



Automatic Detection of Dust and Scratches in Silver Halide Film using Polarized Dark-Field Illumination

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Introduction

Hardware

Software

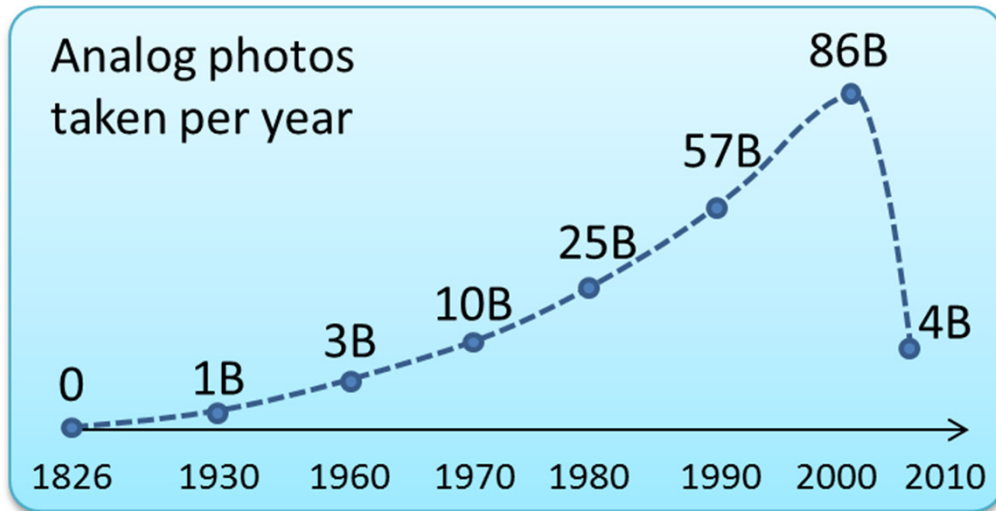
Results

Conclusions

Outline

- **Introduction**
 - Digital Restoration of photographic film
 - Existing Hardware and software methods
- **Hardware Setup**
 - Cross-Polarized Dark Field Illumination
- **Software Processing**
 - Coarse and fine defect masks
- **Experimental Results**
- **Conclusions & Future Work**

Digital Restoration of Photographic Film



Data from <http://blog.1000memories.com/>

- Photographic film may degrade over time
 - Digital restoration can stop (and undo) this degradation process
- Our work focuses on **dust and scratch detection**

Existing Methods I: Hardware

- Infrared Cleaning

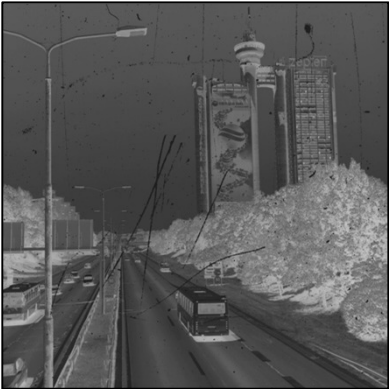


Red channel

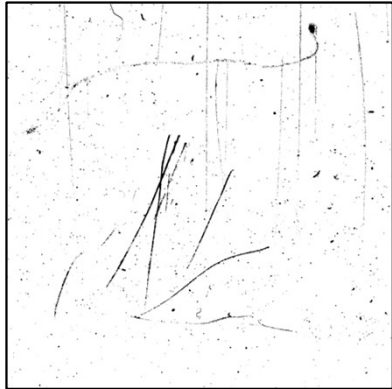
Green channel

Blue channel

NIR channel



+



Existing Methods II: Software

- **Single image approaches**

- Focus on specific defect orientations

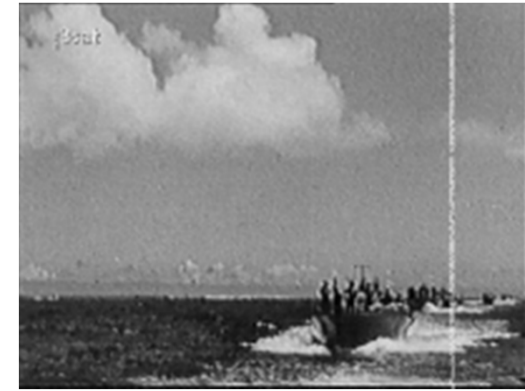
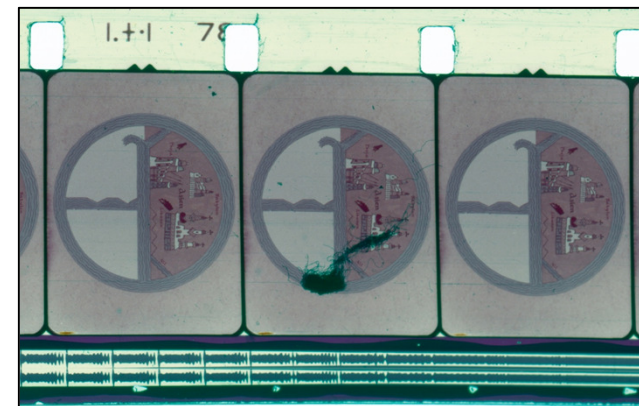


Image from [1]

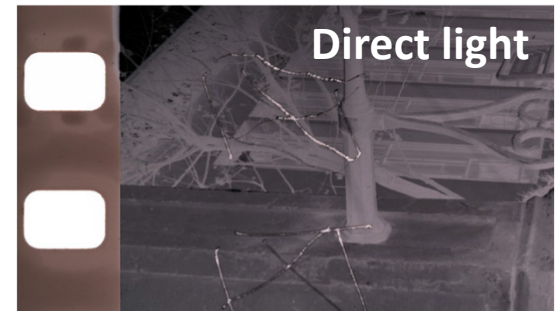
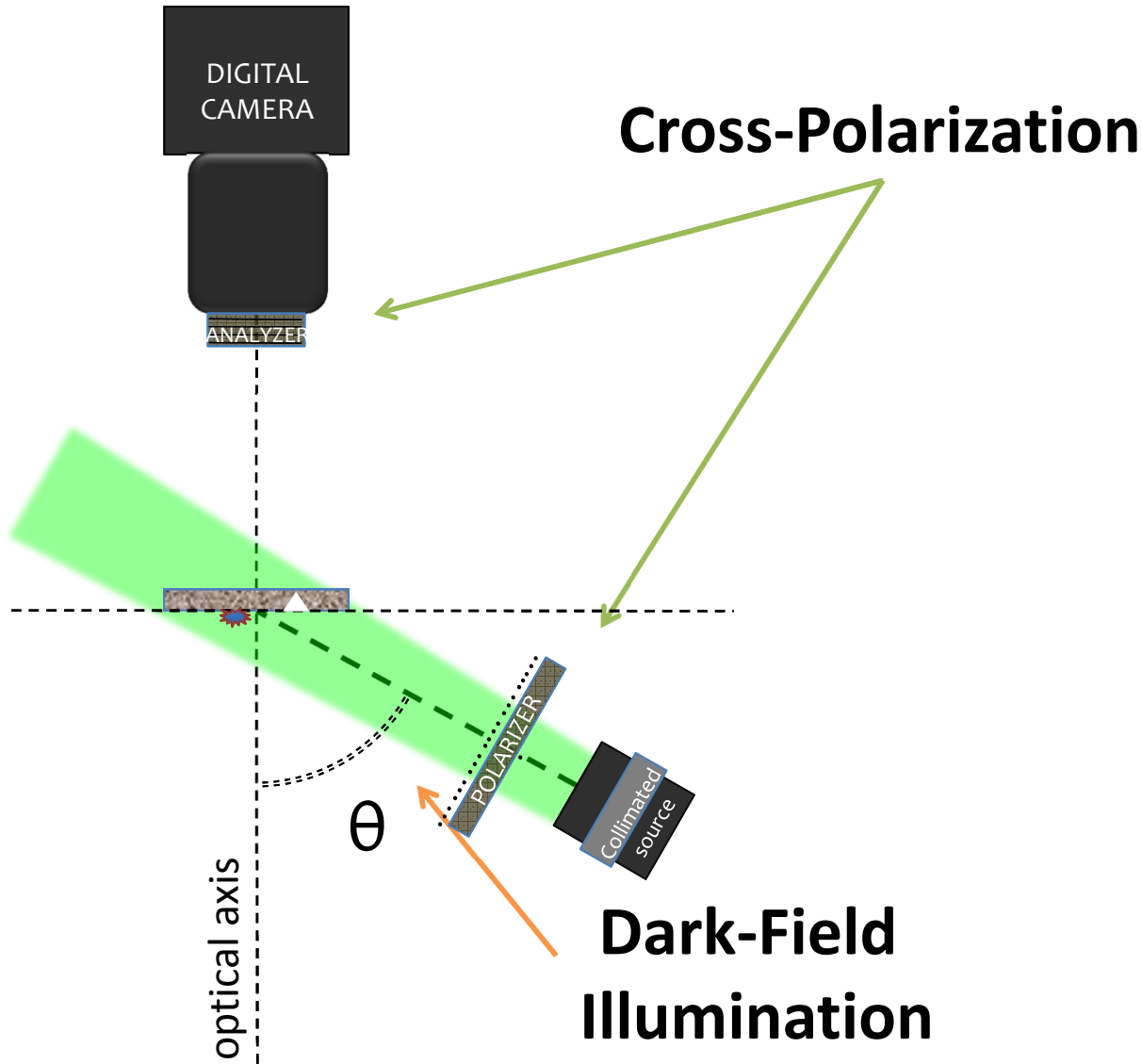
- **Spatio-Temporal approaches**

- Problems with movement in the scene

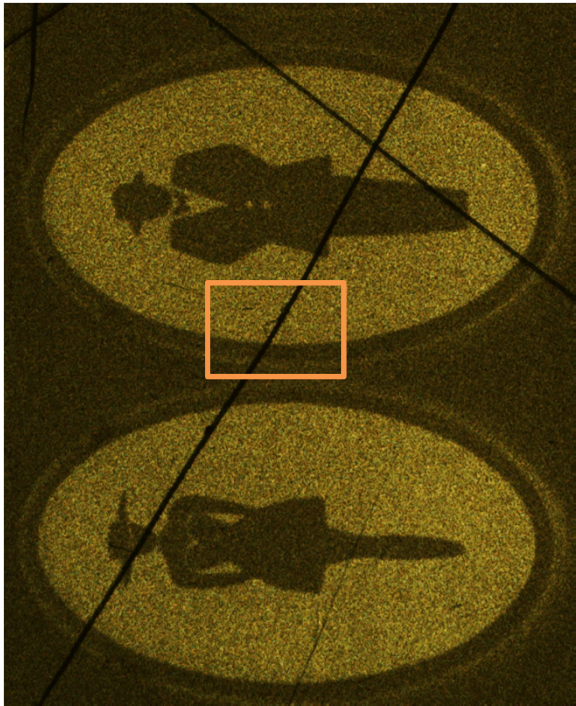
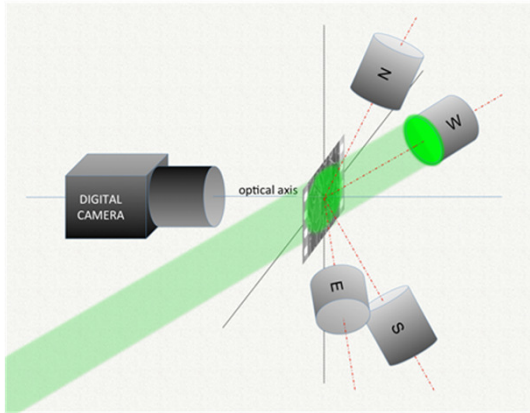


[1] O. Kao and J. Engehausen, "Scratch removal in digitised film sequences," in *Proc. of CISST, 2000*, pp. 171–179

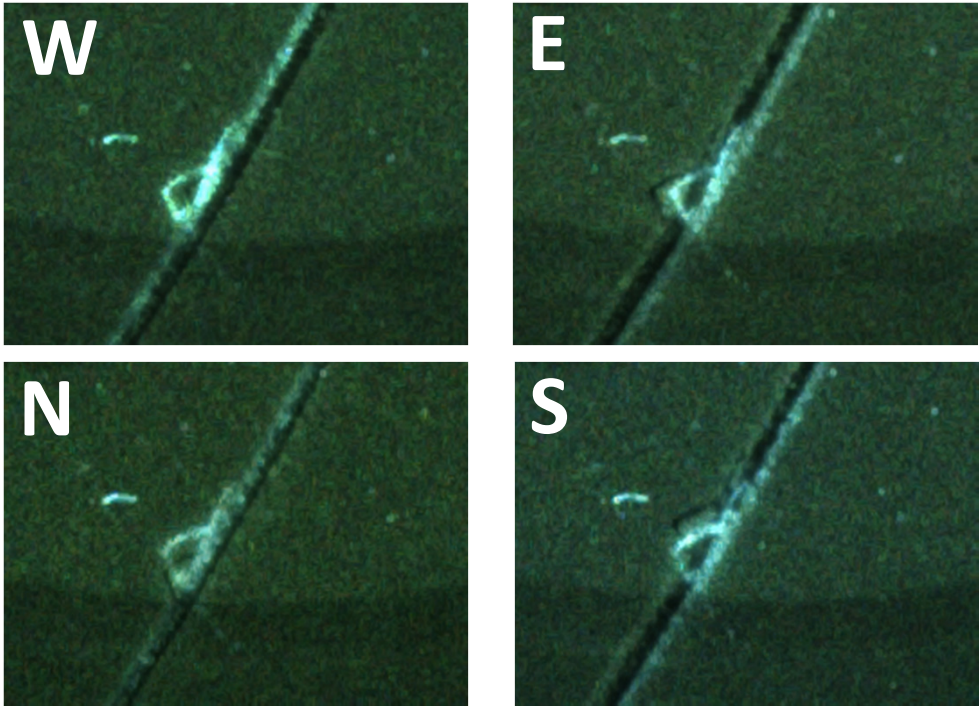
Hardware: Setup Overview



Cardinal Setup

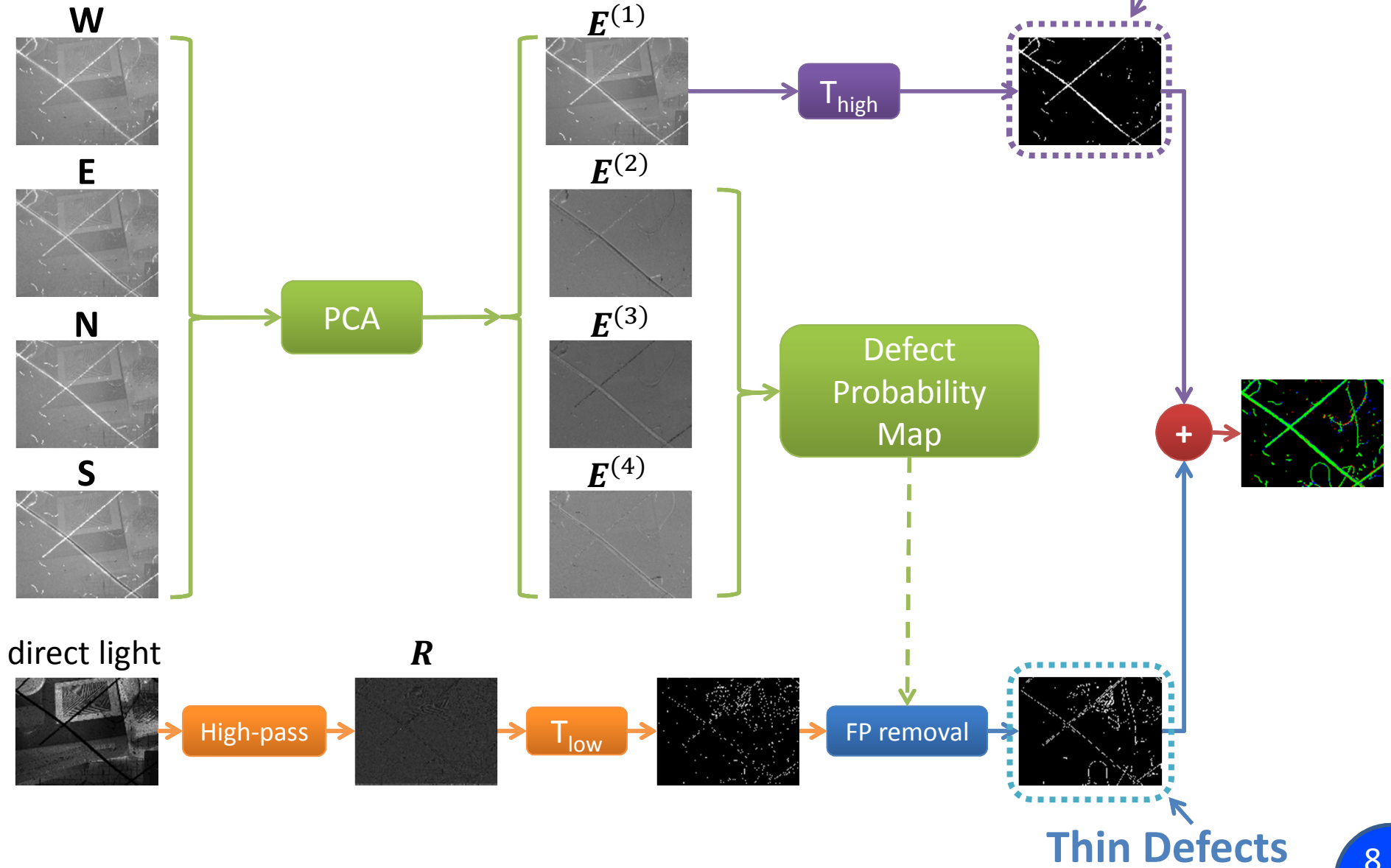


Direct light image

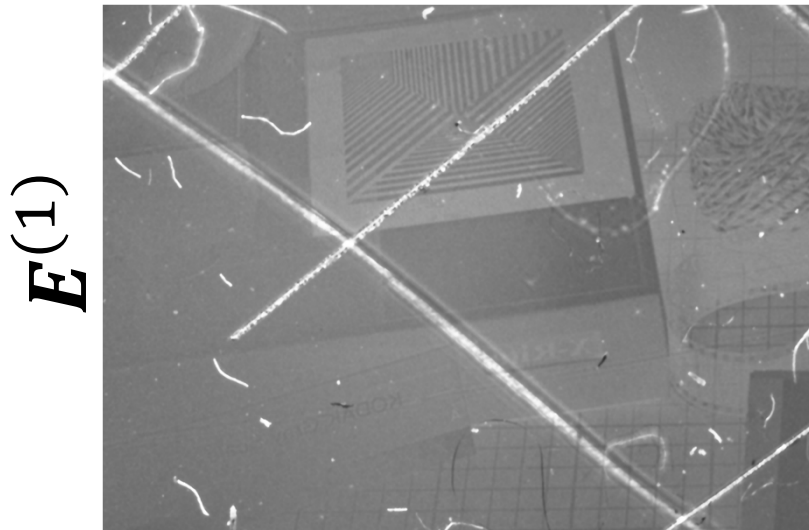


Cardinal Images

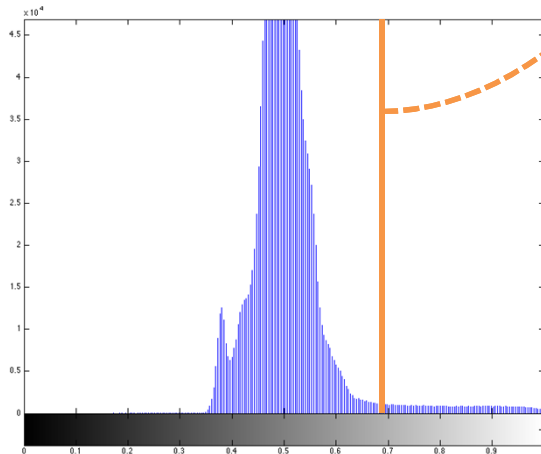
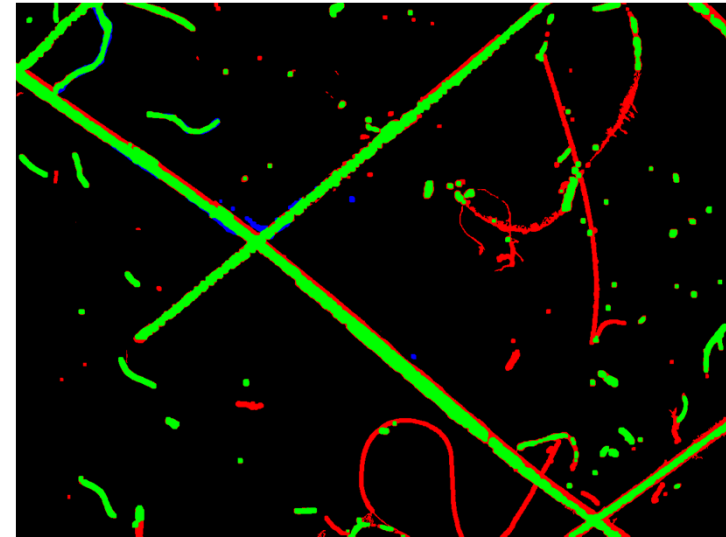
Software: Overview



Part 1: Coarse Defect Map



T_{high}

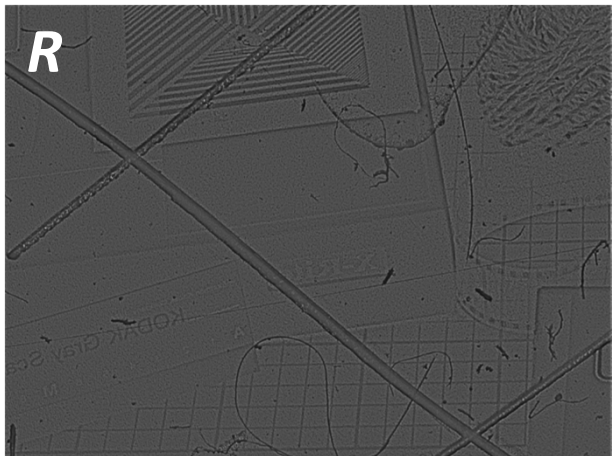


- True positives
- False positives
- False negatives
- True negatives

Part 2: Detecting Thin Defects I

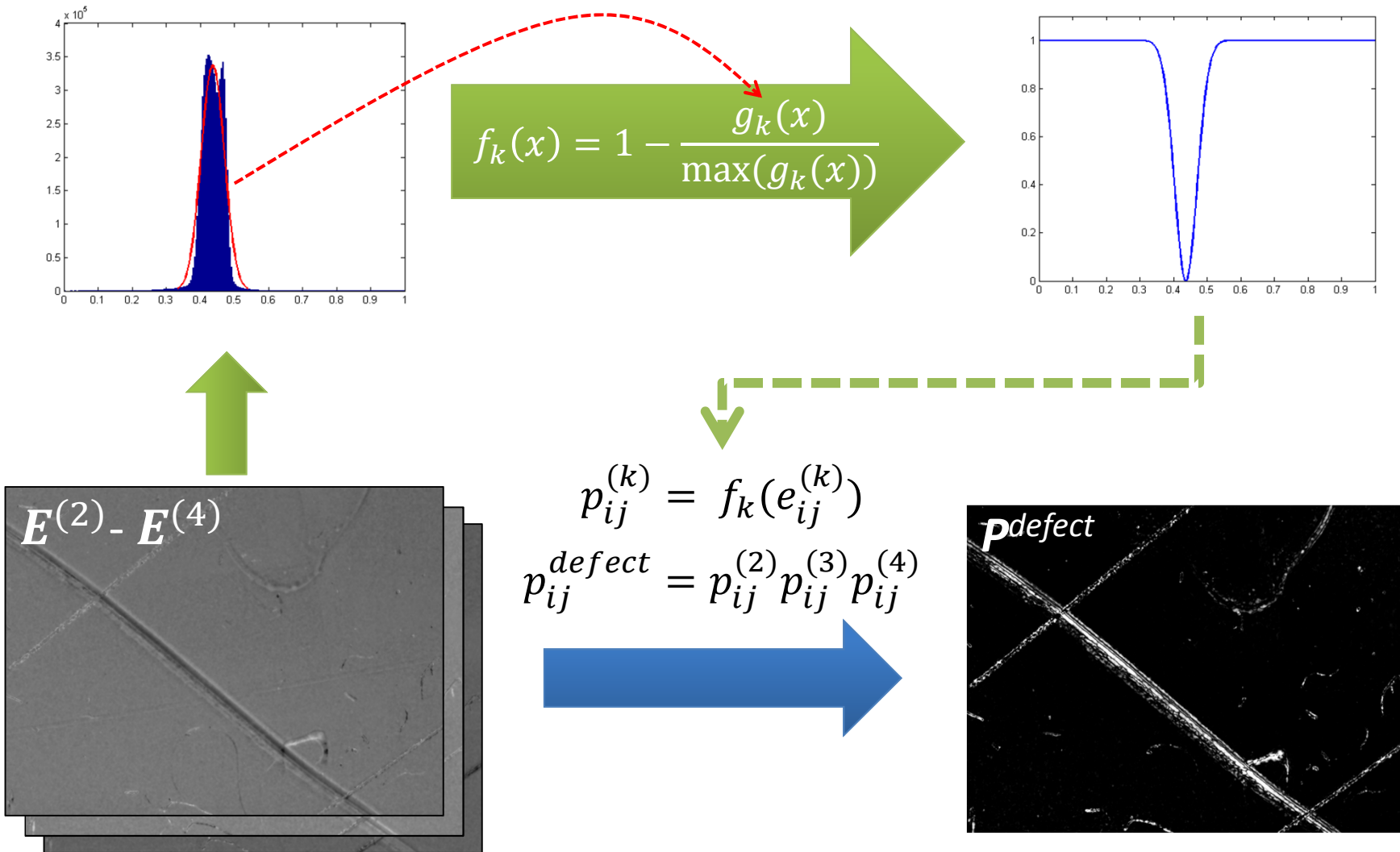


- Direct light image contains much less noise than the cardinal images

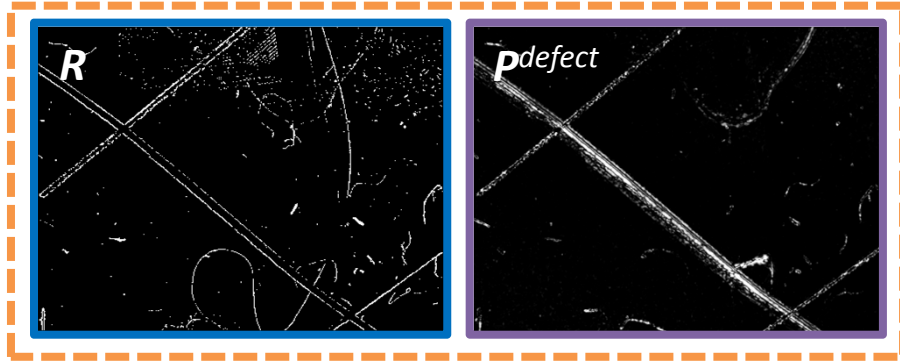


Part 2: Detecting Thin Defects II

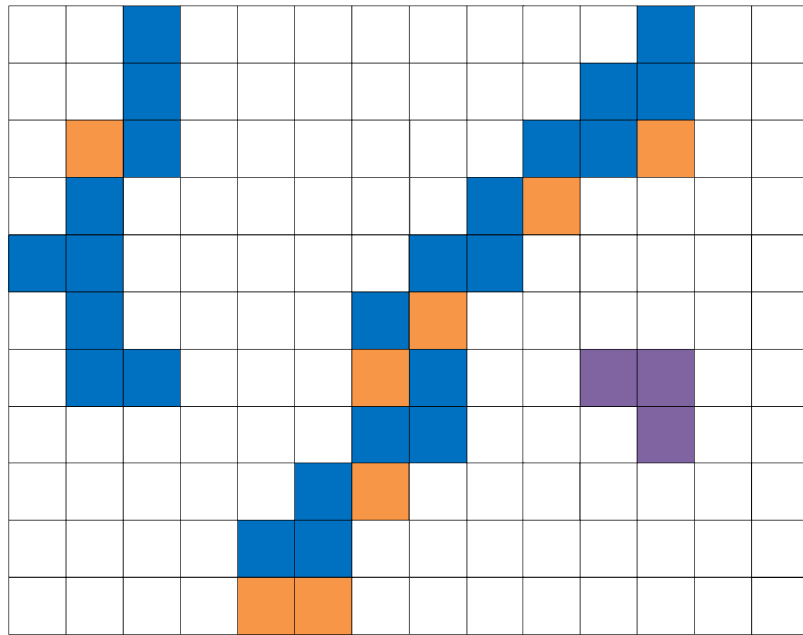
- Defect probability map p^{defect} :



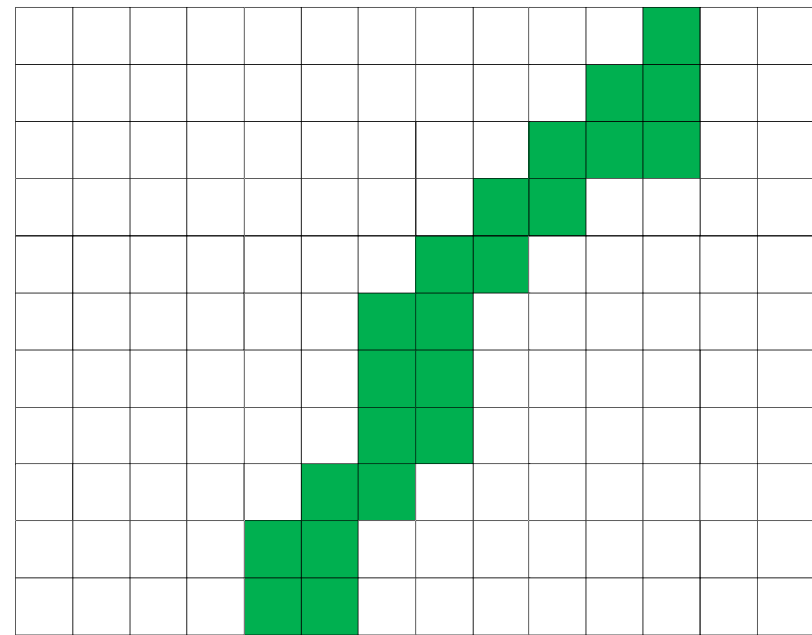
Selecting Thin Defects



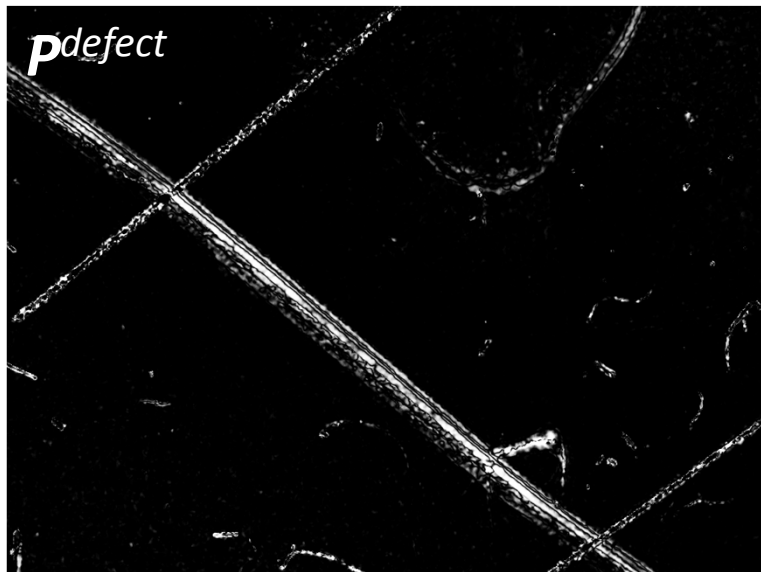
- Pixels in R only
- Pixels in P only
- Pixels in R and P
- Selected pixels



Connected components




Selected pixels



Results (with Groundtruth)

Results on 8 groundtruth images:

True positives from coarse mask: 59.2%

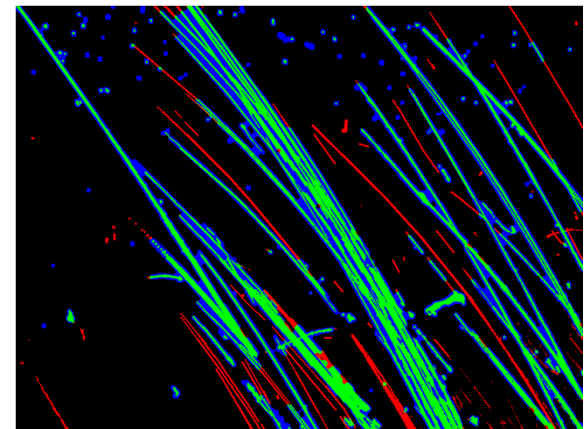
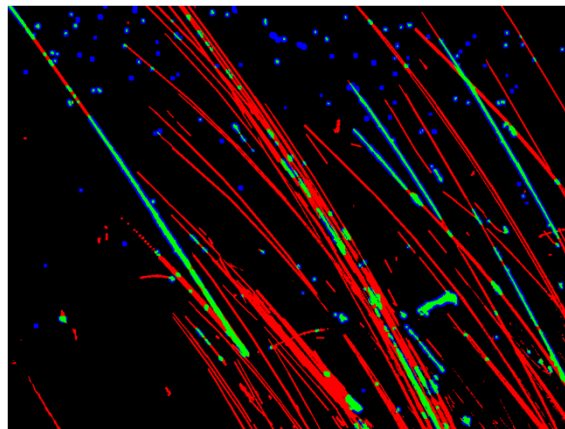
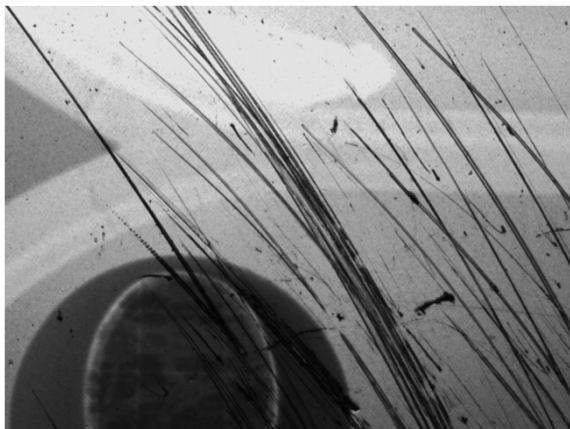
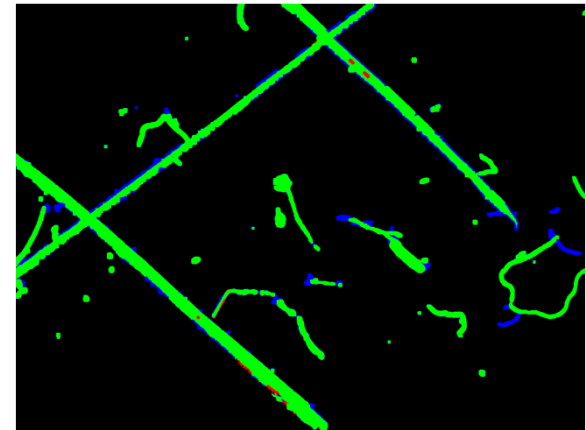
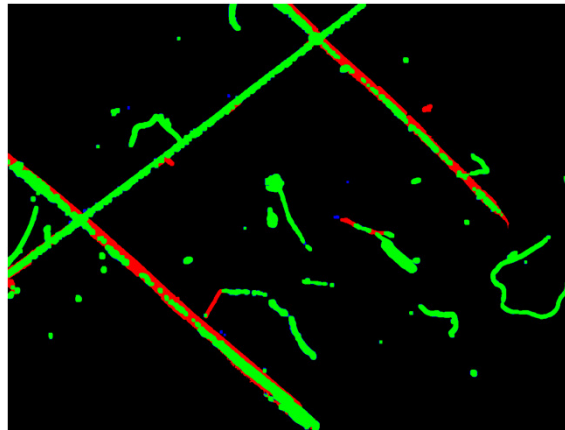
True positives from coarse + fine mask: **88.1%**  ~30% improvement

- True positives
- False positives
- False negatives
- True negatives

Direct light image

Coarse defect mask

Coarse + fine defect mask

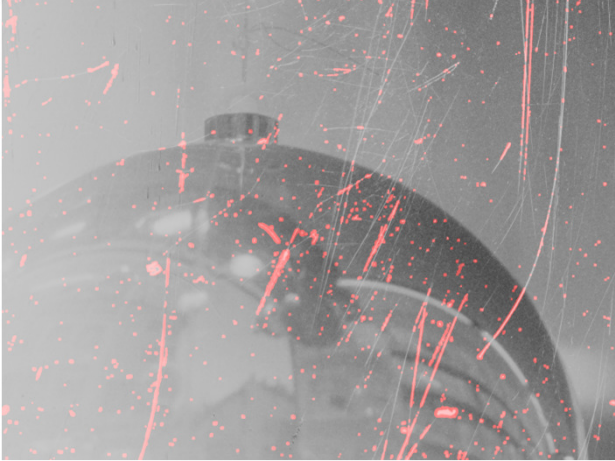


More results (without Groundtruth)

Direct light image



Coarse defect mask

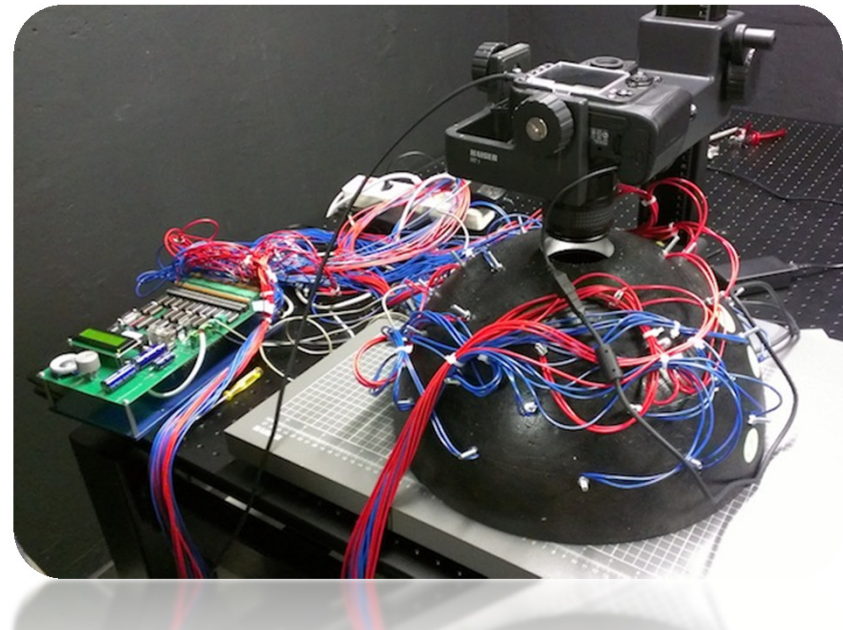


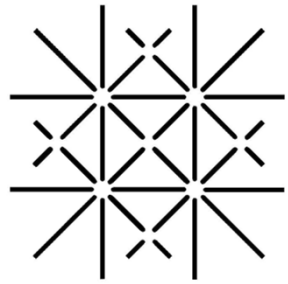
Coarse + fine defect mask



Conclusions and Future Work

- **Detect dust and scratches on silver halide film**
- **Two complementing defect masks**
 - Highly reliable coarse defect mask
 - Refinement to detect thin defects
- **Future Work**
 - Build new hardware setup
 - Evaluate method on more sample data





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Thank you
for your attention



Questions?