Etch Defect Detection by Faster R-CNN

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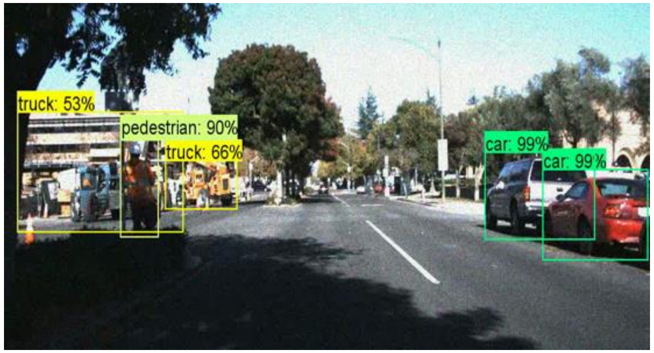
Etch Defect Detection by Faster R-CNN

- **Outline:**

1) Surface defect: Etch defect
2) Deep learning from CNN to Faster R-CNN
3) Results
4) Pros & Cons
5)Recommendation
6) Conclusion

Etch Defect Detection by Faster R-CNN

- Machine learning on vision



- **Advantages**
  - Effective at solving problems: bounding boxes
  - More data equals more accuracy and more stability compared to manual testing
  - Faster to implement than classic computer vision
- **Challenges**
  - Dataset
  - Etches is different: pixel level -> harder to detect

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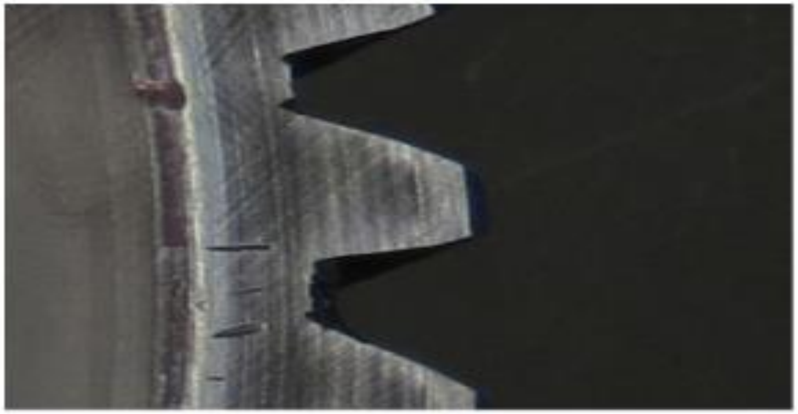
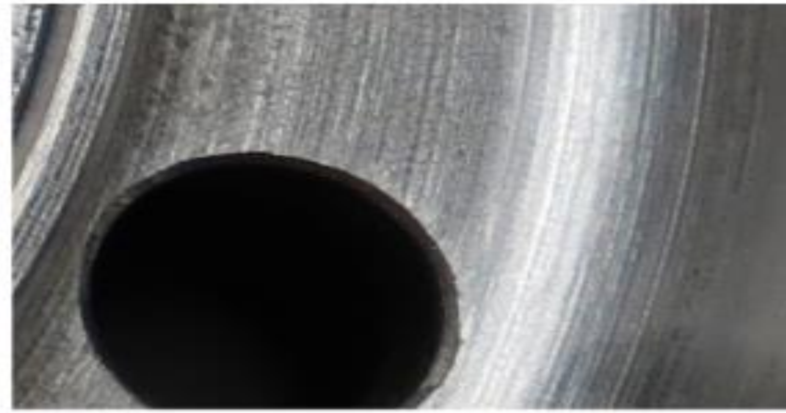
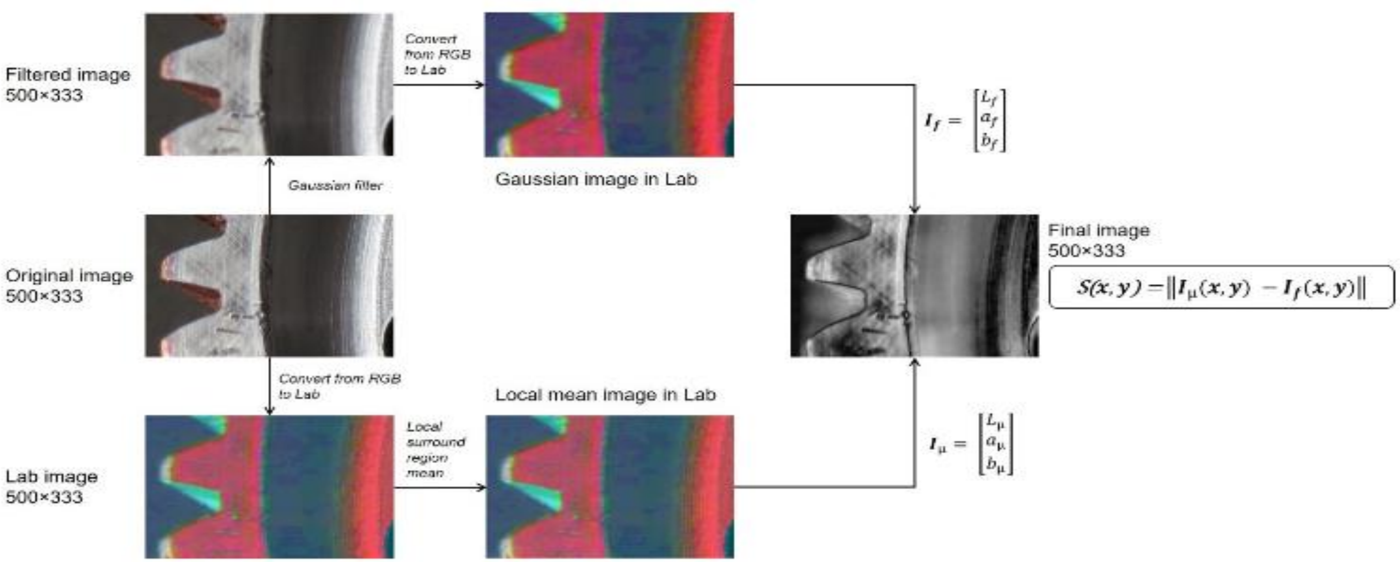
- **Preprocessing phase**





Defects may be clearly observed or ambiguous



Enhancement of defects before training

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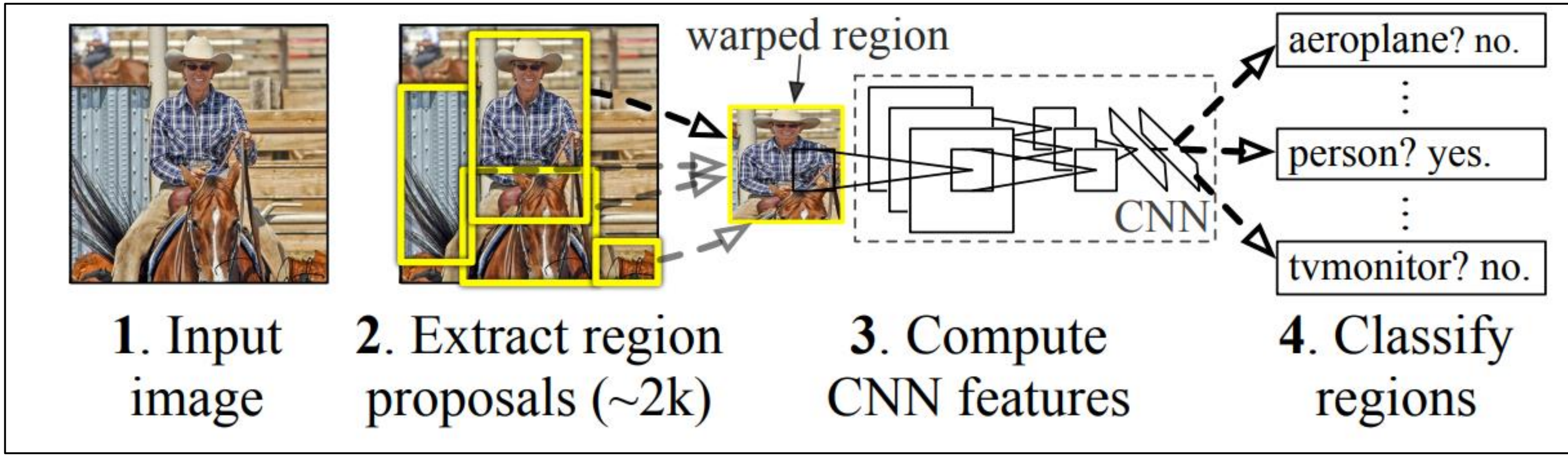
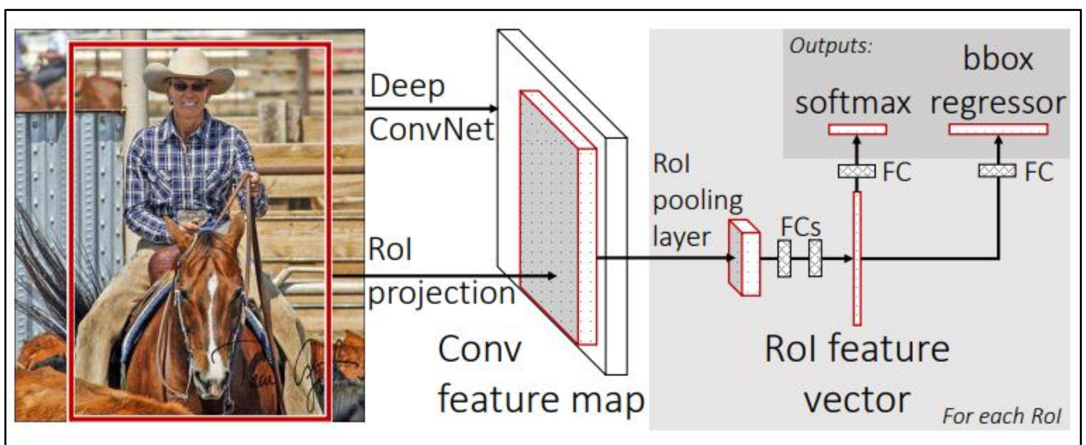
- R-CNN



Girshick, Donahue, Darrell, Malik1, “Rich feature hierarchies for accurate object detection and semantic segmentation”

- Faster R-CNN



Ross Girshick, “Fast R-CNN”

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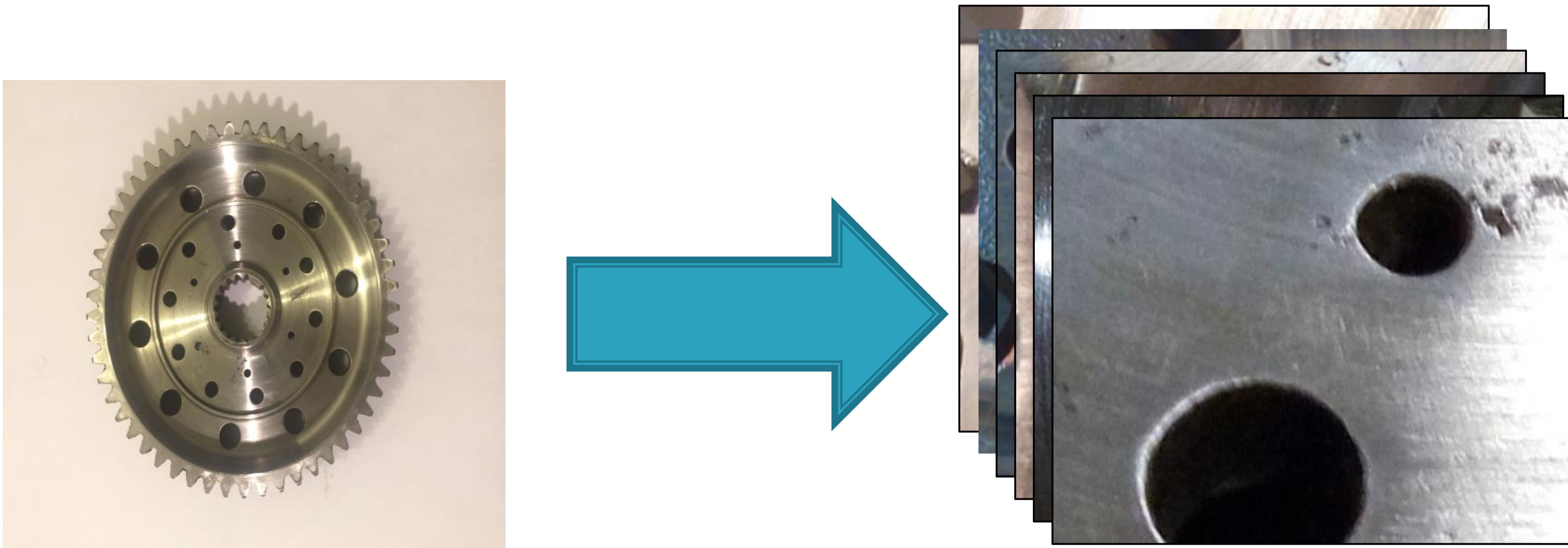
- Dataset building



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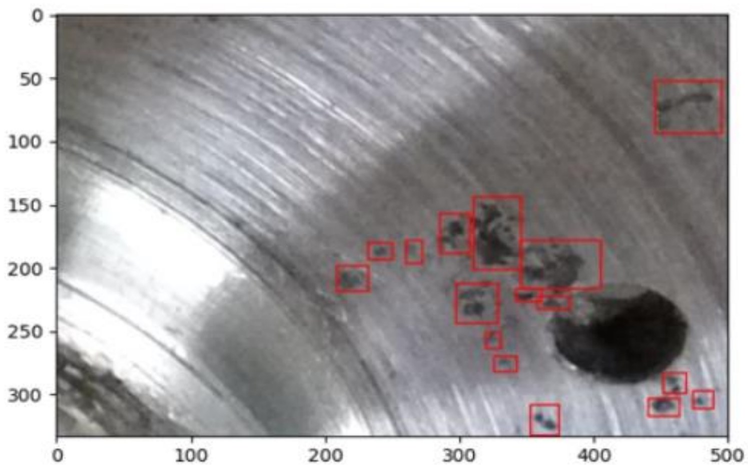
- **Defect detection proposals**

Region proposals



- Building from 4 cameras
- Hand marking one type of defect using bounding box
- Same part used for all the dataset

Programs

- Anaconda
- Package : DeepLearning Caffe
- Pascal VOC
- Python – PyTorch & CUDA

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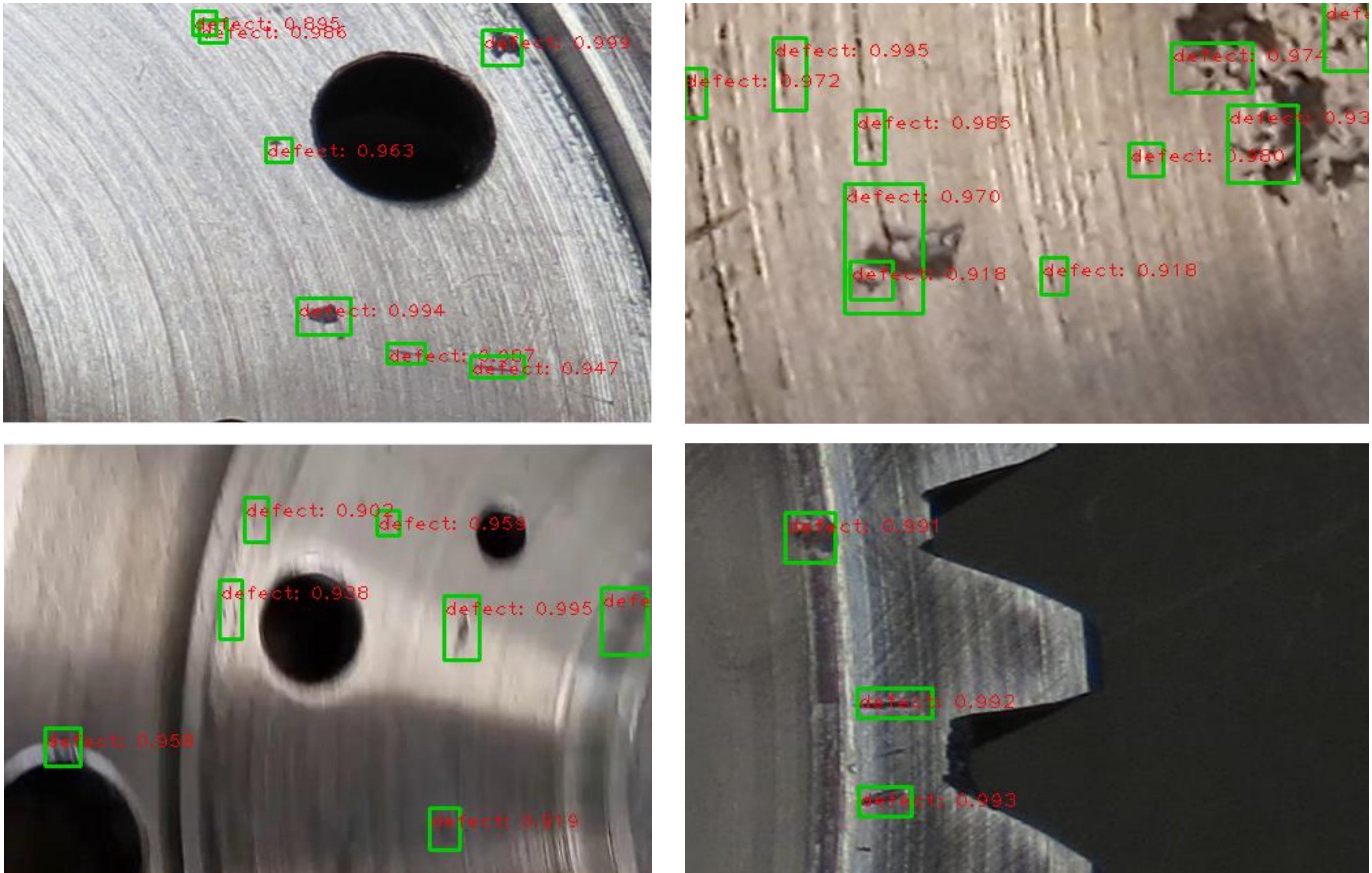
- Results



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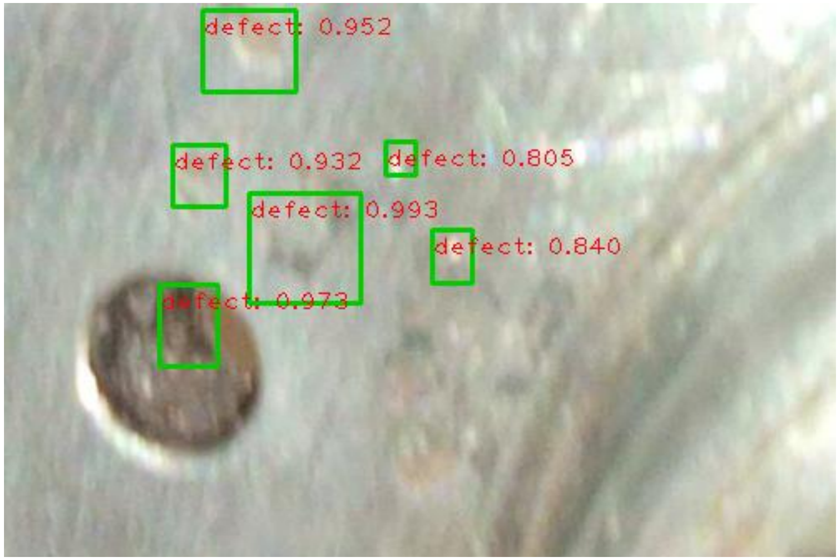
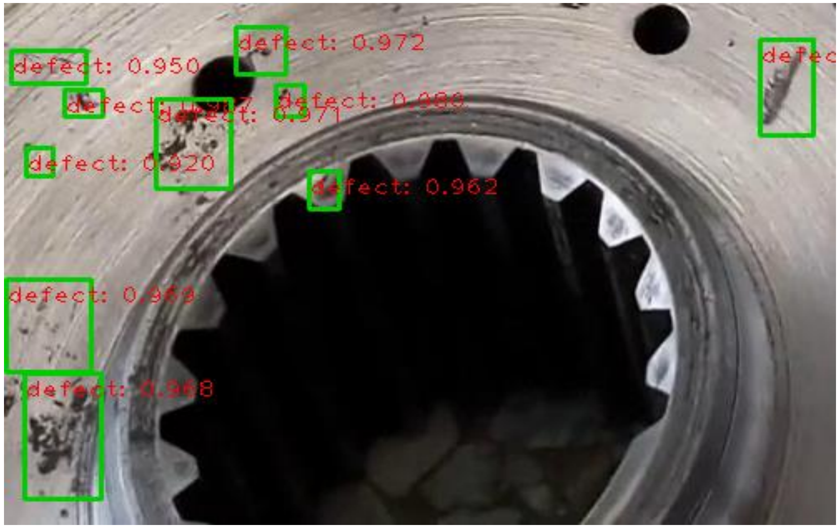
- Results





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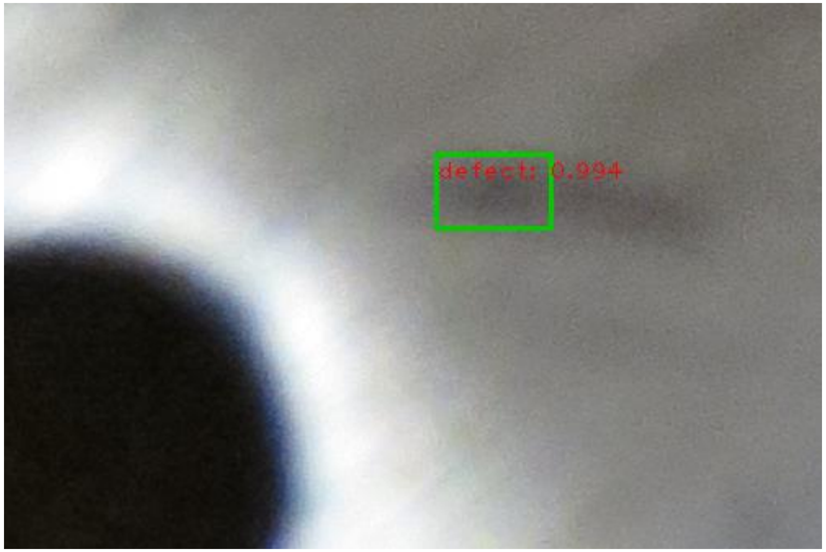
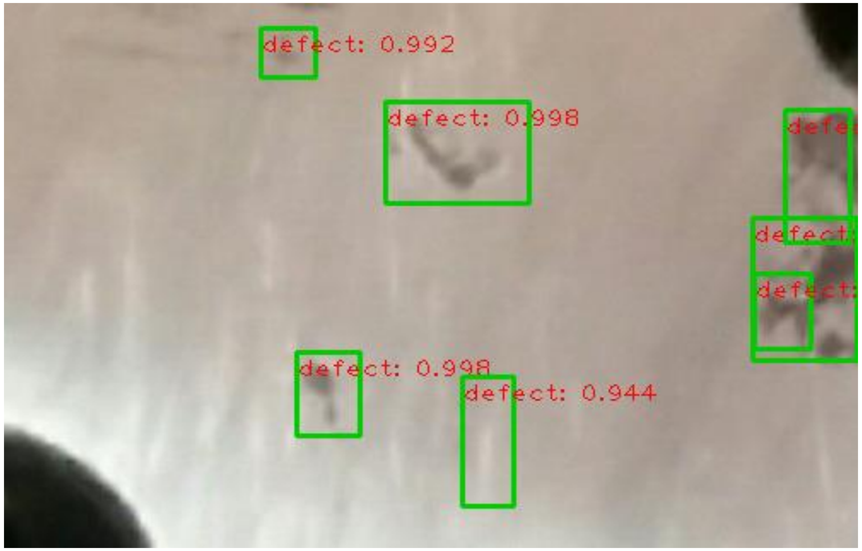
- Results





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- Results: Confusion Matrix

Class	Defect	Non-defect
Defect	889	162
Non-defect	52	200

Table 1: Class Mark List

$$Accuracy = \frac{\texttt{Correctly classified regions}}{\texttt{Total number of evaluated regions}} = 83.57\%$$

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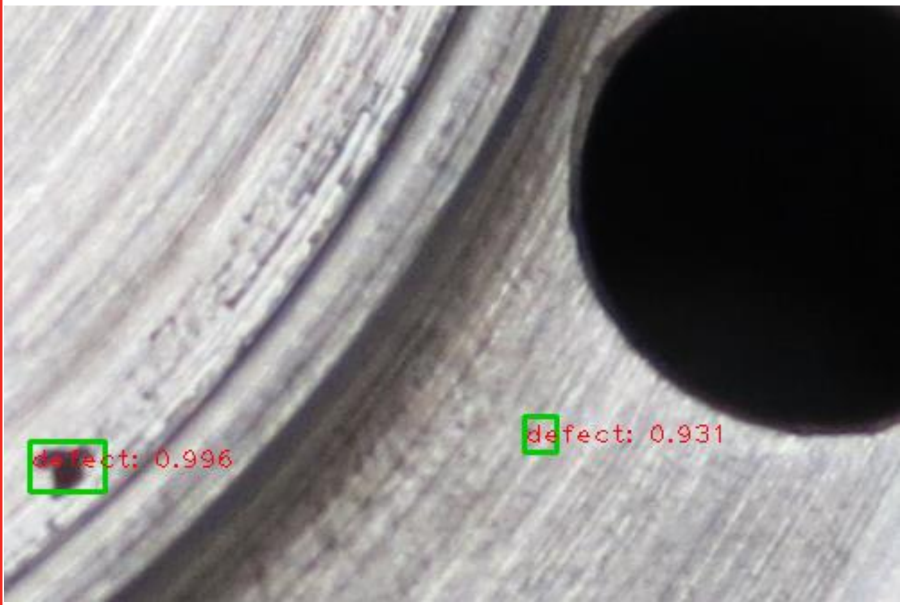
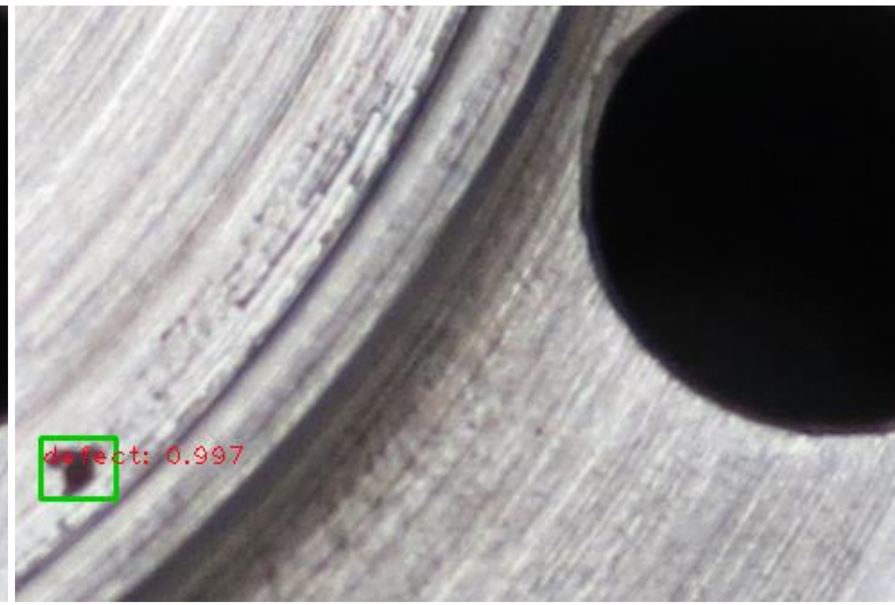
- Results: Hit/Miss/Fail

Training 1



Training 2



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- Results: Hit/Miss/Fail

Training	1				2			
Picture	Hit	Miss	Fail	% Defect Detection	Hit	Miss	Fail	% Defect Detection
Test 1	6	0	1	100.00	5	0	0	100.00
Test 21	6	1	2	85.71	5	1	0	83.33
Test 30	7	0	3	100.00	7	0	3	100.00
Test 41	10	2	0	83.33	10	2	0	83.33
Test 50	2	0	5	100.00	2	0	6	100.00
Test 59	5	0	1	100.00	5	0	0	100.00
Test 61	7	3	3	70.00	9	1	1	90.00
Test 70	7	0	3	100.00	8	0	2	100.00
Test 79	8	3	2	72.73	8	2	2	80.00
Test 91	4	0	3	100.00	4	0	2	100.00
Test 99	1	0	1	100.00	1	0	1	100.00
Test 108	4	1	5	80.00	3	1	1	75.00
Test 116	8	3	2	72.73	6	3	1	66.67
Test 125	5	4	3	55.56	8	2	2	80.00
Test 133	6	0	2	100.00	3	0	0	100.00
Test 139	9	0	1	100.00	10	0	0	100.00
Test 150	5	1	0	83.33	4	1	0	80.00
Test 160	1	0	1	100.00	1	0	0	100.00
Test 165	6	1	4	85.71	7	1	2	87.50
Test 190	5	1	3	83.33	6	0	0	100.00
TOTAL				**84.85**				**88.89**

- **Hit**: Defect spotted
- **Miss**: Defect not spotted
- **Fail**: Bounding box on nothing

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Pros & Cons

- Pros
  - Robust through blur & lighting
  - Possibility to do continuous learning
  - Doesn't require any special setup*

- Cons
  - Need to build initial database
  - Needs a lot of pictures
  - Initial parameters need tuning
  - Training time and computer resources

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Recommendations

To gain reliable results, we need to have :

- A lot of pictures for the training

  Approach works by seeing different scenarios

- To take pictures of all the parts/defects

  The algorithm is very good for what it trained for

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Conclusions

- The proposed Faster R-CNN approach can detect defects and may be further improved to gain higher accuracy.
- It helps to improve the inspection process for the personal by showing them where possible defects are.

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Acknowledgements

- Pratt & Whitney Canada is deeply thanked for its help and assistance through this project.

THANK YOU
FOR YOUR ATTENTION!