Automatic Defect Detection for X-Ray inspection: Identifying defects with deep convolutional network

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Summary

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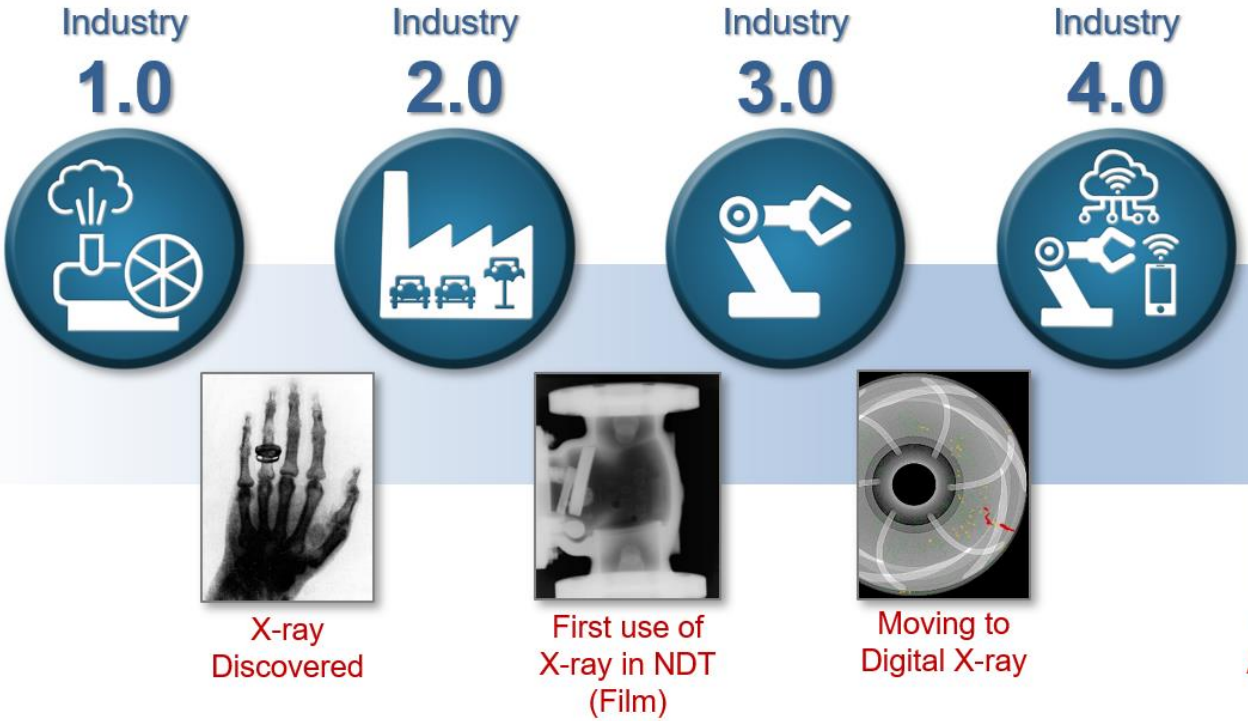
- Methodology
- Database creation
- Network description
- Evaluation metric
- Results
- Conclusion
- Acknowledgements

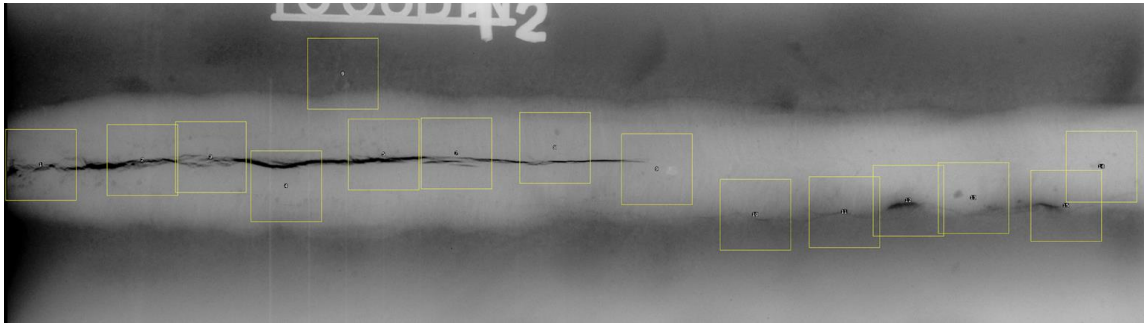
X-ray in NDT


Industry 1.0
Industry 2.0
Industry 3.0
Industry 4.0
X-ray Discovered
First use of X-ray in NDT (Film)
Moving to Digital X-ray
Next step for use of X-ray in NDT
Assisted Defect Detection
Process Automation
100% Inspection
Robotics provide the muscle
Cameras provide the senses
Connectivity is the nervous system
Artificial Intelligence is the brain!

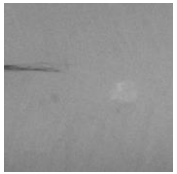
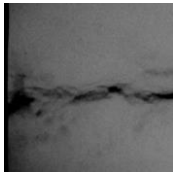
Methodology

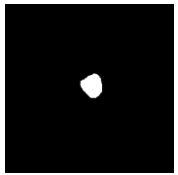
- Create a database representative of the different types of defects that can be analyzed.
- Generalize the problem by adding artificial data (rotation, negative image, noise, etc.).
- Create a binary image database (black and white) associated with all images, which will serve as a ground truth.
- Use a modified version of SegNet as a network model.
- Perform image segmentation (defects and non-defects) with the model.
- Adjust the different parameters of the model to obtain better results.
- Analyze the results obtained with statistical metrics

Database creation

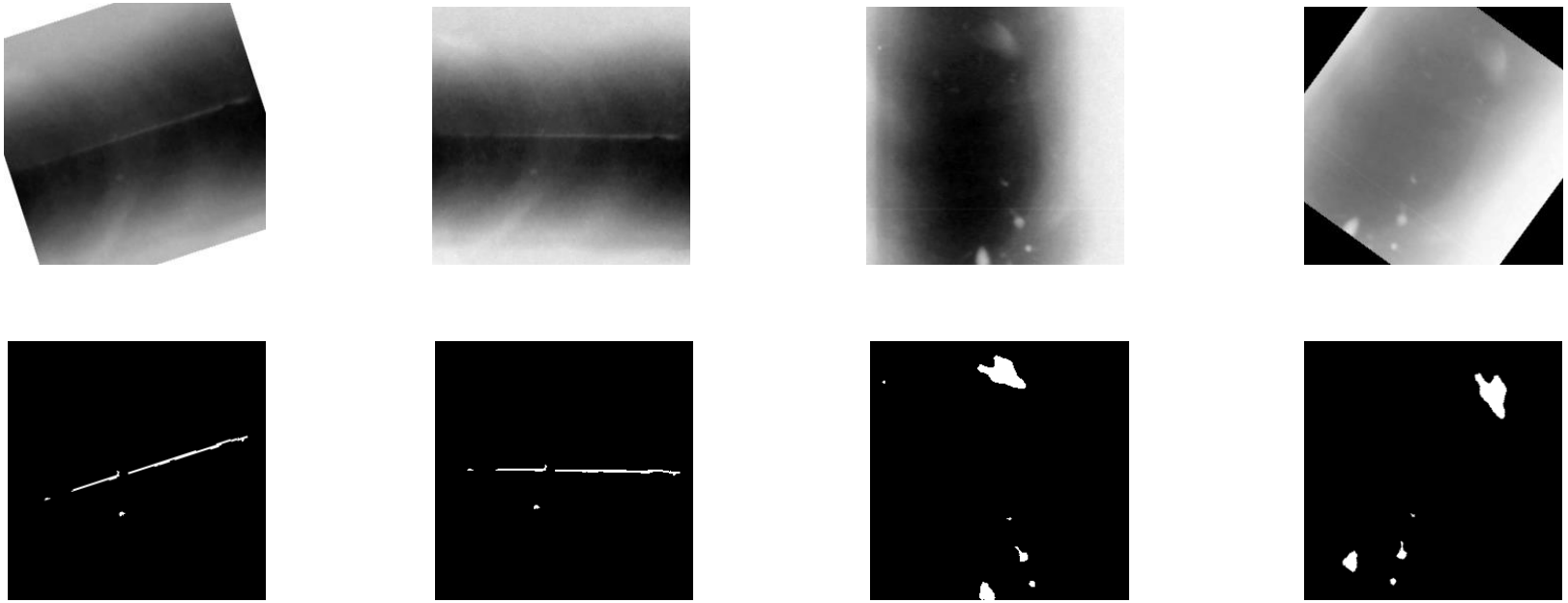




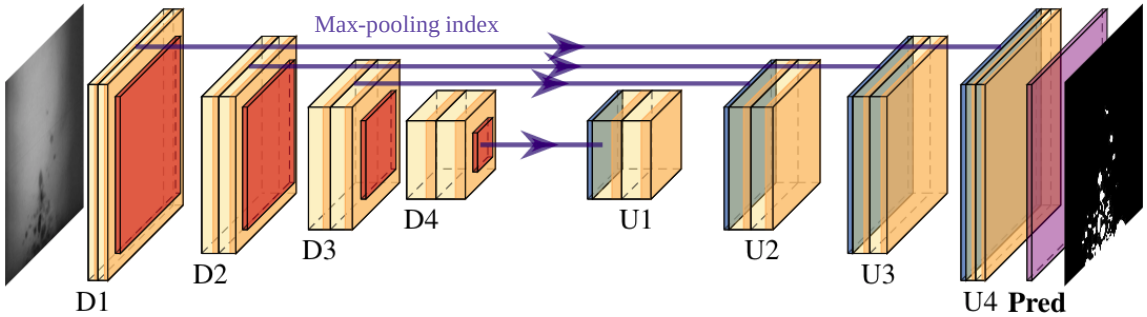



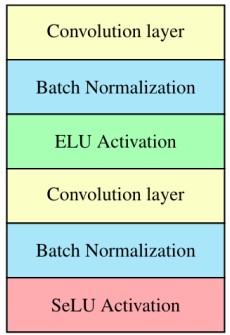



Database creation

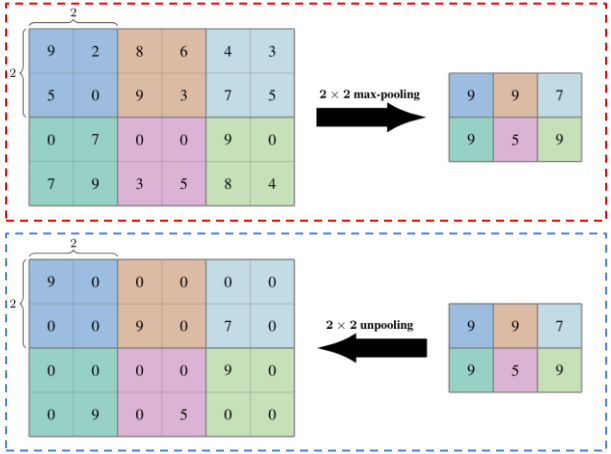


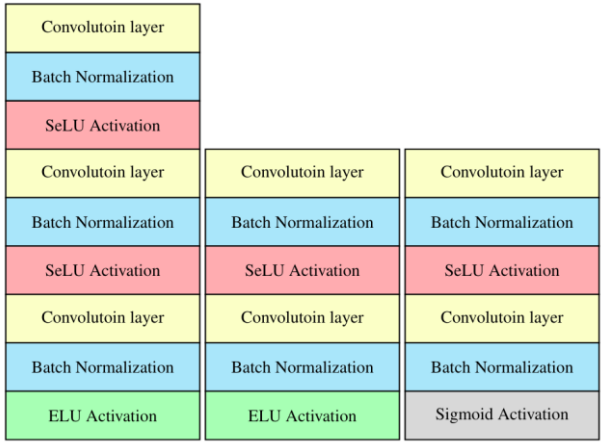
Network description





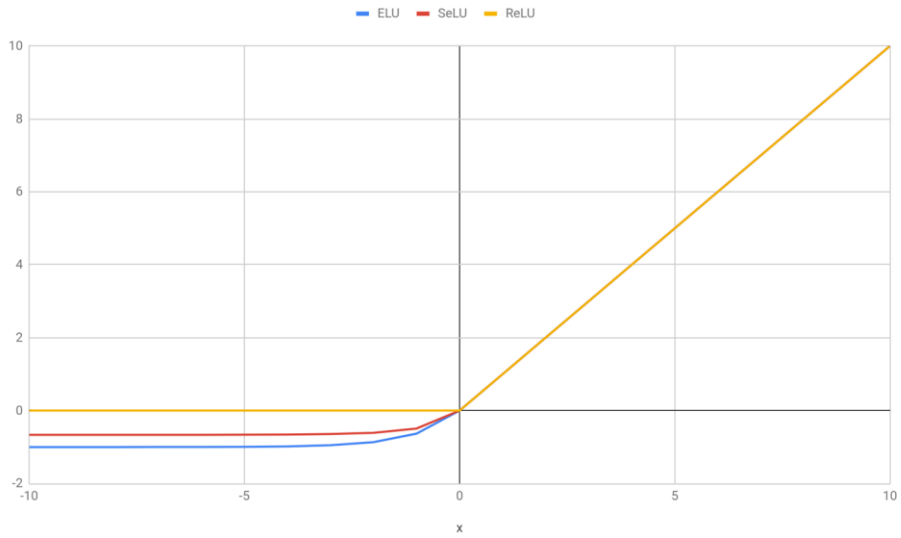
D1 to D4

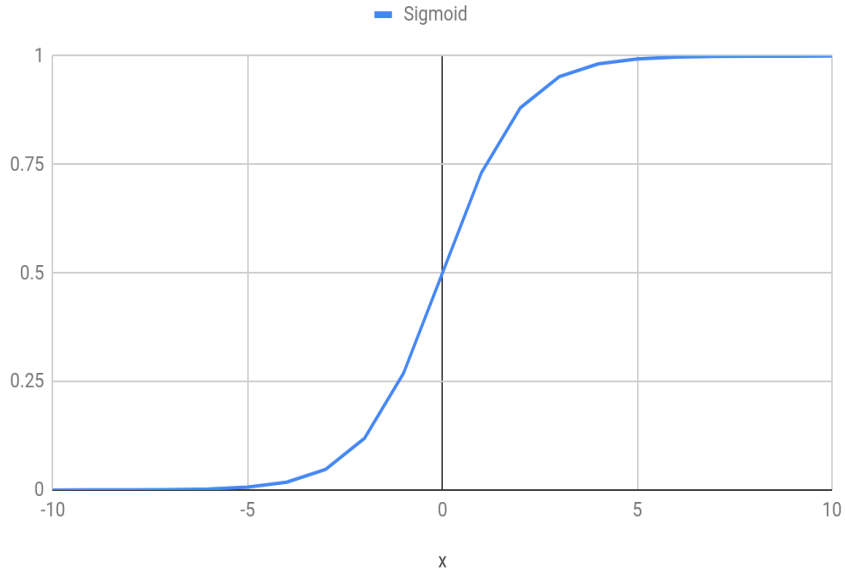




U1 & U2 **U3** **U4**

Network description





Evaluation metric

$$Precision = \frac{truePositive}{truePositive + falsePositive}$$

Tells us how well our system is able to find defects

$$Recall = \frac{truePositive}{truePositive + falseNegative}$$

Tells us how well our system is able to find true defects

$$F1 = 2 * \frac{precision * recall}{precision + recall}$$

Gives us a good indication of the overall performance of our system in terms of predictions and classifications

Evaluation metric

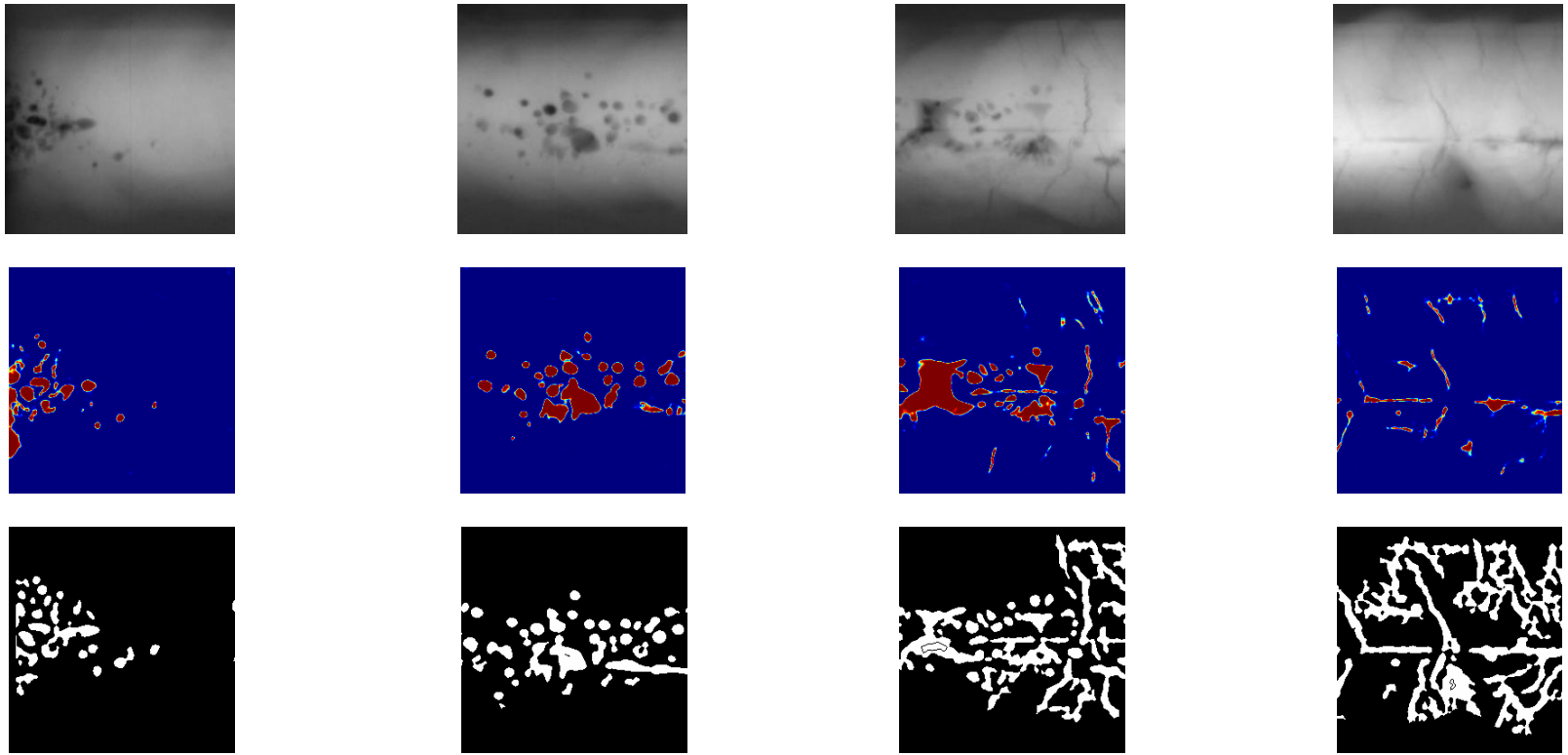
$$Precision = \frac{truePositive}{truePositive + falsePositive}$$

$$Recall = \frac{truePositive}{truePositive + falseNegative}$$

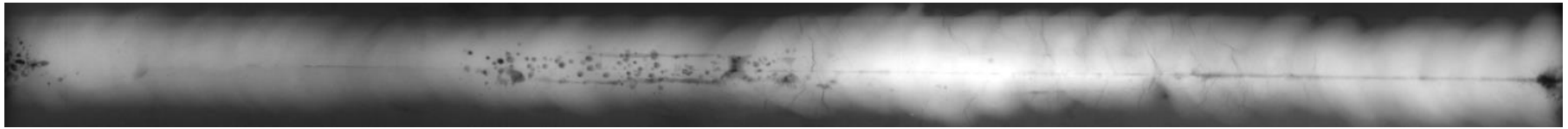
$$F1 = 2 * \frac{precision * recall}{precision + recall}$$

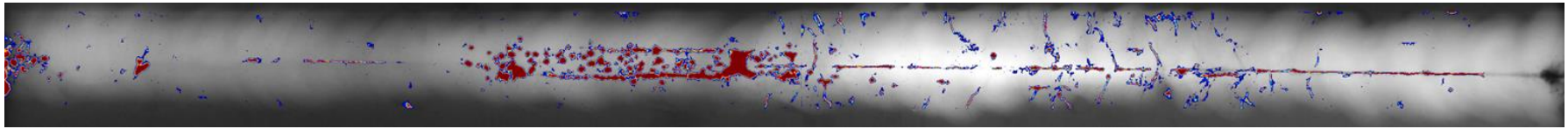
By adjusting the number of filters in our model during our experiments, we were able to achieve an F1 score of 0.8 which represents **80%.**

Results



Results





Conclusion

- Promising results
- The model generalizes the problem of defect segmentation with an F1 score of 80%.
- The model allows the inspection of 100% of the scanned parts.

Future works:

- A model allowing the segmentation and labelling of defects.
- A smaller model.
- A model that can be trained with less data while maintaining a good F1 score.

Acknowledgements