El Ganaoui Omar

Projet VisAGeS – U746 (INSERM\IRISA)
Faculté de Médecine
2 Av du Prof Léon Bernard-CS34317
35043 Rennes cedex
E-mail : omar_elganaoui@yahoo.fr
omar.elganaoui@irisa.fr
Tel : 06 12 99 26 05

FORMATION :

Depuis Novembre 2005 : Doctorant au sein de l'unité/projet U746, INSERM/INRIA, VisAGes (**IRISA/Fac de médecine)** sur le sujet de thèse : « *Modèles numériques et symboliques pour l'optimisation des procédures neurochirurgicales guidées par l'image* »

2004-2005 : Master MVA au CMLA (Centre de **M**athématiques et **L**eurs **A**pplications**), École Normale Supérieure de Cachan, Mention Bien.**

2003-2004 : DEA en Mathématiques et Informatique à l'INPG, spécialité Recherche Opérationnelle et Optimisation Combinatoire.

2002-2003 : Maîtrise de Mathématiques, option maths appliquées, **Mention AB.**

2000-2002 : Licence de Mathématiques, option maths appliquées.

1998-2000 : DEUG de Mathématiques et de Physique.

1997-1998 :Baccalauréat série S, Sciences mathématiques, Mention AB.

EXPERIENCES PROFESSIONNELLES :

- **Mai-Octobre 2005 : Stage de 6 mois à GE Healthcare (BUC)**
  Sujet : Présentation d'images en **mammographie** numérique pour des seins avec implants mammaires.
  Rapport : confidentiel propriété à GE
- **Mars-Septembre 2004 : Stage de 6 mois à l'INRIA Rocquencourt**
  Sujet : La prise en compte du coût de la préemption dans les conditions d'ordonnançabilité temps réel pour le cas monoprocesseur.

ENSEIGNEMENTS :

- **Travaux Dirigés (~24h TP) en optimisation et aide à la modélisation**, 1ère année du cycle ingénieurs au sein de l'école d'ingénieurs « Louis de Broglie» **2007/2008**

- **Interrogateur** en **maths\informatique** (~**52h TP**) pour des classes préparatoires HEC au lycée Chateaubriand **2007-2008**

- **Cours Magistraux** (~**20h TP**) en **statistiques appliquées**, formation licence professionnelle DRACI (Développement, Recherche en Arts Culinaires Industrialisés), **2006-2007**

- **Interrogateur** en **maths\informatique** (~**56h TP**) pour des classes préparatoires HEC au lycée Chateaubriand **2006-2007**

- **Professeur Cours Legendre** en maths, niveau supérieure (IUT, Classes préparatoires,... (~**86**Heures)) (**2004-2008)**

COMPETENCES :

- Deux années d'expériences en **systèmes de neuronavigation** (**Medtronic**) et application en neurochirurgie guidée par l'image

- Mathématiques, Statistiques et **Modélisation** appliqué en médecine

- Traitement d'**images médicales** et apprentissage

DEVELOPPEMENT LOGICIELS :

- **2006/2007 : Logiciel DBSurg ,** pour l'enregistrement des données cliniques et le traitement des informations dans le cadre des **procédures neurochirurgicales** .
- **Octobre 2005 :** Application pour la visualisation numérique des seins avec implants mammaires dans le cadre du stage à **GE Healthcare**
- **Decembre 2004 :** Algorithme de segmentation dans la bibliothéque BETI (ENST)

INFORMATIQUE :

- Programmation **C**, C++, **Python** et développement Web en **PhP** et gestion de base de données en **SQL** (gestion de données médicales)

- Développement en visualisation (**VTK**) appliquée aux données médicales (**IRM**, ...)

- Logiciels : **Matlab**, **IDL**, ...

LANGUES :

Parlé lu et écrit : Français, Anglais

DIVERS :

- **2ème** prix d'innovation aux Doctoriales Internationales de Bretagne (Vannes-Québec) **2007**
- **Président** de l'association LUCA des doctorants de l'école doctoral VAS (**2006/2008**)
- **Vice-président** du réseau BioTechno, co-organisateur de BioTechno Nantes **2006**
- **Représentant** des doctorants au conseil de l'école doctorale VAS (**2006/2008**)
- **Membre** du conseil d'insertion de VAS (**2006/2008**)
- **Sport :** Musique, Natation, Squash …

FORMATIONS DOCTORALES:

- ✓ **Doctoriales-Bretagne 2007 (Palais des Arts de Vannes) (18-23 Novembre 2007)**
- ✓ **Intégration professionnelle (ED Matisse) (3 jours, Avril 2006)**
- ✓ **Journée Docteurs Entreprise (1 jour, Décembre 2005)**
- ✓ **Journées nationales des ARC (2 jours, Octobre 2007)**
- ✓ **Cours Master SIBM (3 jours, Décembre 2006)**
- ✓ **Formation Anglais (ED Matisse) (8 jours Avril/Juin 2007)**
- ✓ **Communication Scientifique en Anglais (IRISA 3 jours Septembre 2006)**

PUBLICATIONS :

- **O. El Ganaoui**, X. Morandi, S. Duchesne, P. Jannin. Preoperative Brain Shift: Study of Three Surgical Cases. In **SPIE Medical Imaging 2008**: Visualization, Image-guided Procedures, and Modeling. San Diego, California, USA, February **2008**, to appear.
- C. Barillot, P. Coupé, **O. El Ganaoui**, B. Gibaud, P. Hellier, P. Jannin, P. Paul, S. Prima, N. Wiest- Daesslé, X. Morandi. Image guidance in neurosurgical procedures, the Visages point of view. In IEEE International Symposium on Biomedical Imaging: From Nano to Macro, **ISBI'2007**, Pages 1056-1059, Washington, États-Unis, Avril **2007.**
- **O. El Ganaoui.** Image presentation in digital mammography with implant. Master Thesis Ecole Normale Supérieure de Cachan **ENSC** and **GE Healthcare**, October **2005**.
- **O. El Ganaoui**. Preemptive real-time systems with precedence and periodicity constraints in monoprocessor case: scheduling algorithm with preemption conditions. Master Thesis **INRIA Rocquencourt**, **September 2004**.

IEEE International Symposium on Biomedical Imaging: From Nano to Macro, ISBI2007

IMAGE GUIDANCE IN NEUROSURGICAL PROCEDURES, THE "VISAGES" POINT OF VIEW

*C. Barillot, P. Coupé, O. El Ganaoui, B. Gibaud, P. Hellier, P. Jannin, P. Paul, S. Prima, N. Wiest-Daesslé, X. Morandi**

INSERM U746, VisAGeS Unit/Project, Campus de Beaulieu, 35042 Rennes Cx, France
INRIA, VisAGeS Unit/Project, Campus de Beaulieu, 35042 Rennes Cx, France
University of Rennes I, UMR CNRS 6074, IRISA, Campus de Beaulieu, 35042 Rennes Cx, France
*CHU Rennes, rue H. le Guillou, 35043 Rennes Cx, France

ABSTRACT

This paper gives an overview of the evolution of clinical neuroinformatics in the domain of neurosurgery. It shows how image guided neurosurgery (IGNS) is evolving according to the integration of new imaging modalities before, during and after the surgical procedure and how this acts as the premise of the Operative Room of the future. These different issues, as addressed by the VisAGeS INRIA/INSERM U746 research team (http://www.irisa.fr/visages), are presented and discussed in order to exhibit the benefits of an integrated work between physicians (radiologists, neurologists and neurosurgeons) and computer scientists to give adequate answers toward a more effective use of images in IGNS.

Index Terms— Medical Imaging, Image Guided Neuro-Surgery, Intraoperative Ultrasound, Magnetic Resonance Imaging, Diffusion Tensor Imaging, Image Registration, Surgical Workflows

1. INTRODUCTION

In the last decade, it has become increasingly common to use image-guided navigation systems to assist surgical procedures with medical images. Benefits have been reported for accuracy improvement, reduction of intervention time, improvement of quality of life, reduction of morbidity (and perhaps mortality), reduction of intensive care and hospital costs. Image-guided systems are used today to help the surgeon to plan the surgery and provide accurate information about anatomy and function during the intervention. Image-guided systems also enable minimally invasive interventions, since the intraoperative images can be used interactively as a guide.

Image guided neurosurgical procedures rely on complex preoperative planning and intraoperative environment. This includes various multimodal examinations: anatomical, vascular, functional explorations and an increasing number of computer-assisted systems taking place in the Operating Room. Hereto, using an image-guided surgery system, a rigid fusion between the patient's head and the preoperative data is preformed. With an optical tracking system and Light Emitting Diodes (LED), it is possible to track the patient's head, the microscope and the surgical instruments in real time (**Erreur ! Source du renvoi introuvable.**). The preoperative data can then be merged with the surgical field of view displayed in the microscope. This fusion is called "augmented reality".

Unfortunately, the assumption of a rigid registration between the patient's head and the preoperative images only holds at the beginning of the procedure as soft tissues tend to deform during the intervention. This is a common problem in many image-guided interventions, the particular case of neurosurgical procedures can be considered as a representative case. Brain shift is one manifestation of this problem but other tissue deformations can occur and must be taken into account for a more realistic predictive work.

To do so, one can perform biomechanical modeling of brain tissue deformation according to the prediction of occurring forces during surgery (e.g. [1]). Another possibility is to deform the anatomical and functional images according to the estimated deformation. Hereto, intraoperative imaging is required. Whereas intraoperative MR has been used for image guided neurosurgery, this is a high cost and rather bulky solution [2-4]. Recently, 3D ultrasound (3DUS) was introduced as a possible intraoperative modality for neurosurgery [5-10]. This modality hardly affects the operating room logistics and is therefore easily accepted by the neurosurgeons. First results have shown the capacity of 3D intraoperative ultrasound to compensate for brain shift [11, 12].

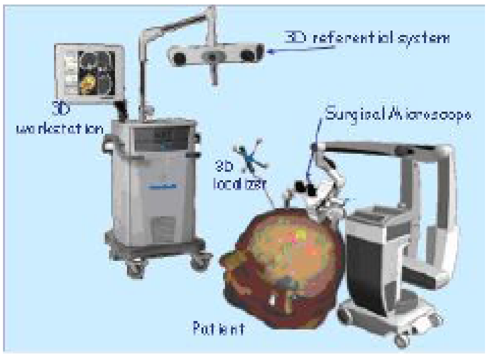

Fig. 1: Principle of Image guided neurosurgical procedures using a neuronavigation system

Preoperative Brain Shift: Study of Three Surgical Cases

O. El Ganaoui[a,b,c], X. Morandi[a,b,c,d], S. Duchesne[b,e], P. Jannin[a,b,c]

[a]INRIA, VisAGeS Project-Team, F-35042 Rennes, France
[b]INSERM, U746, F-35043 Rennes, France
[c]University of Rennes I, CNRS, UMR 6074, IRISA, F-35042 Rennes, France
[d]Hospital of Rennes, Department of Neurosurgery, F-35033 Rennes, France
[e]Centre de Recherche de l'Université Laval - Robert Giffard, 2601 De La Canardière Beauport QC G1J 2G3

ABSTRACT

In successful brain tumor surgery, the neurosurgeon's objectives are threefold: (1) reach the target, (2) remove it and (3) preserve eloquent tissue surrounding it. Surgical Planning (SP) consists in identifying optimal access route(s) to the target based on anatomical references and constrained by functional areas. Preoperative images are essential input in Multi-modal Image Guided NeuroSurgery systems (MIGNS) and update of these images, with precision and accuracy, is crucial to approach the anatomical reality in the Operating Room (OR). Intraoperative brain deformation has been previously identified by many research groups and related update of preoperative images has also been studied. We present a study of three surgical cases with tumors accompanied with edema and where corticosteroids were administered and monitored during a preoperative stage $[t_0, t_1 = t_0 + 10 \text{ days}]$. In each case we observed a significant change in the Region Of Interest (ROI) and in anatomical references around it. This preoperative brain shift could induce error for localization during intervention (time t_S) if the SP is based on the t_0 preoperative images. We computed volume variation, distance maps based on closest point (CP) for different components of the ROI, and displacement of center of mass (CM) of the ROI. The matching between sets of homologous landmarks from t_0 to t_1 was performed by an expert. The estimation of the landmarks displacement showed significant deformations around the ROI (landmarks shifted with mean of 3.90 ± 0.92 *mm* and maximum of 5.45 *mm* for one case resection). The CM of the ROI moved about 6.92 *mm* for one biopsy. Accordingly, there was a sizable difference between SP based at t_0 *vs* SP based at t_1, up to 7.95 *mm* for localization of reference access in one resection case. When compared to the typical MIGNS system accuracy (2 *mm*), it is recommended that preoperative images be updated within the interval time $[t_1, t_S[$ in order to minimize the error correspondence between the anatomical reality and the preoperative data. This should help maximize the accuracy of registration between the preoperative images and the patient in the OR.

Keywords: Neurosurgical Procedures, Brain Shift, MIGNS, Surgical Workflow.

1. INTRODUCTION

This study is set within the context of brain tumor surgery. In this paper, we demonstrate the necessity to update preoperative images in order to allow the recovery of registration error for Multi-modal Image Guided Neurosurgery (MIGNS) systems due to a phenomenon that we call preoperative brain shift. In successful surgery, the neurosurgeon's objectives are threefold: (1) reach the target, (2) remove it and (3) preserve eloquent tissue surrounding it. Surgical Planning (SP) consists in identifying optimal access route(s) to the target based on anatomical references and constrained by functional areas.[1,2] MIGNS systems have been developed and are being used to help reach these objectives. A key component of MIGNS is the accurate registration of preoperative images to the intraoperative coordinate system of the patient.[3] The first registration step consists in a rigid transform, based on assumptions that are not verified during neurosurgical procedures. Intraoperative brain deformation has been previously identified by many research groups and related update of preoperative images

Author information: Send Correspondence to O. El Ganaoui, E-mail: omar.elganaoui@irisa.fr, Telephone: +33 (0)2.23.23.38.29, Fax: +33 (0)2.99.84.71.71