[OMTE 2008/2009] GPU speed-up of a 3D Bayesian CT algorithm: reconstruction of a real foam
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Reconstruction with a non-bayesian method

Segmentation obtained

1) Reconstruction step: Updating $f$

Steps of the Iterative method:

- Inverse problem: Getting the object $f$ from the projections data $g$ collected from a cone beam 3D CT:
  \[ g = H f + \epsilon \] (1)

- Prior model: Object $f(r)$ is composed of $K$ regions $R_k$, corresponding to $K$ materials labeled with a hidden variable $z(r)=k$. A Markov/Potts model corresponding to the homogeneity of materials is used for each region $R_k$.
  \[ p(f(r)/z(r)=k) = \mathcal{N}(m_k, \sigma_k) \] (2)

Steps of the Iterative method:

1. Reconstruction step: Updating $f$ by computing $f^{(i+1)} = \arg \max_f \{ p(f|x, \theta, g) \}$. This is done by using a gradient type optimization algorithm:
   \[ f^{(i+1)} = f^{(i)} + \alpha \left[ H^T (g - H f^{(i)}) + \lambda D^T D f^{(i)} \right] \] (3)

2. Segmentation step: Updating $z$ by generating a sample from $p(z|f, x, g)$ with a sampling algorithm from a Potts-Markov model.

3. Characterization step: Updating the hyperparameters using $p(\theta|f, z, g)$.

2) Segmentation step: Updating $z$

A Gaussian model corresponding to the compactness of materials is used for $z$. It’s a Markov/Potts model corresponding to the homogeneity of materials.

Beyond limitations: Parallelization on a 8 GPUs server has allowed us to go beyond the computing time limitations.

3) Characterization step: Updating the hyperparameters using $p(\theta|f, z, g)$.

A Markov/Potts model corresponding to the compactness of materials is used for $z$. It’s a Gaussian model corresponding to the homogeneity of materials.

Reconstruction time on a GTX 295 ($96 \times 256^3$ data):

- Projector: 755 ms (128 ms for CPU/GPU memory transfer)
- Backproector: 234 ms (133 ms for CPU/GPU memory transfer)

On GPU, we reach a two orders of magnitude acceleration.

Reconstruction time on a GTX 295 ($96 \times 256^3$ data):

- Projector: 755 ms (128 ms for CPU/GPU memory transfer)
- Backproector: 234 ms (133 ms for CPU/GPU memory transfer)

5 Future works:

- Optimization of our Gauss/Markov/Potts method
- Optimization of the GPU memory transfer
- Parallelization on the 8 GPU server of other operators (3D convolution, Potts sampling...)
- Semi automatic setting of the regularization parameters
- Technologic transfer with an industrial partner