Deep Learning of Image Inpainting for Semiconductor Wafer Image Recognition

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Motivation
- AR / VR field advances and moving towards achieving ‘Metaverse’ in mixed reality world, creating the next generation devices – AR glasses is critical problem to solve.
- New challenges of handling transparent wafer auto handling.
- ‘Universal’ solution in fiducial mark image recognition pipeline.
- Sim2real solution for dataset with all confidential information under NDA.

Methods – Context Encoder for Image Inpainting
- Baseline: Part of the fiducial mark missing – 0% success rate in image recognition for wafer alignment.
- Proposed Method: Using image inpainting to ‘guess’ the missing fiducial mark pattern – higher success rate in image recognition, so wafer can be aligned properly!
- A context encoder and decoder pipeline are implemented in the model. The context encoder uses convolutional neural network to learn the surrounding feature of an image, simulated fiducial mark images will be pass through the encoder to study the feature based on the remaining part of the image.
- Encoder: 5 conv layers -> Fully connected layers -> Decoder: 5 conv layers
- Joint loss function: Reconstruction L2 loss function + Adversarial loss function ( real or fake )

Dataset
- A set of simulated fiducial mark images and consider multiple factors to make the fiducial marks look as ‘real’ as possible to the ones on wafer surfaces.
- Second dataset of ‘scratches’ in background images to simulate the wafer conditions and model flexibility.

Experimental Results
- Two sets of data used for testing.
- Most fiducial images were successfully inpainted. -> Success rate > 50%
- Simulated background scratch wafer fiducial image. -> Denoising

References

Future Work
- Using the real wafer and fiducial mark data for training and testing.
- Hardware + SoftwareCreating a camera ISP with denoising and image inpainting algorithm for dealing with real environment.
- Sim2Real adaption, solve wafer alignment issue in real product.

Fig 1. Metaverse AR glasses concept
Fig 2. Next generation optical waveguide demo wafer. Image credit: EVG public
Fig 3. Fiducial mark dataset example
Fig 4. Context encoder trained with joint reconstruction and adversarial loss for fiducial mark inpainting.
Fig 5. Wafer die illustration with potential fiducial marks positions for automatic positioning.
Fig 7. (a) (b) (c) Test dataset 1 with clean background, (d) (e) (f) Test dataset 2 with ‘scratch pattern’ background.
Fig 8. Wafer alignment image processing pipeline