End-to-end training of a two-stage neural network for defect detection

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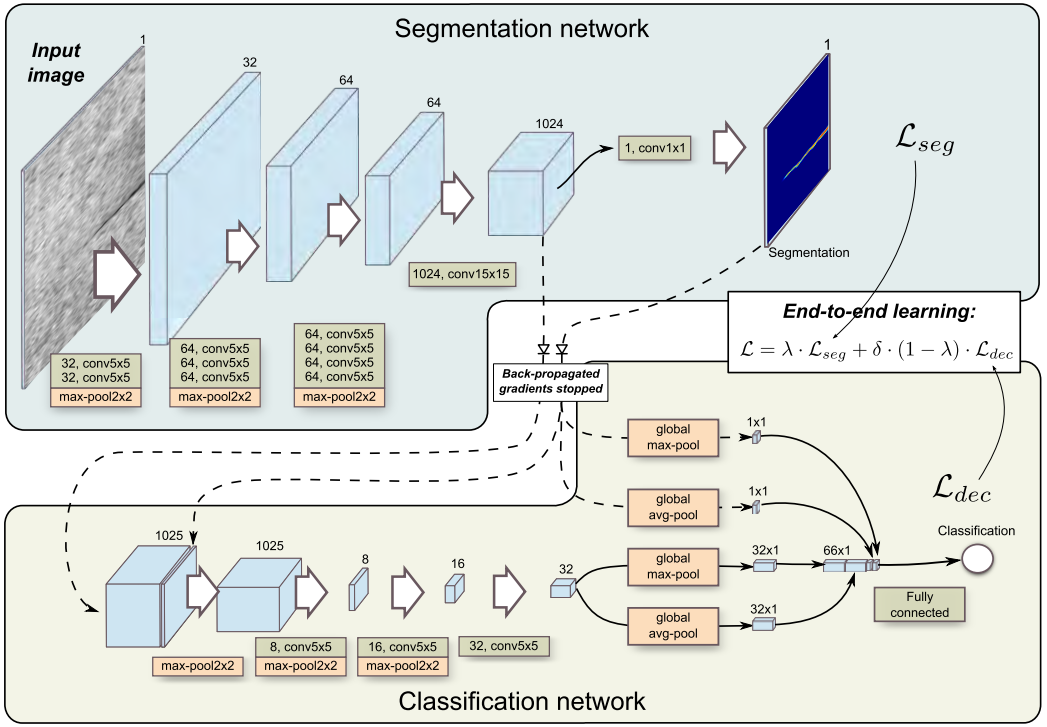
INDUSTRIAL SURFACE-DEFECT DETECTION

- ***Deep learning*** best suited for modern qualtiy inspection in ***Industry 4.0***
  - ***Data-driven learning-based*** detection of visual surface defects
  - ***Easy and fast adaptation*** to new defects and products
- We propose an ***end-to-end learning*** for a ***two-stage architecture***
  - Combine ***pixel-level*** segmentation and ***image-level*** classification
  - Reduce annotation need by using coarse annotations (e.g. rotated bounding box)
  - Improve mini-batch sampling for unbalanced datasets
- ***100% detection rate*** on the DAGM and Kolektor SDD dataset

END-TO-END LEARNING FOR TWO-STAGE ARCHITECTURE



EXPERIMENTAL RESULTS

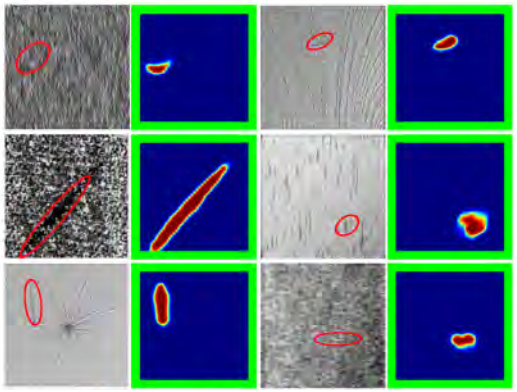
- Related-work comparision on Kolektor SDD:

Architecture and approach	*Learning stages*	*Number of positive training samples*					
		33	*25*	*20*	*15*	*10*	*5*
Extended Segmentation+Decision Network (ours)	*end-to-end*	**100.00**	**99.78**	**100.00**	**99.88**	**99.31**	**96.71**
Segmentation+Decision Network	*separate (two stages)*	99.0	97.5	99.5	97.4	98.8	95.8
Cognex ViDi (commercial software)	-	99.0	97.4	95.7	97.1	95.6	89.2
Xu et al. (image-level label only)	*separate (three stages)*	99.5	-	-	-	98.0	-
Pre-trained ResNet (image-level label only)	-	97.8	-	-	-	-	-

- Ablation study:

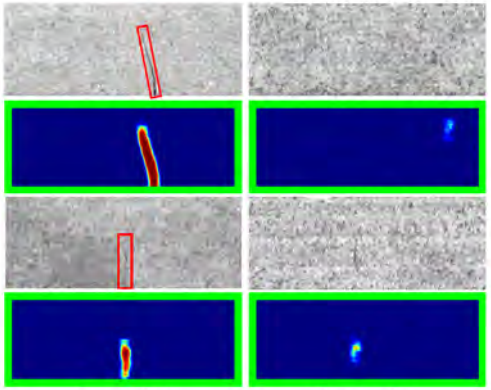
DAGM		*KolektorSDD*		*Severstal Steel*		*Dynamically balanced loss*	*Gradient-flow adjustment*	*Frequency-of-use sampling*	*Distance transform*
AP	FP+FN	AP	FP+FN	AP	FP+FN				
90.84	661+45	99.77	0+1	95.90	59+102				
97.60	26+24	99.88	1+0	97.43	76+72	✓			
99.998	1+0	99.90	1+0	97.59	65+61	✓	✓		
100.00	0+0	99.88	1+0	98.24	52+58	✓	✓	✓	
100.00	**0+0**	**100.00**	**0+0**	**98.74**	**59+40**	✓	✓	✓	✓

DAGM



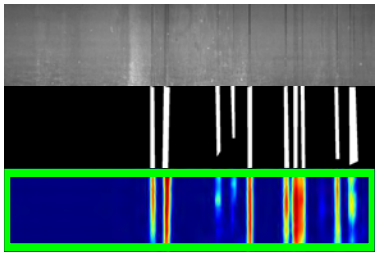
True Positive

KOLEKTOR SDD

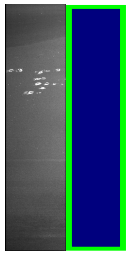


True Positive True Negative

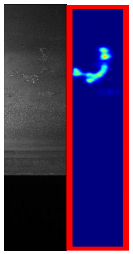
SEVERSTAL STEEL



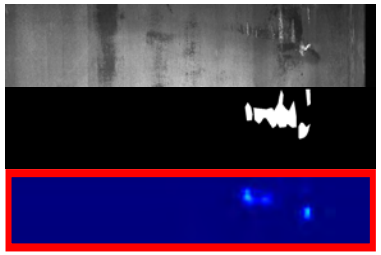
True Positive



True Negative



False positive



False Negative

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