Gaussian Process Interpolation for Uncertainty Estimation in Image Registration

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1. Introduction

Image registration technics are widely used in computer vision. It has been shown that interpolating the image's pixels can help to have a more accurate measure when we want to find the pic of similarity [1]. The paper of Wachinger *et al.* [2] focuses on a new way to interpolate the images, leading to a new similarity measure that takes into account the incertainty of the interpolation.

2. Method

The method is decomposed into three main steps :

1. A prediction of the interpolation of the image J is done with a prior gaussian process on the resampled image J^*.
2. The optimal registration is generated using a bayesian approach with a multivariate Gaussian Likelihood and the prediction of the gaussian process on J^*.
3. Reduction of the computationnal cost for 3D volumes and creation of a new uncertainty estimate (not based on $\mathcal{GP}$) to compare the experiments.

From item 2., they derived a new similarity measure taking into account the uncertainty estimates (thanks to the $\mathcal{GP}$ of item 1.). Finally, they compare there new similarity with the new interpolation to the gold standard interpolation (NN, linear, spline, cubic).

3. Experimentation

I plan to code and run the program using MATLAB. After reading and understading all the paper, I will download the database of patent from the available database BrainWeb and RIRE. I will constrain my work in the registration of 2D images. I will compute the boxplots (with a statistical analysis) to evaluate the impact of the interpolation, the new similarity measure and the gold standard. To extend their work, it can be interesting to invest other kernels for the $\mathcal{GP}$ and the impacts of its parameters. Maybe the use of an EM algorithm or variationnal bayesian on item 2. can be used to improve the accuracy of the similarity measure.

References

[1] D. L. Hill, P. G. Batchelor, M. Holden, and D. J. Hawkes. Medical image registration. *Physics in medicine and biology*, 46(3):R1, 2001.

[2] C. Wachinger, P. Golland, M. Reuter, and W. Wells. Gaussian process interpolation for uncertainty estimation in image registration. In *Medical Image Computing and Computer-Assisted Intervention–MICCAI 2014*, pages 267–274. Springer, 2014.