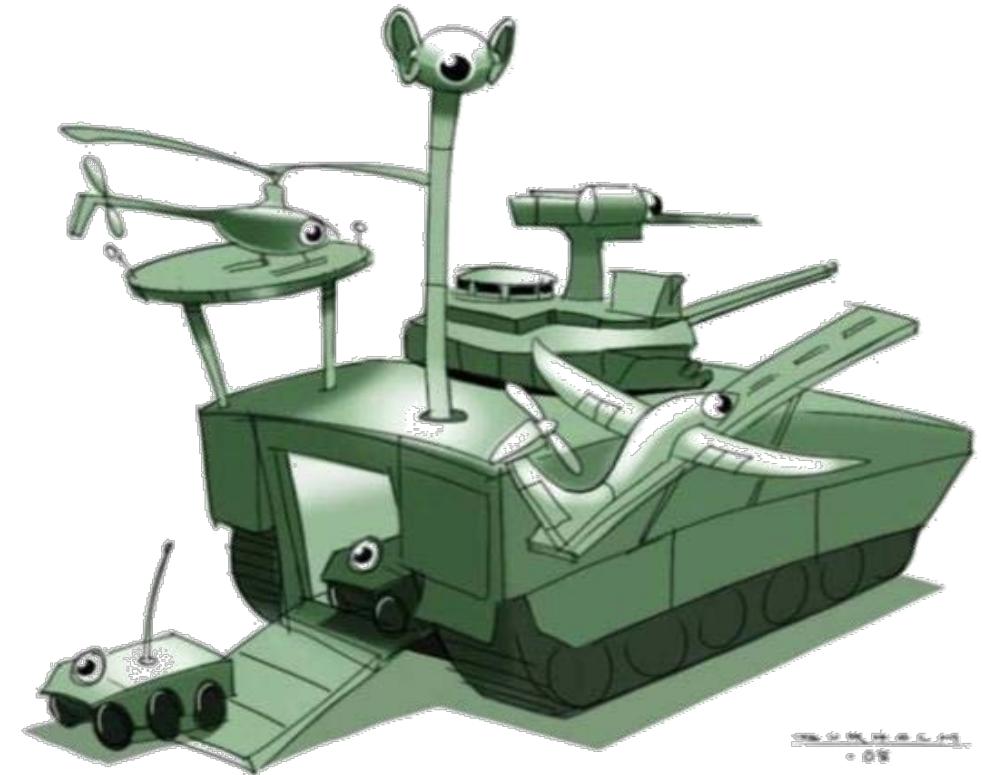
- A quick introduction to computer vision
- About the course
- Lab:
 - Processing live video streams with OpenCV!

Computer vision



Computer vision

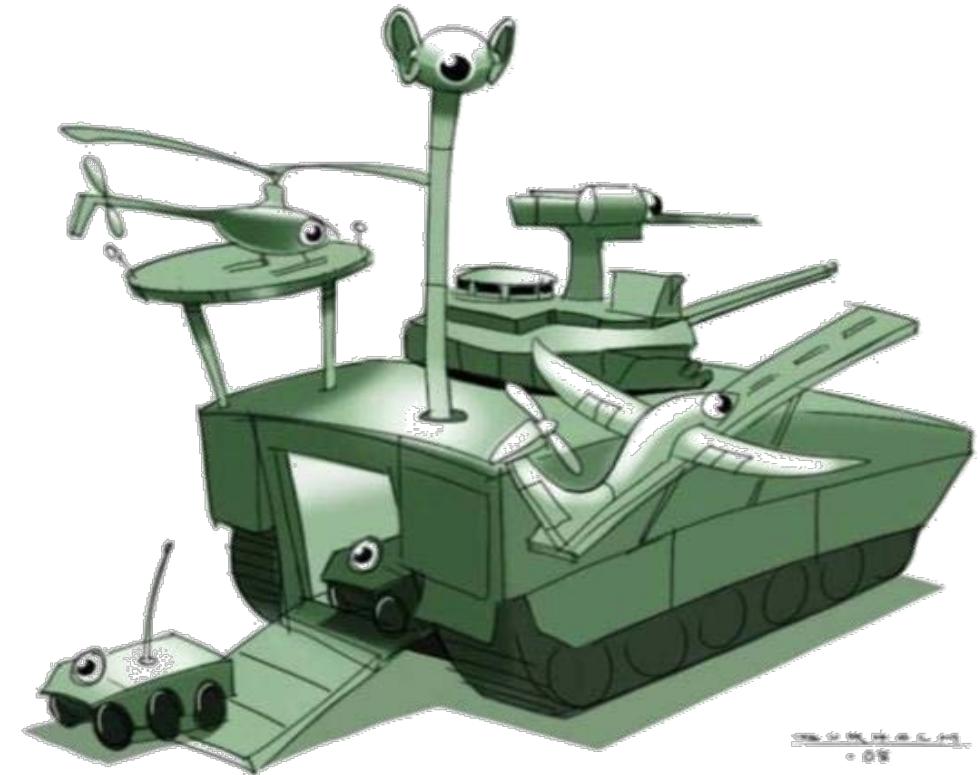
The study of how a machine
can interpret and understand its surroundings
from images



Computer vision

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

- “Enabling computers to see”



«An image is worth more than a thousand words»



«An image is worth more than a thousand words»

How can we extract
this information?



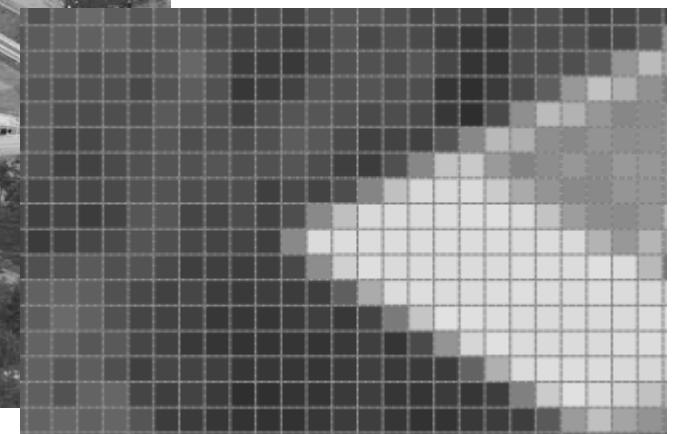
Images and pixels



Images and pixels



Images and pixels



Images and pixels



Images and pixels



80	81	85	77	63	60	80	135	19
77	63	72	67	77	133	192	216	21
76	66	78	137	191	217	219	218	22
68	63	137	219	220	220	220	220	22
61	62	72	141	208	222	218	219	21
58	62	60	62	95	171	219	221	21

It is easy to calculate with images!



It is easy to calculate with images!



=



Floating point operations (FP32) per second (FLOPS)



Photo: Miicchiaeil Hleinizilieir ([CC BY-SA 4.0](#))



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

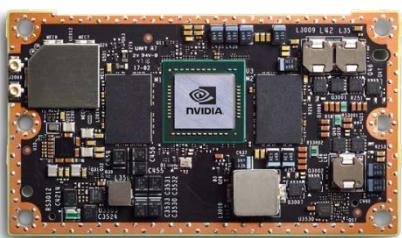


Photo: NVIDIA



Photo: HP

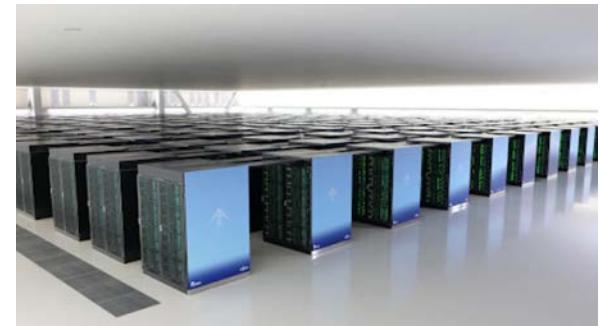


Photo: RIKEN

Raspberry PI 4B
48 GFLOPS

Odroid XU-4
214 GFLOPS

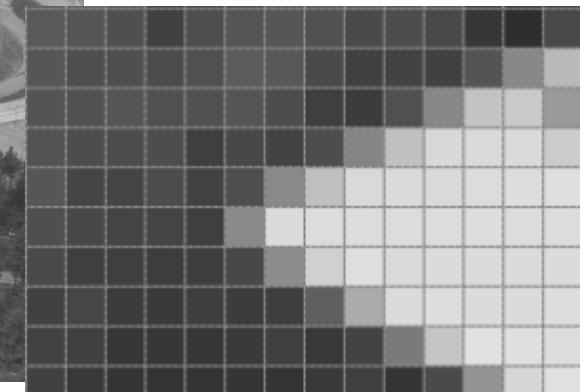
Jetson TX2
782 GFLOPS

My laptop
3 TFLOPS

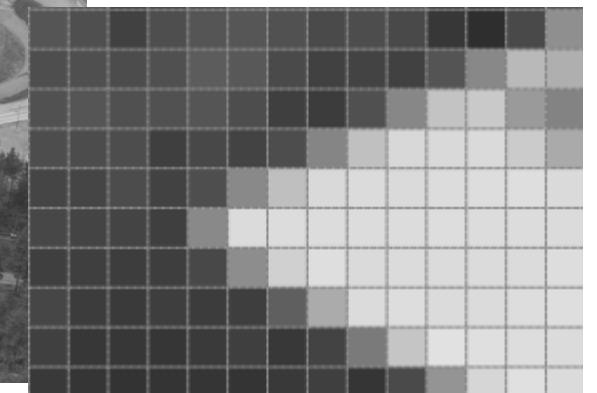
Fugaku supercomputer
>1000 PFLOPS

(theoretical peak)

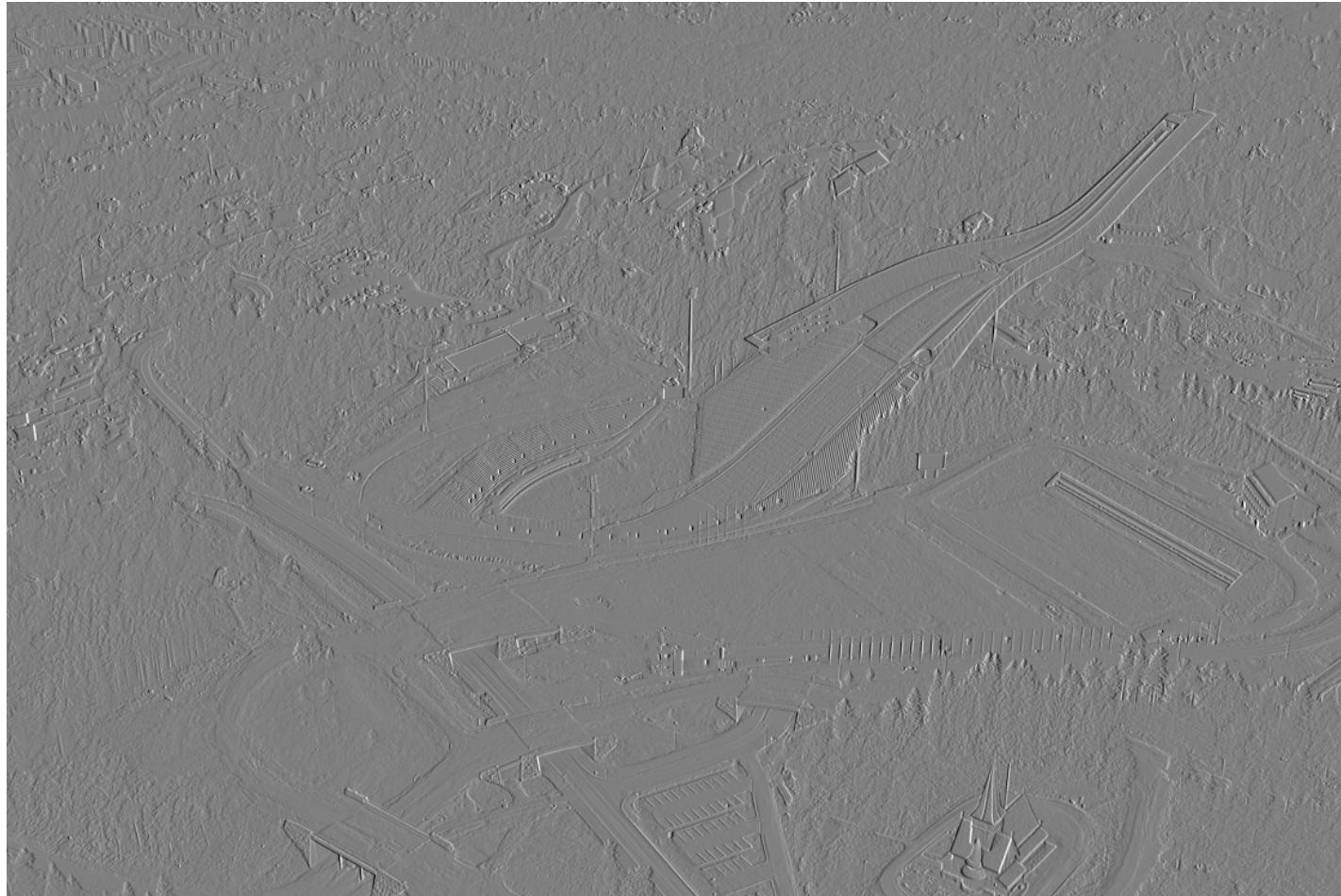
The difference between neighboring pixels



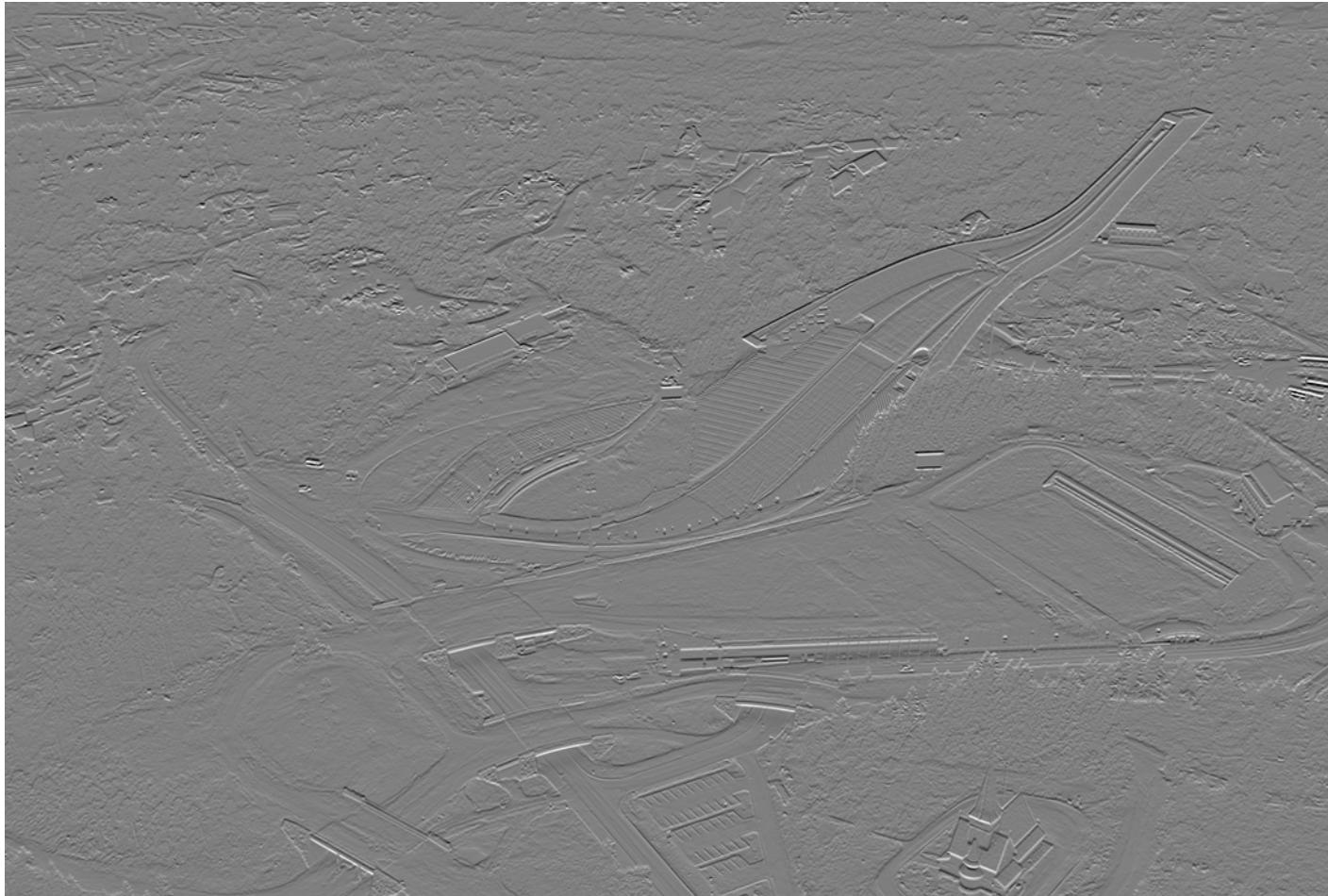
The difference between neighboring pixels



Horizontal differences



Vertical differences



Edges and corners



Significant corners



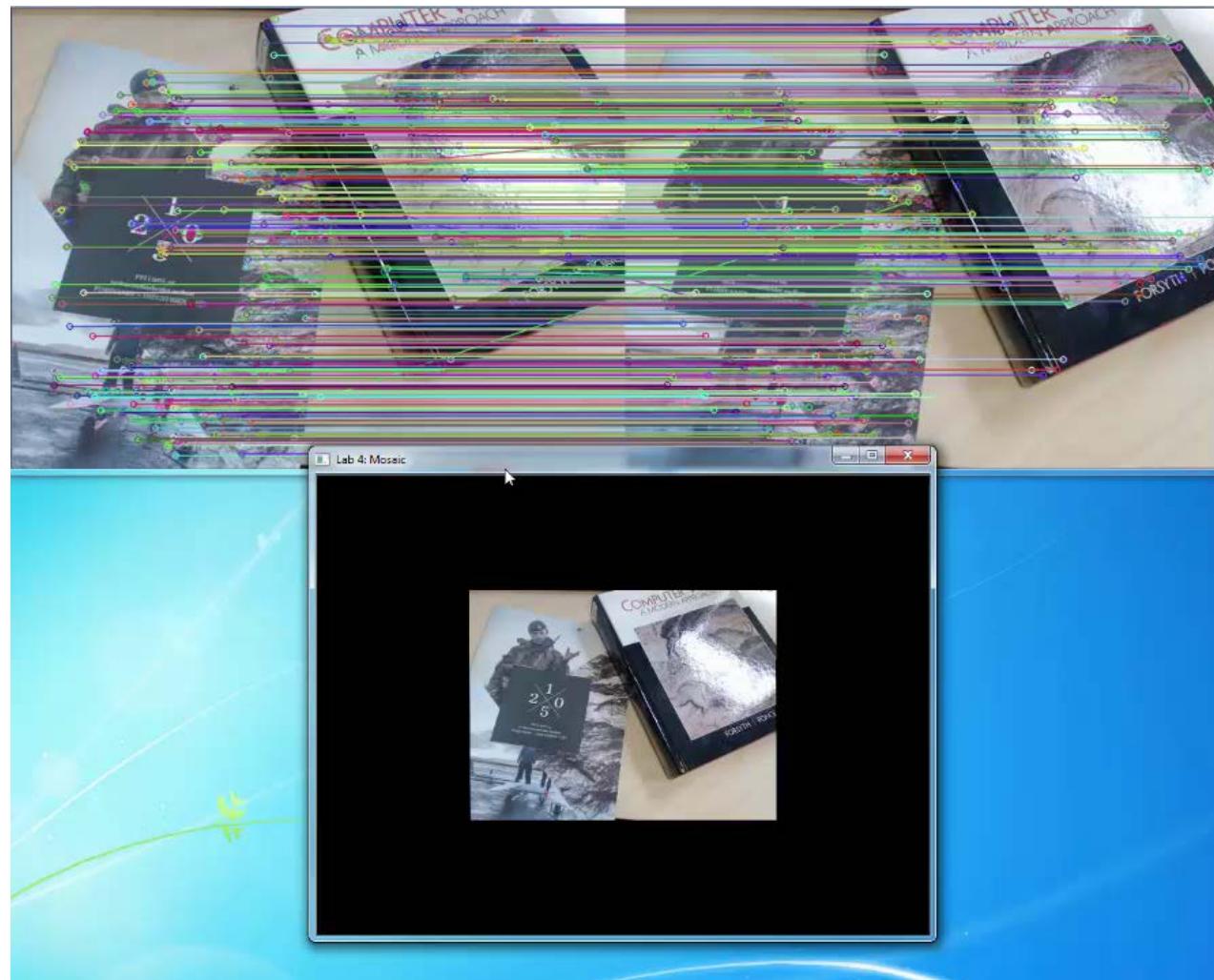
Significant corners



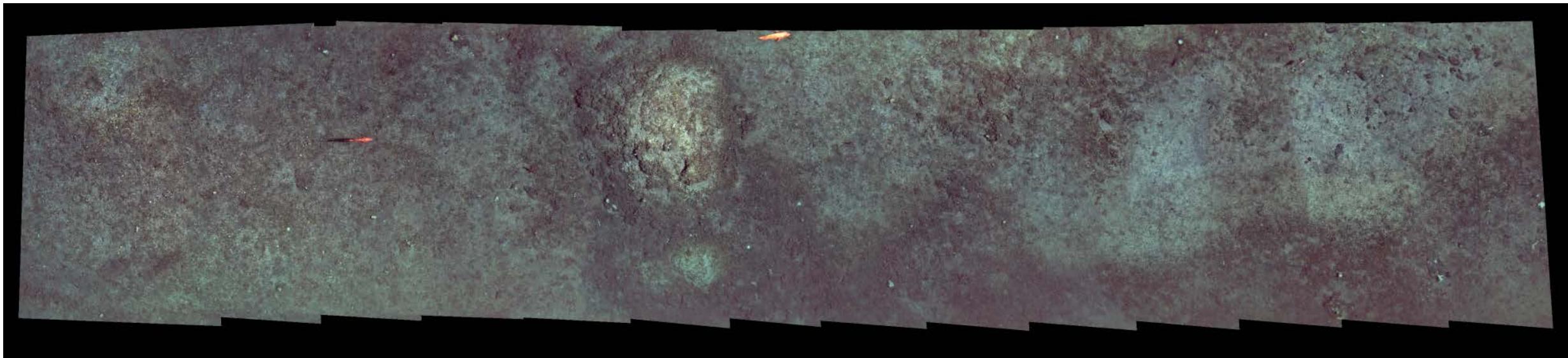
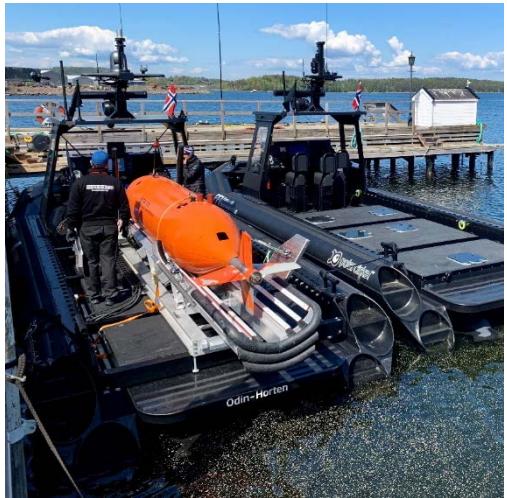
Significant corners



Example: Coregistering images

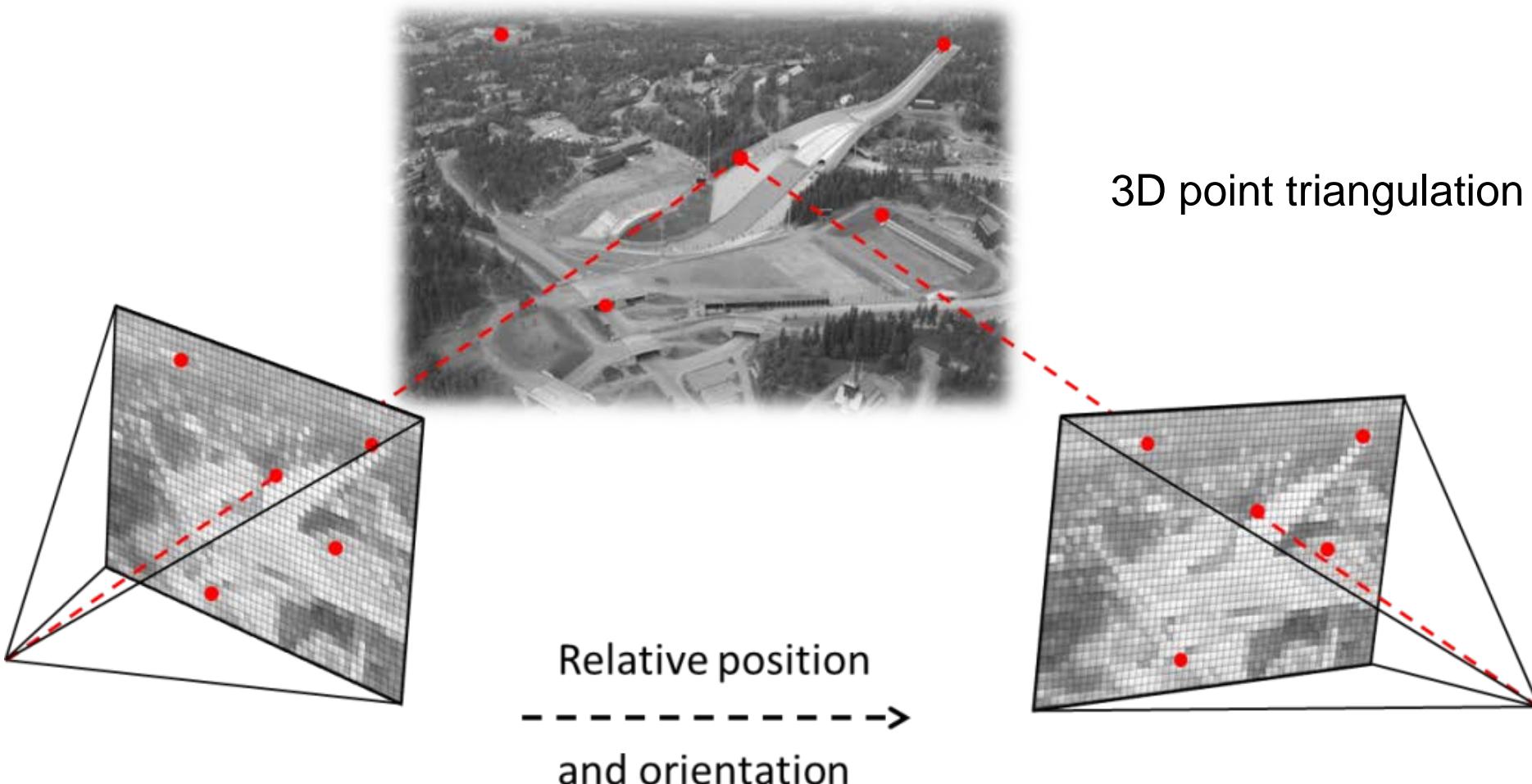


Application: Underwater visual mapping from HUGIN AUV

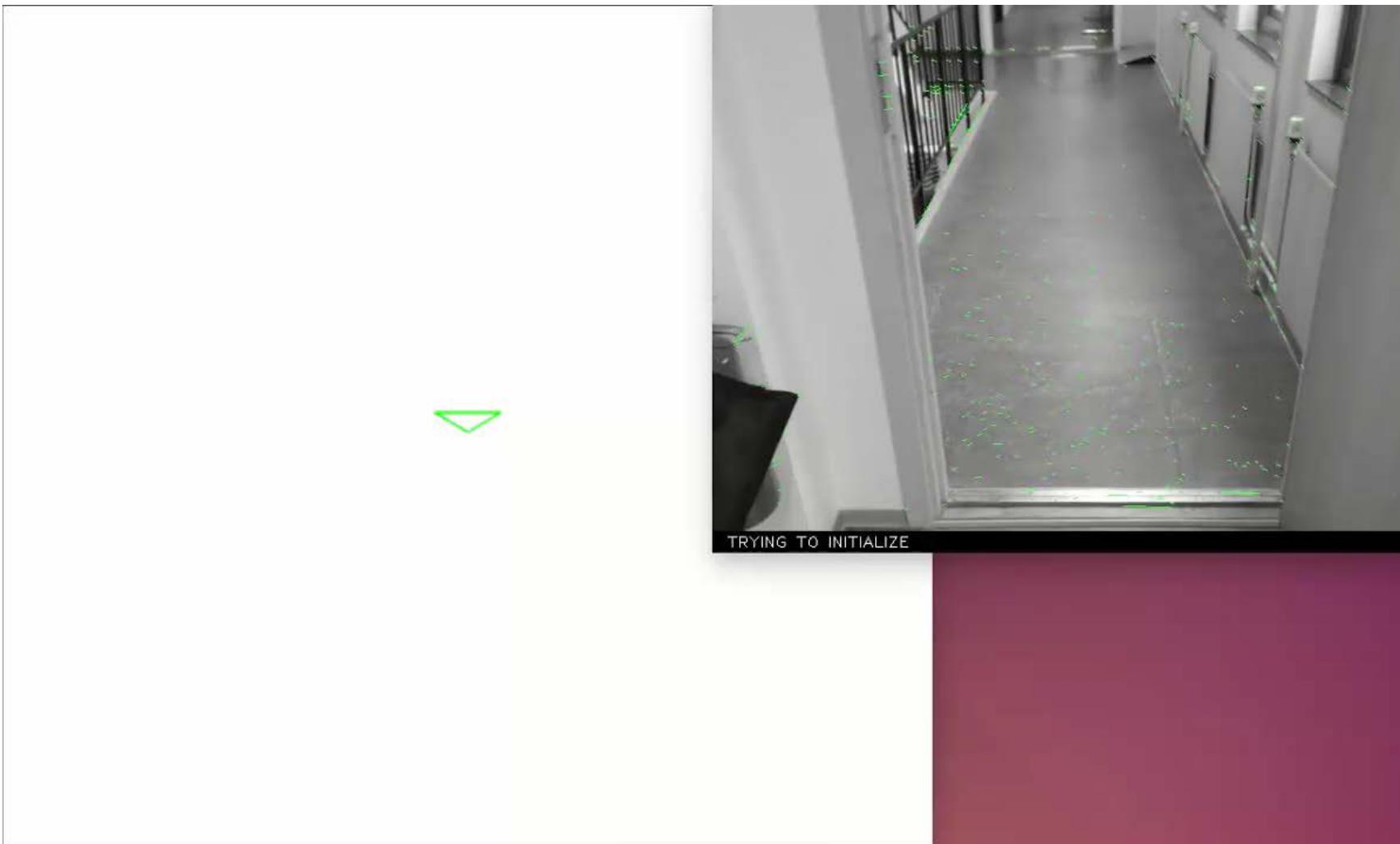


TEK5030

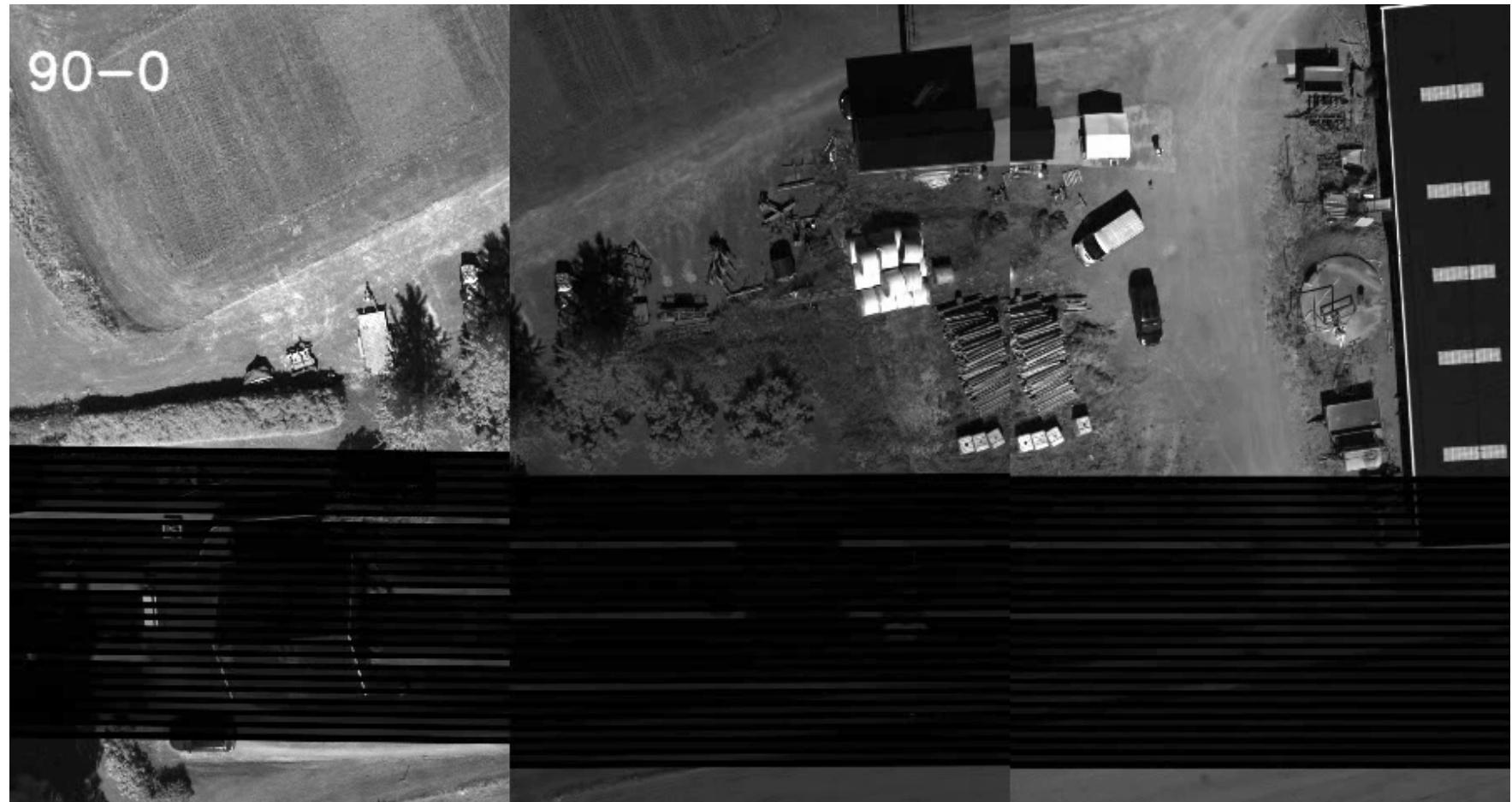
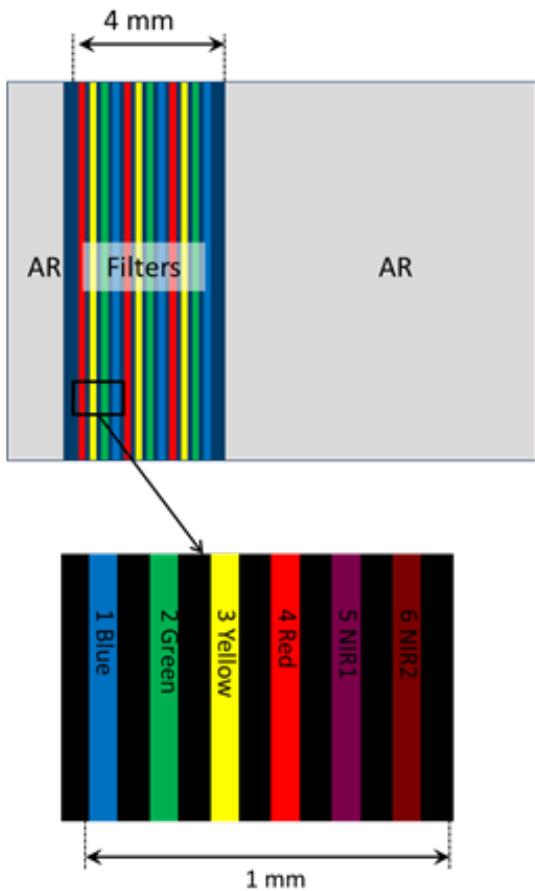
Extracting geometric information from images



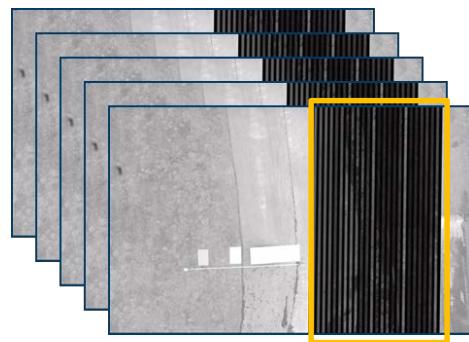
Visual navigation



Application: Mapping with a multimodal multispectral camera



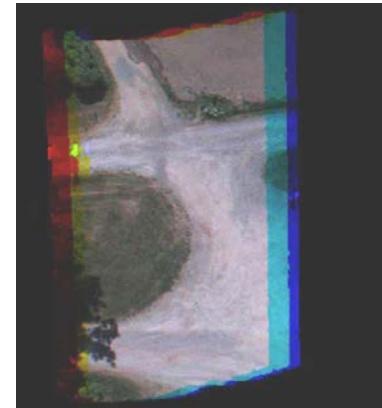
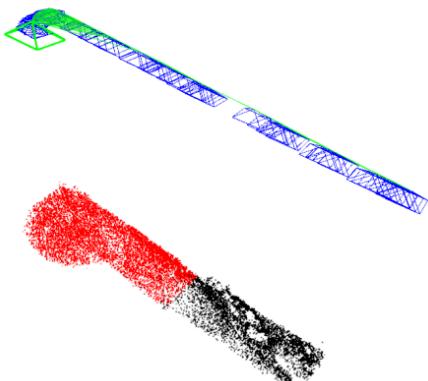
Spectral reconstruction



Raw image sequence



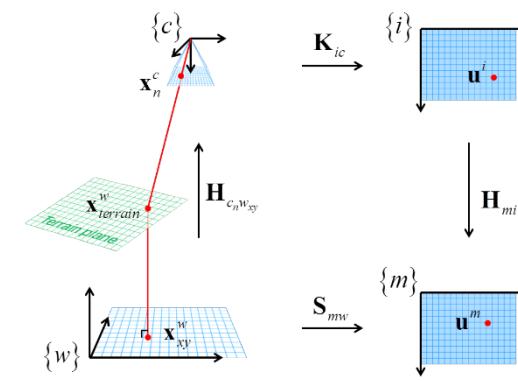
Image-based navigation



Filter maps



Mosaicking

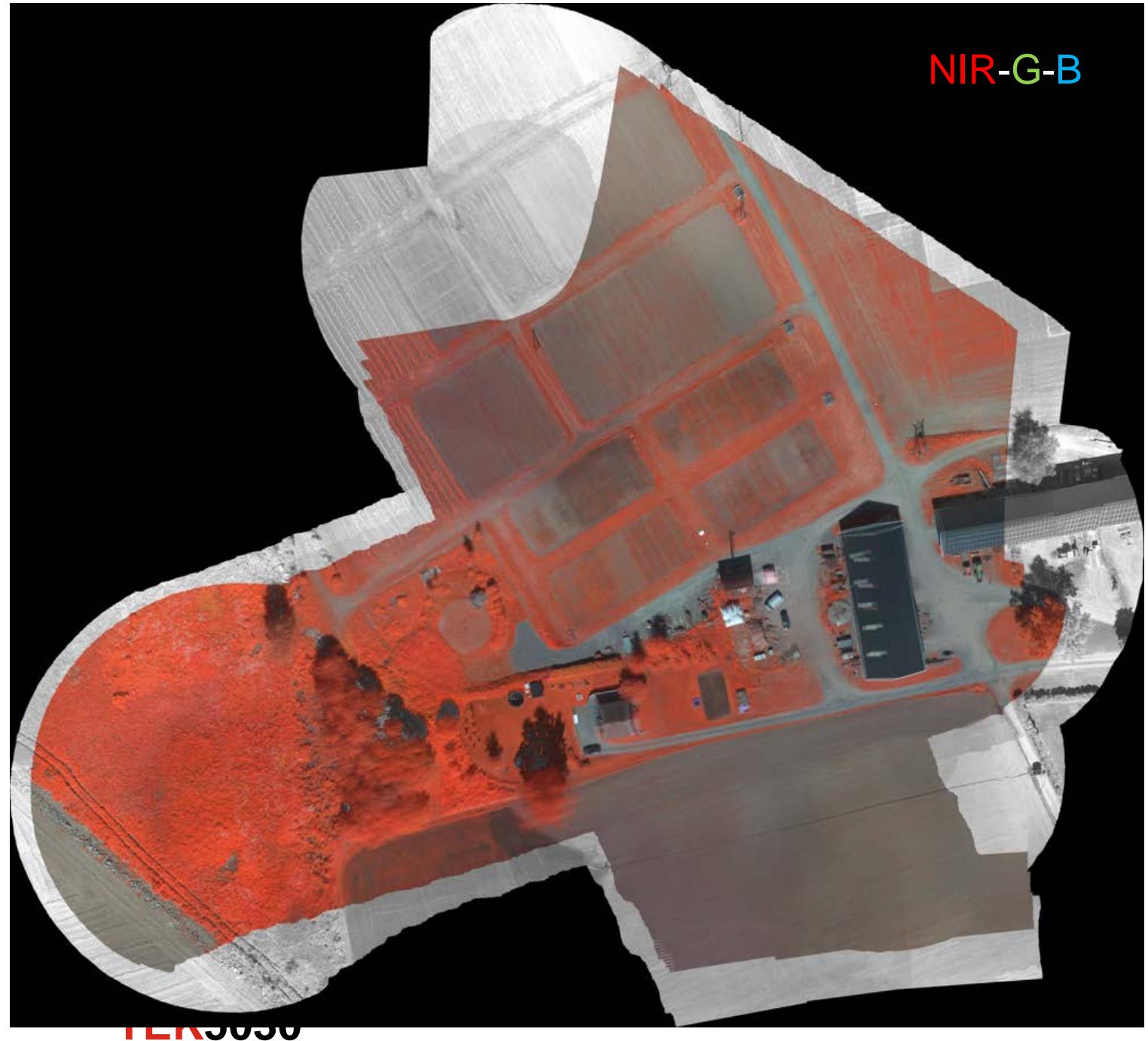


TEK5030

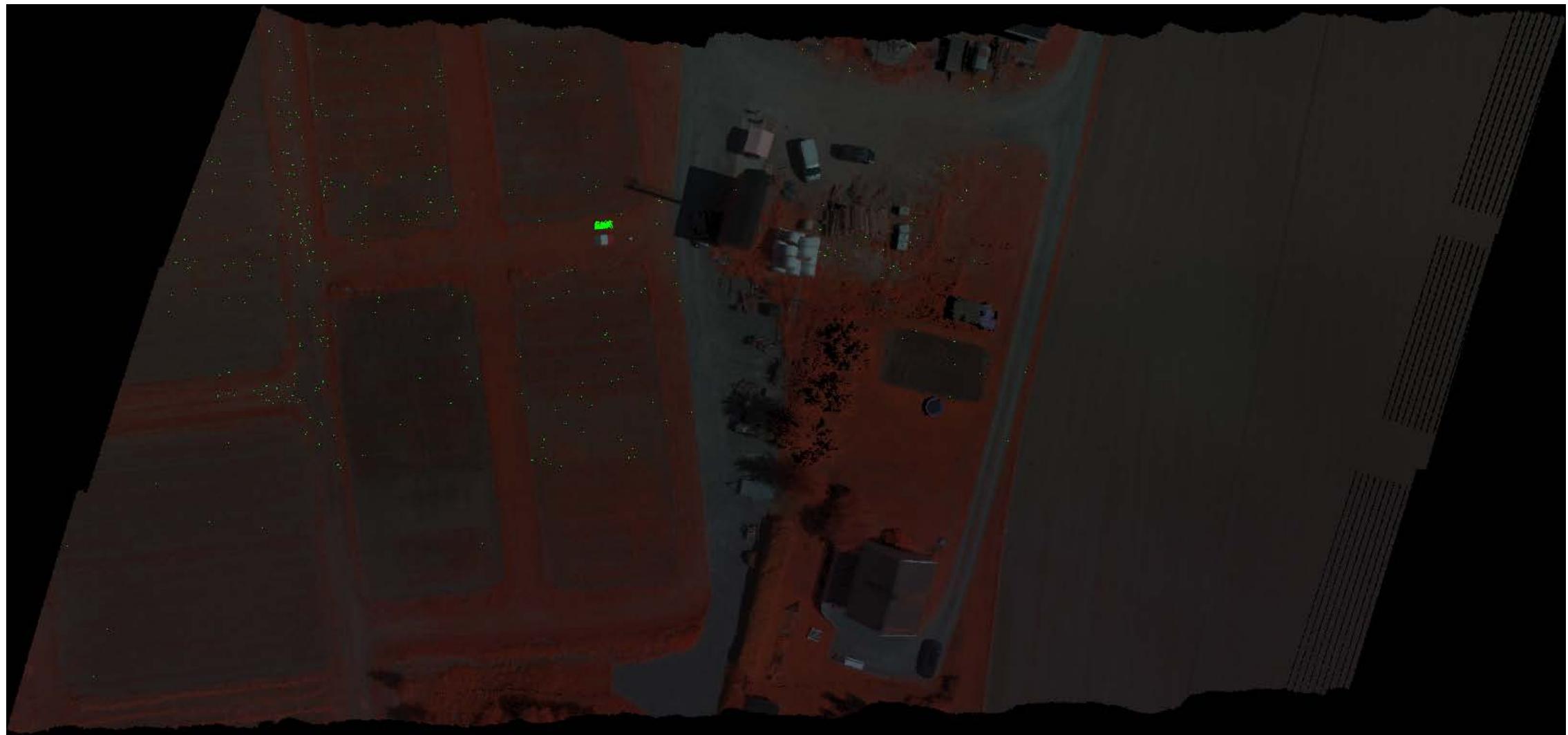
Spectral reconstruction



Spectral reconstruction

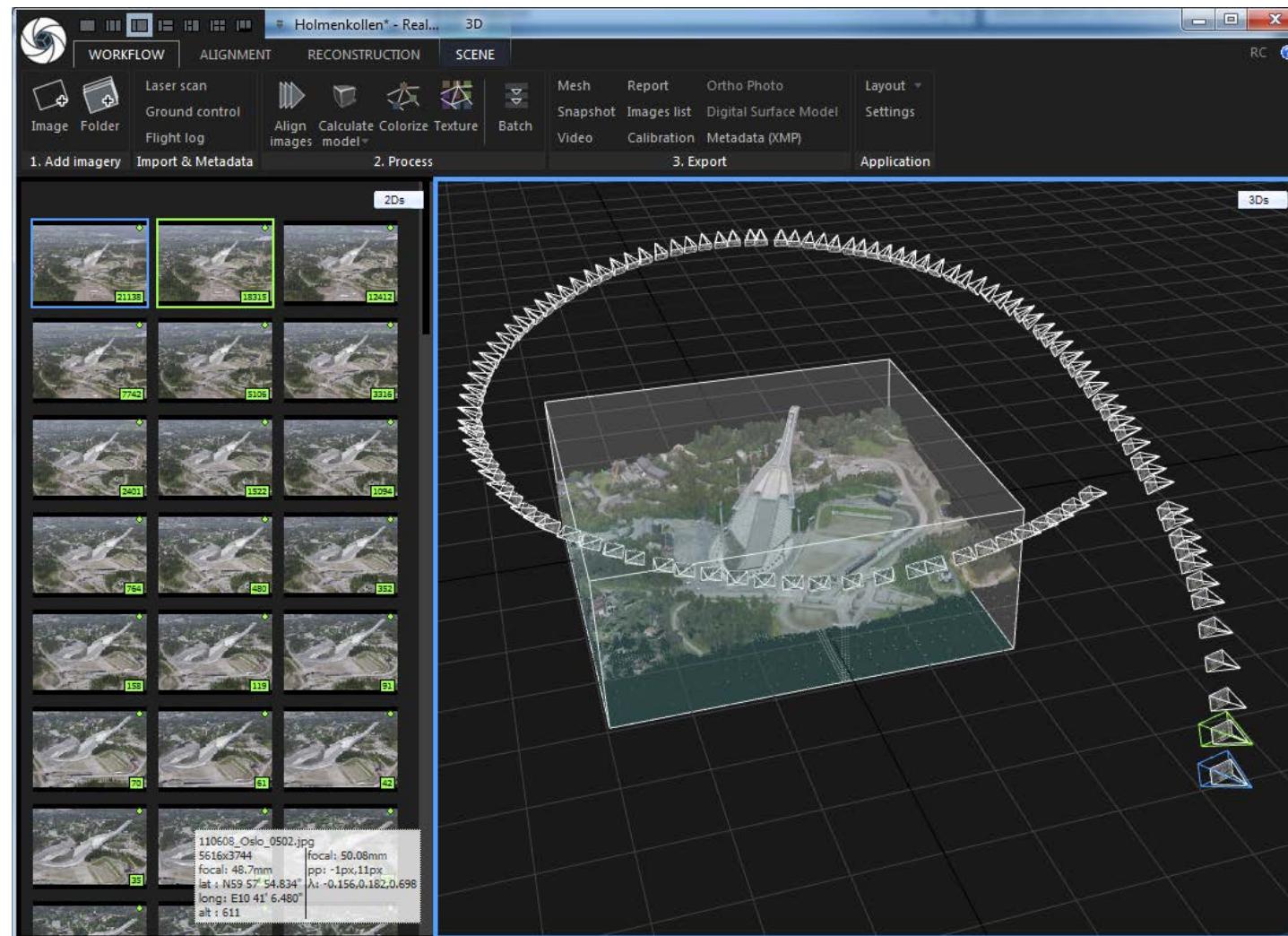


Spectral signature-specific detection



TEK5030

3D reconstruction from images

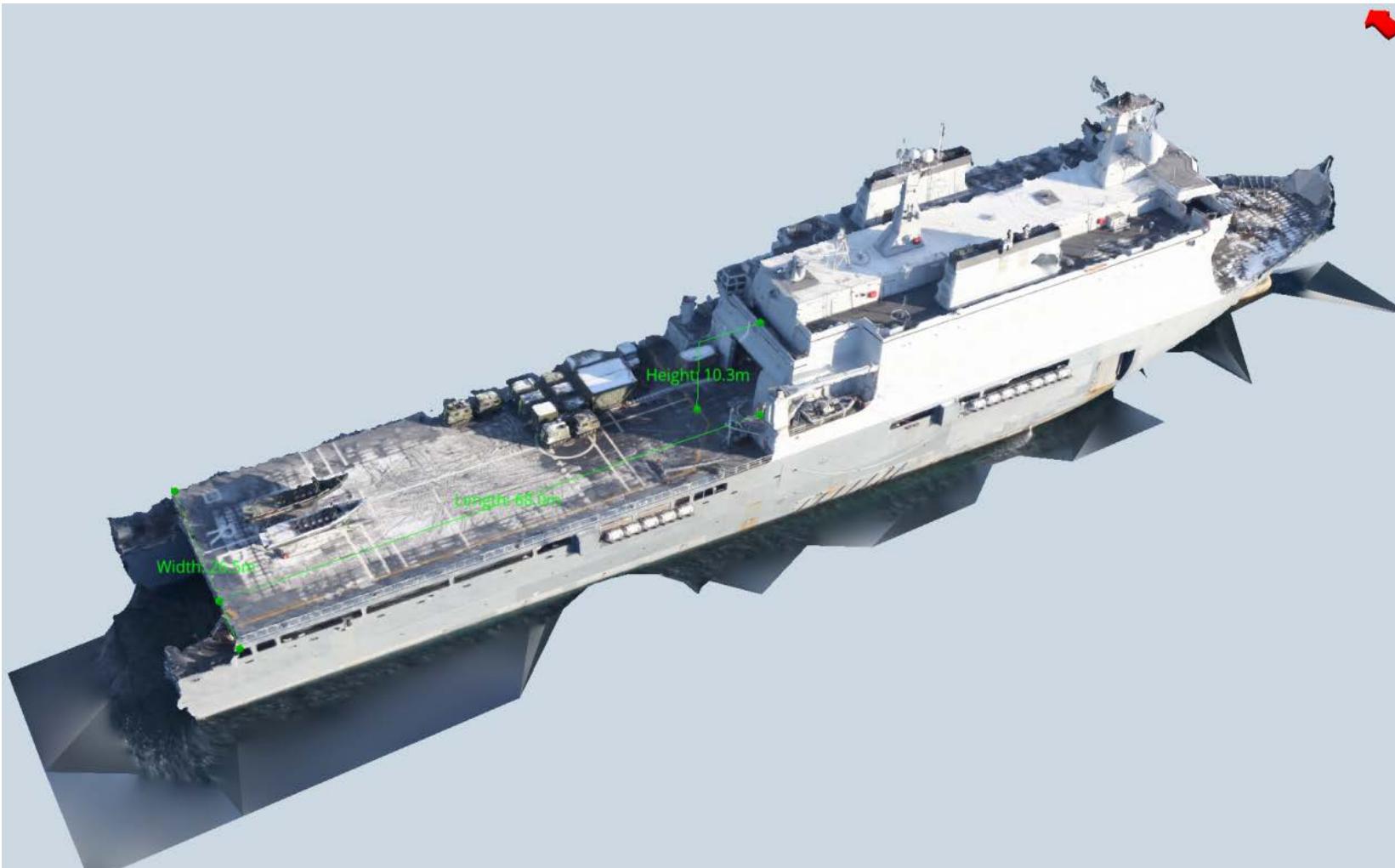


A detailed 3D surface in colors!

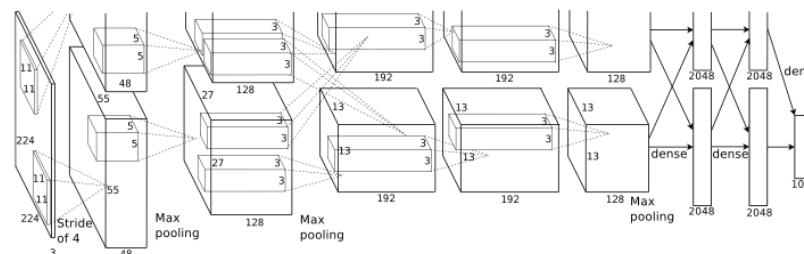


Capturing Reality

Recognize the shape of a ship

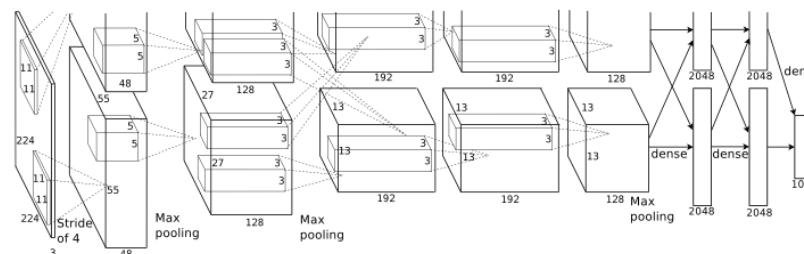


Let the machine learn a better representation itself!



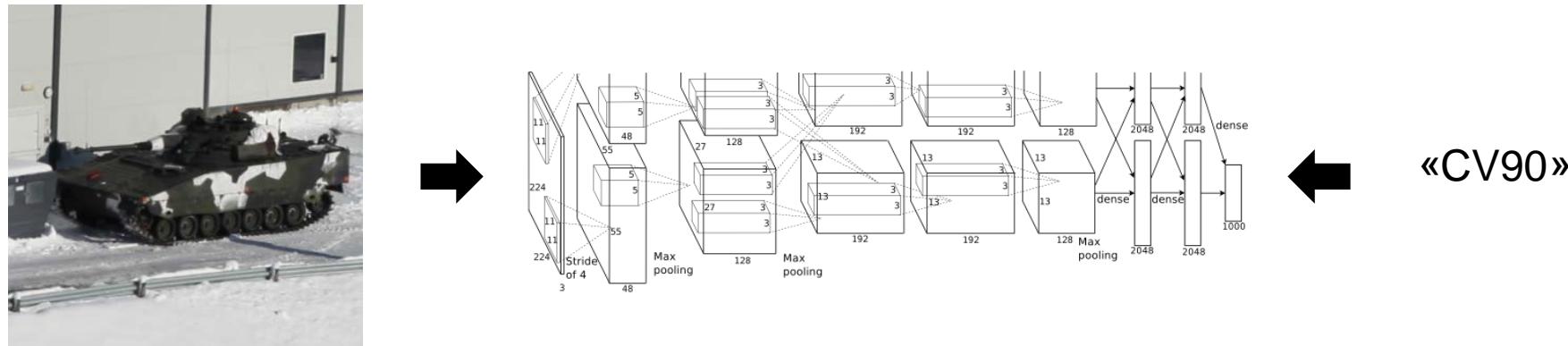
«Warship»

Let the machine learn a better representation itself!

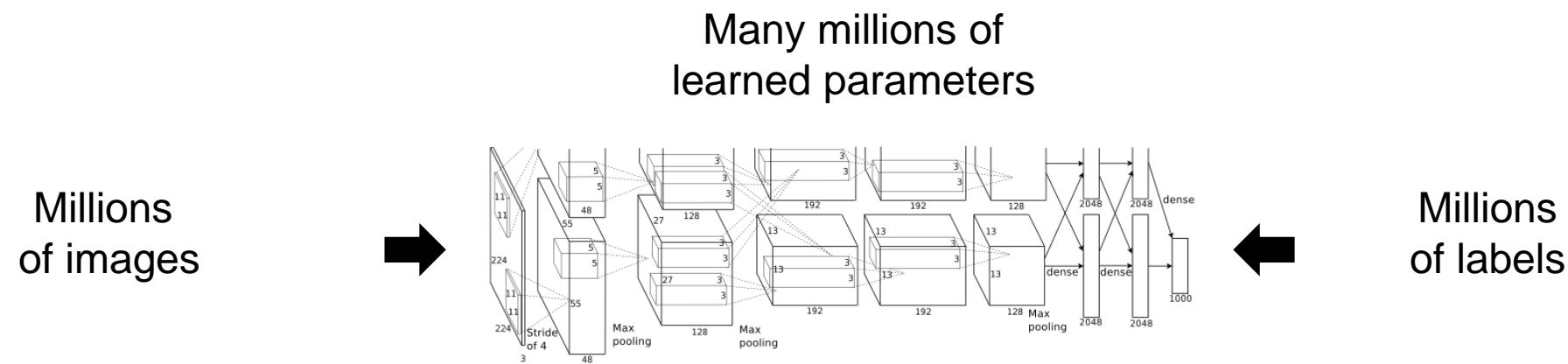


«Warship»

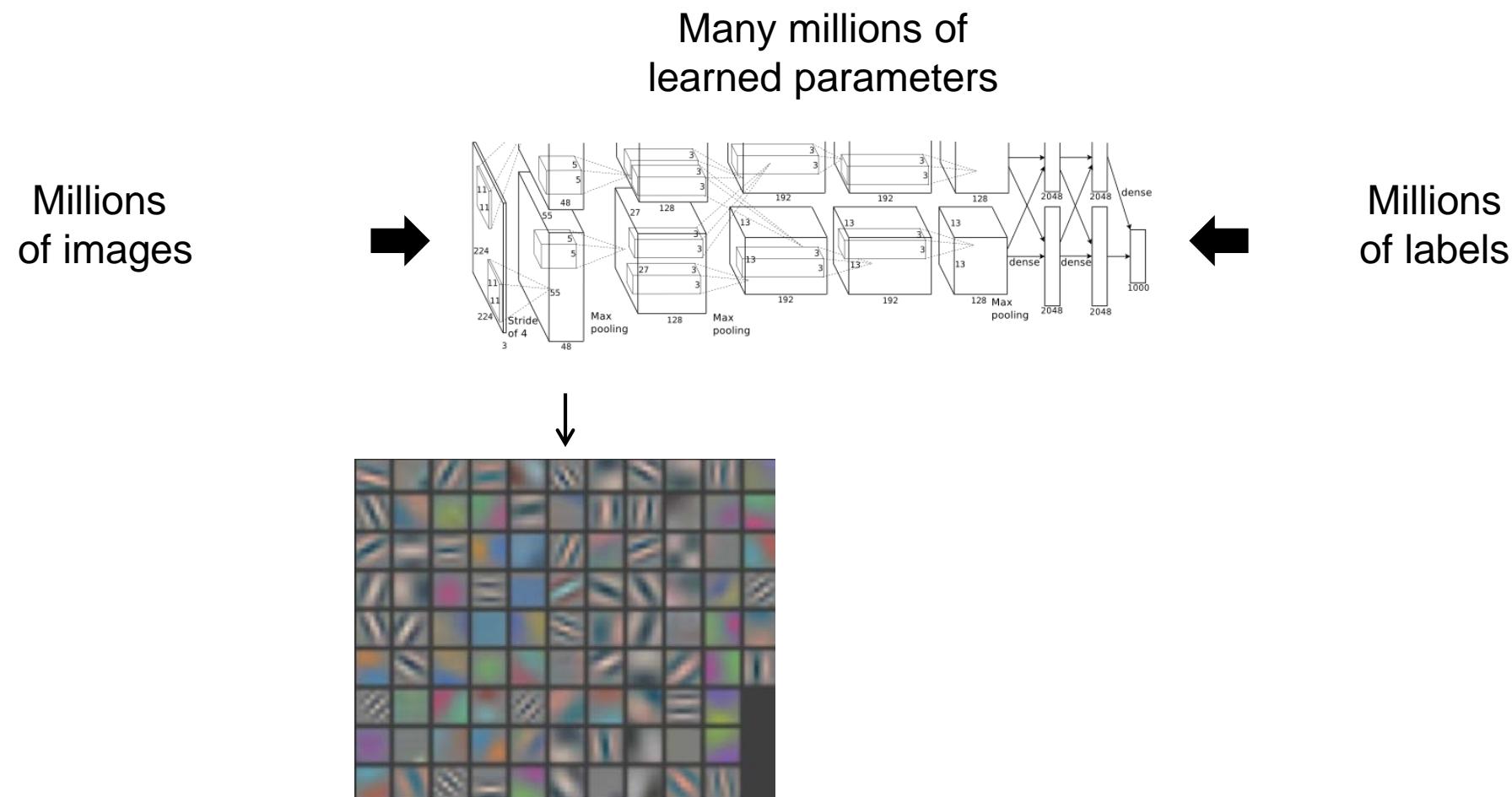
Let the machine learn a better representation itself!



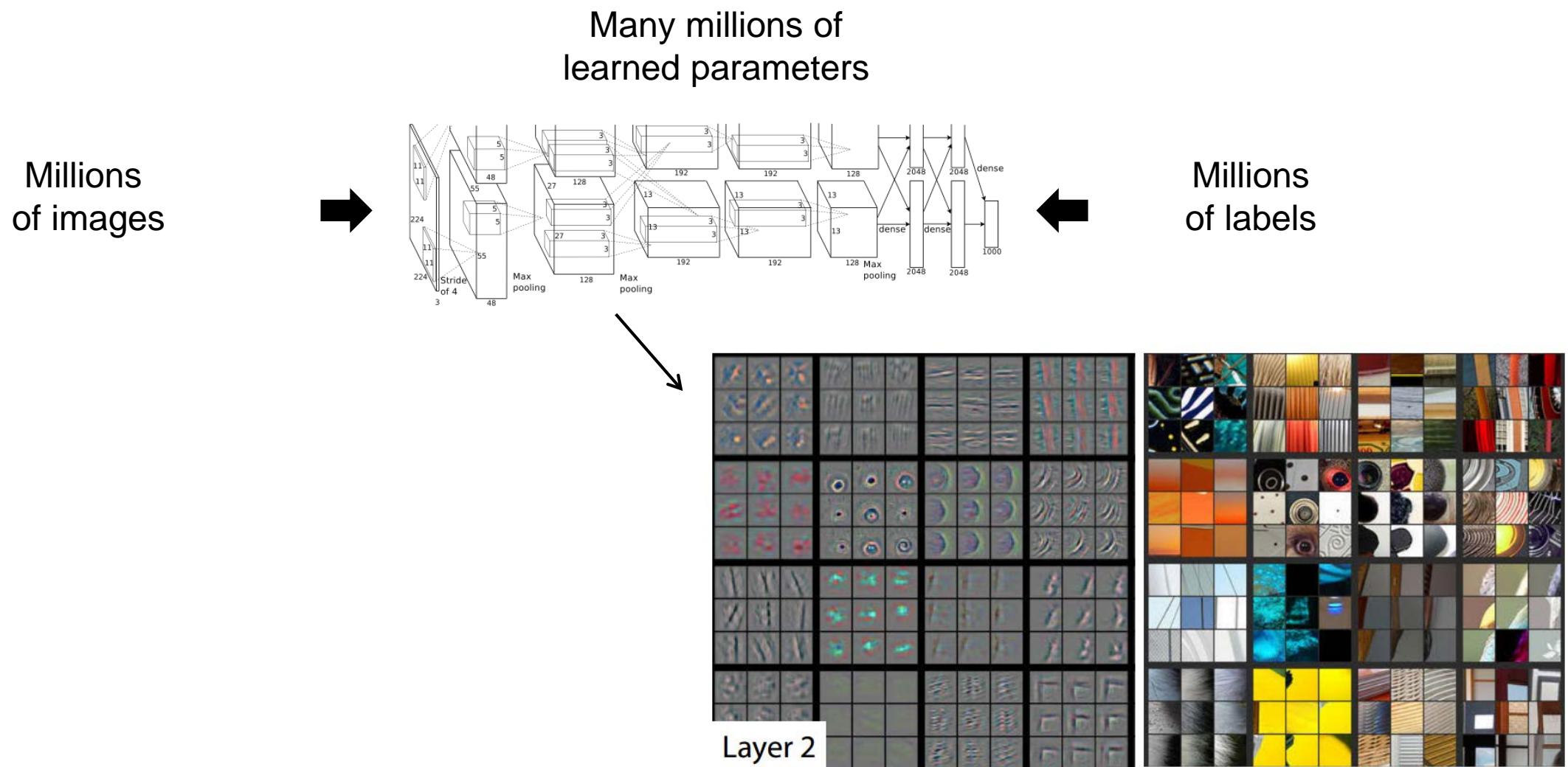
Let the machine learn a better representation itself!



Let the machine learn a better representation itself!



Let the machine learn a better representation itself!



Let the machine learn a better representation itself!

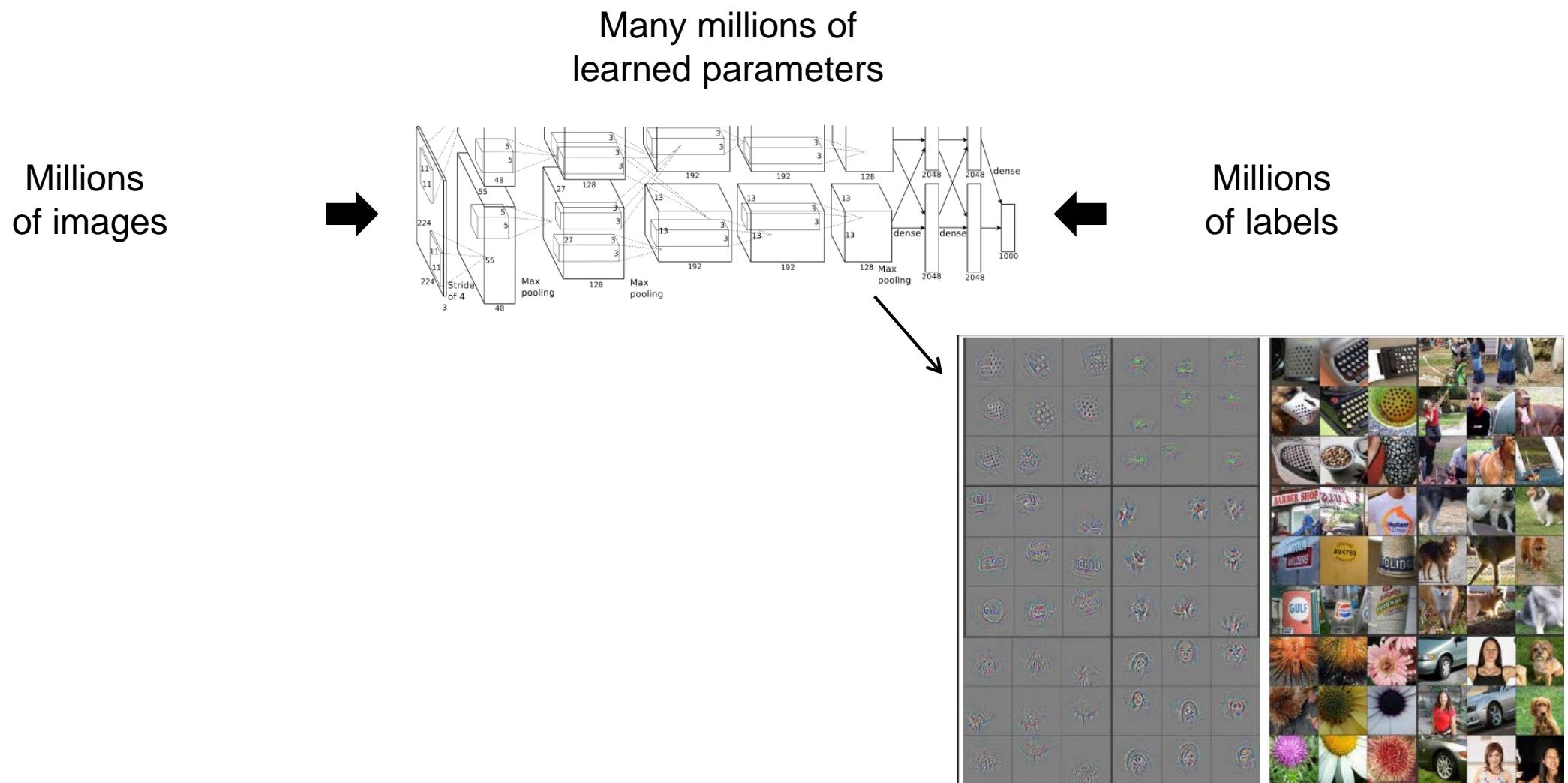


Image search in Google Photo

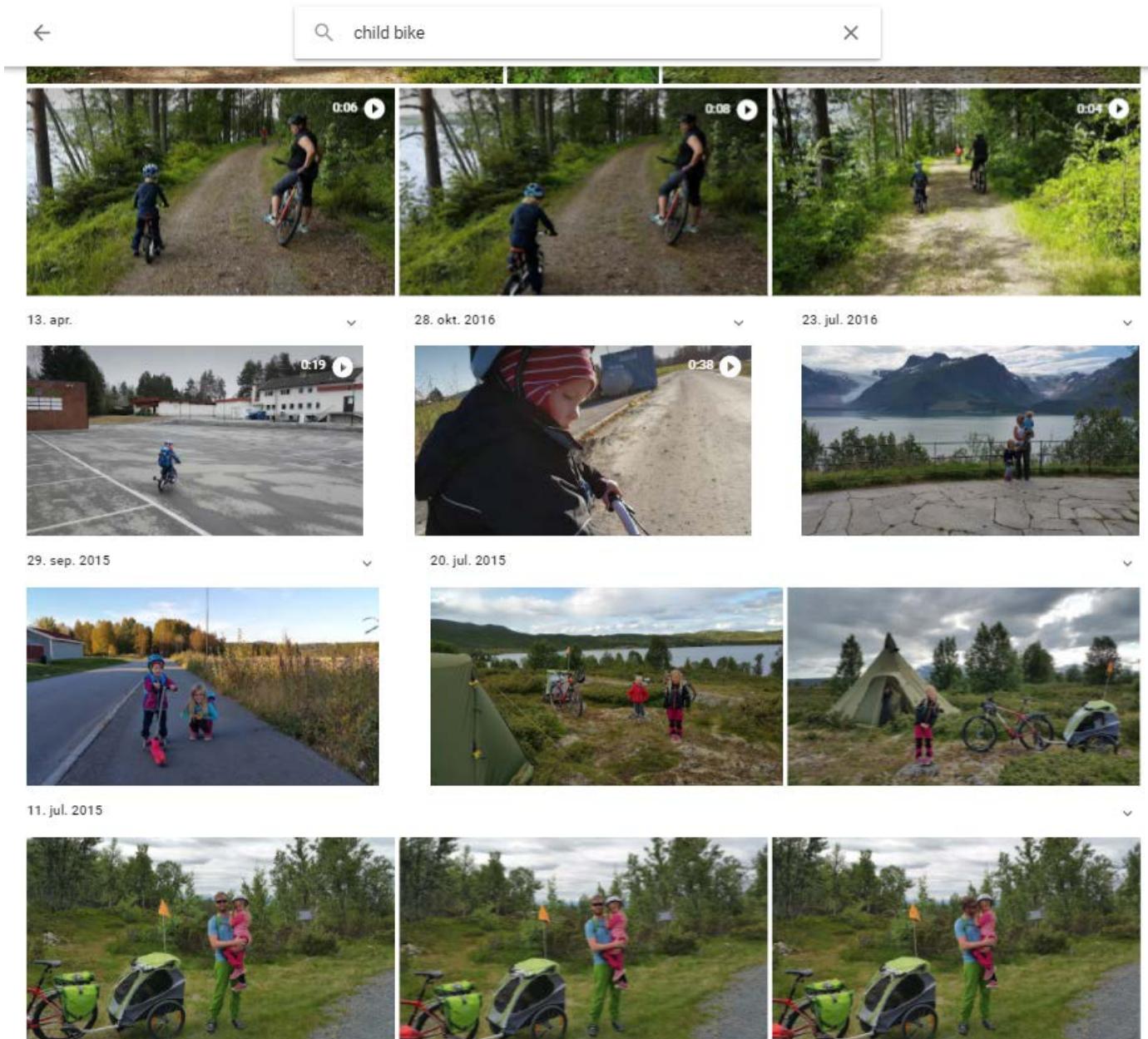
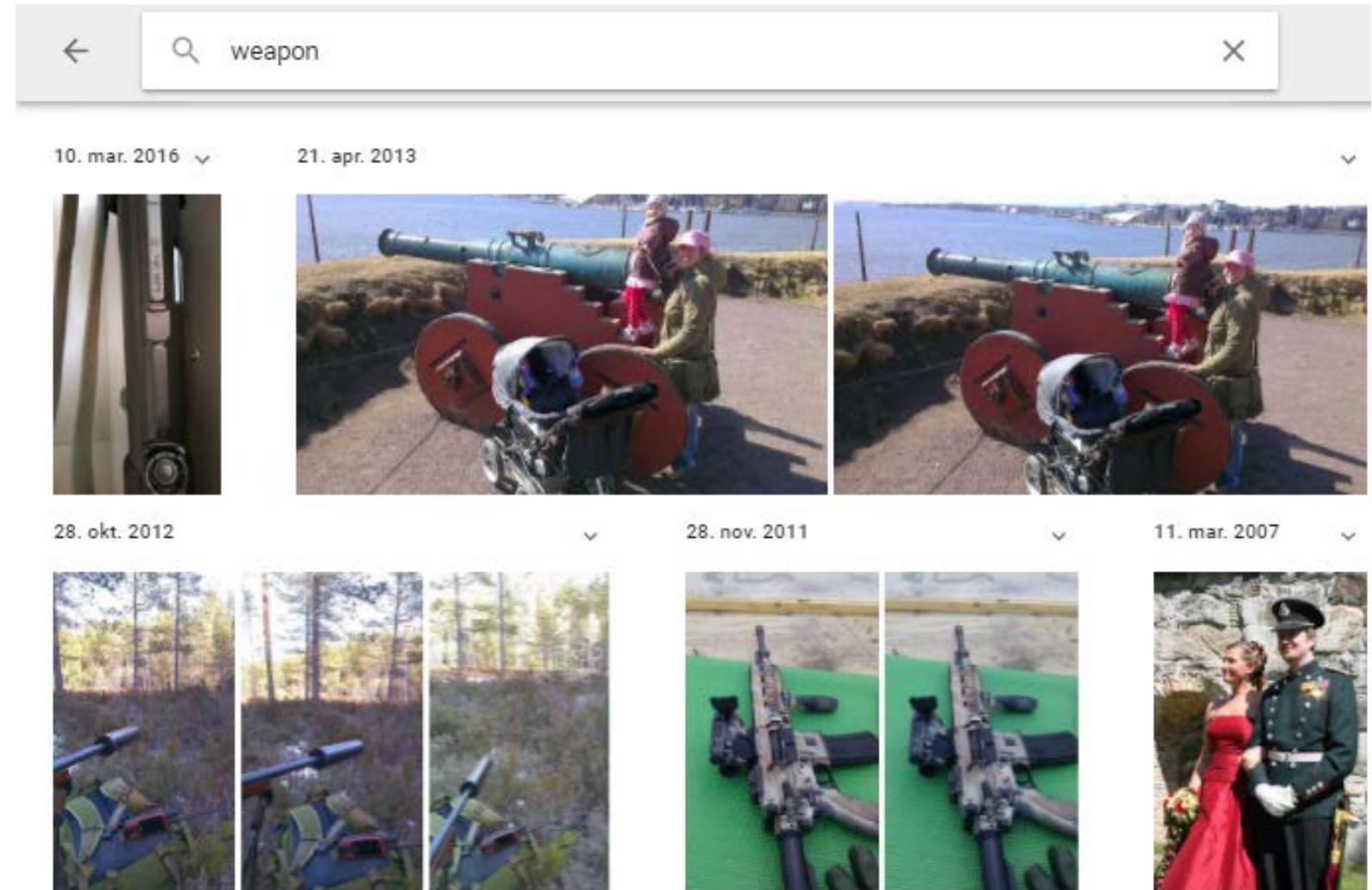
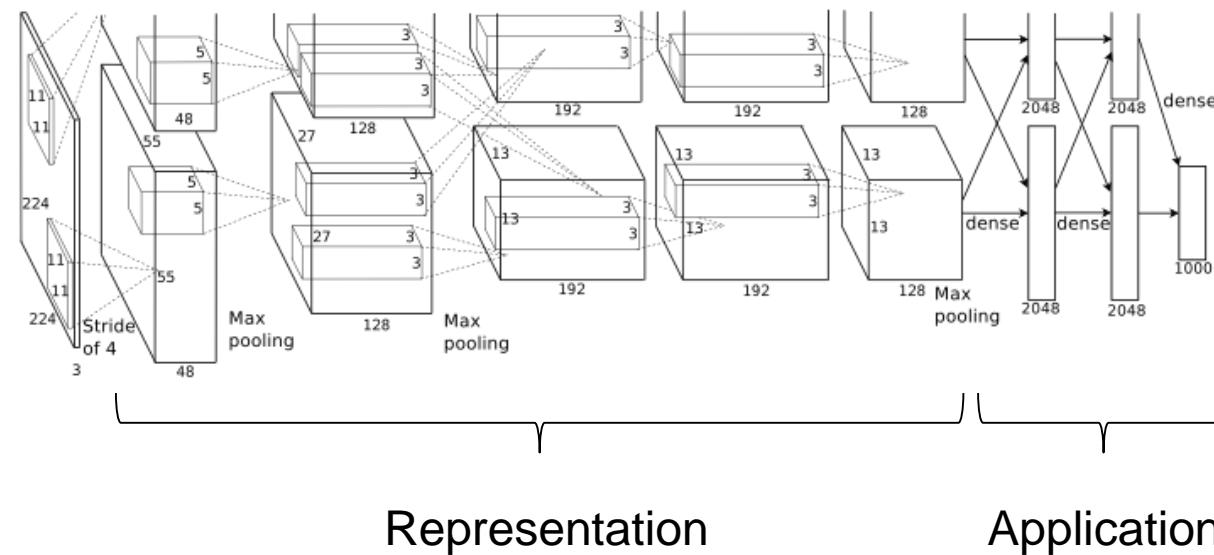


Image search in Google Photo

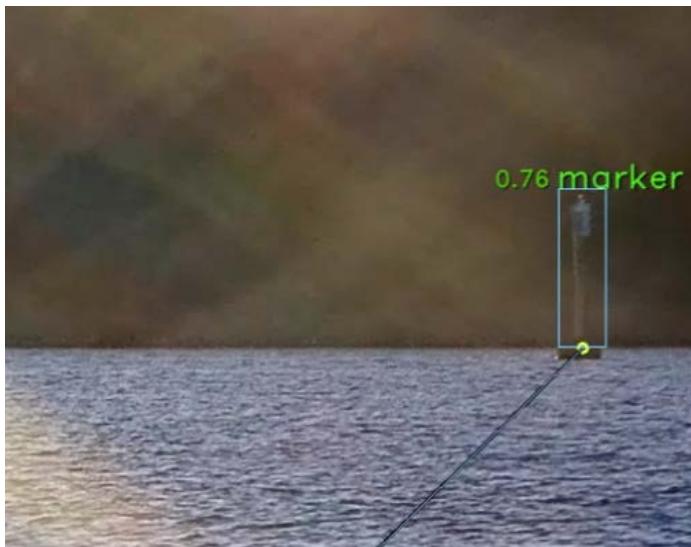


Reuse of learned representations

Download a model learned from millions of examples



Reuse of learned representations in new applications



About the course

Results from the survey



TEK5030 pre course survey

TEK5030 will this year be fully digital.

We follow a flipped classroom strategy:

- The lectures are recorded
- We do programming labs live

This is your first, and probably most important chance to influence how you would like the course to be!

Thank you for completing this survey!

10  

Course information

- We use canvas: <https://canvas.uio.no/>
- Course plan
- Teaching materials
 - Lecture videos
 - Lecture slides
 - Lab exercises
- Questions and discussions
- Project deliveries

The screenshot shows the Canvas course page for TEK5030 19V Maskinsyn. The left sidebar has a dark theme with white icons and text. It includes links for Konto, Dashboard, Emner (with TEK5030 highlighted), Kalender, Innboks, and Hjelp. The main content area has a light background. At the top, it says "TEK5030 19V" and "TEK5030 19V Maskinsyn". Below that is the UoI logo and the text "UiO • Institut for teknologisystemer Det matematisk-naturvitenskapelige fakultet". A large image shows a green tracked vehicle in a snowy field. Below the image, the text "TEK5030: Maskinsyn - Våren 2019" is displayed. To the right, there's a sidebar titled "Å gjøre" with several items listed:

- Se emnesstrøm
- Vis emnekalender
- Da er vi snart i gang med TEK5030 16. jan. i 20.09
- Project proposal 18. april i 12:00
- Project report 19. mai i 23:59
- Project presentation 23. mai i 23:59

«Flipped classroom»

- Original purpose
 - Get as much as possible out of a day at Kjeller
- Online
 - Prerecorded lectures each week
(in Norwegian)
- Thursdays 09:15-12:00
 - ~20 min lecture summary and questions
 - ~2.5 hours programming lab



```
1  #include "opencv2/highgui.hpp"
2  #include <iostream>
3
4  int main()
5  {
6      cv::VideoCapture input_stream(0);
7
8      if (!input_stream.isOpened())
9      {
10         std::cerr << "Could not open camera\n";
11         return EXIT_FAILURE;
12     }
13
14     const std::string window_title = "Lab 0: Introduction to OpenCV";
15     cv::namedWindow(window_title, cv::WINDOW_NORMAL);
16
17     cv::Mat frame;
18
19     while(true)
20     {
21         input_stream >> frame;
22
23         if (frame.empty())
24         {
25             break;
26         }
27
28         cv::imshow("cam", frame);
29
30         if (cv::waitKey(15) >= 0)
31         {
32             break;
33         }
34     }
35
36     return EXIT_SUCCESS;
37 }
```

Labs – How it usually is

- Students work together
- We walk around the room
- We talk about common problems and solutions



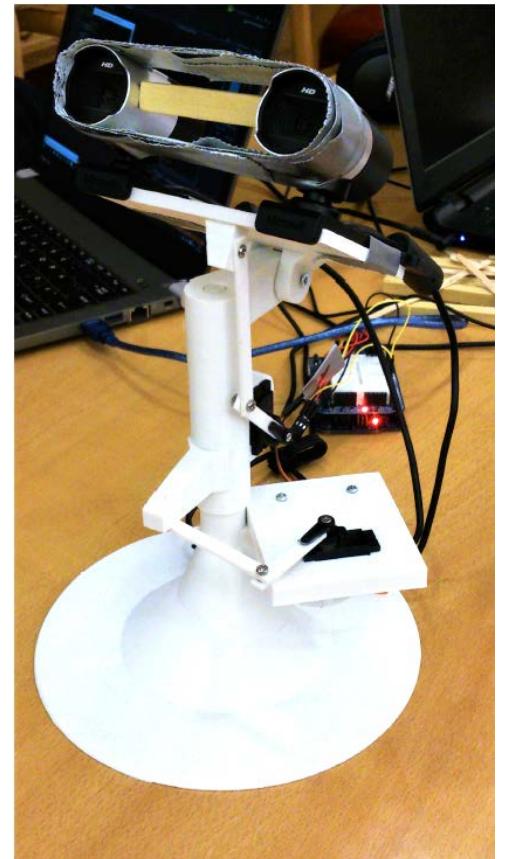
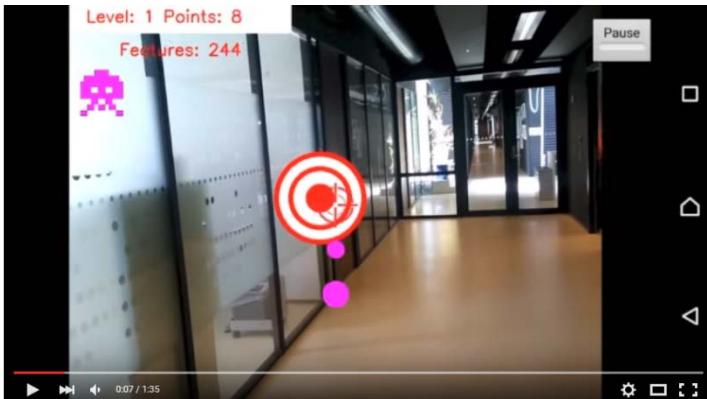
Labs – How it is now

- We need to find good ways for you to collaborate!
- We need to find good ways for us to give help and feedback
- You need to take **more initiative!**



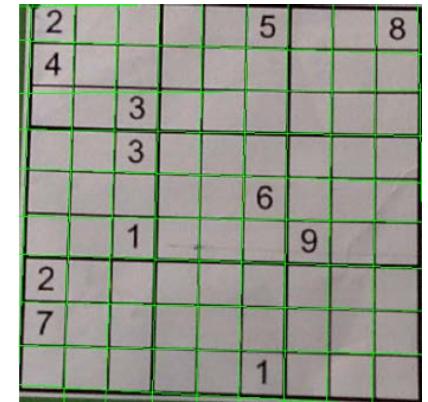
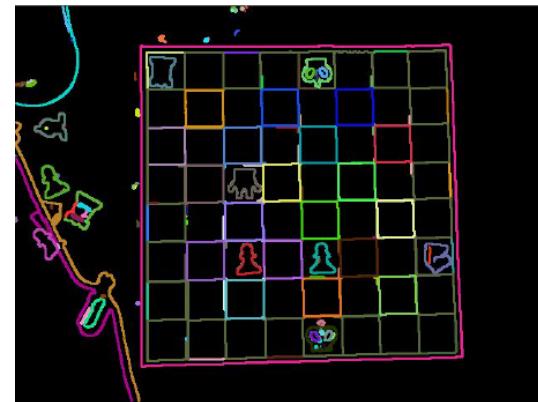
Student projects

- 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



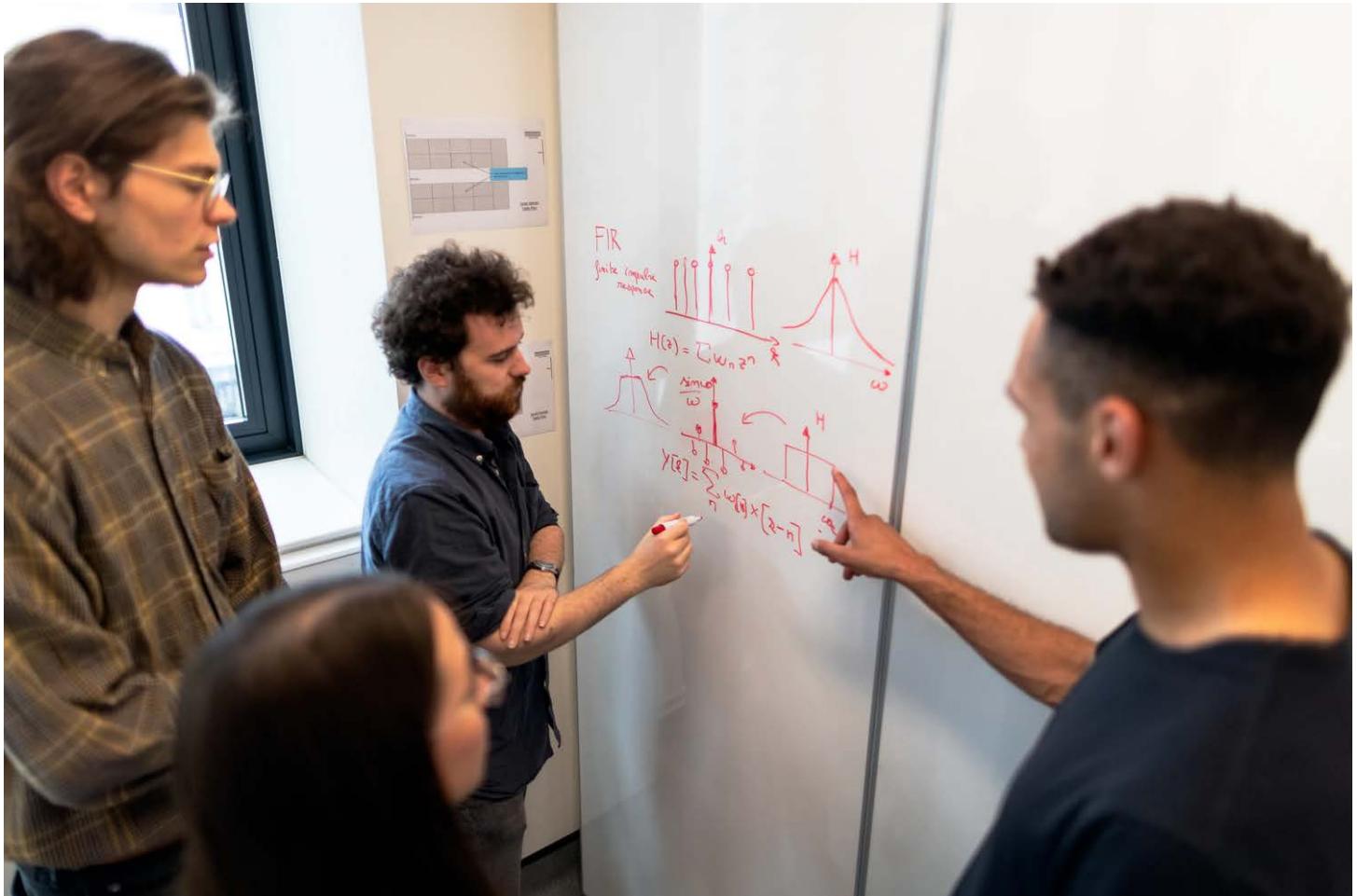
Student projects

- 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



Exam

- Oral exam (probably)
- Mid June



Digital lecturing tools

- [Canvas](#)
- [Zoom](#)
- [Mentimeter](#)
- [Microsoft Teams?](#)



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?

