Paper # 47, MIDL Conference 2020

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Deblurring for spiral real-time MRI using convolutional neural networks

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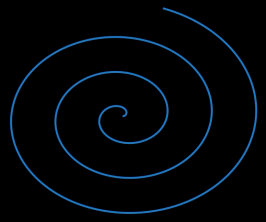
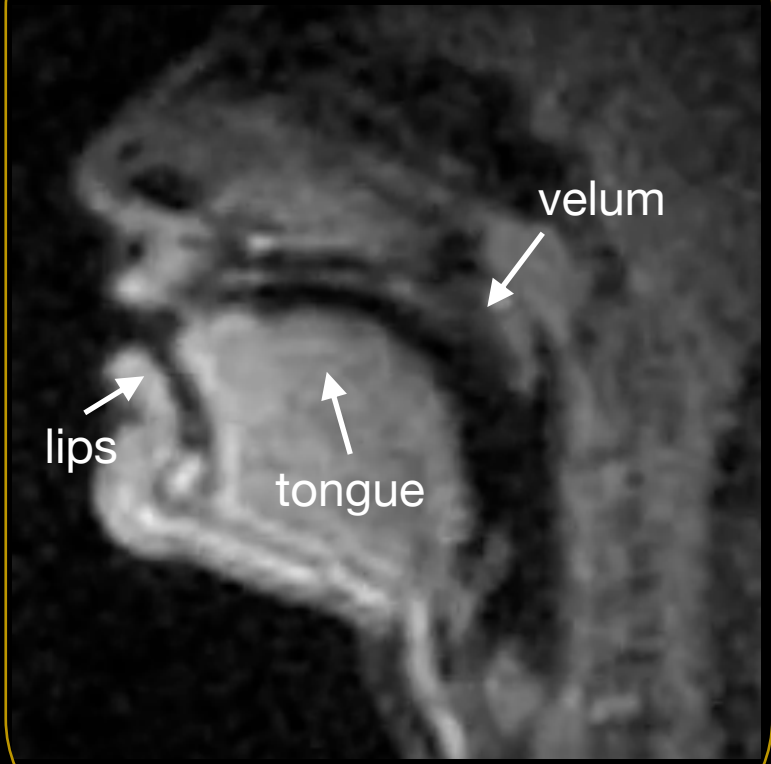


Spiral Real-time MRI

Vocal Tract



Source: USC

Heart

Source: Max Plank BiomedNMR

Joints

Source: Chaudhari Lab, UC Davis

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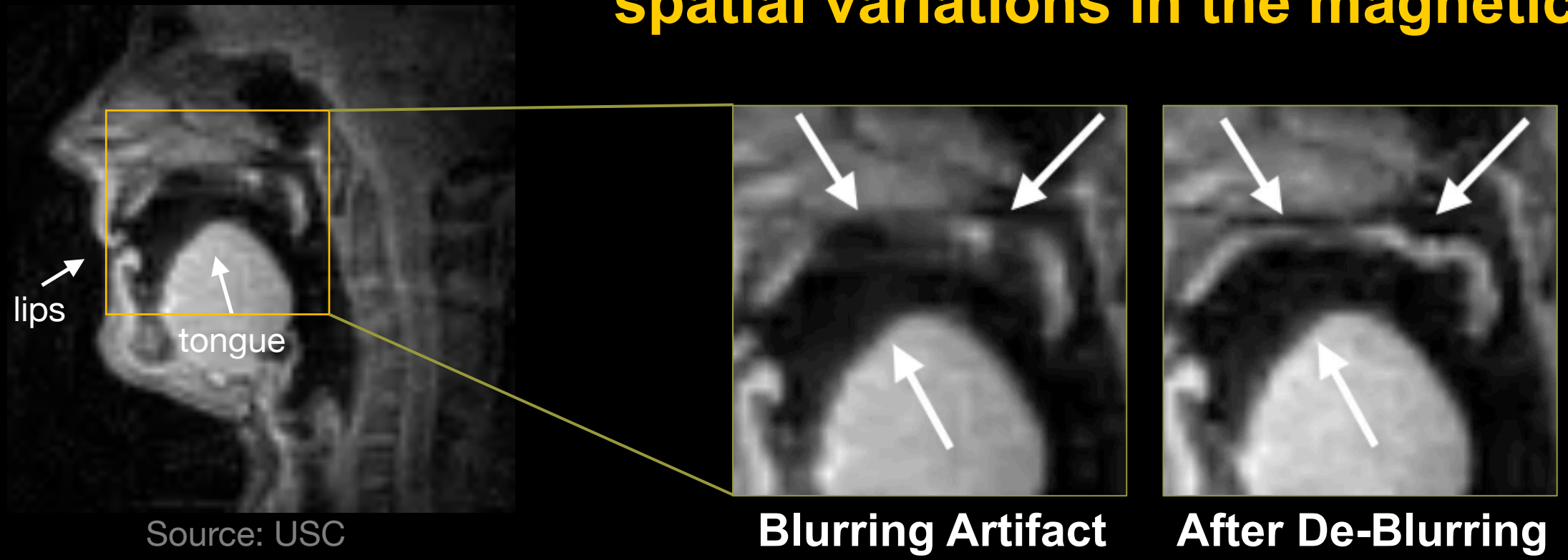
Spiral Real-time MRI

Spatially-varying blur due to spatial variations in the magnetic field



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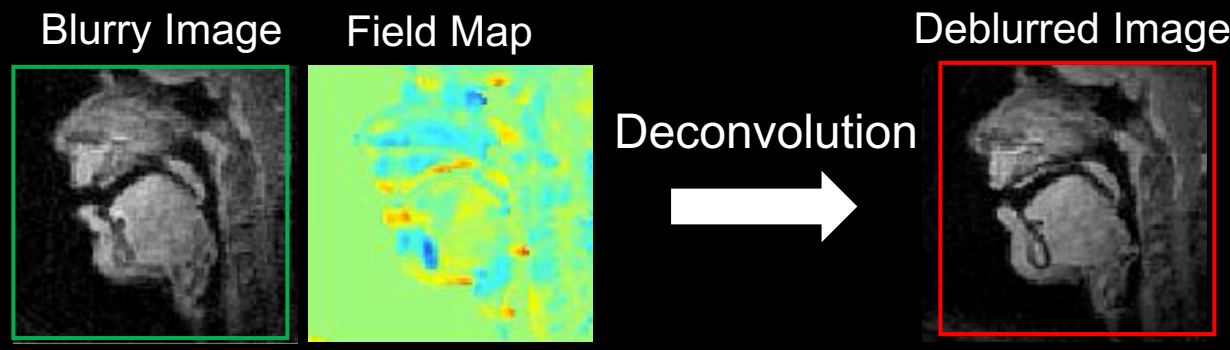
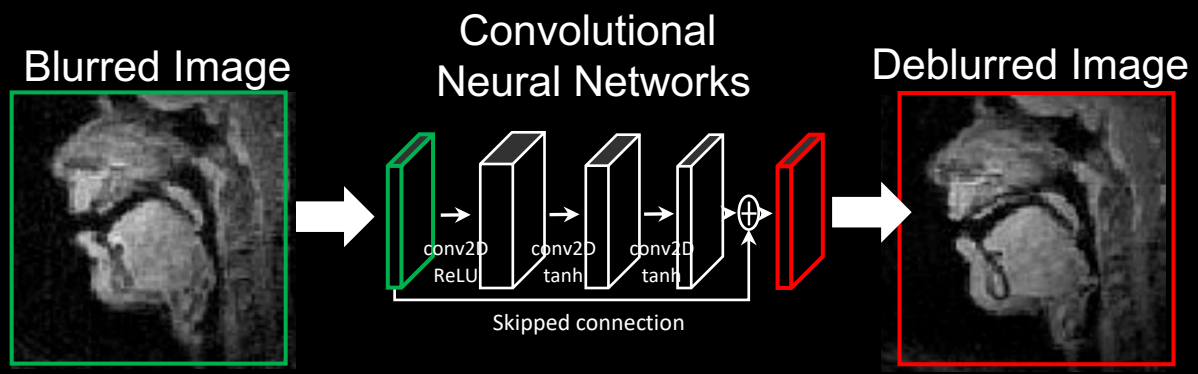
Off-resonance Deblurring

- Standard Approaches[1-4]:



1. Field map acquisition
   - Reduced scan efficiency
2. Spatially-varying deconvolution
   - Computationally slow (~minutes)

- Proposed Approach: A supervised end-to-end learning



In test time
1. Does NOT rely on field map
2. FAST (~milliseconds)

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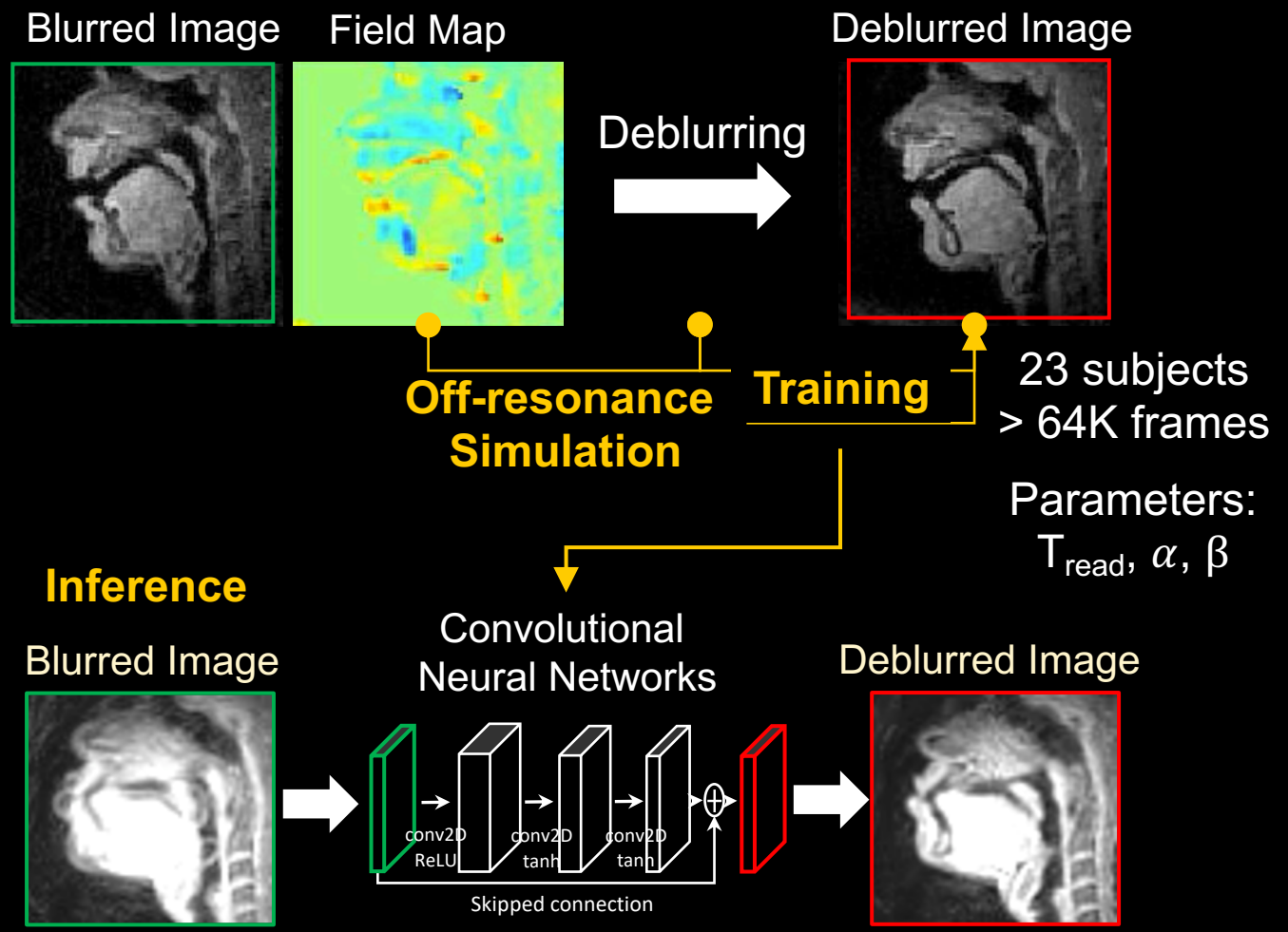
1. KS Nayak et al, MRM. 2001
2. BP Sutton et al, JMRI. 2010
3. Y Lim et al. MRM. 2019
4. DC Noll et al, MRM. 1992

Proposed Supervised Deblurring



Deblur residual blurring using a previous method[1]

Simulate blurring based on MRI physics and data augmentation[2]

Train CNNs

1. Y Lim et al. MRM. 2019
2. Y Lim et al. MRM. 2020

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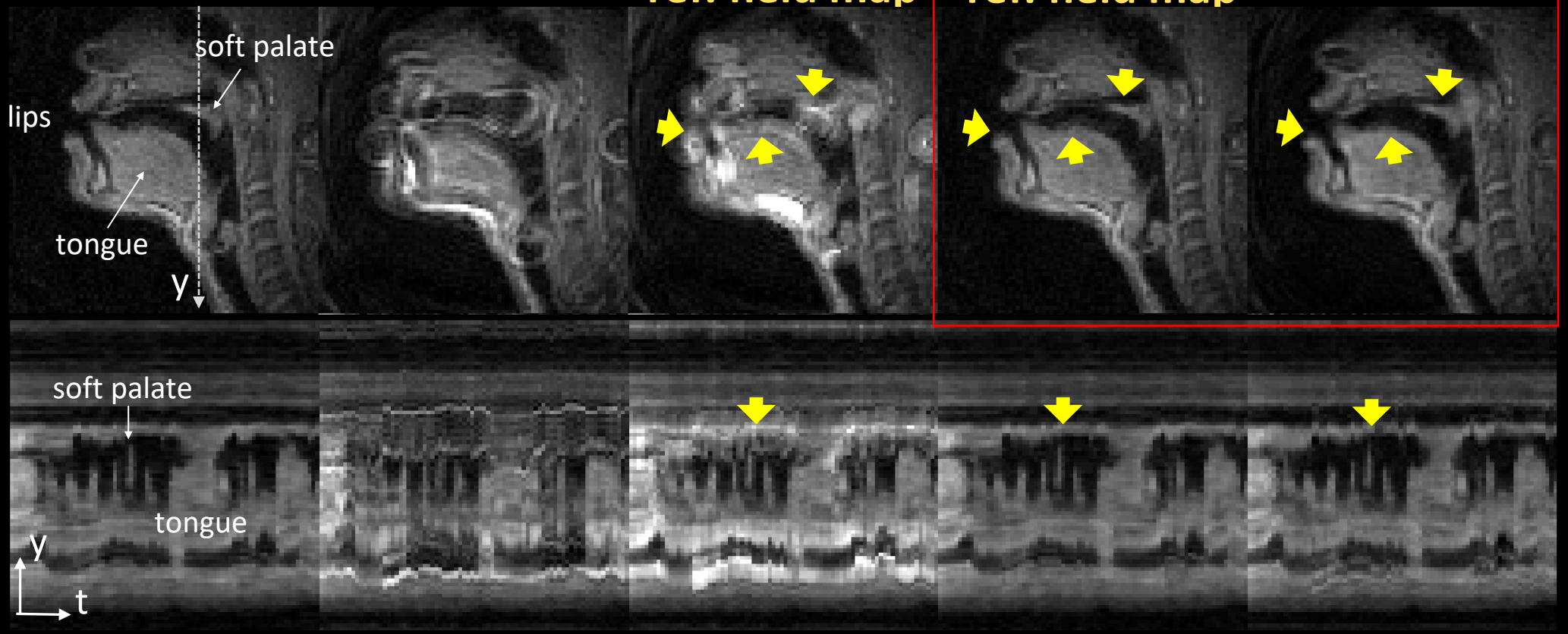
Result: Synthetic Test Data



	Uncorrected	MFI[1] with ref. field map	IR[2] with ref. field map	Proposed
PSNR	22.16 ± 1.413	20.75 ± 1.363	**38.53** ± 1.259	29.30 ± 1.762
SSIM	0.812 ± 0.039	0.875 ± 0.023	**0.992** ± 0.002	0.944 ± 0.016
HFEN	0.568 ± 0.131	0.448 ± 0.113	**0.004** ± 0.003	0.088 ± 0.049

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1. LC Man et al. MRM. 1997 2. BP Sutton et al. MRM. 2003

Result: Real Test Data

Uncorrected

IR with estimated field map[1]

Proposed

Readout = 7.94 ms

Temporal resolution = 46 ms

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1. Y Lim et al. MRM. 2019

Summary

- We develop a CNN-based deblurring method for spiral RT-MRI in speech production.
- It is field-map-free and effective at resolving spatially varying blur at the articulator boundaries.
- It is extremely fast (12.3 ms per-frame) with negligible impact on latency or workflow for RT-MRI applications.

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Thank you for your attention!

If you have any questions, please contact me: yongwanl@usc.edu

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