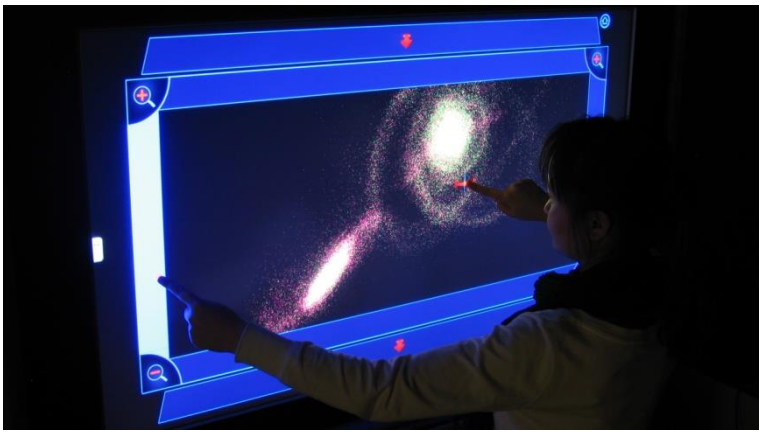
PhD Project Proposal:

Interactive 3D Data Registration for Proton Therapy using Touch-Based Interfaces



Direct-touch interfaces have recently become a popular way of interacting with computers. However, in scientific visualization and medical applications only few approaches, thus far, have been explored (e.g., see example on the right). While touch-based interfaces have shown to have advantages over traditional input devices in various studies, these advantages have still to be shown to be useful in practice such as in the medical domain. For this purpose this project will investigate the use of touch-based interaction with 3D data in a medical context with a direct practical application. Specifically, the goal is to develop an interaction approach for the manual registration of different medical images in the context of proton therapy.

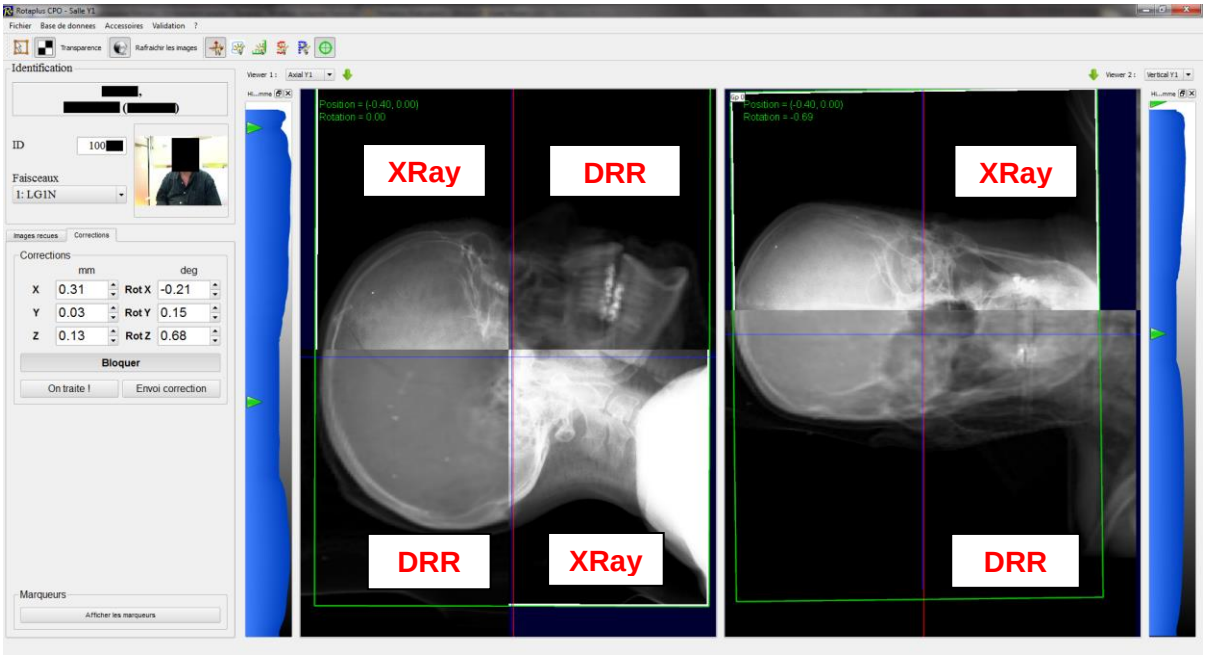
The work will be carried out as a collaboration between Inria and the ICPO (Institut Curie - Centre de Protonthérapie d'Orsay). Being part of the Radiation Oncology Department of the Institut Curie, the ICPO has been treating patients since 1991 and was the first high energy proton therapy facility in France. The proton therapy is a discipline of radiotherapy consisting in treating cancers by irradiating the tumor with proton beams. Proton beams have several accuracy advantages compared to standard photon irradiation and are of much interest for pediatric cancers and for some very badly localized tumors (close to organ at risk like in head and neck cancers).

The challenge of this interaction project is that proton beams are very precise tools and thus imply an extra need of accuracy in setting the patient at the right position in 3D in front of the beam line. The tolerances for positioning the patient in proton therapy are 1.5mm for all 3 directions and 1.5° for all 3 rotation axes of space. In order to position a patient with this accuracy, we use X-Ray imaging matching. The preparation process includes a manual registration of the patient's real radiologic 2D orthogonal images to digitally reconstructed 2D radiographs (DRR) which represents how the patient will look at the treatment position. This registration tells the therapist whether a patient is correctly positioned in space (within the 1.5mm & 1.5° tolerances) or if the position needs to be corrected. Currently, this registration is done manually by the therapist using the mouse of the software's computer.

The goal of this project is to improve the proton therapy healthcare my benefiting from the new touch-based interaction technologies. We want to allow the therapist to grab the 3D data and control its location, orientation, and scale with respect to the captured X-Ray images to match them manually and accurately to their DRRs, with the speed and intuitiveness of the touch technologies.

At the same time, the challenge is to overcome the inherent precision problems of touch input, as well as to address the challenge of interacting in 2D space while manipulating 3D data.

Using interaction technology developed in the past by Inria researchers and others, the goal is to investigate how the interactive data registration can best be realized. Because the intention is a practical application of the developed techniques, the student has the responsibility of integrating the touch panel capabilities in the current image registration software (Rotaplus; C++, Qt libraries, Visual Studio development software). In addition, the research will be carried out in close collaboration with the therapists of the treatment rooms in order to propose the more intuitive and efficient tools for matching the patient accurately and fluently during the treatment workflow.



The current registration software: Rotaplus.
Left & Right views of the patient's real XRays registered on their consistent DRRs.

Required applicants skills

- highly motivated student
- Master's degree (M.Sc., M. Eng, or equivalent) in computer science or closely related fields
- education background in one or more of the following fields: visualization, human-computer interaction, computer graphics, and machine learning
- interest in applications in neuroimaging and/or in knowledge discovery
- previous experience in these fields (in particular, neuroimaging) would be highly beneficial (evident, for example, in form of publications)
- experience in modern computer graphics (GPU) programming
- fluent in written and spoken English (French language skills are not required but would be beneficial for living in France and interacting with people outside of the lab)
- previous experience in research and publication of research results beneficial

Application package (to be prepared in English)

- detailed CV (including education, degrees and dates, publications/scientific presentations, skills/experiences in programming languages, project work, academic awards, …)
- motivation letter explaining why you apply specifically for this project and why you are the perfect candidate
- summary of the Master's thesis
- transcript of the grades from the Master's degree
- contact details for two academic references
- **prepare all application documents electronically and in English** (transcripts do not need to be translated, these are sufficient in the native language)
- send **a link** (e.g., though DropBox, Box, OneDrive, or similar services) to the application file (**one big PDF file** named **familyname_givenname.pdf**) by e-mail to Tobias Isenberg <tobias.isenberg@inria.fr>

Deadlines:

- **application deadline**: applications are reviewed as they are received; however, for full consideration please submit your application by **August 1, 2016**
- starting date: October 1, 2016 or later

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