Microscopic Image Analysis of Printed Structures Without a Microscope: A Deep Learning Approach

Motivation
- Knowledge of finger geometry crucial for print quality inspection.
- High-resolution finger profile obtained via offline microscopic measurements.
- But: additional time and effort.
- AOI tools provide low-resolution images of solar cells → Affects quality inspection.
- Critical for very thin printed structures.
- Derive microscopic-like finger geometry directly from inline optical images.

Approach
1. Superresolution model to predict high-resolution images from inline images.
2. DeepFineUp model to predict the geometrical statistics from the generated high-resolution images.
3. User-friendly geometrical quality maps

Superresolution model
- CNN learns to predict the microscopic-like high-resolution images.
- Input: Cropped inline optical images.
  - Red-illuminated image
  - Laser projected shadow image
  - Shadow contour image obtained by shadow segmentation ‘SS’ model.
- Optimization by pixel-wise error minimization via microscopic reference data.

DeepFineUp model
- Image processing-based analysis tool[1] estimates the finger geometry from high-resolution images.
- But: time expensive at whole cell level.
- We implement a CNN[2] to predict the geometrical parameters.
  - Input: high-resolution images containing 2D and 3D information.
  - Target parameters obtained by applying FineUp on the images.
  - Optimized via supervised learning using paired data.

Results

Q-maps: Reduced to statistically relevant quality parameters

Conclusion
- Tool to generate quality maps from inline optical images without the need of offline microscopic measurements.
- Superresolution model generates respective high-resolution images.
- DeepFineUp model successfully predicts geometrical parameters from generated high-resolution images.
- Quality maps revealing the geometrical finger profile are generated.
- Applicable on different metallization layouts, different printing methods.

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