Interactive Smoothing of Handwritten Text Images Using a Bilateral Filter

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The Problem

- An increasing number of people are using text images
- Volunteers read text images to index important information
- Many of the images are unreadable due to quality and age of the documents
- Artifacts in the images include background noise and undistinguishable ink strokes
### The Problem

<table>
<thead>
<tr>
<th>Name</th>
<th>Place</th>
<th>Date</th>
<th>Age</th>
<th>Where interred</th>
</tr>
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<tbody>
<tr>
<td>Charlotte Pels</td>
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<tr>
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<td>Thomas Gutter</td>
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<td>John Mellish</td>
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<td>June 19th 70</td>
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<td>Elizabeth Bath</td>
<td>The Valley</td>
<td>June 29th 60</td>
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The Solution

• We improve image visibility by,

• Using a bilateral filter to even out the noise in the background

• Accentuating weak stroke pixels to make them more visible (Laplacian)

• We can apply interactively the algorithm in desired regions

• We adjust the parameters of the algorithm to improve results
The Solution

<table>
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<tr>
<th>Name</th>
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</tbody>
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Background

**Bilateral Filter** (Tomasi et al. 1998)
- Smooths regions while preserving edges
Background - Bilateral Filter

- It uses 2 weighting functions

- $G_s = \text{spatial normal distribution}$

- $G_r = \text{range (color) normal distribution}$
Background - Bilateral Filter

We combine the two weighing functions and we have:

\[ I'_p = \sum G_s(|p - q|) \cdot G_r(|I_p - I_q|) \cdot I_q / W_p \]

where

\[ W_p = \sum G_s(|p - q|) \cdot G_r(|I_p - I_q|) \]

(a) (b) (c)
Background

Laplacian Filter

• Calculates the 2nd derivative of the image (edge detection)

\[
\begin{pmatrix}
0 & -1 & 0 \\
-1 & 4 & -1 \\
0 & -1 & 0
\end{pmatrix}
\quad
\begin{pmatrix}
-1 & -1 & -1 \\
-1 & 8 & -1 \\
-1 & -1 & -1
\end{pmatrix}
\]

• We combine it with the bilateral filter to augment soft strokes
Our Algorithm

- We identify if the mouse is over an edge (ink stroke)
  - The Laplacian filter gives us zero crossings
- We apply the bilateral filter on mouse\_down and mouse\_move events
- If we are over an edge, we darken the stroke
- Otherwise, we make the background lighter
Results

Original Image

Result ( $G_r = 3$, $G_s = 5$)

Result ( $G_r = 3$, $G_s = 10$)

Result ( $G_r = 3$, $G_s = 15$)
Results

Original Image

Result ( $G_r = 3$, $G_s = 5$)

Result ( $G_r = 3$, $G_s = 10$)

Result ( $G_r = 3$, $G_s = 15$)
Results

Original Image

Result - Accentuated Strokes
Conclusion

• We applied the Bilateral filter and Laplacian to solve the problem of low quality text images.

• Results are promising and indicate that;

• Bilateral filter is robust and smooths text images without losing important pixels.

• Edge enhancement can make faint text more readable.
Further Work

• Improve identifying the edges better, using a better edge detector.

• Automatically select the parameters to work with the bilateral and laplacian filters.

• Use the bilateral filter for text segmentation of old document images.
Questions?