UNIVERSITÀ DI PAVIA

CompMat 2022 Spring Workshop March, 16/17 Università degli Studi di Pavia

SEAVISION

Speaker

Luigi Carrioli

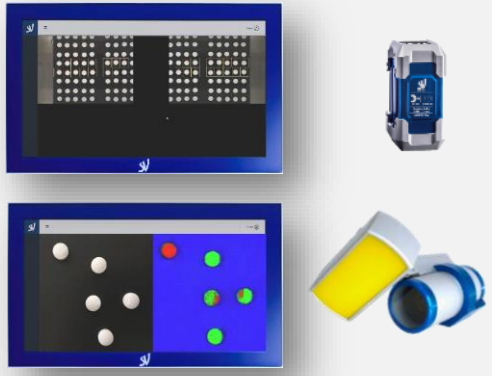
President & Co- Founder

www.linkedin.com/in/luigi-carrioli

SEA Vision is…

Business areas

Vision inspection systems



harleblister_
harletray_ harleNIRc_

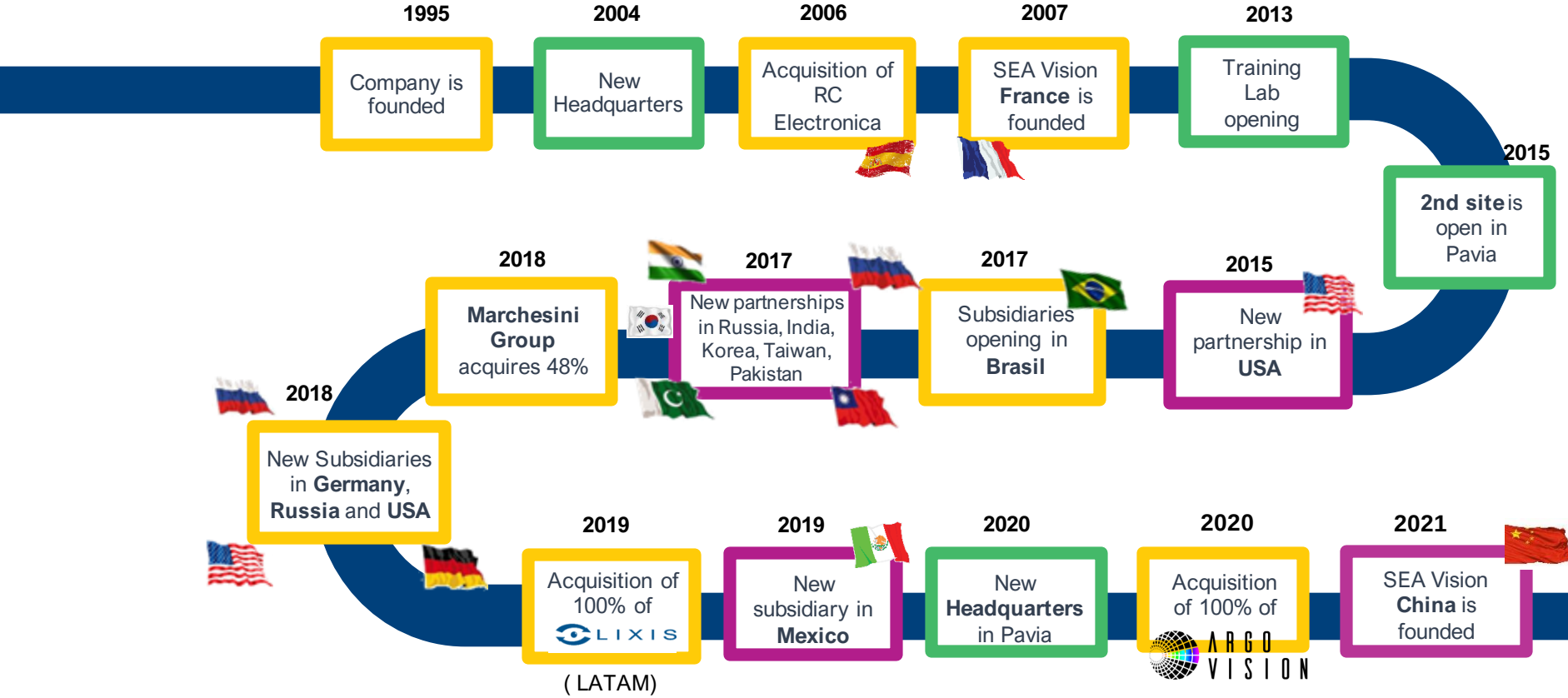
Serialization and Aggregation solutions

tracker_

4.0 Pharma Software Suite

yudoo_

History


1995
Company is founded
2004
New Headquarters
2006
Acquisition of RC Electronica
2007
SEA Vision **France** is founded
2013
Training Lab opening
2015
2nd site is open in Pavia
2015
New partnership in **USA**
2017
Subsidiaries opening in **Brasil**
2017
New partnerships in Russia, India, Korea, Taiwan, Pakistan
2018
Marchesini Group acquires 48%
2018
New Subsidiaries in **Germany**, **Russia** and **USA**
2019
Acquisition of 100% of LIXIS
(LATAM)
2019
New subsidiary in **Mexico**
2020
New **Headquarters** in Pavia
2020
Acquisition of 100% of ARGO VISION
2021
SEA Vision **China** is founded

SEA Vision is…

Over **180 people** working in Pavia HQ

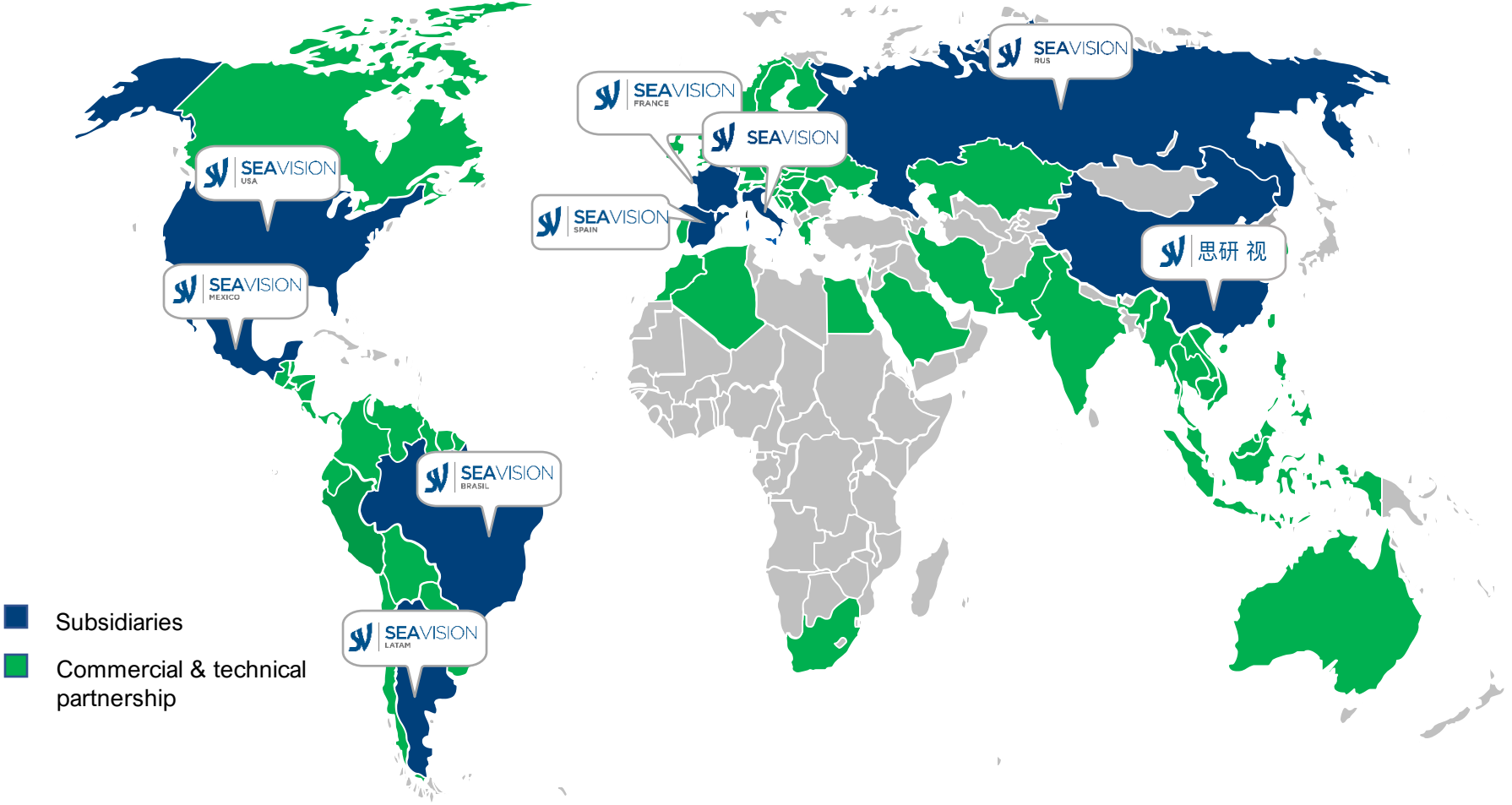
Average age: **30/31 years**

75% employees with technical degrees

International environment

Over **330 people** in the world

Where we are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SEAVISION USA
SEAVISION MEXICO
SEAVISION BRASIL
SEAVISION LATAM
SEAVISION FRANCE
SEAVISION
SEAVISION SPAIN
SEAVISION RUS
思研视
Subsidiaries
Commercial & technical partnership

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Some of our Best Pharma Customers

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Some of our best OEM Customers

Focus on: Line Clearance

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Digitalization of the Pharma Production Site

Pharmaceutical companies have to face very meticulous control and cleaning processes in their production sites. These cleaning controls are carried out by operators, but it may happen that in some areas of the line it can't be accessible to the waste areas.

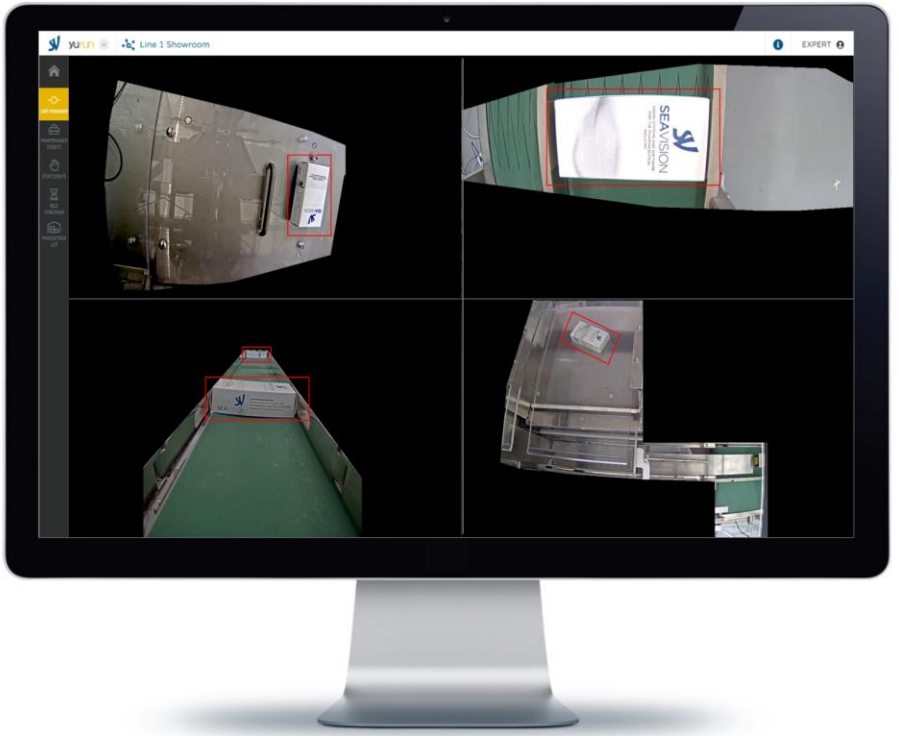
If the waste is not eliminated completely, this can **lead to inefficiency in the production line.**

What are the aims of automatic line clearance?

Digitalization of the Process

Improvement of the processes
for cleaning and checking

Avoidance of human errors
for more safety



What are the aims of automatic line clearance?

Increase OEE
increasing process performance

Speed up to 40%

Reducing time of operations and speed up your line clearance procedures **up to 40%**

Better reports, with photo evidence

Paperless, GMP compliant

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How does line clearance work?

- Industrial cameras for scene inspection (ARGO algorithm)
- Smart sensor for spot detection
- Manual acknowledge system (scan ID code)

Deep Learning nowadays

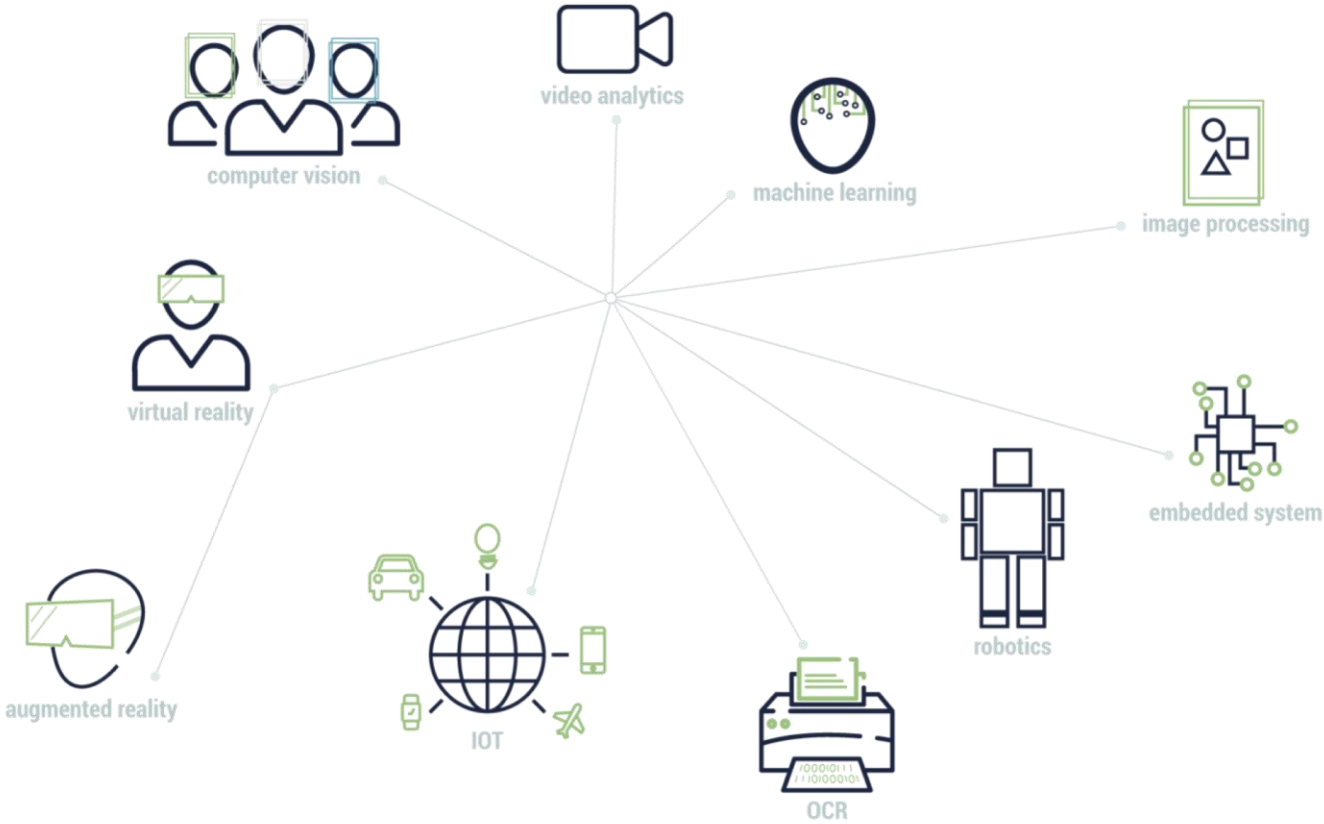
Speaker

Gabriele Lombardi

CTO

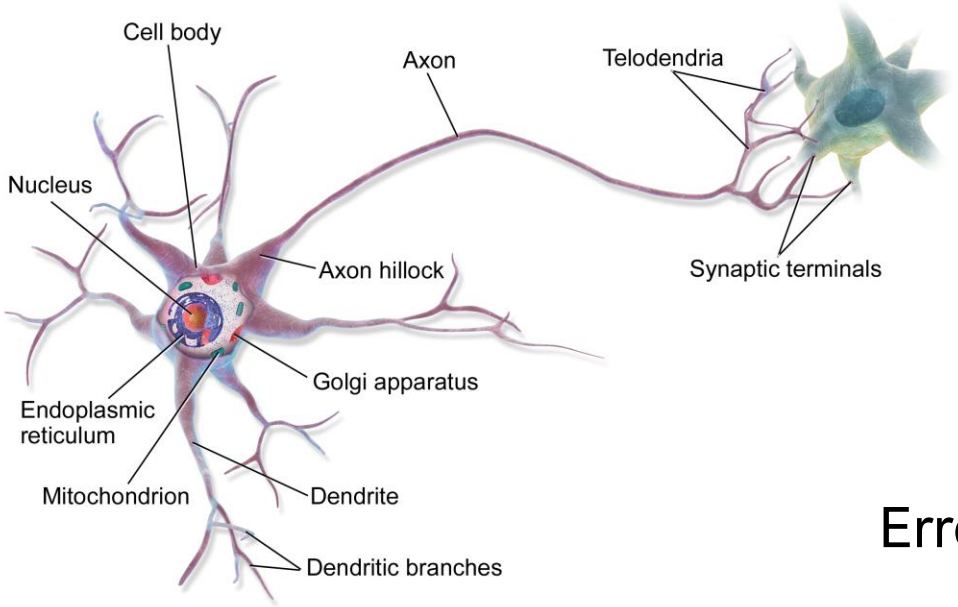
Argo VISION

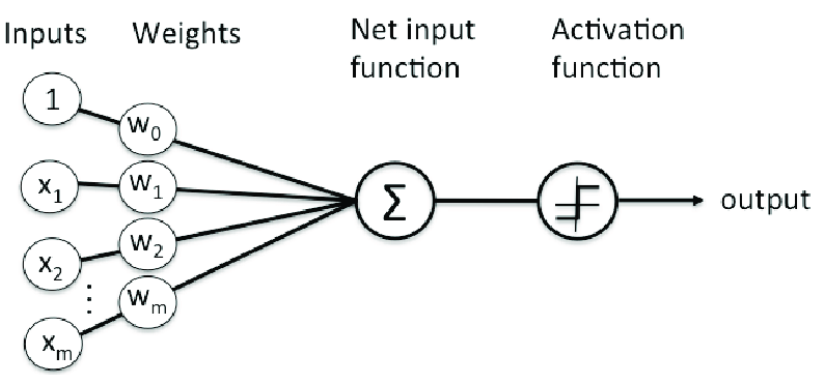
What do we do?


computer vision
video analytics
machine learning
image processing
virtual reality
embedded system
robotics
augmented reality
IOT
OCR

Deep Learning
History of Convolutional Neural Networks

Artificial Neural Networks **imitating the brain**
1958, Rosenblatt's perceptron



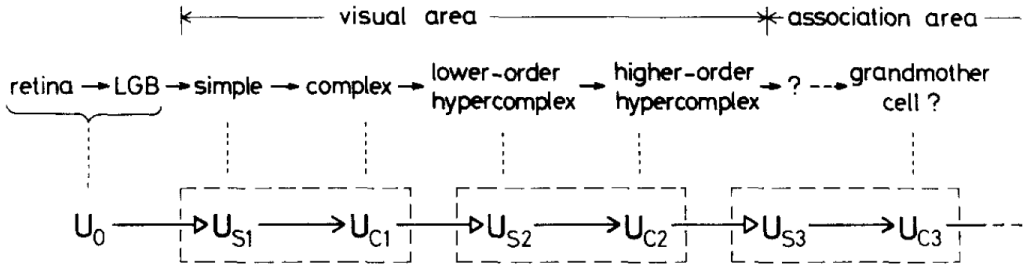


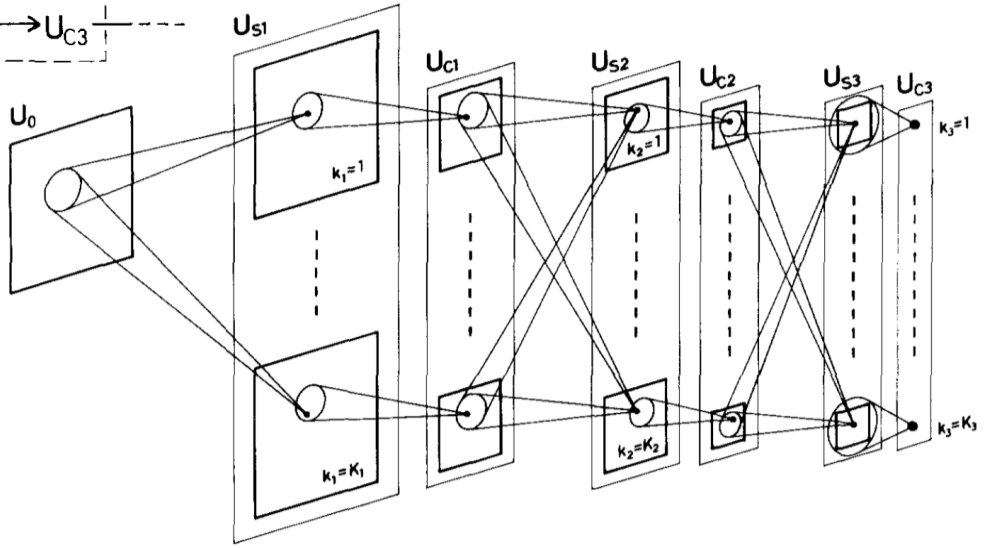
Error-function driven weights learning

"THE PERCEPTRON: A PROBABILISTIC MODEL FOR INFORMATION STORAGE AND ORGANIZATION IN THE BRAIN", F. ROSENBLATT, 1958

Deep Learning
History of Convolutional Neural Networks

Fukushima, 1975, Cognitron, 1980, Neocognitron



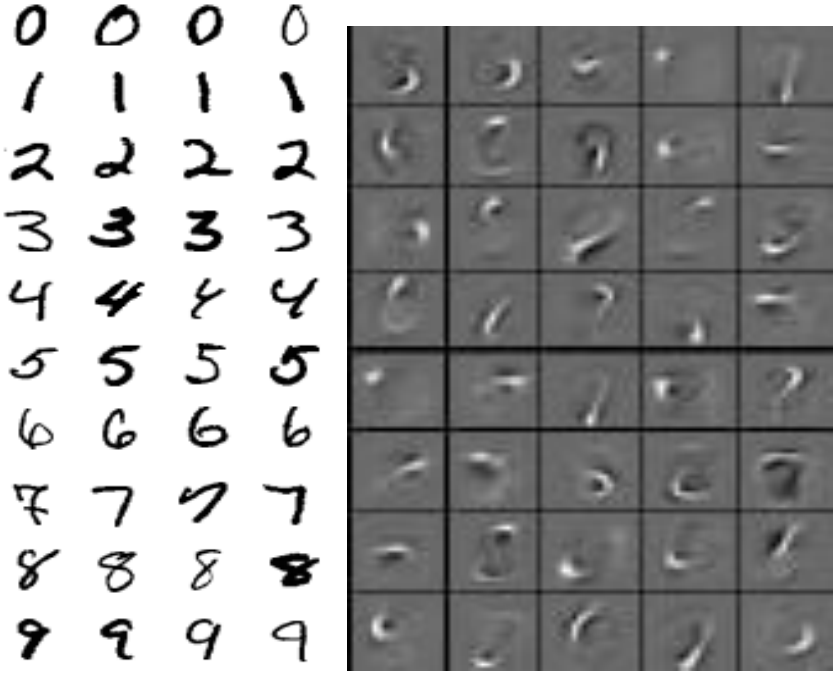


Multi-step processing
Notion of locality

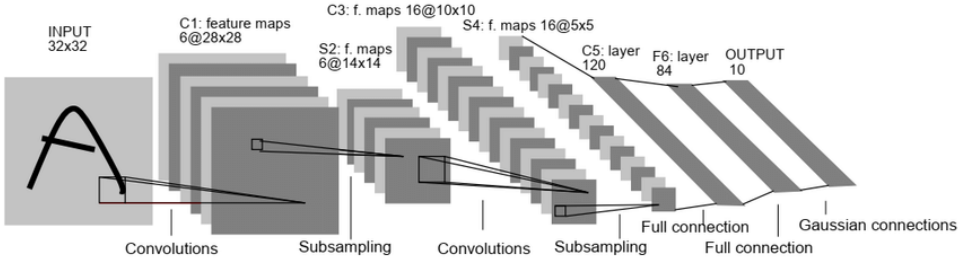
"Neocognitron: A Self-organizing Neural Network Model for a Mechanism of Pattern Recognition Unaffected by Shift in Position ", Kunihiko Fukushima, 1980

Deep Learning
History of Convolutional Neural Networks

MNIST dataset



1998, LeCun: LeNet

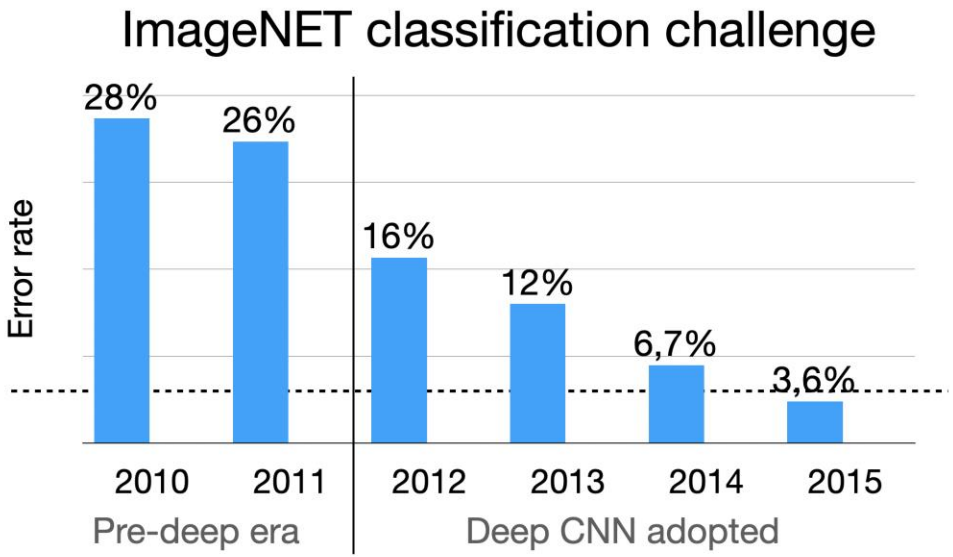


Gradient-based learning
of **convolution** weights
First modern CNN

"**GradientBased Learning Applied to Document Recognition**", Yann LeCun Leon Bottou Yoshua Bengio and Patrick Haner, 1998

Deep Learning
History of Convolutional Neural Networks

2012, AlexNet



What's the **meaning of "deep"**?

What are deep CNNs **good for**?

CNNs proven to be:

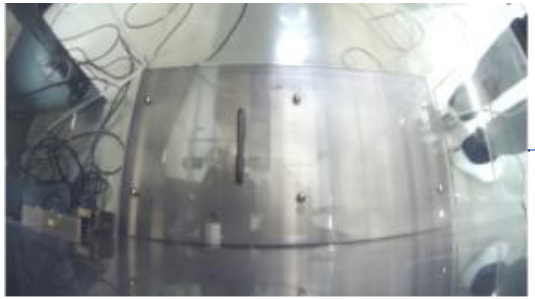
Effective

Expressive

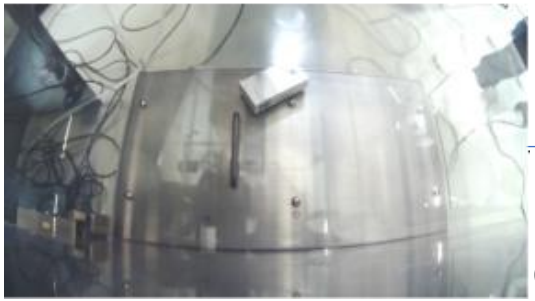
"ImageNet Classification with Deep Convolutional Neural Networks", Alex Krizhevsky, Ilya Sutskever, Geoffrey E. Hinton, 2012

Deep Learning
Applied to Line Clearance.. WHY?

Line Clearance needs pattern recognition

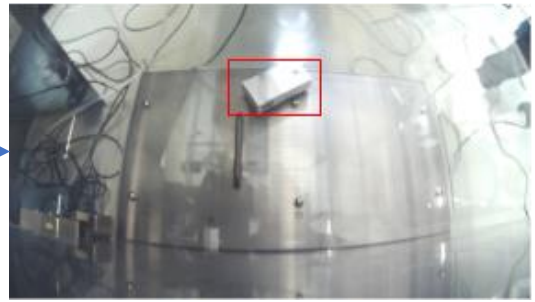


Reference image

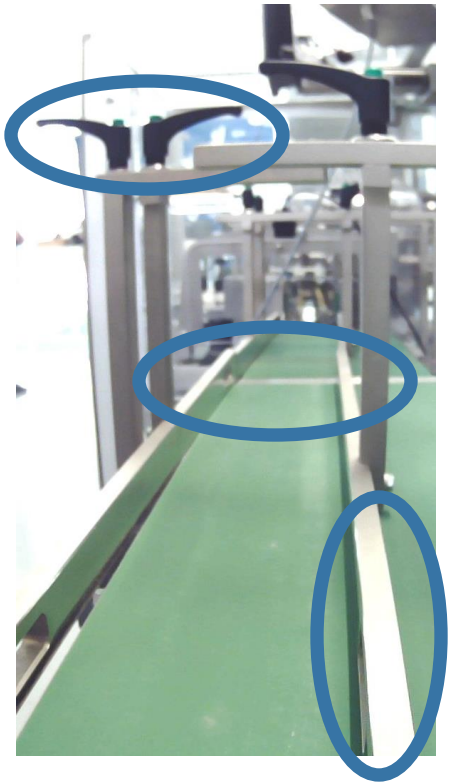


Comparison image

Localized anomaly



Variability to manage:
- Moving parts
- Lighting conditions
- Pose change



Line Clearance in the Deep Learning era

Speaker

Andrea Codegoni

Ph.D. Student "Computational Mathematics and Decision Sciences"

UNIVERSITÀ DI PAVIA

Università della Svizzera italiana

Change detection (in changing env.)

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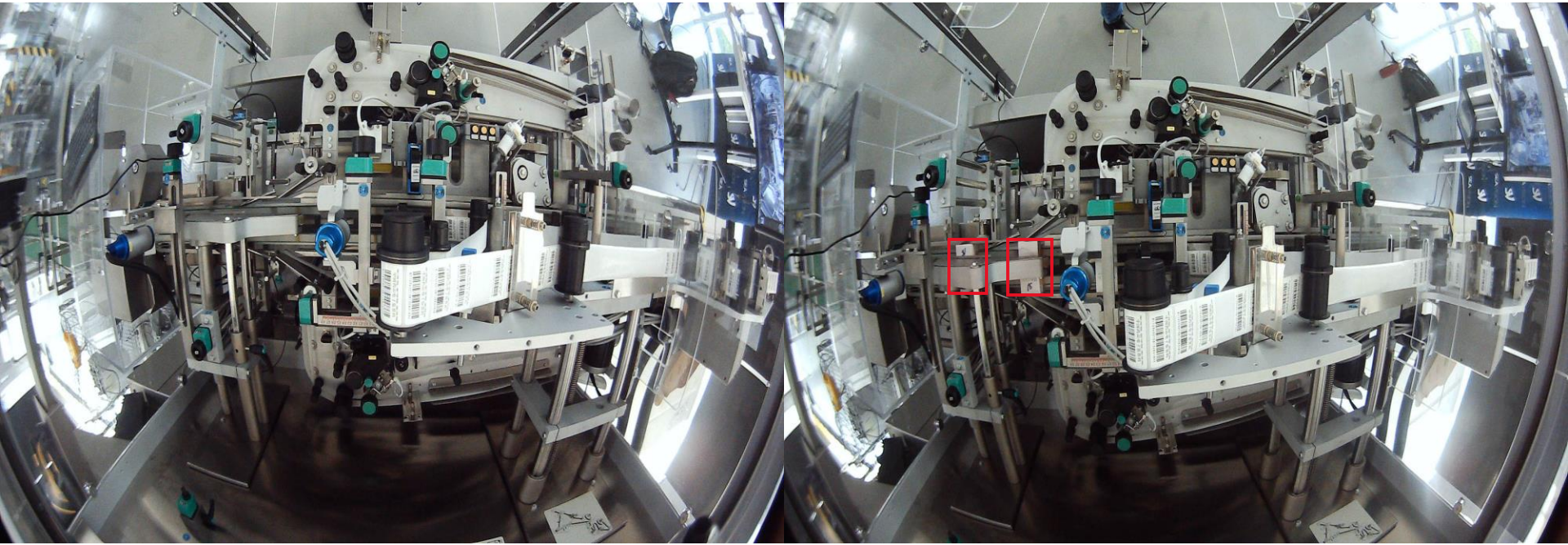
T0: clean machine

T1: ??? machine



Problem recap

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- Goal: segmentation/bounding boxes of anomalous objects

- Constraints:
  1. Low number/variety of available data
  2. Find unseen anomalous objects
  3. Robustness wrt working conditions and machine configurations
  4. Holy Grail: generalize to unseen reference configuration without retraining

What does literature provide us?

Useful tools

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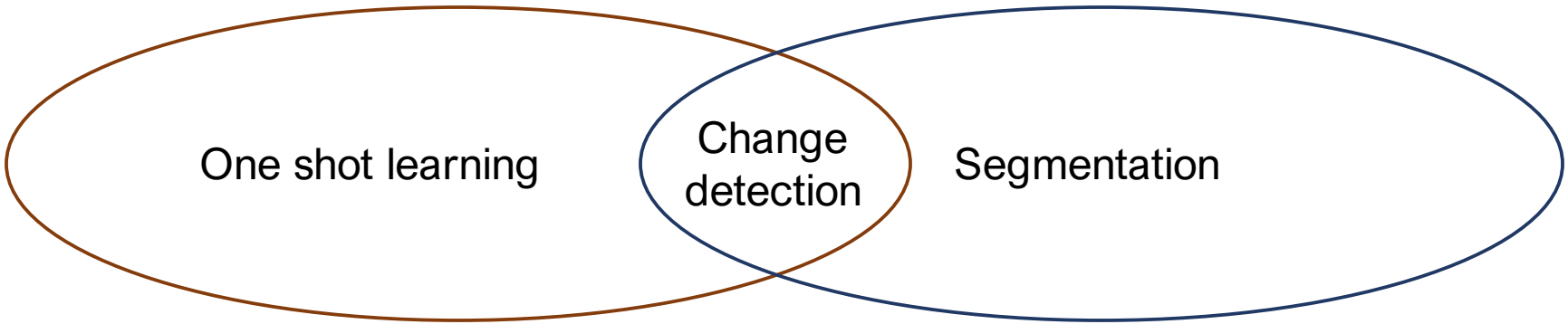
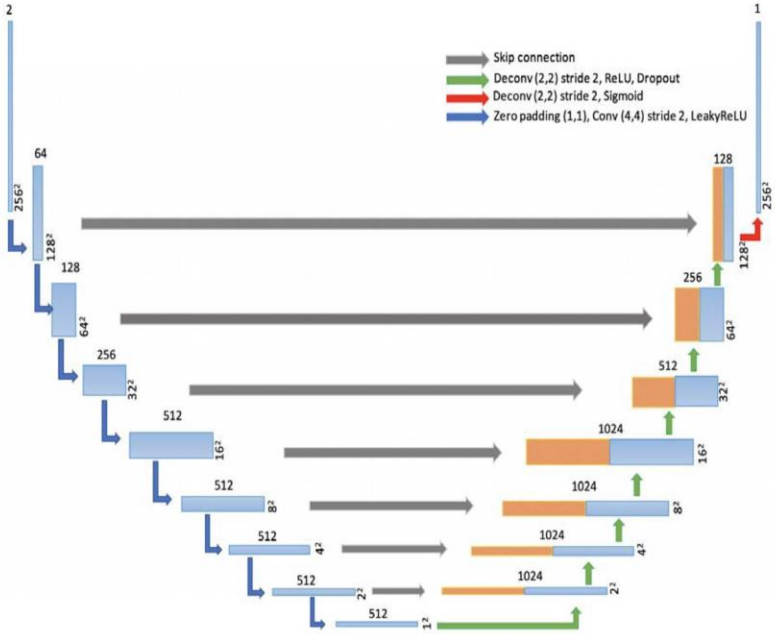
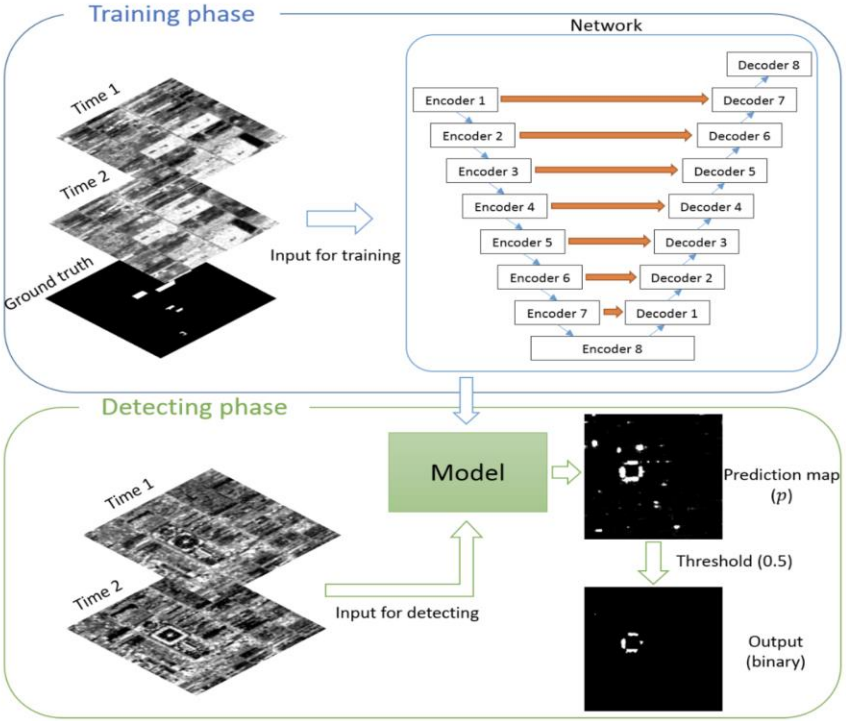


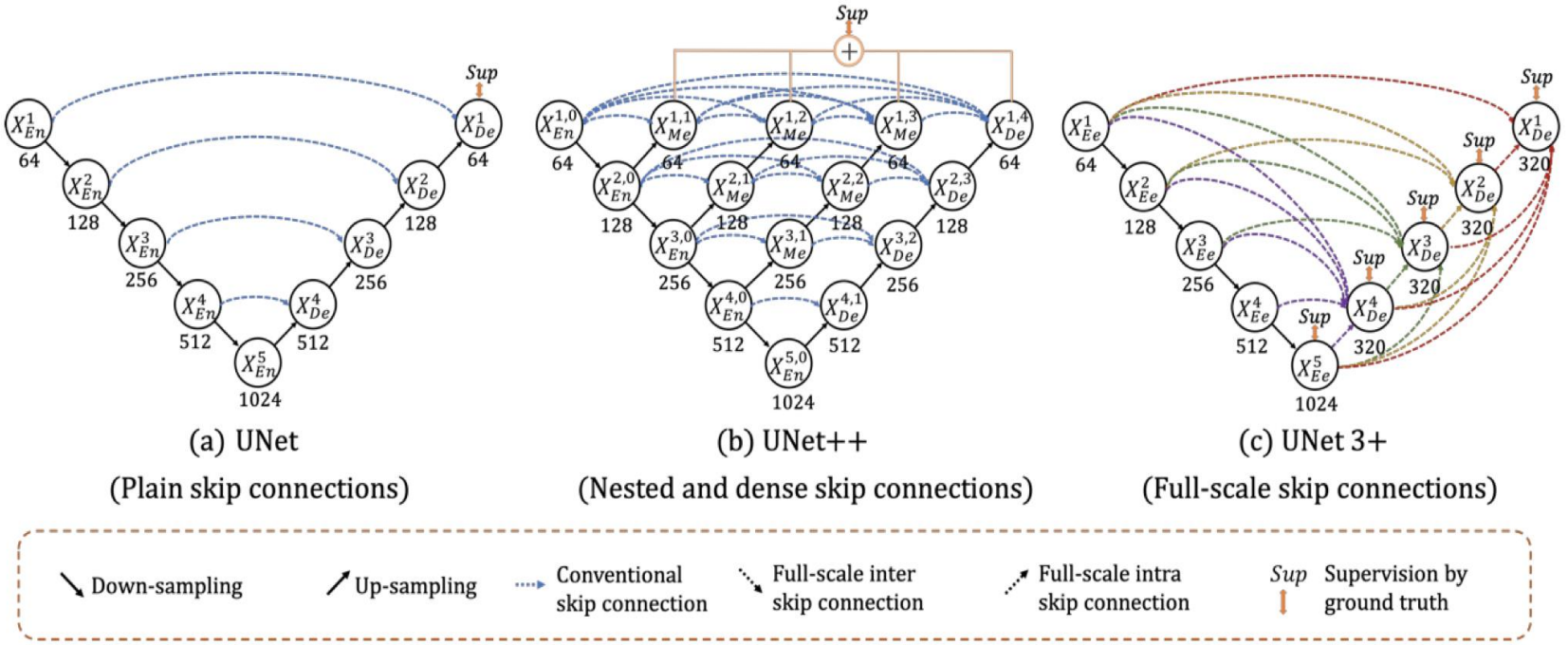
UNet





Jaturapitpornchai, R., Matsuoka, M., Kanemoto, N., Kuzuoka, S., Ito, R., & Nakamura, R. (2019). Newly built construction detection in SAR images using deep learning. *Remote Sensing*, *11*(12), 1444.

UNet saga



Huang, H., Lin, L., Tong, R., Hu, H., Zhang, Q., Iwamoto, Y., ... & Wu, J. (2020, May). UNet 3+: A full-scale connected UNet for medical image segmentation. In *ICASSP 2020-2020 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)* (pp. 1055-1059). IEEE.

Unet and Siamese nets for change det.

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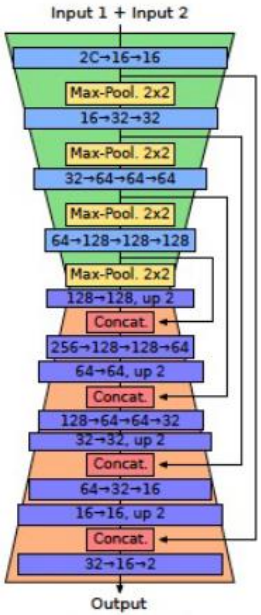
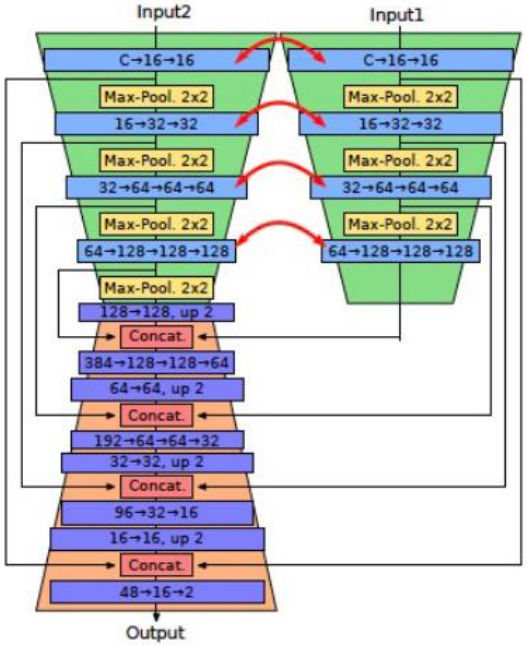
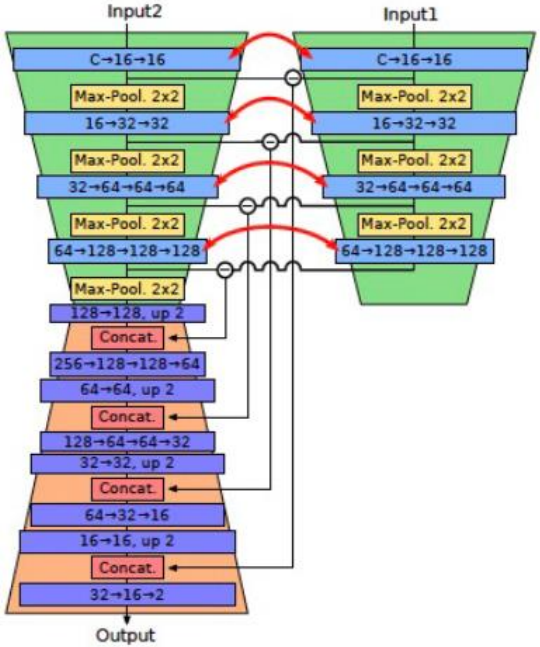


(a) FC-EF.



(b)FC-Siam-conc.



(c) FC-Siam-diff.

Blue: convolution

Yellow: max pooling

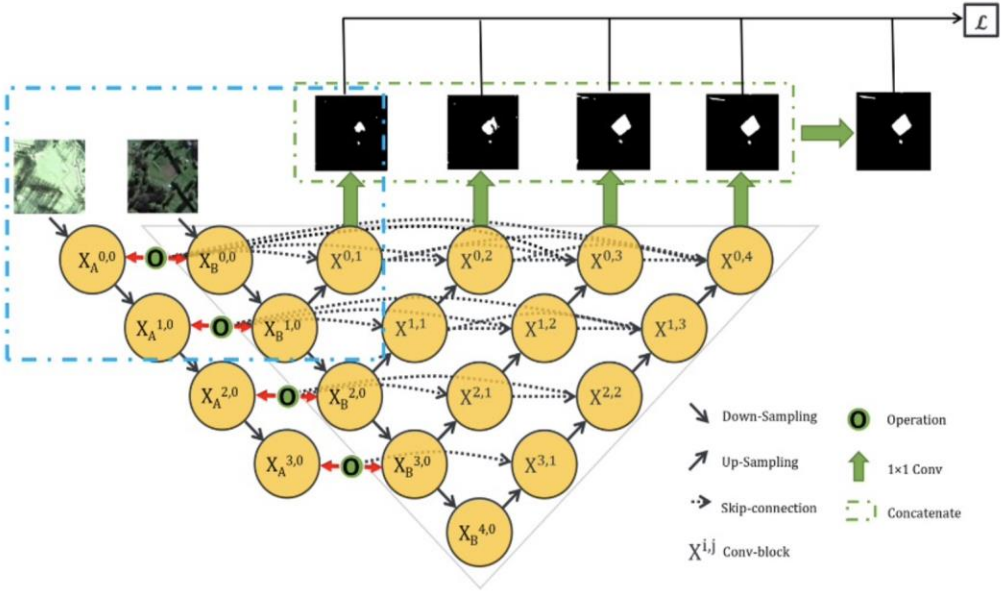
Red: concatenation

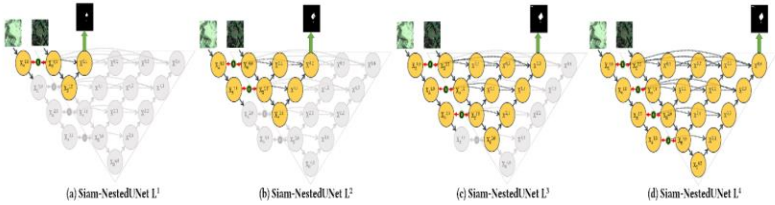
Purple: transpose convolution

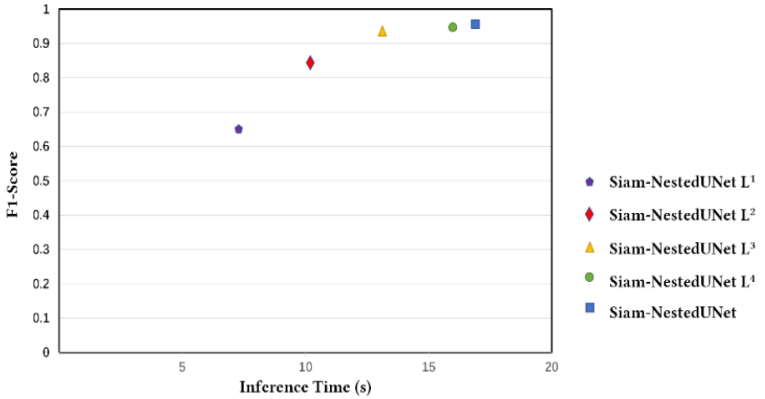
Red arrows: shared weights.

Daudt, R. C., Le Saux, B., & Boulch, A. (2018, October). Fully convolutional Siamese networks for change detection. In *2018 25th IEEE International Conference on Image Processing (ICIP)* (pp. 4063-4067). IEEE.

UNet++ & Siamese



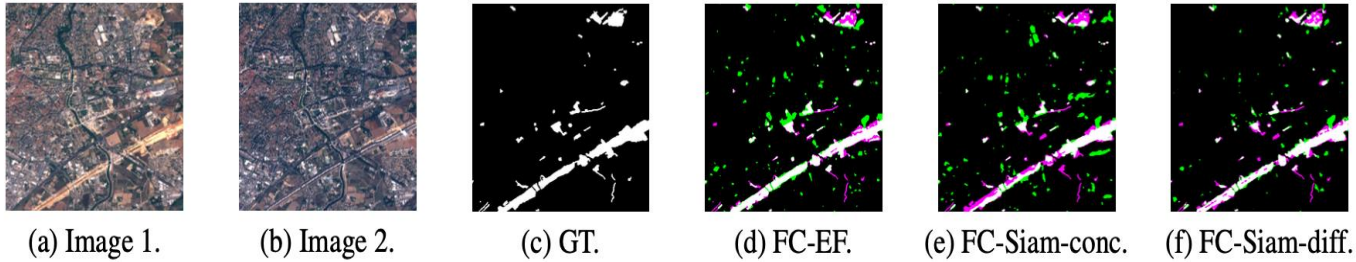




On a Tesla V100 (>6k $)

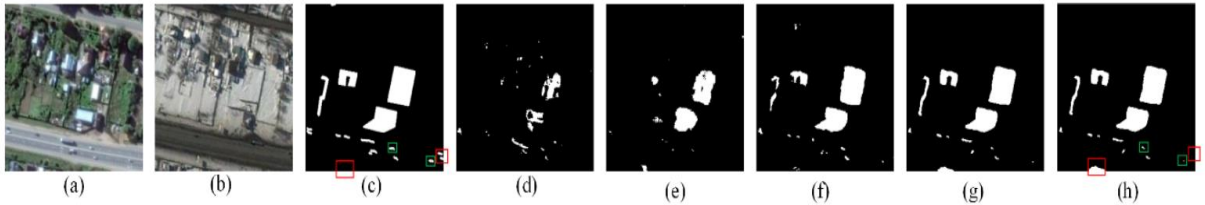
Li, K., Li, Z., & Fang, S. (2020, October). Siamese NestedUNet networks for change detection of high resolution satellite image. In *2020 International Conference on Control, Robotics and Intelligent System* (pp. 42-48).

Results



(a) Image 1. (b) Image 2. (c) GT. (d) FC-EF. (e) FC-Siam-conc. (f) FC-Siam-diff.

Fig. 2. Illustrative results on the *montpellier* test case of the OSCD dataset using all 13 color channels. In images (d), (e), and (f) white means true positive, black means true negative, green is false positive, and magenta is false negative.



(a) (b) (c) (d) (e) (f) (g) (h)

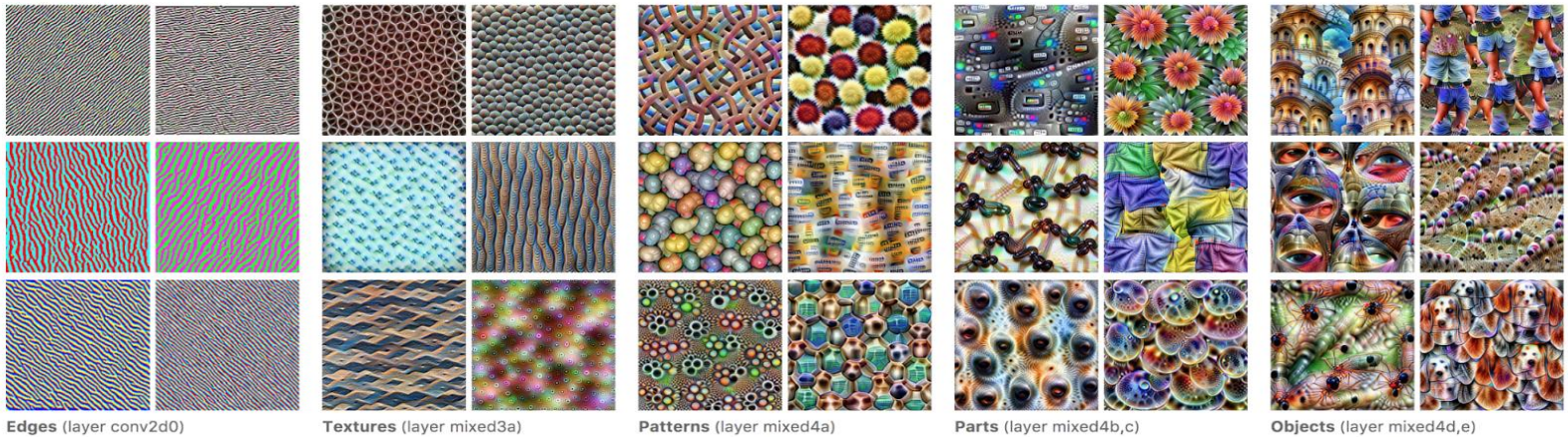
Figure 7: Problems and defects of the proposed approach. (a) and (b) are the original bi-temporal image, (c) is ground truth, (d), (e), (f) and (g) correspond to the prediction results of Siam-NestedUNet L^1 to Siam-NestedUNet L^4 respectively, and (h) is the final result of Siam-NestedUNet.

What can we explore?

Open questions

1. Feature fusion:

- Which is the best strategy to mix features?
- Does working with mixed features increase generalization?
- How deep the network must be?



Feature fusion

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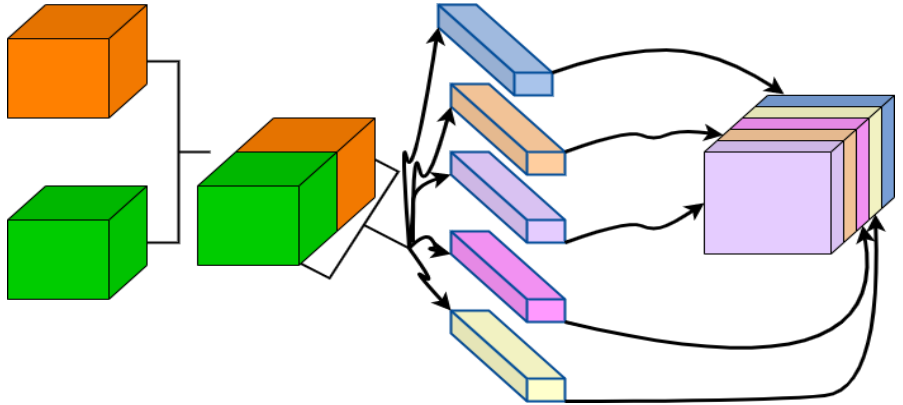
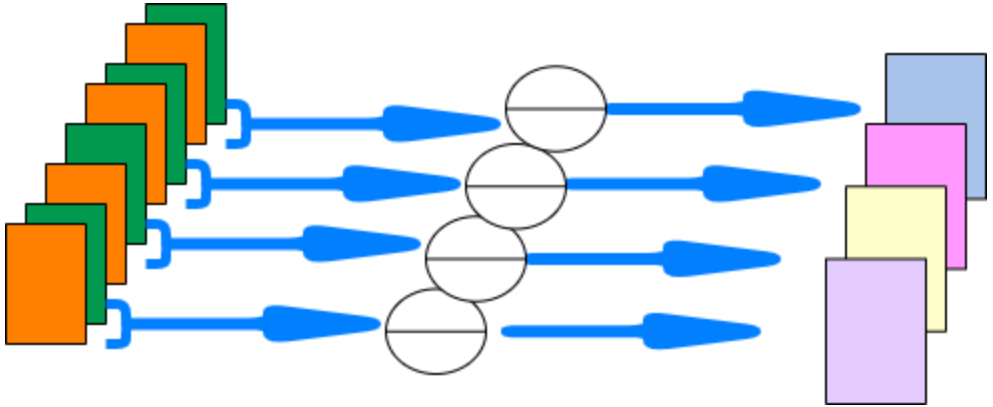
- Concatenation
  (+ at least a convolution)



- Subtraction



Featurewise concatenation + grouped convolution

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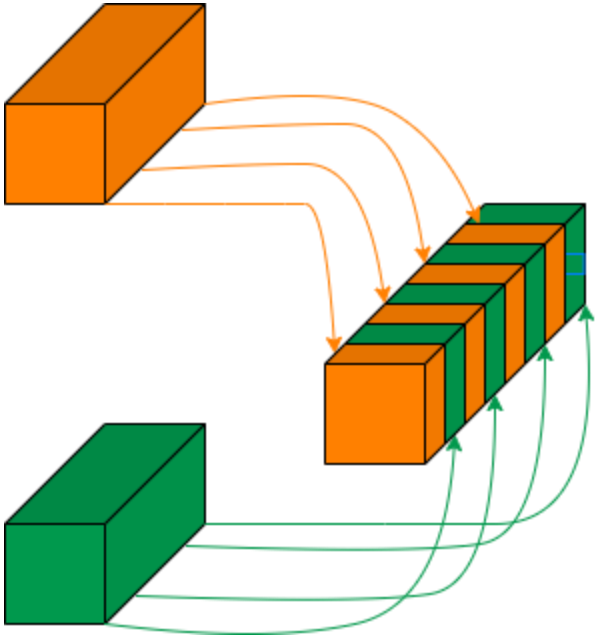

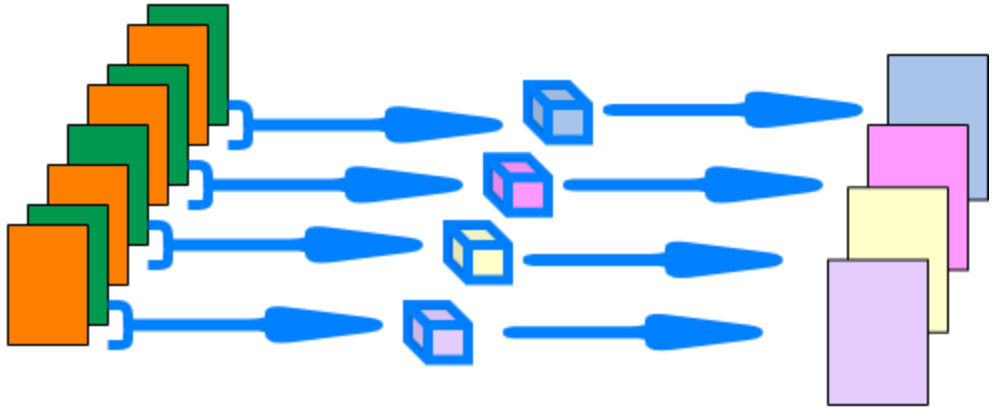

8 inputs, 4 kernels with depth = 2, 4 outputs

Mixing Strategy evaluation

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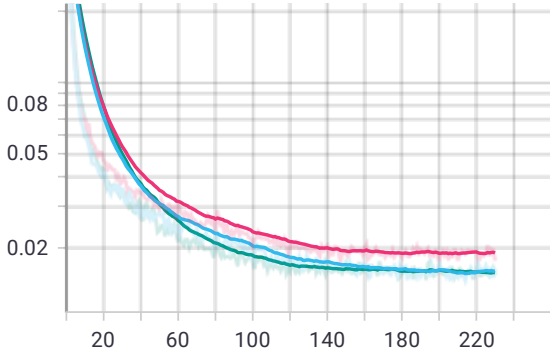
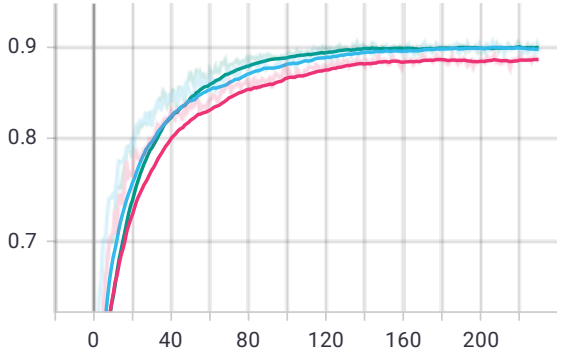
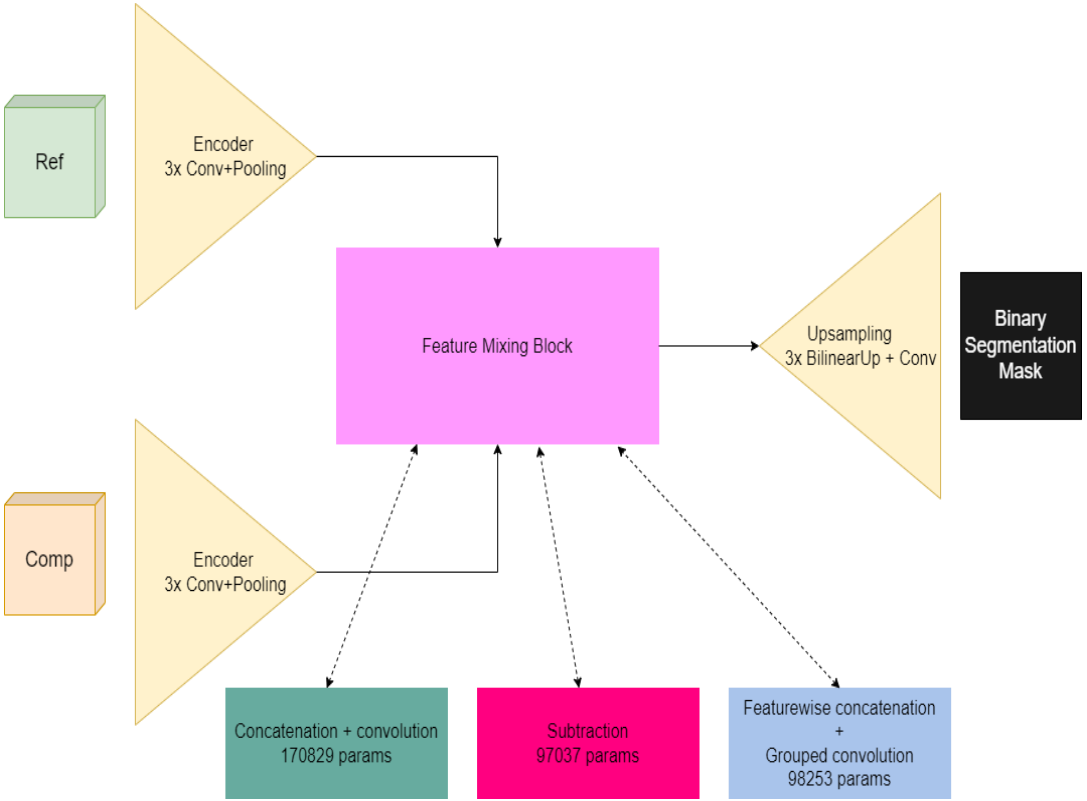
BCE Loss / Epoch



Jaccard Index (IoU) / Epoch

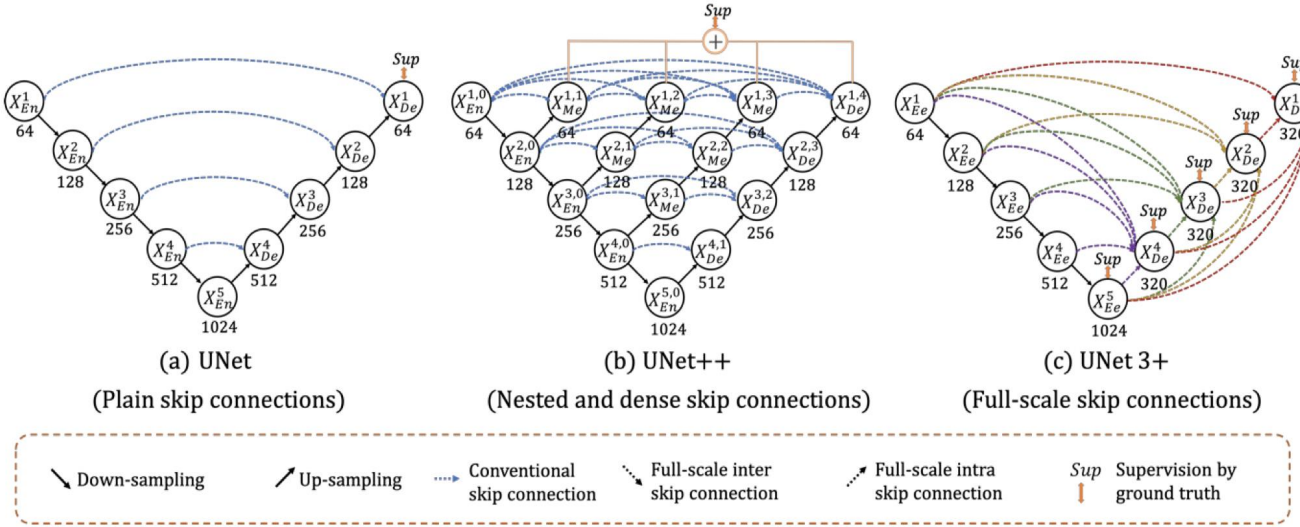




Open questions

2. Skip connections:

- Solve vanishing gradient problem in deep networks.
- Make the segmentation result sharper.
- Which skip connections are suitable for our problem?



Mixing & skip connections

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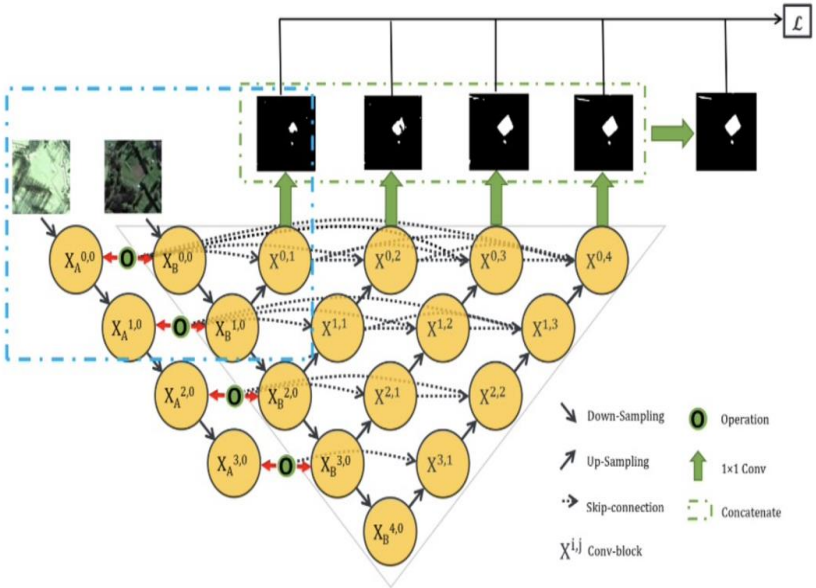

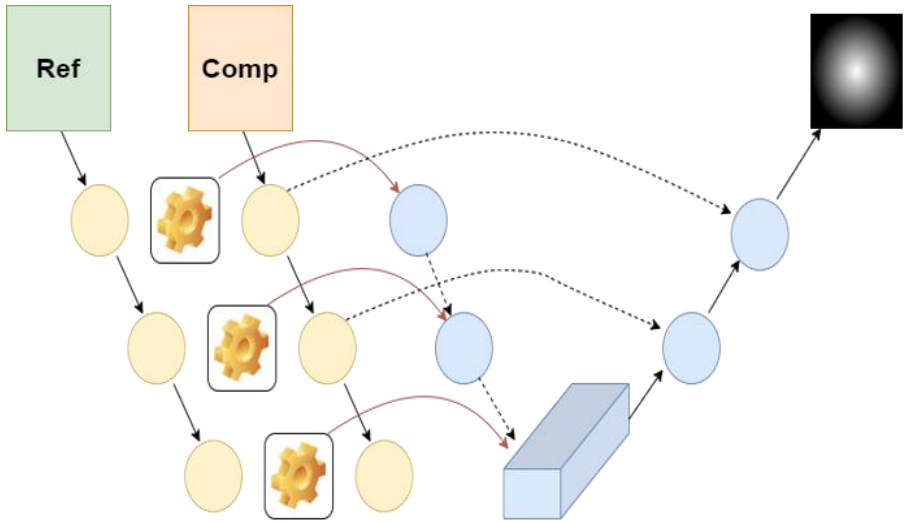

Training with few data

Training strategy

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Dirty

Clean

Sampling

Data augmentation

Reference	Comparison	Mask
Reference	Comparison	Mask
...		
Reference	Comparison	Mask

Reference	Comparison	Mask
Reference	Comparison	Mask
...		
Reference	Comparison	Mask

Test

Training

Data augmentation

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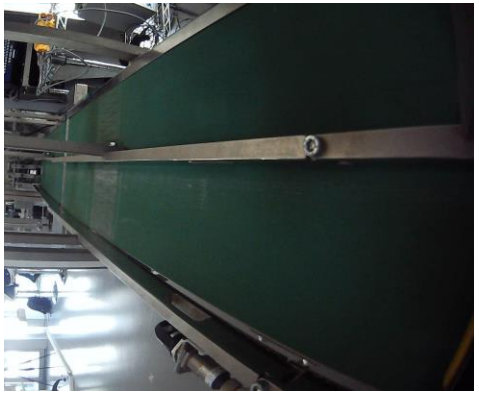
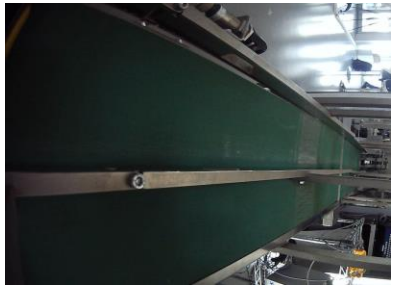
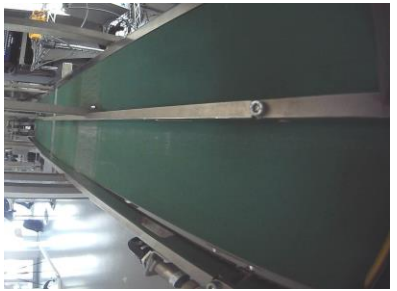


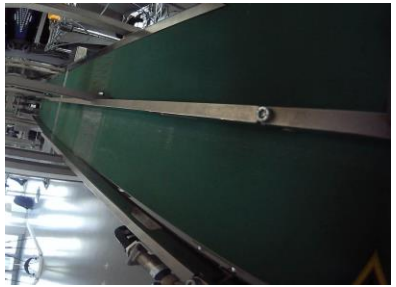
Flip



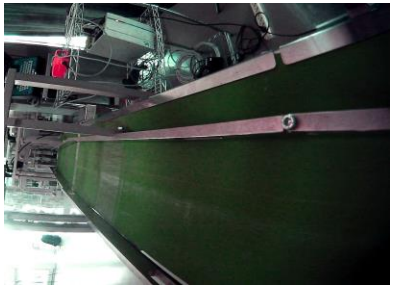
Random brightness and contrast



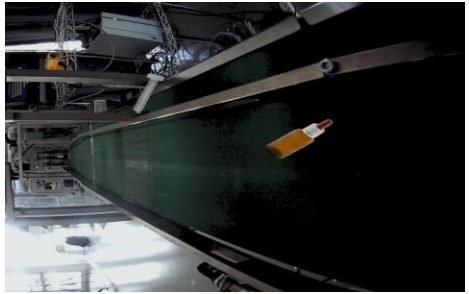
Rotation



Color jitter



Add object(s)



Preliminary results

Preliminary results

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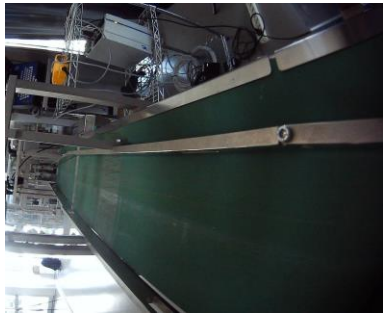
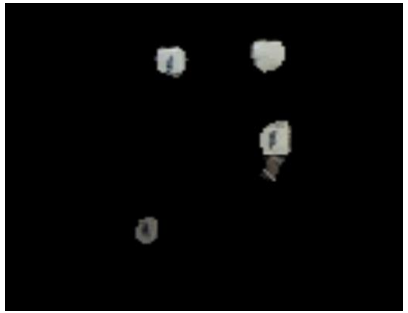
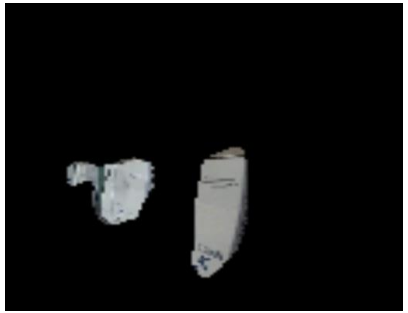


UNet

3 encoder layers + 3 decoder layers with skip connections: 677435 parameters

Proposed

3 encoder layers + 3 decoder layers w/o skip connections: 130317 parameters

Preliminary results: unseen machine

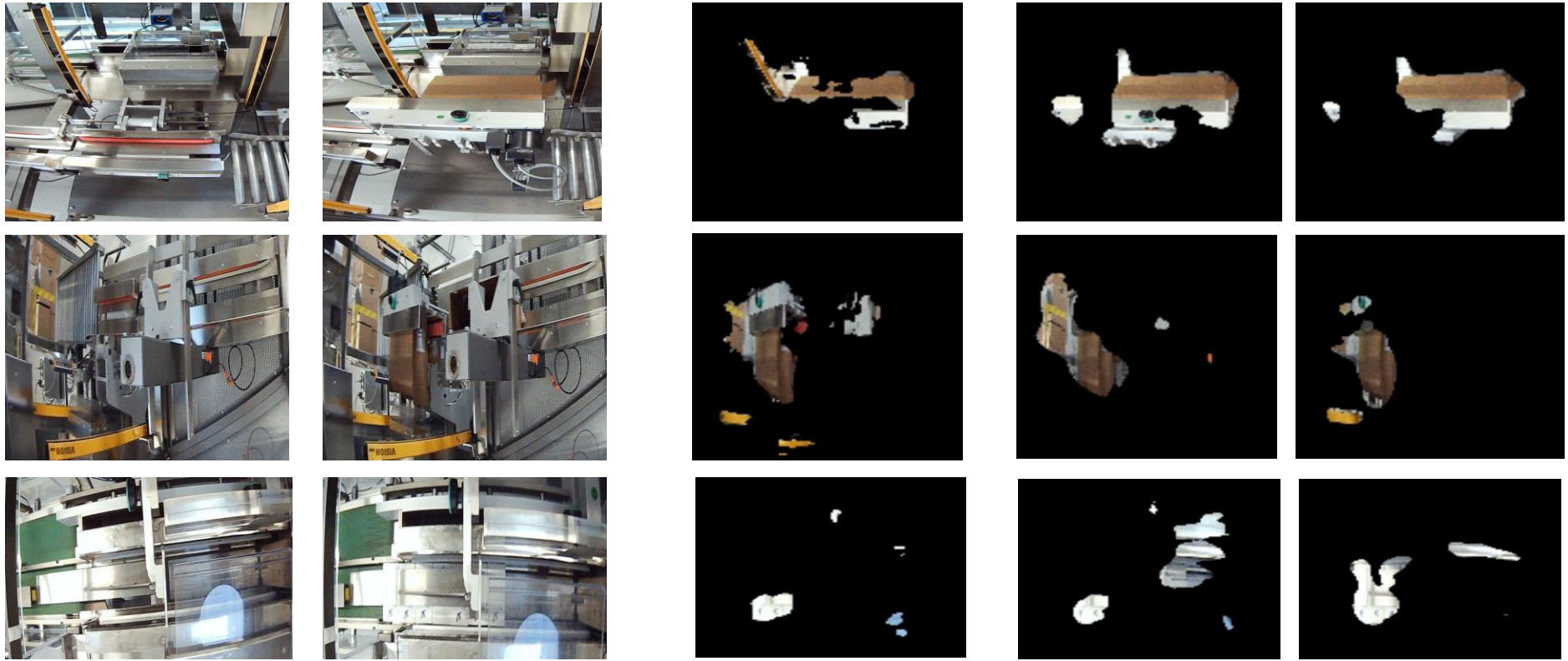
SEAVISION

UNet

Proposed

With skip conn

W/o skip conn



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