

Evaluation of Different Strategies for Distortion Correction in Fetal Diffusion-Weighted Imaging

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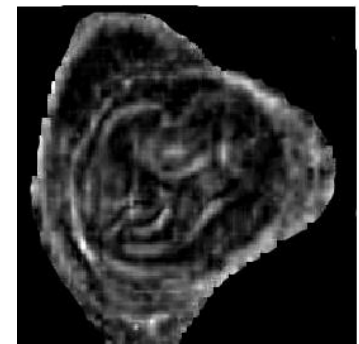
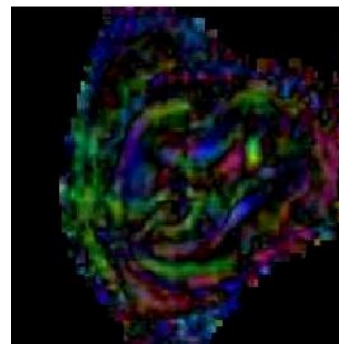
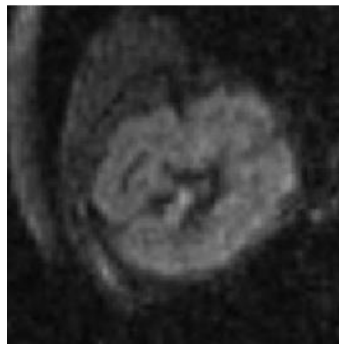
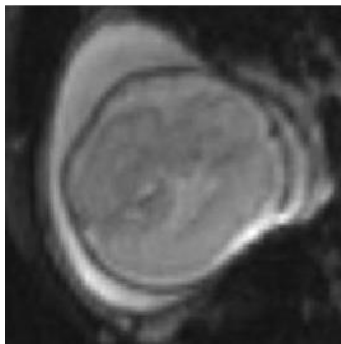
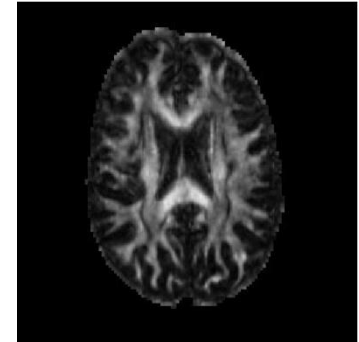
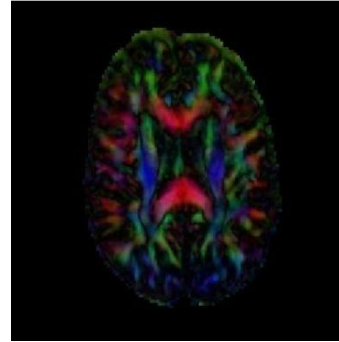
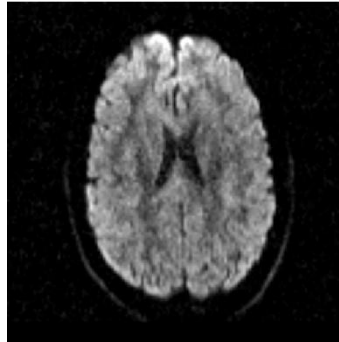
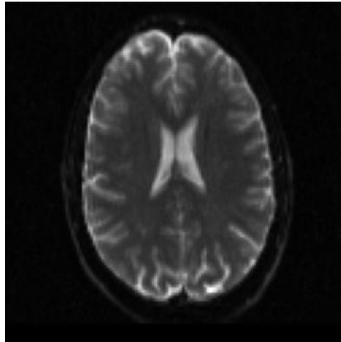
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Distortion correction

- Correction of distortions is a key element in the processing pipeline of D-MRI images.
- This is challenging for the fetus because of:
 1. Fetal motion
 2. Low signal-to-noise ratio (SNR)
 3. Low resolution (compared to the fetal brain size)
 4. Surrounding structures (uterus, placenta, fetal limbs, etc).

What does it look like ?



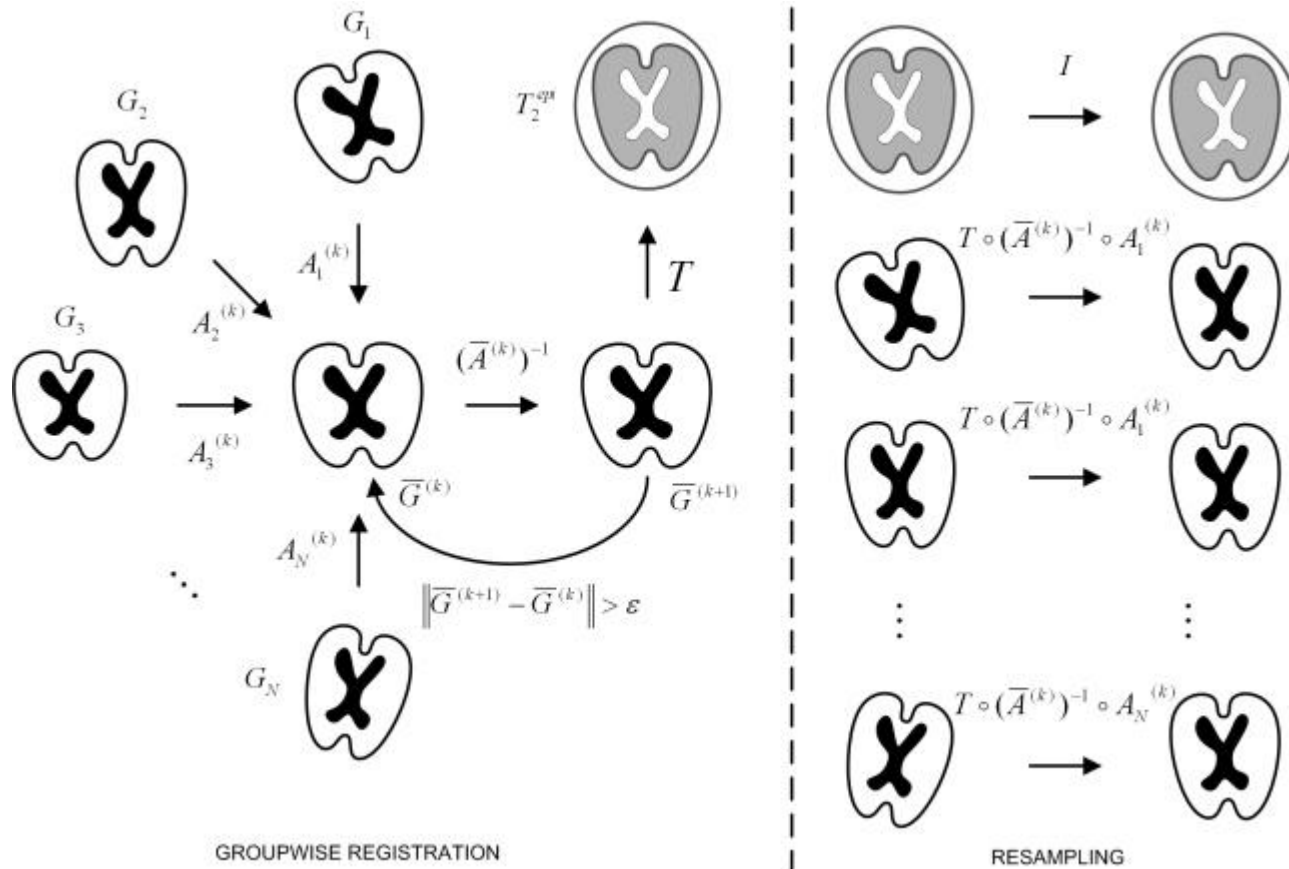
T_2^{epi}

DW_1

FA-Orientation

FA

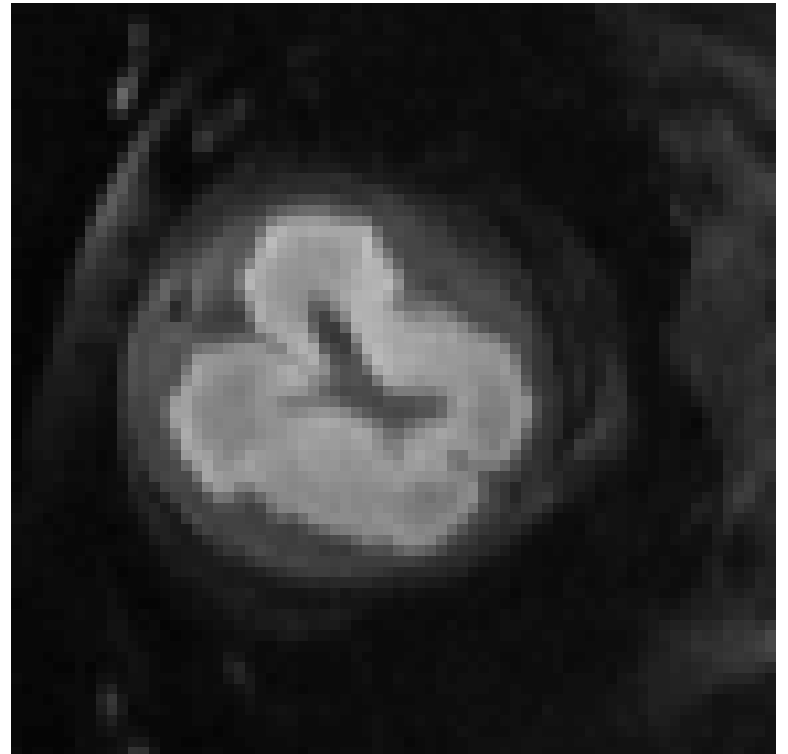
Method



Results (1)



original



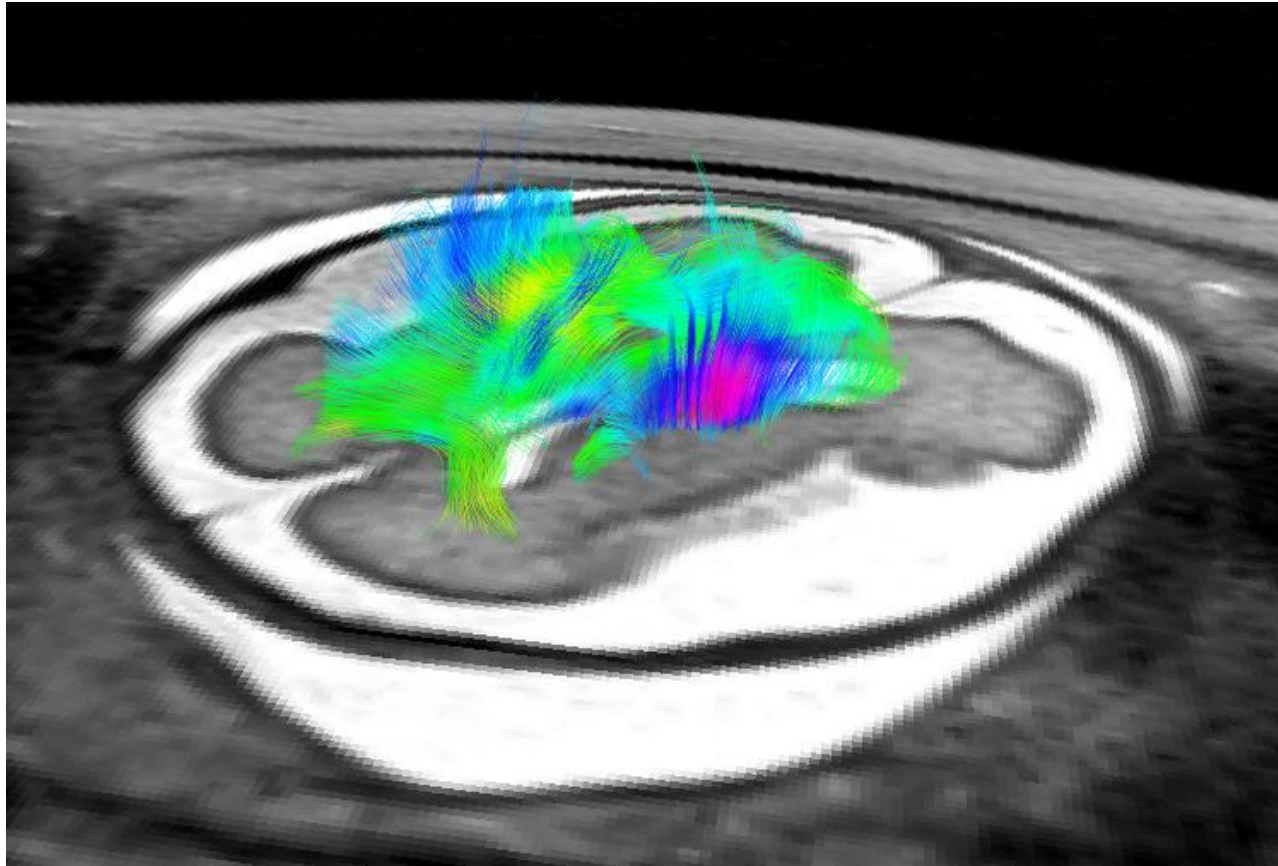
corrected

Results (2)

Table 1: Descriptors of FA distribution for the the evaluated methods on the fetus. $H(FA)$ = Entropy, D_{KL} = Kullback-Leibler divergence, FA_{cfs} = mean FA in the CSF. For each column, the best value is shown in bold. Dashed entries for Fetus #3 mean omitted values because of complete misregistration.

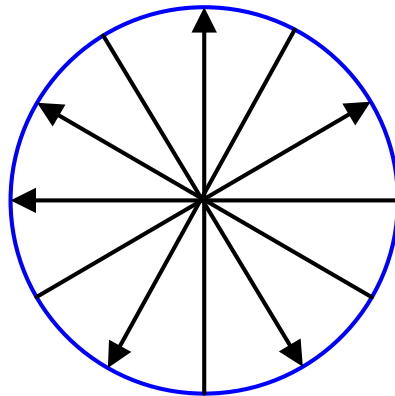
Method	Fetus #1			Fetus #2			Fetus #3			Adult		
	$H(FA)$	D_{KL}	FA_{cfs}	$H(FA)$	D_{KL}	FA_{cfs}	$H(FA)$	D_{KL}	FA_{cfs}	$H(FA)$	D_{KL}	FA_{cfs}
Affine	2.07	0.37	0.09	1.97	0.53	0.19	1.95	0.50	0.18	2.40	1.08	0.09
NRR	2.05	0.58	0.09	1.82	0.58	0.18	-	-	-	2.34	1.26	0.09
Original	2.04	0.48	0.14	2.17	0.14	0.26	2.15	0.21	0.23	2.51	0.52	0.15
Manufacturer	2.11	0.22	0.12	2.09	0.19	0.21	2.20	0.10	0.20	2.46	0.85	0.13
Our approach	1.96	0.59	0.08	1.80	0.87	0.14	1.72	0.96	0.15	2.36	1.24	0.09

Work in Progress

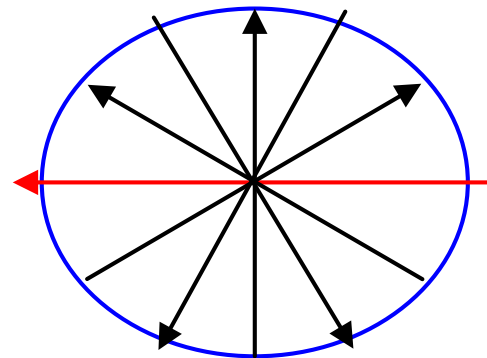


Evaluation (1)

- $mean_{csf}(FA)$
 - It should be zero ideally (isotropic diffusion properties of CSF)
 - Distortion introduces different diffusion values
 - Segmentation required, performed on T_2^{se}

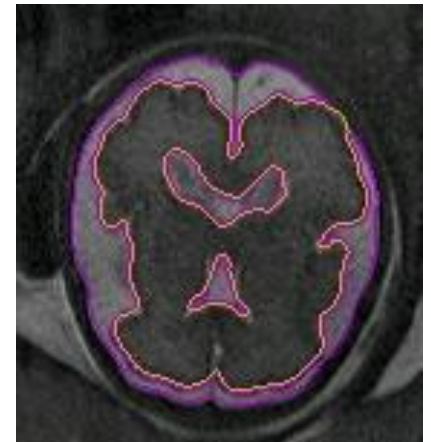


FA=0



FA>0

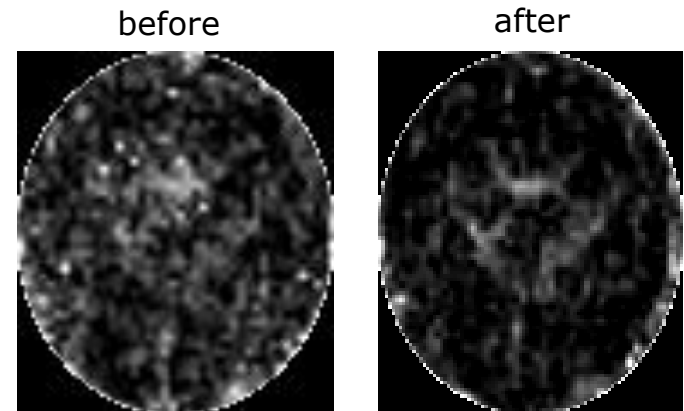
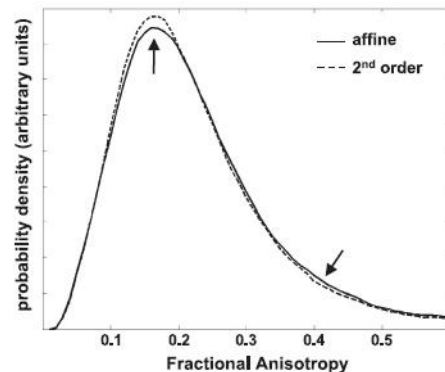
Change in FA
introduced by distortion



Brain and CSF in T_2^{epi}

Evaluation (2)

- $H(FA)$
 - Better registration results present more spiky FA distributions [1]
 - There is an increase in sharpness of FA images after distortion correction [2]



[1] Nielsen, J. F. et al. Affine and polynomial mutual information coregistration for artifact elimination in diffusion tensor imaging of newborns *Magn Reson Imag*, 22(9):1319–1323, 2004.

[2] Netsch, T. and van Muiswinkel, A. Quantitative evaluation of image-based distortion correction in diffusion tensor imaging *Trans Med Imag*, 23(7):789-798,2004.

Evaluation (3)

- $D_{KL}(p(FA) || p_{ref}(FA))$
 - Maximize the distance between $p(FA)$, and $p_{ref}(FA)$ for misaligned sequences

