Image processing: Applications of mathematics in industry

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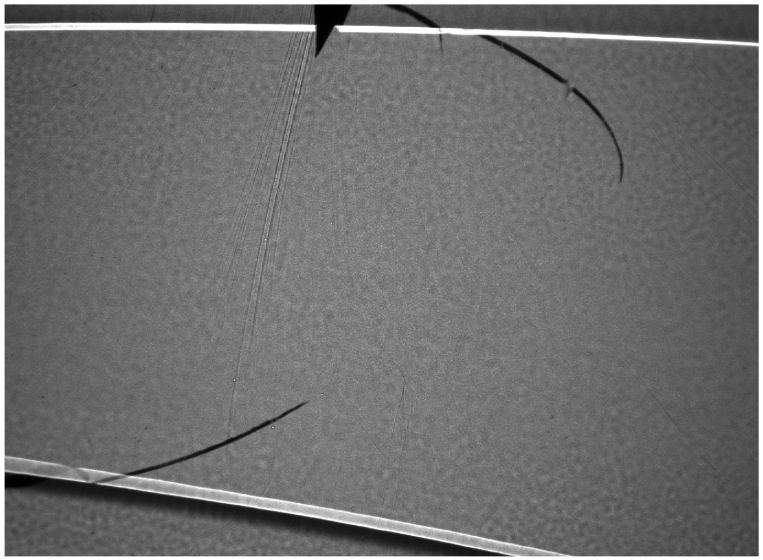
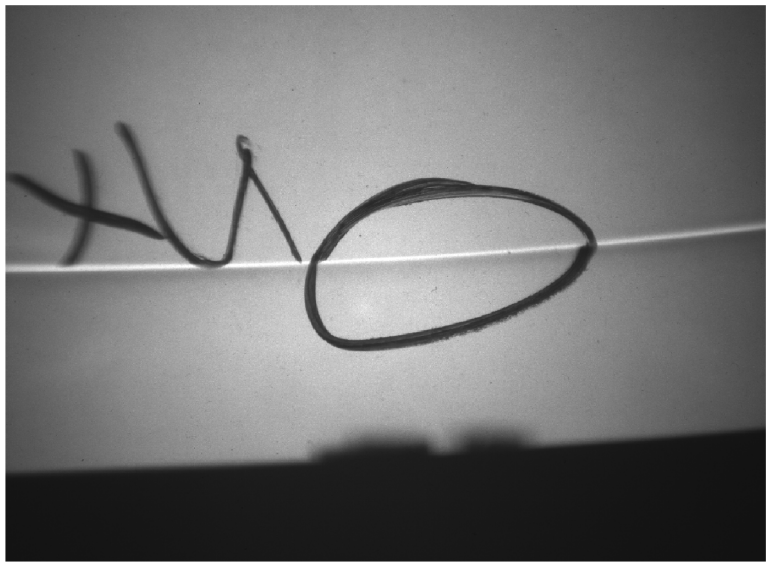
Overview

- Introduction
- Source of light: LED
  - Image preprocessing
  - Image evaluation
- Source of light: light bulb
  - Image preprocessing
  - Image evaluation
- Summary

Introduction

- LED method - phase defects (left)
- Light bulb method - amplitude defects (right)



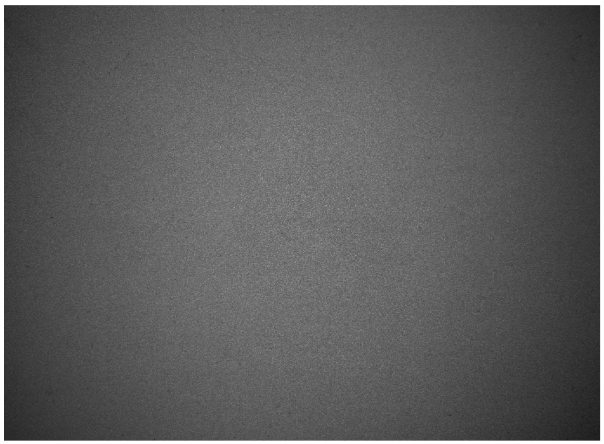


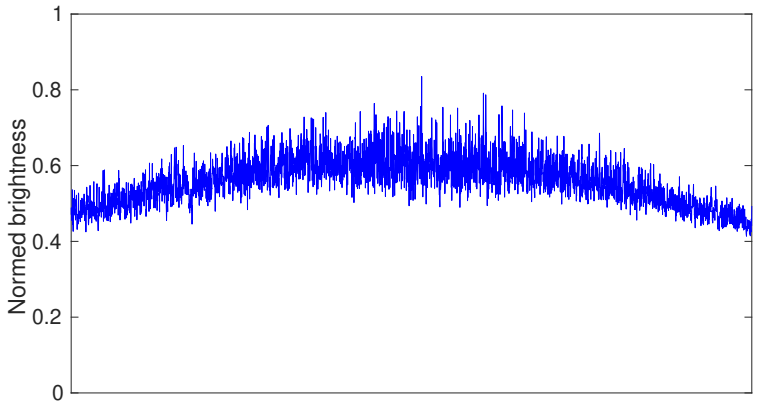
LED method

1. Image preprocessing
   - Denoising
   - Brightness equalization
   - Variance equalization
2. Image evaluation
   - Orange peel
   - Edge detection
   - Final evaluation

LED method: Image preprocessing

- The reference image and its horizontal section:

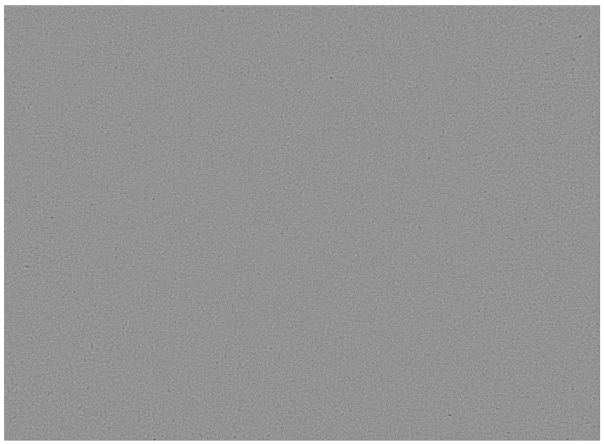


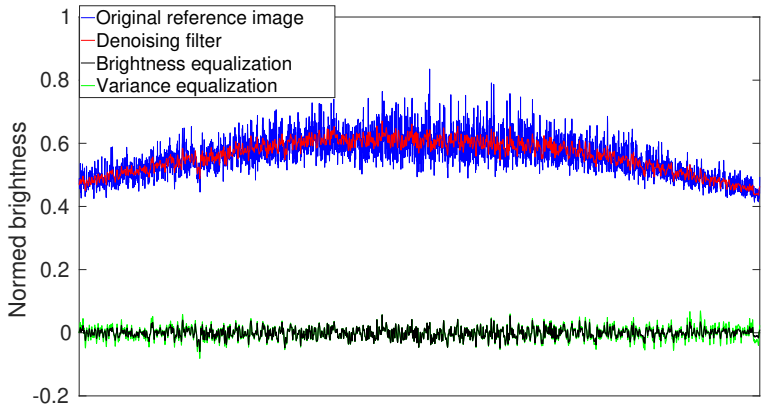


- Significant noise, uneven illumination, and inconsistent variance.

LED method: Image preprocessing

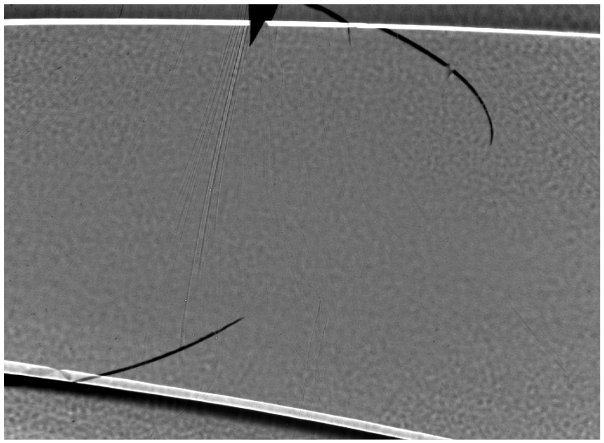
- Significant noise: Fourier transform with a low-pass Butterworth filter.
- Uneven illumination: background of the image (subtracting).
- Inconsistent variance: background of the standard deviation (division).
- Using images from the previous steps.

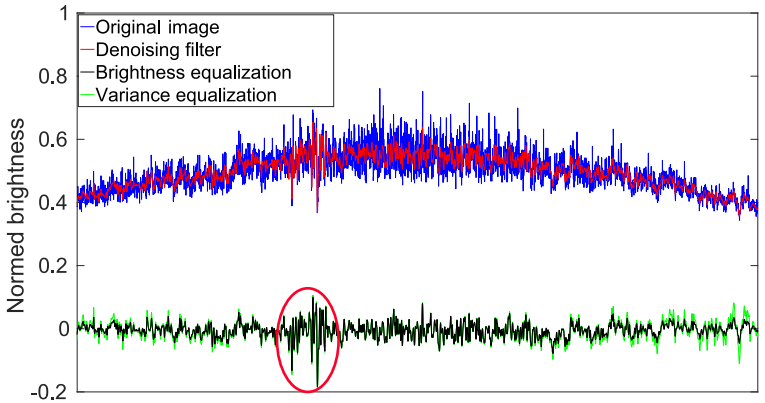




LED method: Image preprocessing

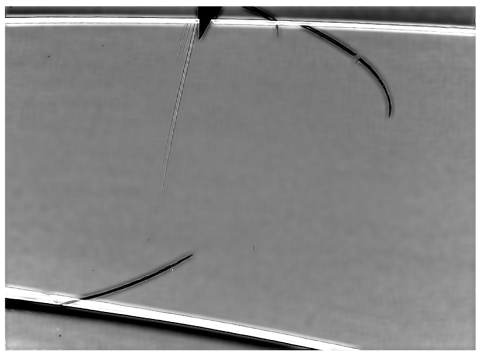
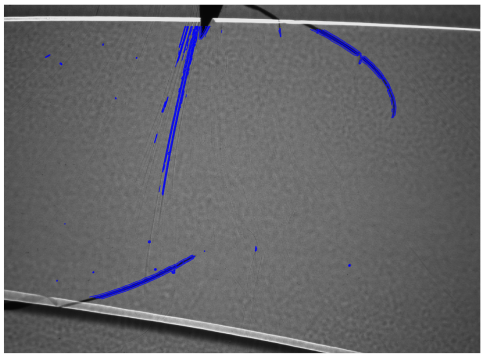
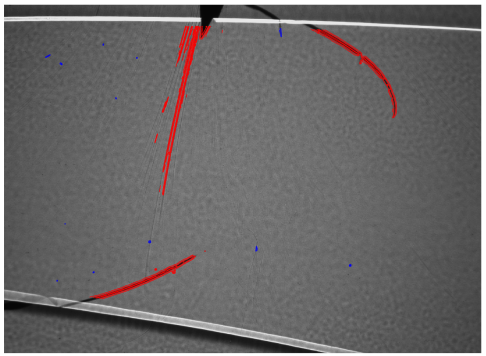
- Image preprocessing of the image of the tested object:





LED method: Image evaluation

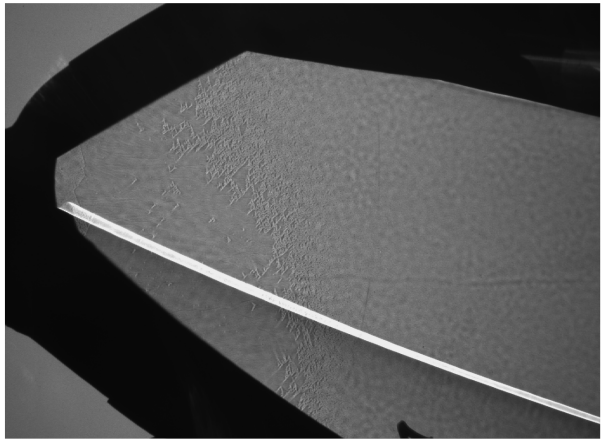
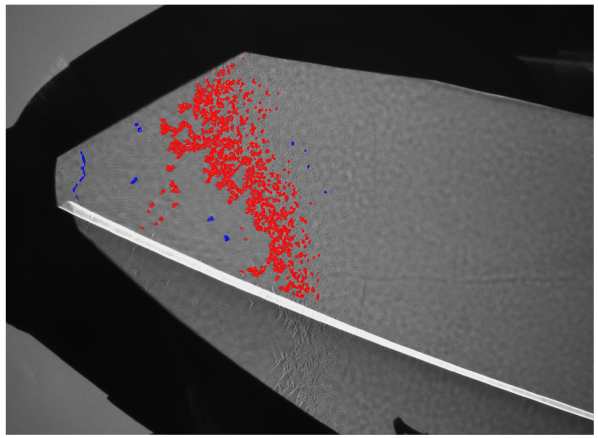
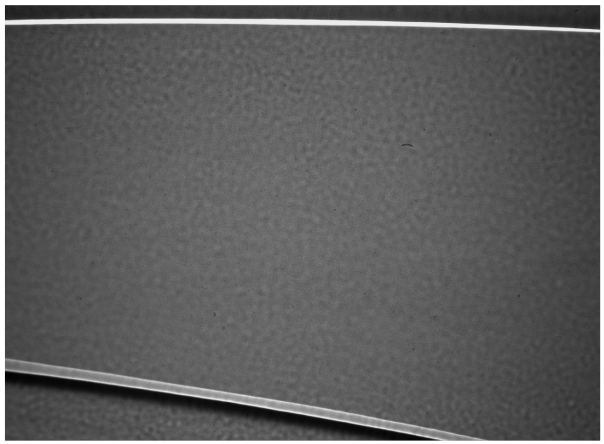
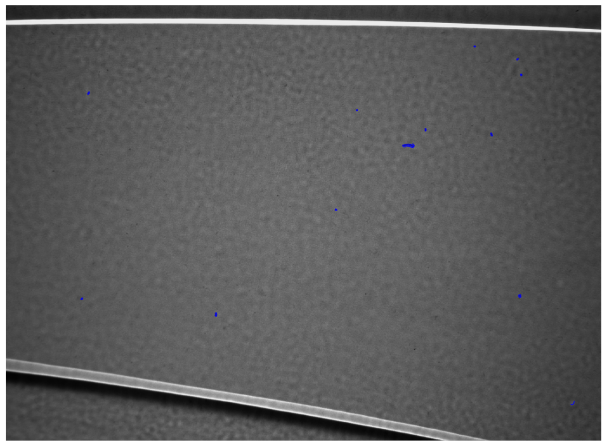
- Removing orange peel - Wiener filter.
- Edge detection - Canny edge detector.
- Final evaluation - size of the defects ($>$ 1000 defective pixels).

Left: Removing orange peel. Middle: Edge detection. Right: Final evaluation.

LED method: Image evaluation

- Examples of defective and defect-free tested objects:

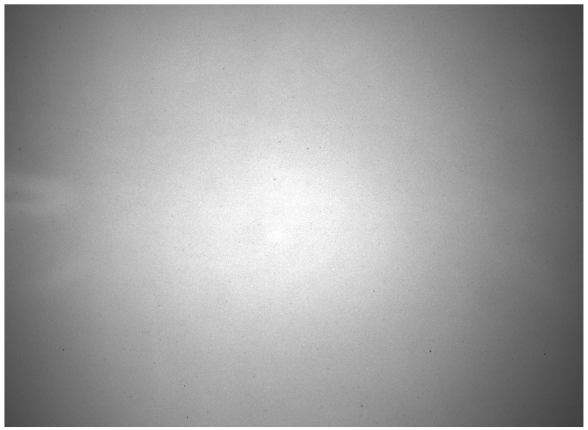





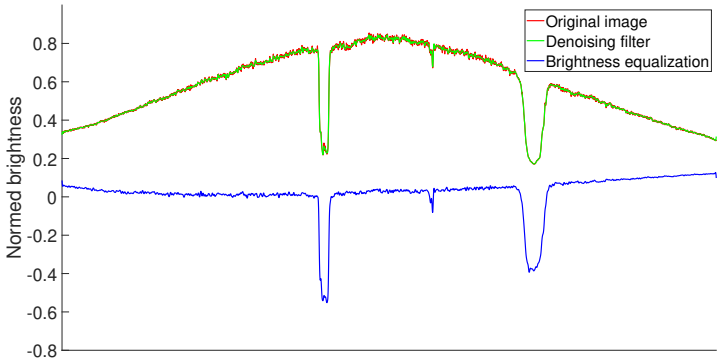
Light bulb method

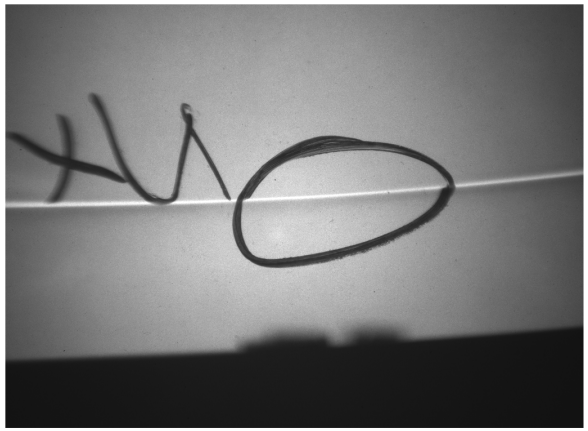
1. Image preprocessing
   - Denoising
   - Variance equalization - not performed yet
   - Removing defects of the translucent screen
2. Image evaluation
   - Eliminating shibr
   - Local brightness comparison
   - Final evaluation

Light bulb method: Image preprocessing

- Denoising and removing defects of the translucent screen

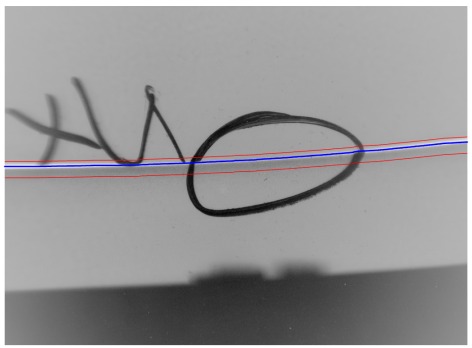


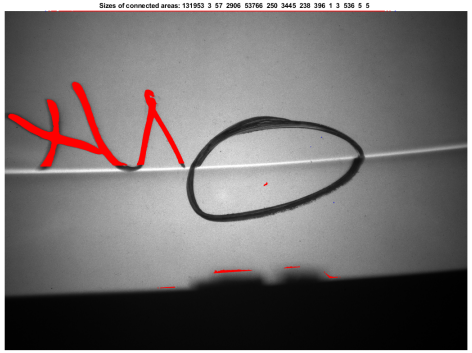




Light bulb method: Image evaluation

- Find and eliminate shibr.
- Find the background image for local brightness comparison.
- Final evaluation - size of the defects ($>$ 100 defective pixels).

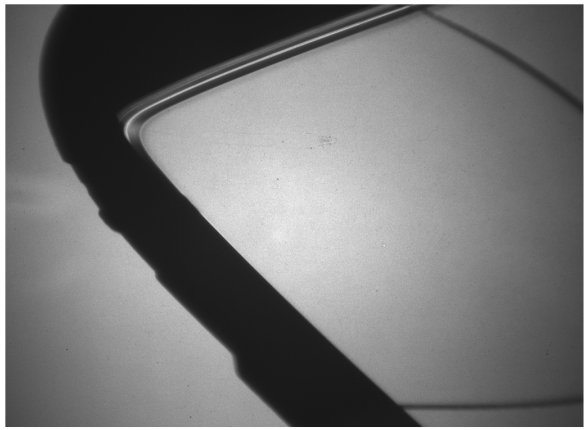


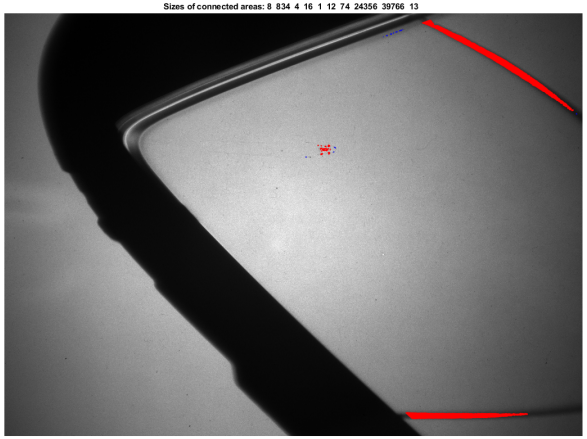


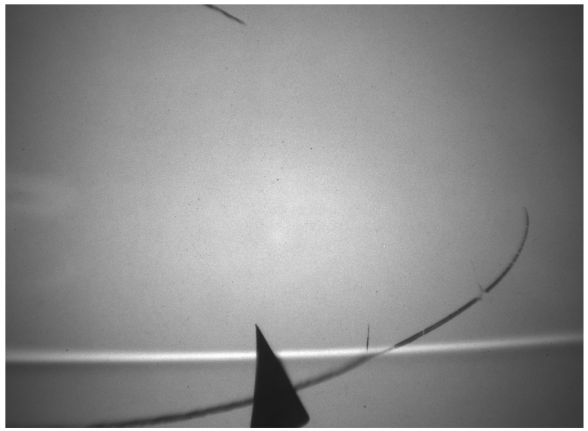
Left: Finding shibr. Middle: Background image. Right: Final evaluation.

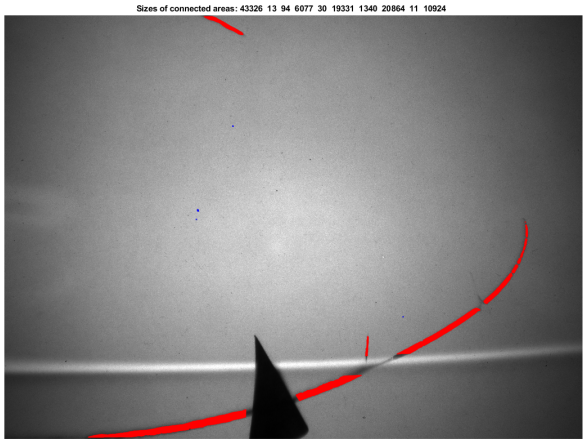
Light bulb method: Image evaluation

- Examples of defective and "defect-free" tested objects:









Summary

- Two types of defects: phase and amplitude.
- Two sources of light: LED and light bulb.
- Two mathematical methods: some similarities.

Thank you for your attention!