Exploring Circular Corner Regions as Seed Points for PDE-based Inpainting

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What is inpainting...

https://upload.wikimedia.org/wikipedia/commons/a/ae/Digital_Image_Restoration_and_Reconstraction.jpg

- Restoration technique (antique paintings etc.)
- Used for decades
- Digital inpainting introduced in 2000

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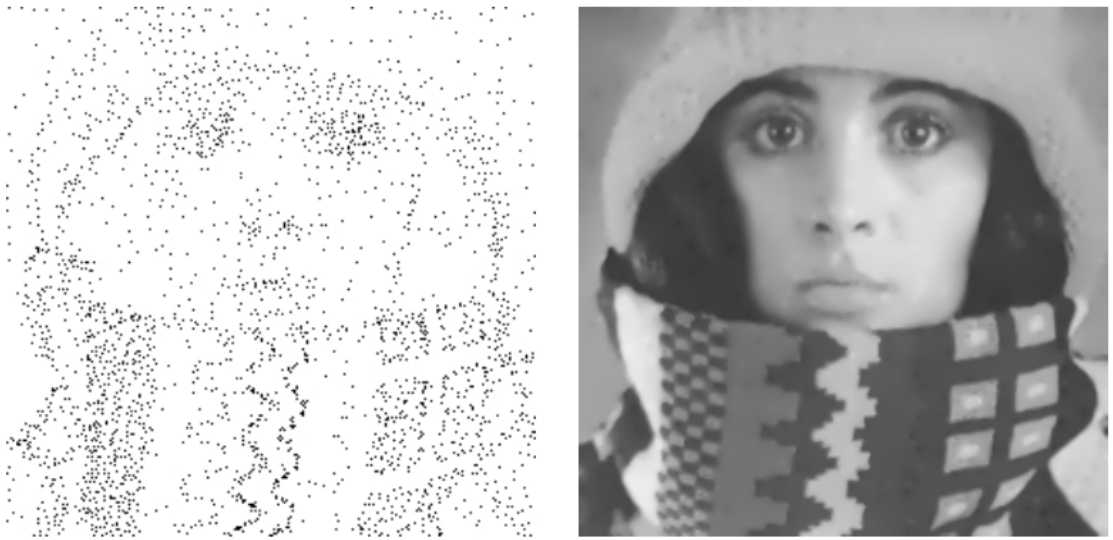

Source: [Hoeltgen et al., 2017]

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- Many different approaches (semantic, tree-based, analytic, . . .)
- Semantic: use image features as seeds (edges/corners)
- Edge-based methods successful
- Corners as seed points barely explored

Related Work

PDE-based inpainting using corner information (Zimmer, 2007)

- Examined how well images can be compressed using only corners

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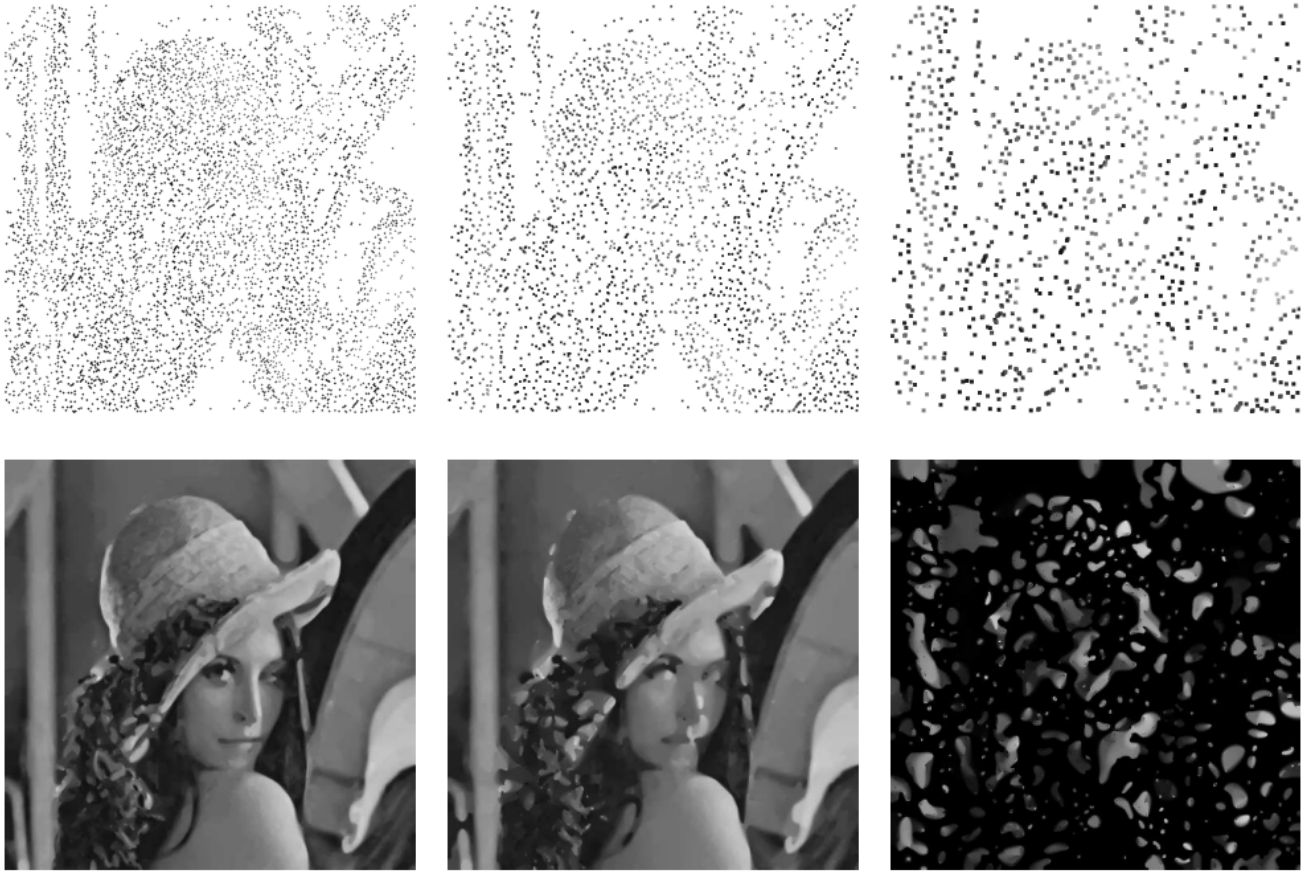

Inpainting results from [Zimmer, 2007] for corner regions of different sizes

Related Work

PDE-based inpainting using corner information (Zimmer, 2007)

- Examined how well images can be compressed using only corners
- Masks as small neighbourhood around important corners
- Reconstruction using mean curvature motion (MCM) + edge-enhancing diffusion (EED)
- Open potential:
  - Corner detection very fuzzy (example results)
  - Corner regions not optimised properly
  - MCM not well suited for inpainting

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- Follow up on approach of Zimmer
- Förstner-Harris corner detection
- Introduce modifications
  - to better control mask size
  - to adapt detection to circular corner regions
- Pure EED inpainting
- Quantitative evaluation using **MSE/PSNR**

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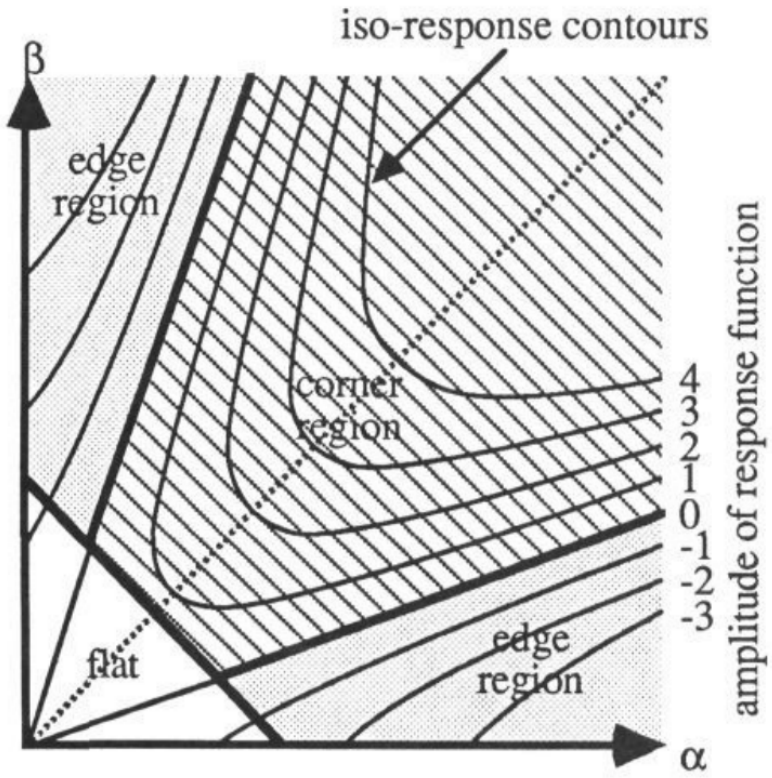
$$\det(J)/\mathrm{tr}(J) = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2} > T$$

Structure tensor based corner detection



Visualization of relation between eigenvalues of structure tensor. Source: [Harris and Stephens, 1988]

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- Förstner-Harris measure:

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- Local maxima of this measure are marked as corners

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Amount of corners varying on input image with fixed threshold
Makes it hard to reliably produce masks of the same size

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Alternative

Instead of filtering out percentage of corners, calculate upper bound for number of corners such that only a certain percentage of *pixels* is kept.

Non-maximum Suppression

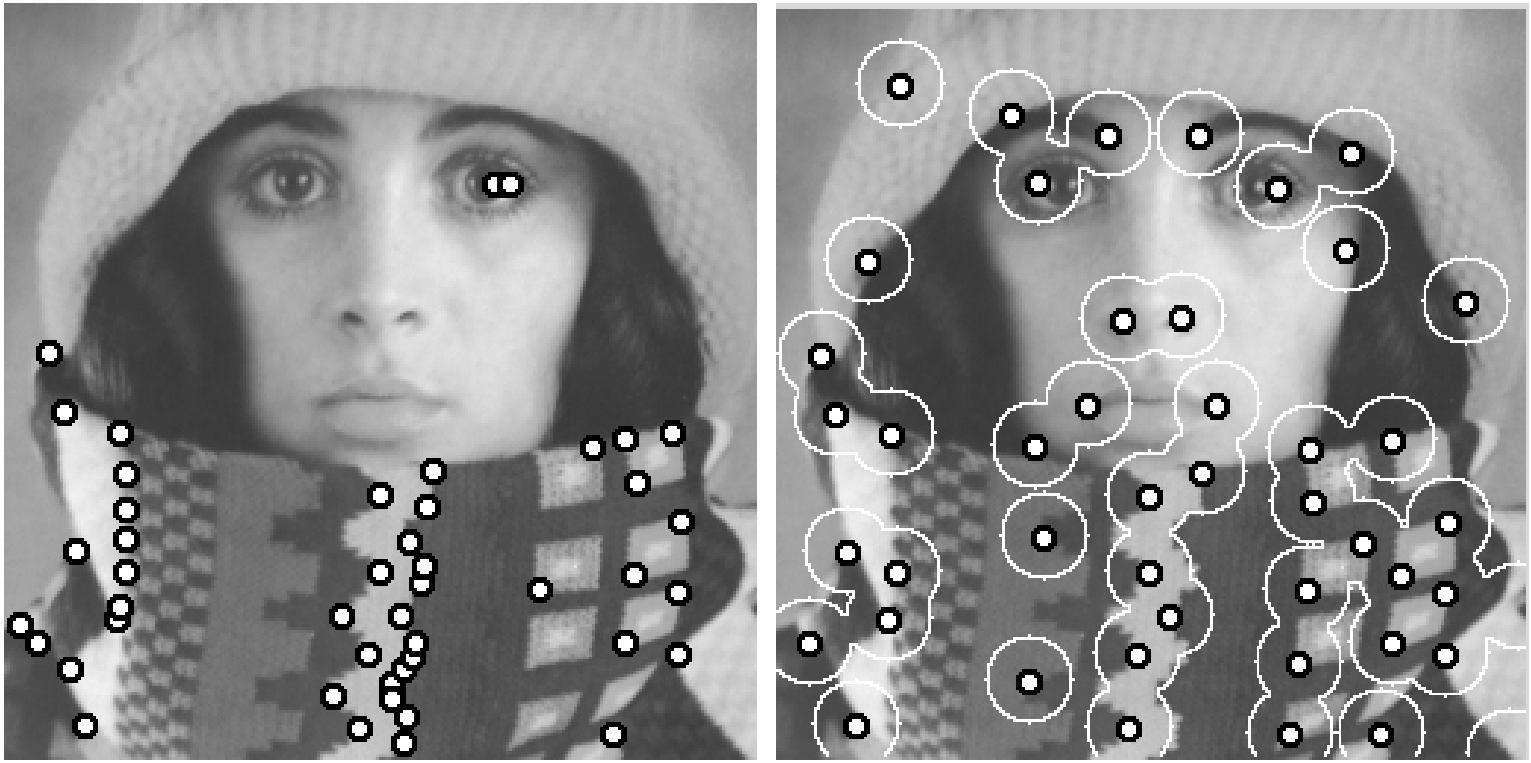
Observation

Corner regions tend to overlap a lot, especially in textured regions
Results in poorly distributed inpainting mask

Possible Remedy

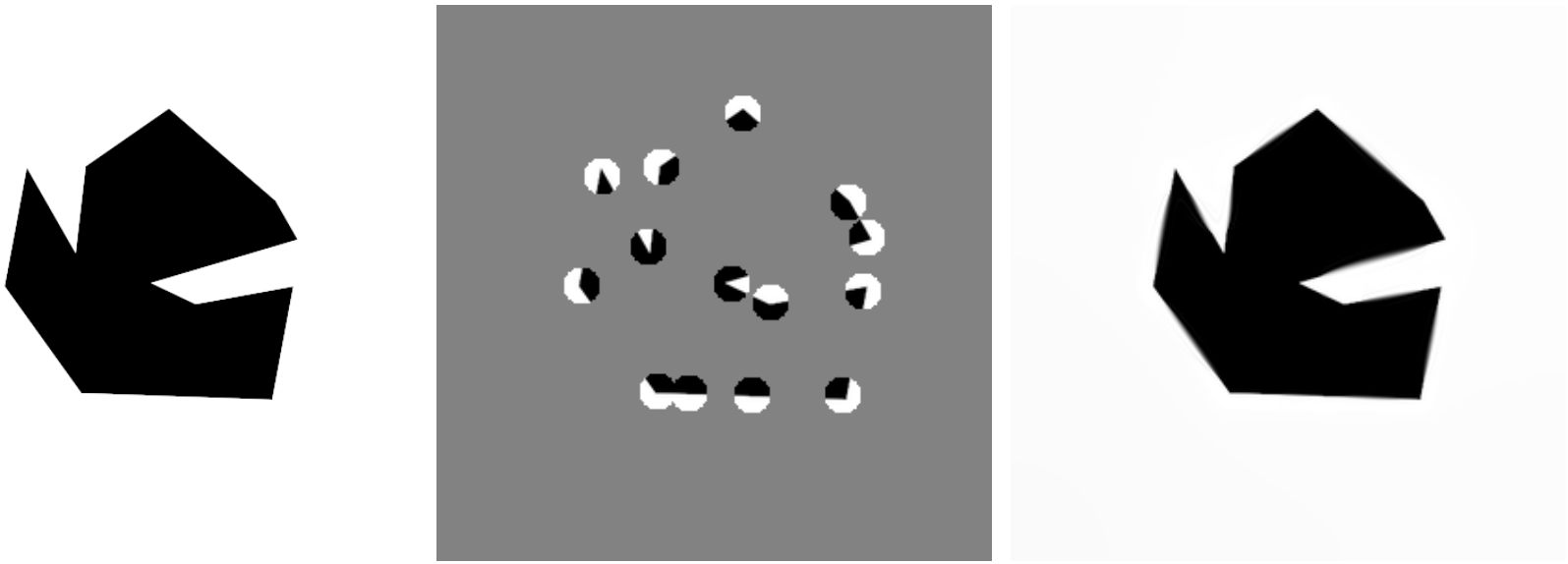
Discard corners already covered by a 'better' corner

Non-maximum suppression



Left: Centre points of corner regions without suppression. **Right:** With suppression (boundary of each region highlighted). Corner detection using Förstner-Harris detector with identical parameters

Expectations and Limitations



Left: Mask ($\approx 5\%$ of all pixels). **Right:** Inpainting result ($\sigma = 4, \lambda = 0.03$, stopped after 1000 iterations with $\tau = 1000$) PSNR=32.04

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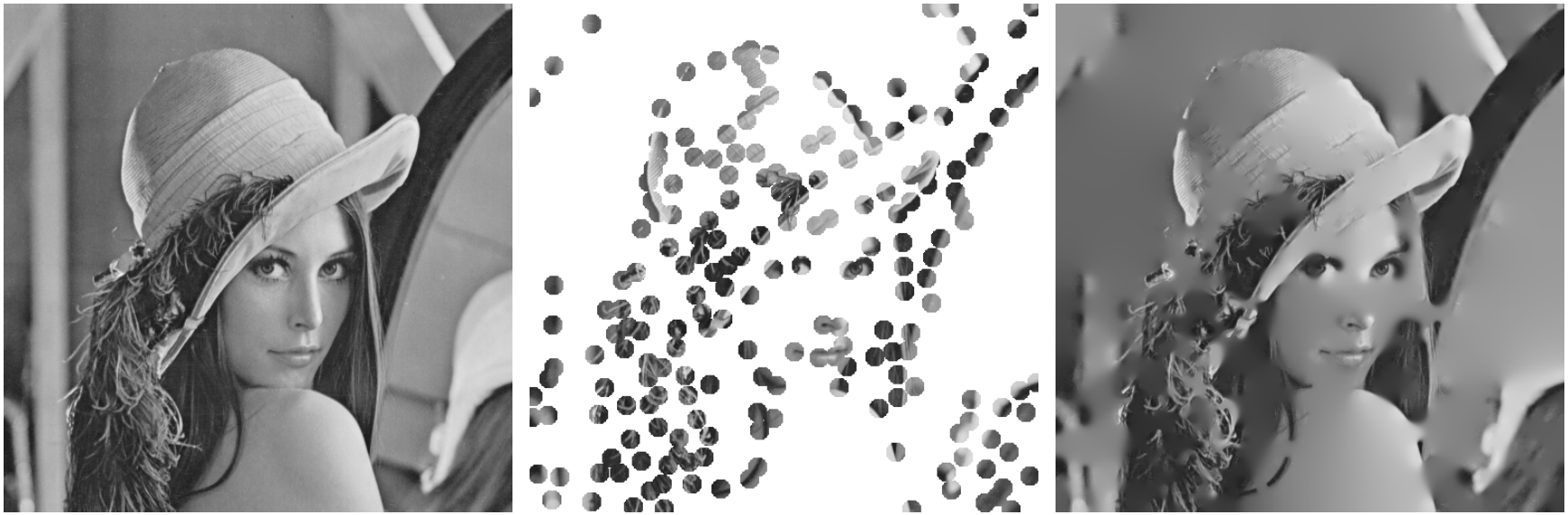

Left: Original image *lena512*. **Middle:** Mask (filled with white for visualisation, $\approx 20\%$ of all pixels) **Right:** Inpainting result ($\sigma = 2, \lambda = 0.4$, stopped after 1000 iterations with $\tau = 1000$) PSNR=21.56

Any questions?

Thank you for your time!

Bibliography

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In *Alvey Vision Conference*, pages 147–151.

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[Zimmer, 2007] Zimmer, H. L. (2007).
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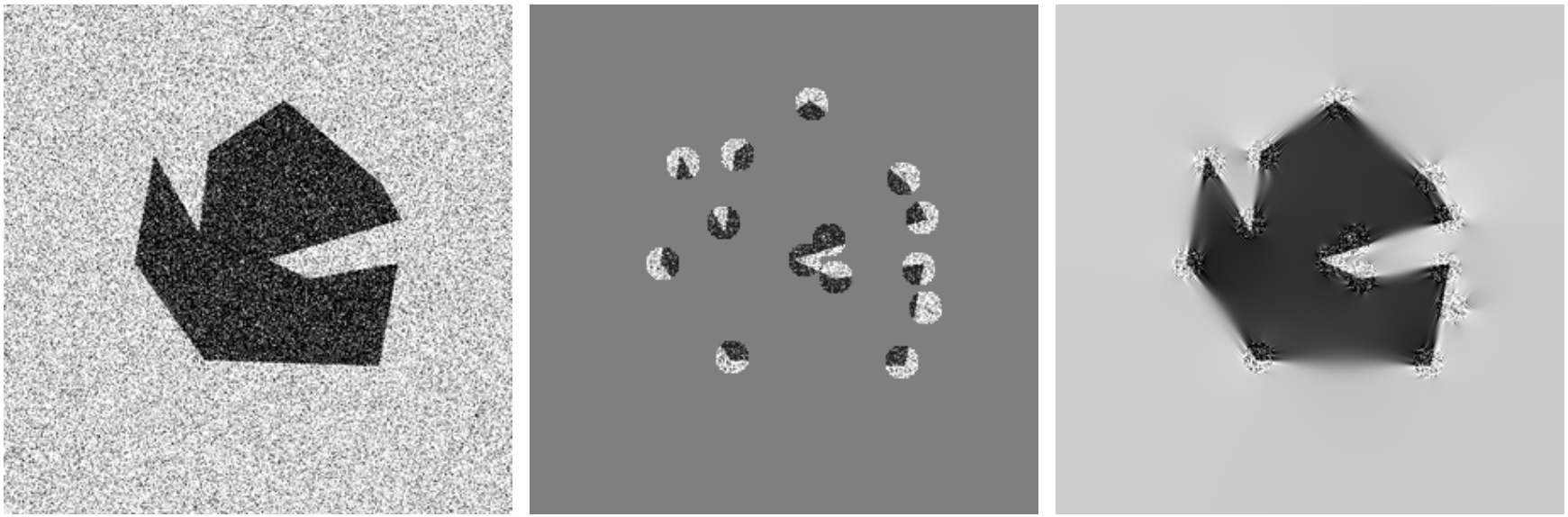
Master's thesis, Saarland University.

Examples (3)



Left: Original image. **Middle:** Mask ($\approx 5\%$ of all pixels) **Right:** Inpainting result ($\sigma = 4, \lambda = 0.3$, stopped after 1000 iterations with $\tau = 1000$) PSNR=16.72