Quickshear Defacing for Neuroimages

Nakeisha Schimke and John Hale

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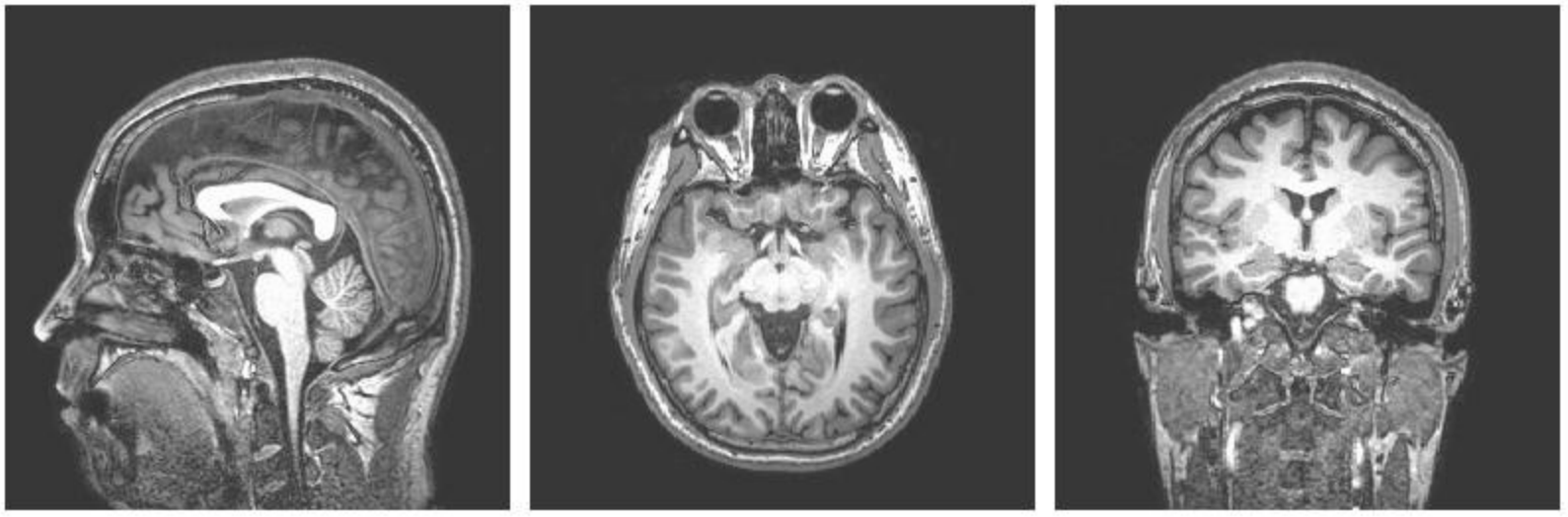
Institute of Bioinformatics and Computational Biology

The University of Tulsa

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)

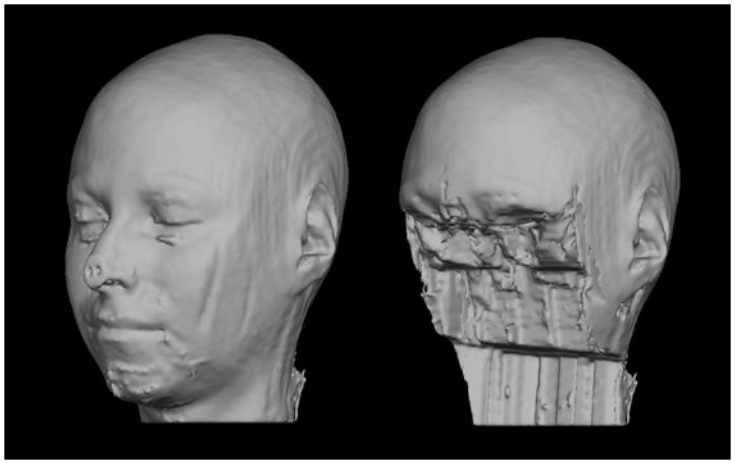
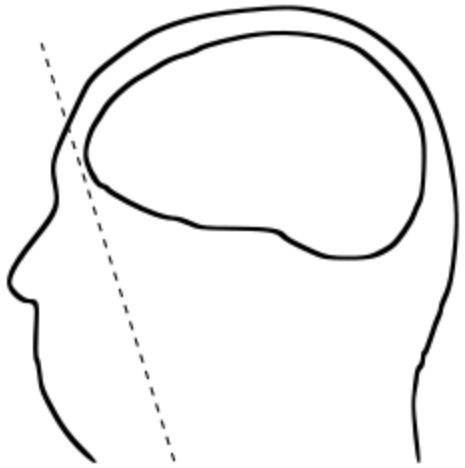


Image from Bischoff-Grethe et. al, “A technique for the deidentication of structural brain MR images,” 2007.

Quickshear Defacing

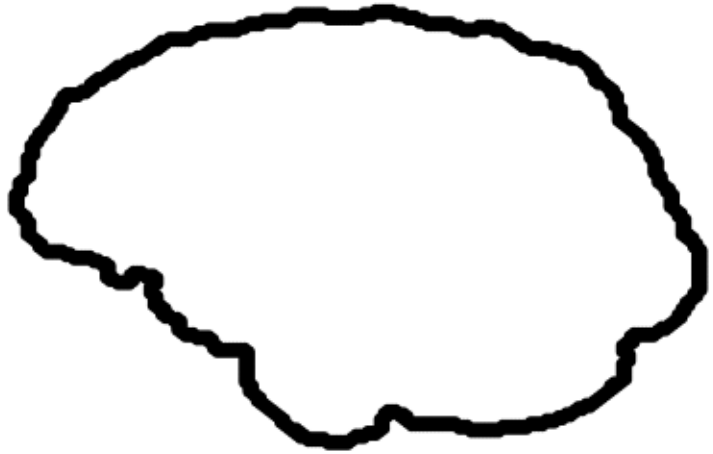
- Identify brain mask
- Create flattened edge-of-brain mask
- Find convex hull
- Identify plane that divides volume
- Set voxels on face side to zero

- 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

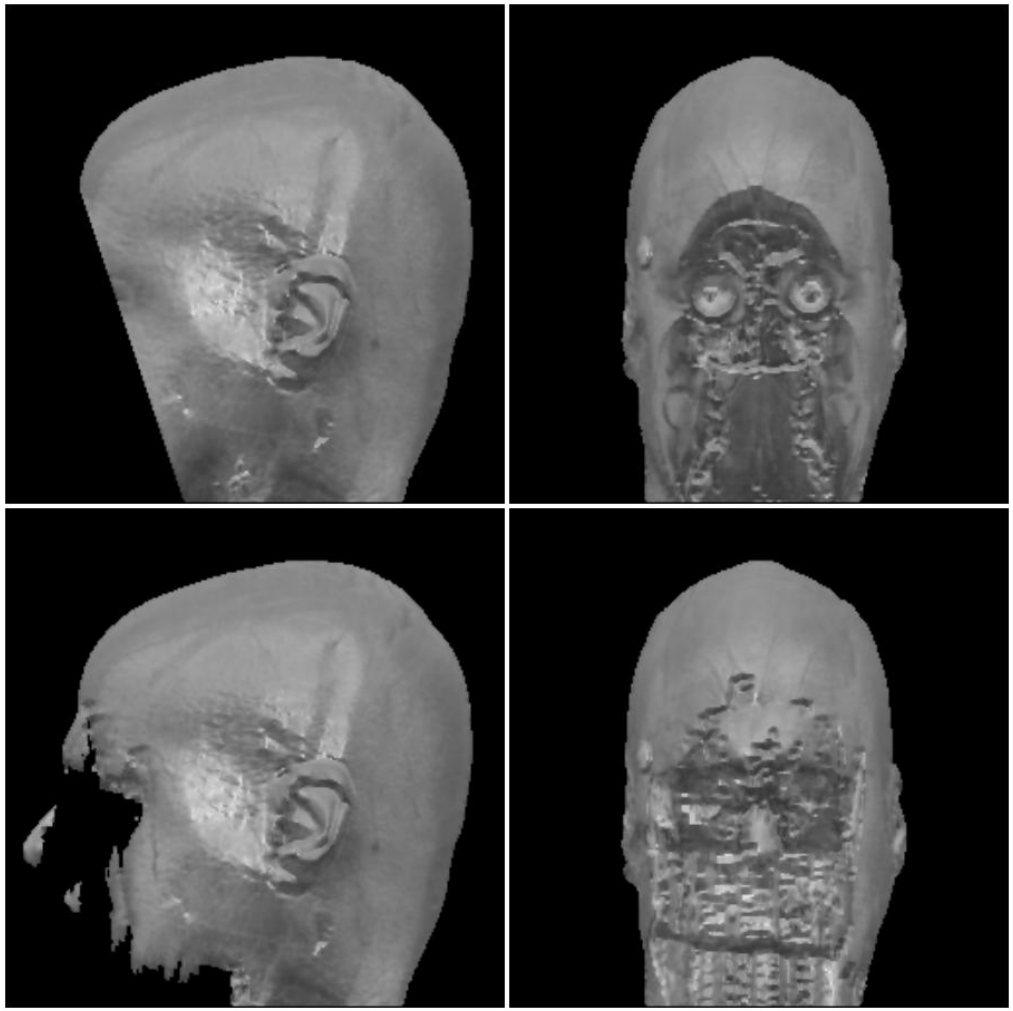
Quickshear Defacing

- 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

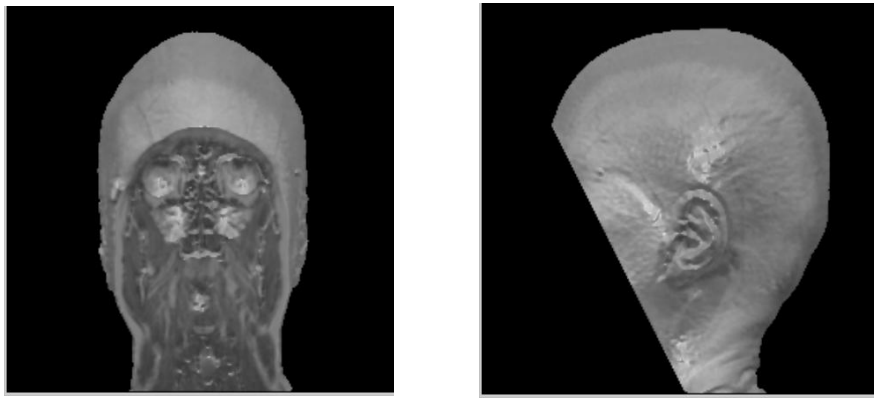
		Brain Mask					
Defacing Method		3dSkullStrip		BET		HWA	
MRI Defacer		408.74	(12)	75271.93	(42)	422.00	(7)
Quickshear	3dSkullStrip	0.00	(0)	5560.76	(13)	0.00	(0)
	BET	0.21	(1)	0.00	(0)	1.00	(2)
	HWA	0.00	(0)	7587.24	(12)	0.00	(0)

Average number of voxels discarded (Number of images with voxels discarded)

Results – Facial Feature Recognition

Defacing Method		Faces detected
MRI Defacer		9
Quickshear	3dSkullStrip	10
	BET	10
	HWA	12

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

- William K. Warren Foundation