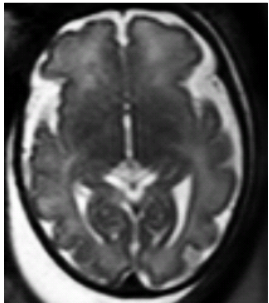
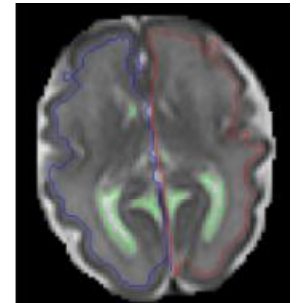

Brain Tissue Segmentation of Fetal MRI

***M. Bach Cuadra¹, M. Schaer^{1,2}, A. André¹,
L. Guibaud³, S. Eliez², and J.-Ph. Thiran¹***



*¹Signal Processing Laboratories (LTS5), EPFL,
²Service Médico-pédagogique, Psychiatry Department, HUG,
³Imagerie pédiatrique et foétale, Hôpital Debrousse, Lyon*



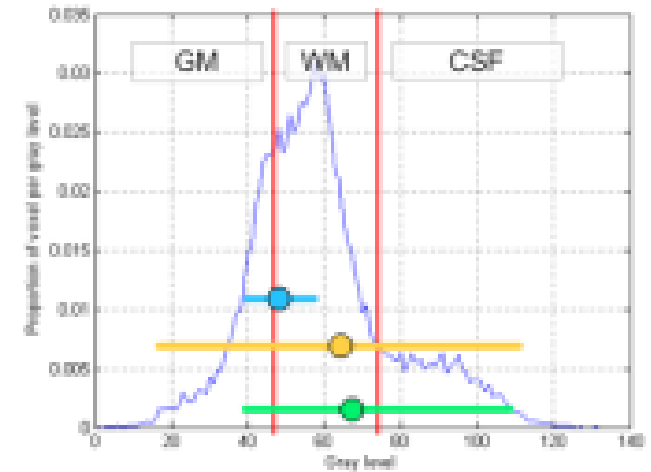
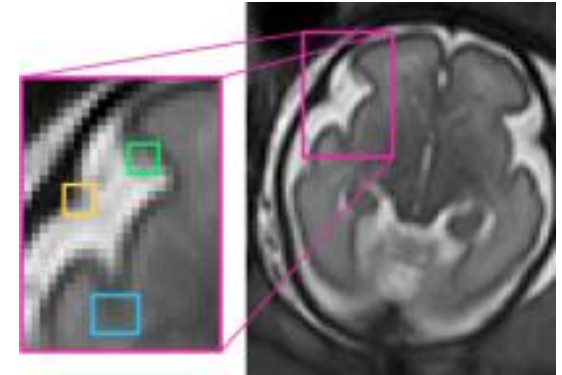
IADB Workshop, MICCAI 2009

Motivation

Goal: Quantitative analysis of cortical surface of the fetus for the study of gyration (brain development)

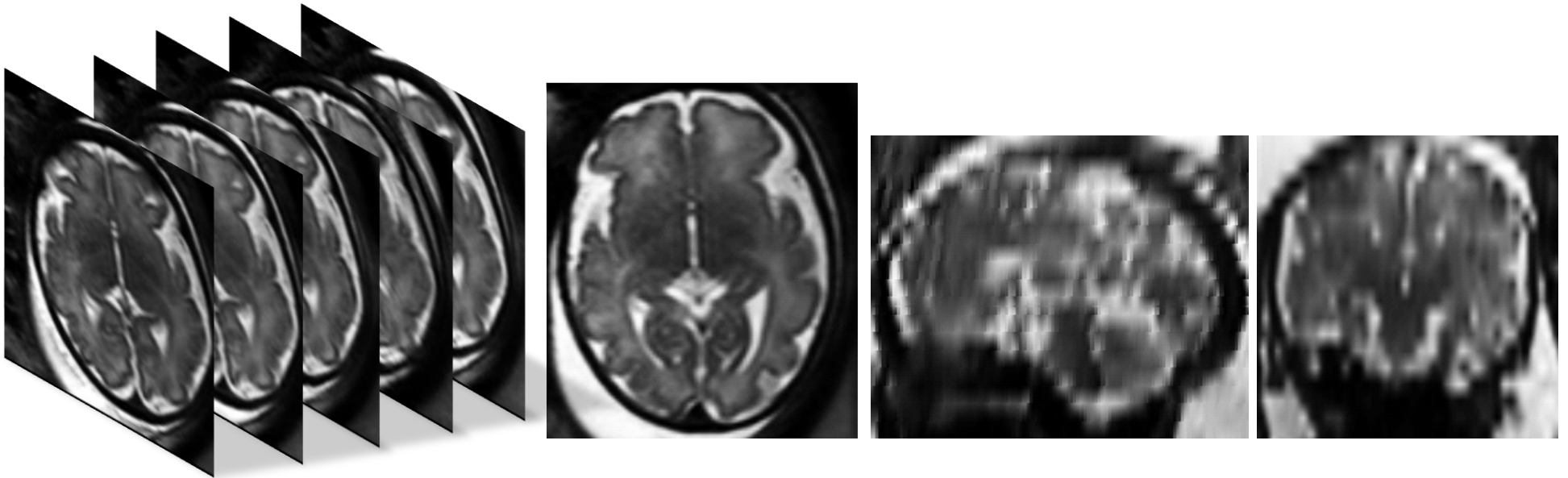
But **current limitations** are:

- * **poor spatial resolution**
- and/or **low SNR** in MR acquisitions due to **fast acquisition**
- * **non-homogeneous** brain tissue (myelination and cortical maturation).
- * **partial volume (PV)**



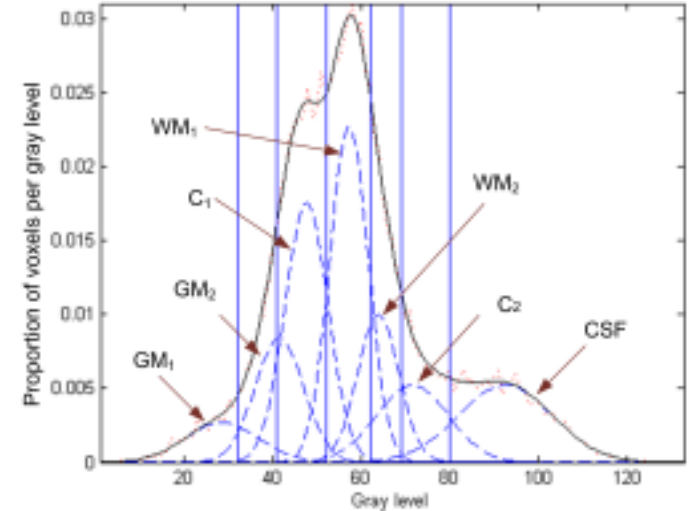
Data set

Prenatal MR images, 1T system (GE), SSFSE sequences (TR 7000 ms, TE 180 ms, FOV 40 x 40 cm, slice thickness 5.4 mm, spatial resolution 1.09 mm). For every study **6 axial volumes are acquired**. 4 subjects of GA of 29, 30, 31 and 32 weeks are used.



Methods and contributions

- 1. Preprocessing:** brain volume segmentation, inhomogeneity intensity correction.
- 1. Image model:** **Finite Gaussian Mixture Model** using 7 Gaussian distributions, 2 for **gray mater** (GM1 and GM2), 2 for **white mater** (WM1 and WM2), 1 for **cerebrospinal fluid**, (CSF) 2 for **transitions** (C1 and C2).



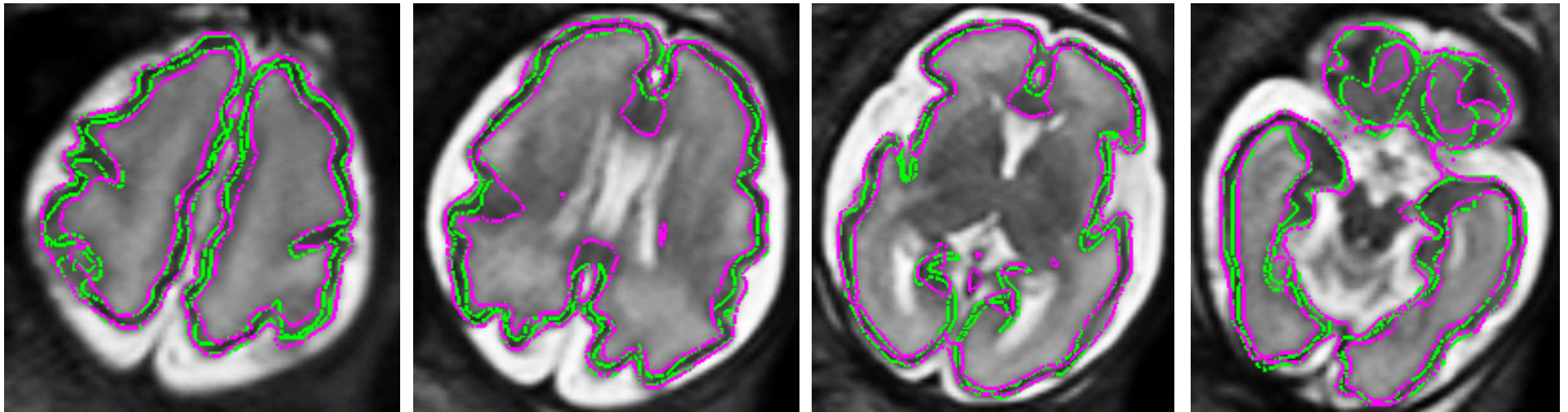
- 3. Spatial distribution model:** **Markov Random Field**

Labelling process to remove C1 and C2 $x'_i = \max_{\forall x \in L} (U_i(x))$

$$\text{where : } U_i(x) = V_i(x_i) + \sum_{j \in N_i} \frac{\delta_n(x_i, x_j)}{d(x_i, x_j)}, n = 1, 2, 3$$

Local MRF depending on distance to the cortex

Preliminary results



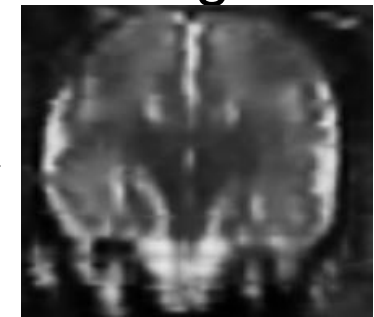
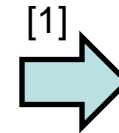
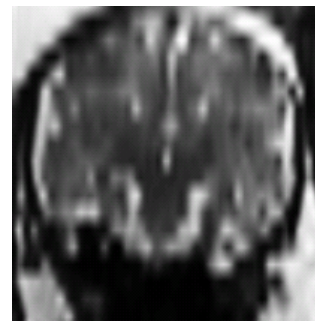
- Contour extracted after statistical classification
- Manual segmented contour

Name (GA)	Case 19 (30)	Case23 (29)	Case 22 (32)	Case20 (31)
DSM on CoGM	0.64	0.68	0.58	0.60
Manual CoGM*	8060	7405	12480	10158
Automated CoGM*	10108	9995	8775	7520

*Volumes in Table are in number of pixels

Discussion (I)

- Preliminary work on brain tissue segmentation for fetus of 29 to 32 weeks of GA
- Automatization of brain volume segmentation
- **Basal ganglia** segmentation
- Pial and outer **surface reconstruction** (Freesurfer)
- **Validation** on different GA's and sequences/scanners
- Including other probabilistic priors: **atlas construction**
- Improved SNR and **high resolution images**: combining the 6 volumes



[1] F. Rousseau et al,
Acad Radiol, Vol. 13, 2006

Original resolution: 5.4 mm

Higher resolution space:
1.09 mm isotropic

Discussion (II)

- Our result
- Freesurfer surface

