Quickshear Defacing for Neuroimages

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Neuroimages

- Contain two elements
  - Metadata: names, identifiers, dates, etc.
  - Pixel data
Volume Rendering from Neuroimages

Rendering using Slicer (left), AFNI (middle), MRICron (right).
Existing Image De-identification Methods

- Skull stripping


- MRI Defacer (Bischoff-Grethe et al. 2007)
Quickshear Defacing

- Identify brain mask
- Create flattened edge-of-brain mask
- Find convex hull
- Identify plane that divides volume
- Set voxels on face side to zero

- Input: Original image, Brain mask
- Output: Defaced image
Creating Brain Mask

- Skull stripping techniques identify brain and non-brain tissue
- Works with any skull stripped volume
- Create edge of brain mask
Convex Hull

• Identifies area to protect from shearing
• Cutting along consecutive points on convex hull ensures all brain voxels lie on one side
Quickshear Defacing

- Shearing occurs along the line formed by the two points on the hull with the smallest x-coordinate
- A buffer is added to preserve brain tissue
- All voxels that fall on the face side of the plane are set to zero
Testing Quickshear

- Data from MRI Reproducibility Study (Landman et. al, 2010)
  - 42 images from 21 subjects
  - T1-weighted MP-RAGE
- MRI Defacer run using provided atlas
- Quickshear Defacing using brain masks generated from three skull stripping techniques: AFNI 3dSkullStrip, FSL BET, and FreeSurfer HWA
- Verification against brain masks using AFNI 3dSkullStrip, FSL BET, and FreeSurfer HWA
- Validation using OpenCV Face Detector
Quickshear vs MRI Defacer

Defaced images using Quickshear (top) and MRI Defacer (bottom)
## Results – Brain Volume Preservation

<table>
<thead>
<tr>
<th>Defacing Method</th>
<th>3dSkullStrip</th>
<th>BET</th>
<th>HWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI Defacer</td>
<td>408.74</td>
<td>75271.93</td>
<td>422.00</td>
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<tr>
<td>Quickshear</td>
<td>0.00</td>
<td>5560.76</td>
<td>0.00</td>
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<tr>
<td>HWA</td>
<td>0.00</td>
<td>7587.24</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Average number of voxels discarded (Number of images with voxels discarded)
Results – Facial Feature Recognition

<table>
<thead>
<tr>
<th>Defacing Method</th>
<th>Faces detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI Defacer</td>
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<tr>
<td>Quickshear</td>
<td>10</td>
</tr>
<tr>
<td>3dSkullStrip</td>
<td>10</td>
</tr>
<tr>
<td>BET</td>
<td>10</td>
</tr>
<tr>
<td>HWA</td>
<td>12</td>
</tr>
</tbody>
</table>

Number of images with faces detected by OpenCV

Quickshear defaced image with face detected.
Quickshear—Conclusions

- Preserves more brain tissue
- Effectively defaces neuroimages
- Does not require previously constructed face atlas
- Significant performance gains
- Integrates seamlessly into the neuroimaging workflow
Acknowledgments

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