

Post-Doctoral Fellowship: Variance reduction technique and GPU-based Monte Carlo simulation

Scientific context

Monte Carlo simulations (MCS) are using random sampling methods for solving physical and mathematical problems. They play a key role in medical applications, especially in radiotherapy by accurately modeling the different physical processes and interactions between particles and matter (tissues). However, MCS are also associated with long execution times, which is one of the major issues preventing their use in routine clinical practice for dosimetry applications. A solution to the intensive computational issues of MCS can be based on the use of graphics processing units (GPU) [Bert2013]. For example, in prostate brachytherapy context, a complete treatment can be simulated in few seconds [Lemaréchal2016]. However, in case of MCS-based treatment planning system where thousand of optimization steps are required, GPU-based simulations are still not fast enough. There are techniques, called variance reduction techniques, that allow speeding up the simulations.

Job description and missions

The aim of this project is to propose a new variance reduction technique fully adapted to GPU architecture. By combining hardware accelerated system and new algorithm, the dose calculation should be quasi real-time. The hired postdoc will evaluate and develop the new variance reduction technique into the GPU-based MCS platform named GGEMS (platform developed by our team). A treatment planning system using the final GGEMS dose engine will be proposed and evaluated against a standard clinical system. Evaluation will be performed in a brachytherapy context using simulated, experimental and patients' data.

Profile

We look for a candidate with a PhD in computer sciences, control engineering, applied mathematics. Good programming skills is an important requisite. Autonomy, open-mindedness and motivation, as well as good English speaking/writing skills, are also expected.

Position context

The postdoc will join the Laboratory of Medical Information Processing (LaTIM, Brest, France) in the team "Action Thérapeutique guidée par l'Imagerie multimodale en ONcologie" (ACTION, INSERM, UMR1101). The position will be for an initial duration of two years and could be renewable. Salary is about 2000-2200 € net/month, depending on the candidate's experience.

Contact and additional information

For application, a folder that contains a CV, a motivation letter, a resume of the thesis, a complete list of publications, as well as letters of recommendation, have to be sent to the following e-mails:

Julien Bert (julien.bert@univ-brest.fr)

Dimitris Visvikis (dimitris@univ-brest.fr)

[Bert2013] Bert, J., Perez-Ponce, H., El Bitar, Z., Jan, S., Boursier, Y., Vintache, D., Bonissent, A., Morel, C., Brasse, D., Visvikis, D., 2013. Geant4-based Monte Carlo simulations on GPU for medical applications. *Phys. Med. Biol.* 58, 5593–5611.

[Lemaréchal 2016] Lemaréchal, Y., Bert, J., Falconnet, C., Després, P., Valeri, A., Schick, U., Pradier, O., Garcia, M.-P., BouSSION, N., Visvikis, D., 2015. GGEMS-Brachy: GPU GEant4-based Monte Carlo simulation for brachytherapy applications. *Phys. Med. Biol.* 60, 4987–5006.