Automatic defect detection

CASTET Nicolas
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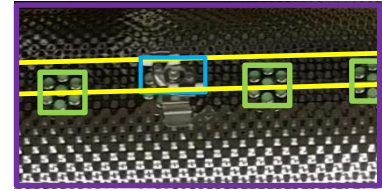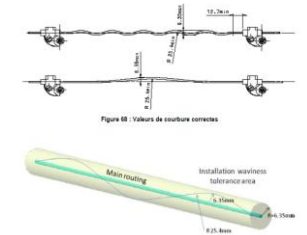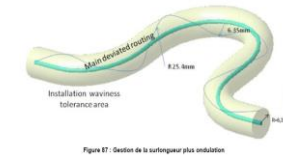
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Goals and Challenges

1. Automatic detection of elements

2. Measure distance and angle required by standard

3. Real time display of defects

4. Prototype for proof of concept done in a short amount of time
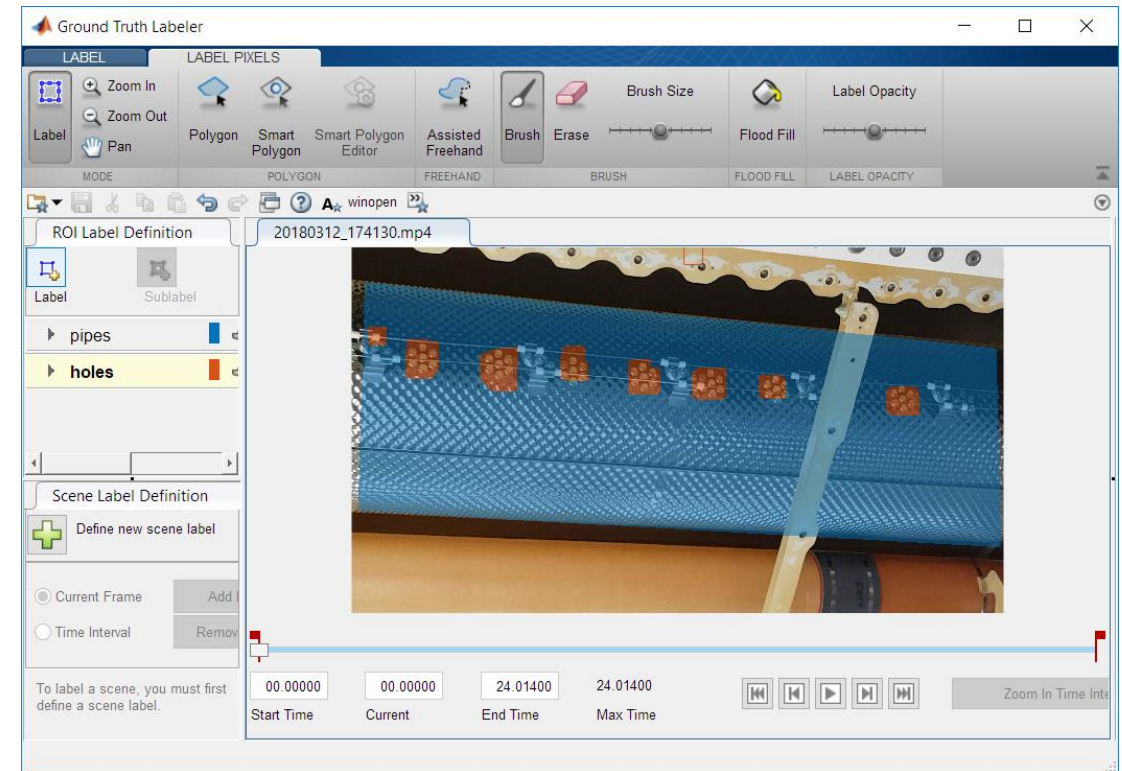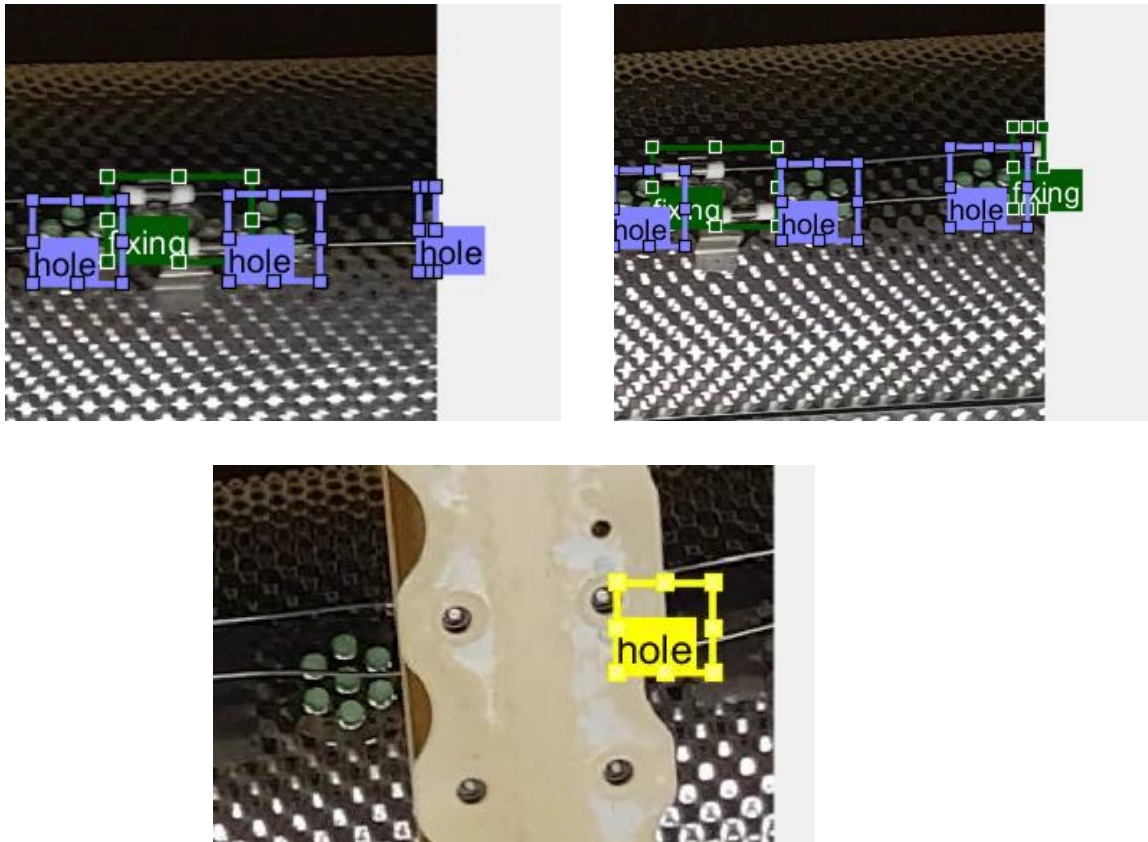
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Key Takeaways

Pluses

- ✓ Immediate results of Deep Learning on real case (plug and play JETSON)

- ✓ Seamless workflow MATLAB → JETSON CPU + GPU (GPU Coder)

- ✓ Integrated environnement: labeling tools, image processing + Deep Learning + deployment on JETSON

Delta

- ❑ Hardware limit on JETSON TX2

- ❑ Detection difficulties on high complex cases

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How did we get there and leverage MathWorks

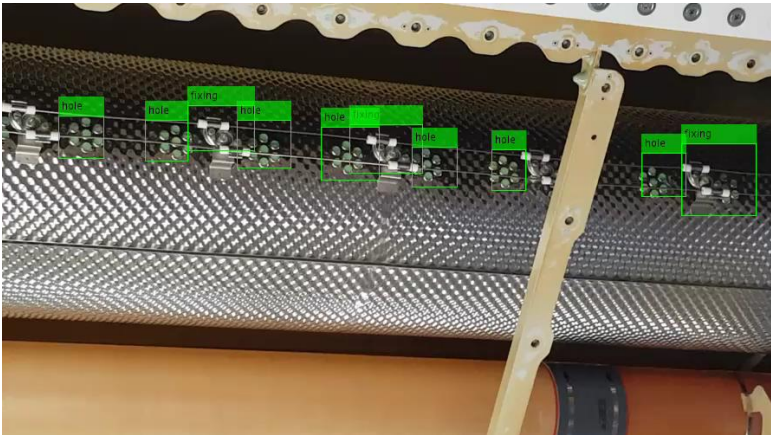*1. Automatic detection of elements*

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How did we get there and leverage MathWorks

1. Automatic detection of elements

Method: Deep Learning's object detection + tracking
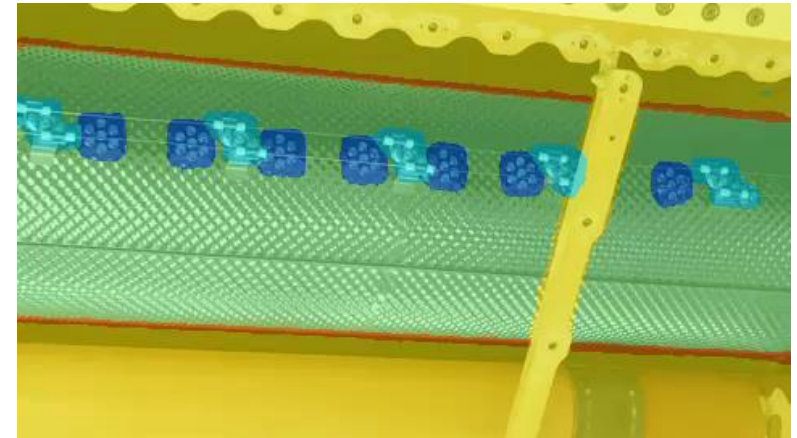Results: Good to average
Conclusion: Required post processing

Method: Deep Learning's semantic segmentation
Results: Very good to good
Conclusion: Keep it

- ✓ **Works well on nominal videos**
- - Time-consuming detection
- - Sensitive to scale & perspective

- ✓ **Works very well on all videos**
- ✓ **Simpler and faster network**
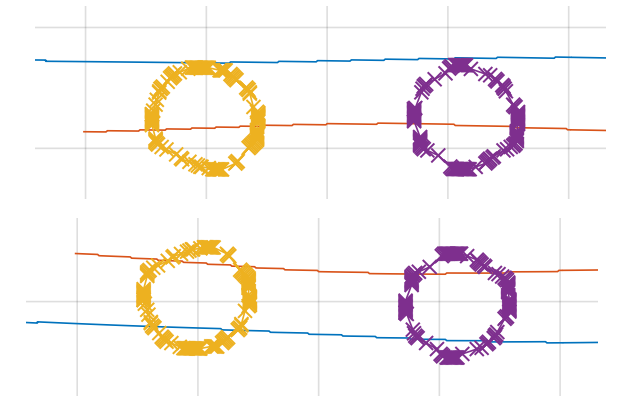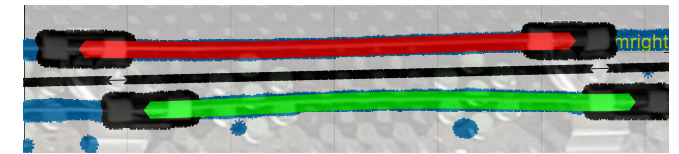- ✓ **Easier labeling**

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How did we get there and leverage MathWorks

2. Measure distance and angle required by standard

« Alignment in front of holes »

1. Interpolate lines from semseg

2. Use center of pipe for correcting curve

3. From position of holes on pipe, deduce angle and rotate measures around pipe

$d1.\cos(a)$

$d1$

$d2$

r

$r.\sin(a)$

$a°$

$R.\sin(a)$

$ymc = R.\sin(a)$

R: pipe radius
r: distance between pipe surface and middle of wires

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3. Real time display of defects

4. Prototype for proof of concept done in a short amount of time

Training phase:
Videos taken on Aircraft with different conditions:
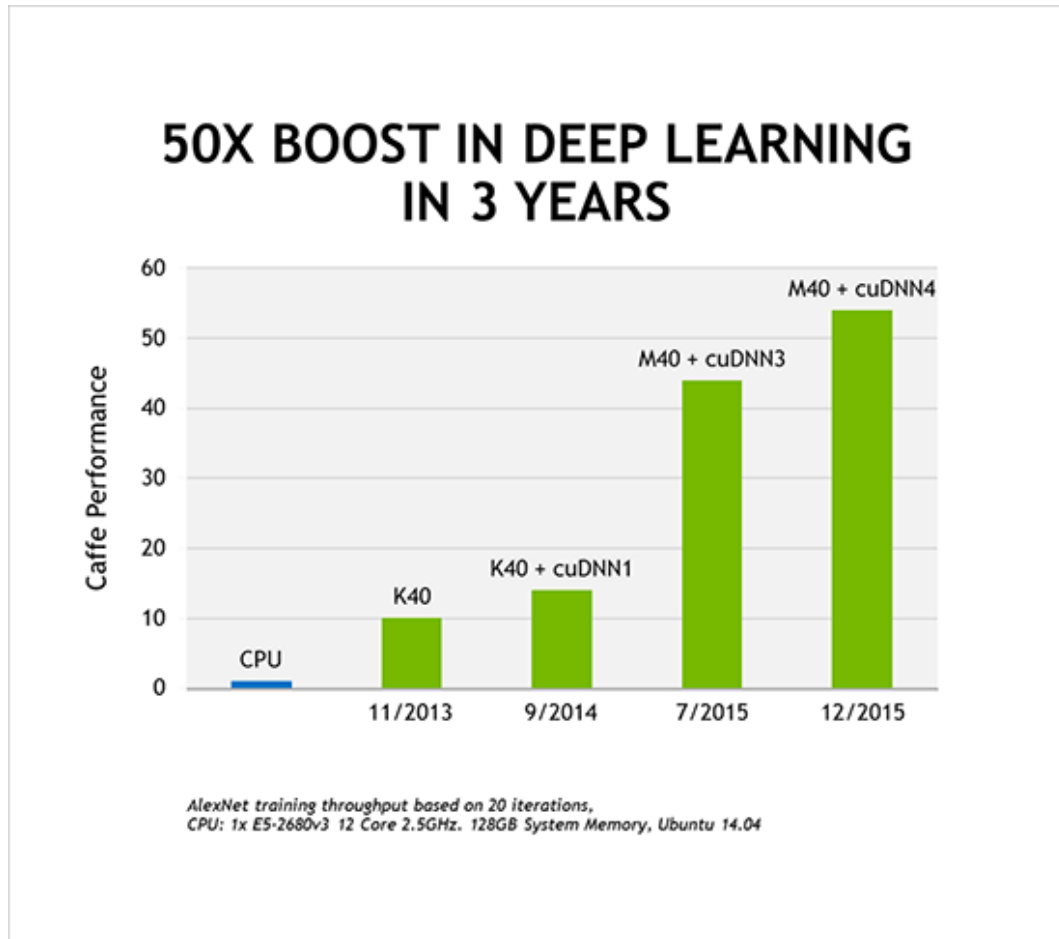- Different areas,
- Different light conditions,
- Different angle condition.

Labeling videos, designing & training Deep Learning network in MATLAB.

Test phase:
From trained networks on videos, we experiment and fine tune network for 2 days directly on the aircraft on an area different from the videos used for training.
→ Detection was already correct without any adjustment.

Adaptability & connectivity:
A lot of time was gained by having the possibility to train the network by simply using an internet connection.

MATLAB includes a direct language convertor from MATLAB to CUDA and it was possible to transfer by wifi the code to the JETSON

Having the possibility to test → Modify → Train → test again in a short period of time was key to the success of this project.

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Achievements and Outlook

- **Detection of elements**

Detection of elements is satisfactory on nominal use case, but not adapted for complex and area with difficult access
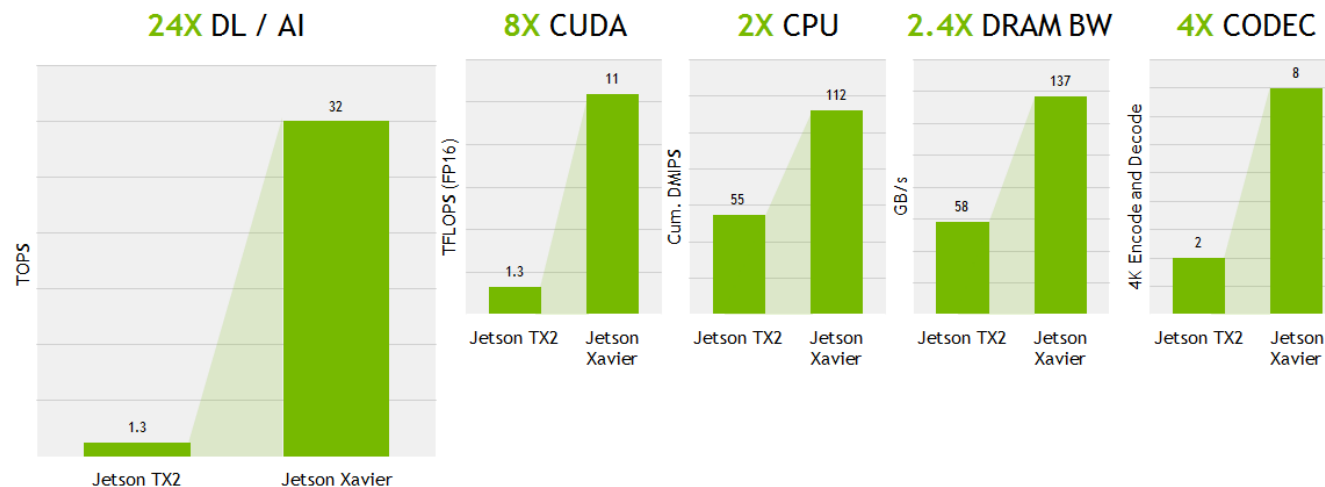
- **Measurements**

It has been possible to add measurement on the real time display.
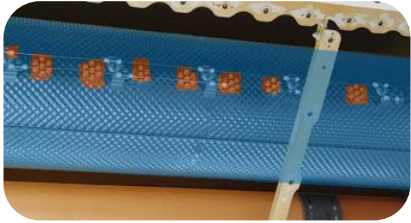Next step will be to assess precision by integrating measurement scale

- **Real-time display**

Encouraging results, for a complex use case we still manage to get real time display of the applications. On simpler detection system and with the exponential growth of GPU capacities we might be able to have industrial solutions in the near future

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Concluding remarks

- **MATLAB, a software with a lot of different capacities**

An integrated environment with:
- ✓ Video labeling modules (different kind)
- ✓ Network designing & training
- ✓ Image processing

- **MATLAB, the possibility to work with trials and error**

- ✓ Quick testing
- ✓ Possibility to do distance network training

- **MATLAB, a well-connected software**

- ✓ Direct translation from MATLAB language to others languages
- ✓ Wifi transfer on Jetson

- **Using Artificial Intelligence for aeronautical inspection**

- ✓ Detection of elements is possible
- ✓ Hardware limit reached but we can expect with exponential growth in GPU speed to have device able to support high complex algorithm in the next few years

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Thank you

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