Marine Breuilly

Seeking for a post-doctoral fellowship

Detailed research resume

23rd April 2014

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Marine Breuilly
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Overview

PhD in Sciences at University of Nice Sophia Antipolis (UNS) (2009-2013)
Under supervision of Grégoire Malandain (DR INRIA, INRIA Sophia Antipolis) and Jacques Darcourt (Pr., Practitioner, UNS), jointly prepared at INRIA Sophia Antipolis - Méditerrannée, Asclepios team, and at UNS, TIRO team.
PhD defended on 21st November 2013.

ATER at IUT Nice Côte d'Azur, RT and GEII departments (2012-1013)

MSc Intelligent and Communicants Systems (SIC) at UCP (2009)

Engineer from ENSEA (2009)

Research

Signal and image processing, small animal SPECT imaging, dynamic images, respiratory motion, respiratory gating, radiotracer biodistribution (^{99m}Tc - pertechnetate), compartmental analysis, active contour segmentation (level set)

Chosen publications and presentations

- **PMB'13**: *Amplitude-based data selection for optimal retrospective reconstruction in micro-SPECT* (peer-reviewed journal)
- **ISBI'13**: *Image-based motion detection in 4D images and application to respiratory motion suppression* (international conference)
- **SNM'13**: *Simulated breath-hold reconstruction in micro-SPECT: application to peritoneal metastases expressing NIS as reporter gene* (international colloquium of nuclear medicine)
- **CLFMN'12**: *Prise en compte du mouvement respiratoire du petit animal pour la reconstruction 3D TEMP synchronisée: application aux métastases péritonéales* (national colloquium of nuclear medicine)
- **GRETSI'09**: *Segmentation des muscles oculomoteurs en IRM cérébro-orbitaire pour l'aide au diagnostic de l'exophtalmie* (national conference)

Teaching

Practical classes and tutorials in informatics, signal and electronic

- **261h effective** in 2012-2013
- Logic/Boolean algebra in computer science and assembly language,
- Introduction to signal in telecommunications,
- 2nd order systems and filters in electrical engineering
- Electronics: basics

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Resume

Education and Diploma

2009-2013	**PhD in Sciences**, specialised in Automatic, Signal and Image processing, University of Nice Sophia Antipolis, *Distinction: with first-class honors*
2008-2009	**MSc in Intelligent and Communicants Systems (SIC)**, University of Cergy-Pontoise
2006-2009	**Engineer in Electronic Sciences**, specialised in **Electronic, Instrumentation and Biosciences**, École Nationale Supérieure d'Électronique et ses Applications
2004-2006	Scientific preparation to competitive entrance exams for French graduate engineering schools, specialised in Mathematics and Physics (MP), Lycée Carnot, Dijon, FR
2004	Equivalent A-Levels, specialised in Mathematics, Physics and Biology, Lycée Anna Judic, Semur-en-Auxois, FR, *Distinction: Honours*
Additional	
2010	Summer shool: Registration and Video Analysis, ICVSS'10 at Scicli, Sicily, IT

Area of expertise

Education	signal processing, image processing, digital image analysis, segmentation, compartmental analysis, digital and analog electronic, radio-frequency electronic, indexation, signal transmission, information theory, digital communications
Programming languages	C, shell, system integrator, Java™
Softwares	Matlab®, Mathematica®, Maple™, QUCS, PSpice™
Languages	French (native), English (fluent), German (intermediate), Chinese (beginner)
Miscellaneous	Climbing instructor at French Federation of Mountain and Climbing (FFME) since 2003

Professional experience

2012-2013 **Teaching and research temporary assistant (ATER)**

School	University Institute of Technology (IUT) Nice Côte d'Azur
Teaching	Network and Telecommunications (RT) and Electrical and Industrial Computer Engineering (GEII) departments
Research	Publication and continuation of thesis work, Asclepios team (INRIA) and TIRO team (UNS)

2009-2013 **PhD in Sciences**

Title	Small Animal 4D SPECT Imaging - Assessment of Respiratory Motion and Iodide Biodistribution -
Supervision	Grégoire Malandain (DR INRIA, INRIA Sophia Antipolis) Jacques Darcourt (Pr., Practitioner, UNS)
Reviewers	David Sarrut (DR CNRS, INSA Lyon) Régine Trébossen (Research engineer, CEA Orsay)
Examiners	Laure Blanc-Féraud (DR CNRS, UNS) Catherine Ghezzi (Pr., University of Grenoble) Mauricio Reyes Aguirre (Associate Pr., University of Bern)
Defense	21st November 2013, Sophia Antipolis, FR
Keywords	small animal SPECT, dynamic images, respiratory motion, respiratory gating, ^{99m}Tc pertechnetate biodistribution, compartmental analysis
Description	Joint supervision INRIA Sophia Antipolis - Méditerrannée, Asclepios team, and UNS, TIRO team Dynamic study of evolving phenomena with single photon emission computed tomography (SPECT) of small animals. A method that takes into account respiratory motion was developed in order to reconstruct a single 3D SPECT image without motion artefact. A first simplified model for iodide biodistribution in murine stomach was proposed using a compartmental analysis approach.

2009 (5 months) Final Year MSc Project : Investigation of medical active contour segmentation techniques

Supervisory staff	Bogdan Matuszewski (Pr., UCLan, Preston, UK)
Key words	Pelvic MRI, histogram-based segmentation, active contour (level set), Wasserstein distance, Chi-2 comparison
Description	ADSIP laboratory, University of Central Lancashire, ECSON European project

2009 (3 months) MSc Project : Segmentation and volumetry in medical images: application to exophthalmos diagnosis

Supervisory staff	Aymeric Histace (Associate Pr., UCP) and Frédéric Précioso (Associate Pr., ENSEA)
Key words	MRI, cerebroorbital images, semi-automatic segmentation, active contour
Description	ETIS laboratory, University of Cergy-Pontoise (UCP)

Activities statement

Teaching activities

Provided courses

In 2012-2013, I was a full-time teaching and research assistant at IUT Nice Côte d'Azur. I provided practical classes (TD) and tutorials (TP) for 1st year HND student (DUT) in two departments: Network and Telecommunications (RT) and Electrical and Industrial Computer Engineering (GEII). My teaching was therefore divided into two semesters: I taught in RT department during the first semester (S1) and in GEII department during the second semester (S2).

I taught to students enrolled in different courses: traditional training and apprenticeship training, as well as Malaysian students. Practical classes (respectively tutorials) were taught to groups of 24 (respectively 12) students maximum.

The provided courses deal with informatics basis (logic and boolean algebra in computer science and assembly) as well as analog electronic (transistors, operational amplifier, first and second order filters) or signal processing. Concepts were studied theoretically in TD and experimentally in TP both on models and with simulation softwares (QUCS, PSpice).

I thus had the opportunity to dedicate myself to courses beyond my on-going research thematics. Moreover, I took part in different tasks related to teaching: tutorial preparation, tutorial exams writing, tutorial report and exams marking, exam surveillance, and taking part to teachers' conference.

The whole list of my past teaching is summarised in table 1.

Year	Level	Title	Person in charge	TD	TP
2013	DUT S2	Second order systems and filters (GE2)	P. Le Thuc	-	24h
2013	DUT S2	Analog electronic (EN2 and MCAA-EN)	P. Le Thuc	24h	72h
2012	DUT S1	Introduction to signals and telecommunications (T1)	F. Payan	-	69h
2012	DUT S1	Logic/boolean algebra in computer science and assembly (I2)	P. Mathieu	24h	48h

Table 1: Teaching recap chart

Courses that can be taught

I taught various subjects to a set of first year HND students following different trainings.

At the moment, my skills are stronger in signal and image processing. However, during my studies at ENSEA, I acquired basic knowledge in signal transmission from information theory to digital communication. I am ready to dedicate myself to perfect and improve my knowledge in this field or in any other to fulfill the teaching pre-requisite.

I am also ready to take more part in teaching functions according to the higher education department I will join: schedule management, pedagogic responsibility, student follow-up.

Research activities

Accomplished work

Study of evolving phenomena in small animal nuclear imaging: Kinetic of biodistribution of a radiotracer in stomach

Keywords: small animal, dynamic SPECT images, ^{99m}Tc pertechnetate biodistribution, compartmental analysis

The aim of this work is to model the kinetic of iodide uptake in extrathyroidal tissues, and to identify the properties of this phenomenon with the use of scintigraphy (SPECT). The idea is to study this uptake with compartmental analysis, to propose a simplified model, and to determine and to solve the equations of the model based on the analysis of 4D SPECT images. 4D stands for 3 spatial dimensions plus one time dimension. This iodide uptake phenomenon was observed and studied through the study of a specific radiotracer, that is a iodide analog: ^{99m}Tc-pertechnetate.

Taking into consideration the respiratory motion in small animal nuclear imaging (SPECT)

Keywords: small animal, SPECT imaging, respiratory motion, respiratory gating

In order to study evolving phenomena in abdominal area of mice, it was first necessary to take into consideration the respiratory motion in the process of SPECT image reconstruction. The abdominal region is subject to a high amplitude motion that impairs the quality of reconstructed images. The consequences of this low quality are a volume overestimation and an activity underestimation in the structures of interest, such as metastases. My work consisted in the study and the setting up of a dedicated method for the selection of events recorded in listmode during the acquisition. The idea was to use only events that correspond to a motionless phase of the respiration in order to optimise the quality of the reconstructed 3D image. In comparison to other existing methods, the reconstructed images achieve a better compromise between counting statistics and measure accuracy.

This work led to the development of a software that allows the biologists to apply this method in routine. This software was used to obtain the reconstruction of images and therefore the presented results. The final goal was to propose a working procedure that is adapted to a routine use for the biologists involved in this project.

This work has been presented in my PhD thesis [1] and published in an international peer-reviewed journal [2], in an american colloquium on nuclear medicine [3], in an international biomedical imaging conference [4], and in french colloquium on nuclear medicine [7].

In-depth study of active contour segmentation techniques: application to pelvic MRI images

Keywords: Histogram-based segmentation, active contour (level set), Wasserstein distance, Chi-2 comparison

This work consisted in the study of segmentation techniques based on active contour with level set. The tested methods are based on the comparison between histograms of voxel intensity in a neighbourhood. In particular, several measures of distance between histograms were computed in order to lead the segmentation (Wasserstein distance and Chi-2 comparison). Distances were computed between cumulative histograms in each region, and either a reference histogram or a neighbourhood histogram. Such a segmentation method allows us to distinguish the subject from the background in images. The active contours allow the segmentation of a subject made of several non connected regions. This method allows the segmentation of regions characterised by a texture

or a noise that is different from the background, both in synthetic images and in male pelvic MRI images.

Segmentation and volumetry in medical images: application to the exophthalmos diagnosis

Keywords: MRI images, ocular images, semi-automatic segmentation, active contours

This work was a preliminary study for the automation of the segmentation of extra-ocular muscles and of the pre-orbital fat in cerebroorbital MRI images. We proposed to use a method based on active contours (level set) that, in addition to the traditional formalism, integrate a term for speeding up the convergence of the segmentation. This method was tested on a first set of data (3 subjects) and achieves satisfying results in comparison to manual segmentation proceeded by ophthalmologist.

This work was published in a french conference [5] and in a french colloquium on radiology [6].

On-going work

^{99m}Tc pertechnetate biodistribution in murine stomach

This work consists in applying a method proposed in my PhD thesis to a larger data set in order to conclude on a law of kinetic of iodide biodistribution in the murine stomach. The method will be compared with other image analysis methods used in clinical research.

For this work, we also would like to take into account respiratory motion method that was proposed in order to improve the accuracy of the measures.

The publication goals are two methodological papers, one in an international conference (in submission to MICCAI 2014 [11]) and another one in a peer-reviewed journal, as well as a significant contribution to a biological peer-reviewed journal.

Research plan

In the medium term, I wish to pursue the in-depth study of several thematic that take the following of my PhD work, on the edge between computer science, biomedical imaging, biology and medicine. These thematic fields are related to the quantification of evolving phenomena and to the longitudinal study in dynamic images.

I currently consider two main research axes.

Tracking and quantification of tumour growth in moving area (abdomen and lungs)

This line of research was the initial goal of my PhD thesis. Since the first step that consists in taking into consideration respiratory motion has been processed, I would like to perform longitudinal studies on tumour growth quantification. This will be done by setting up tumour matching tools [WGR+01].

In a first time, I will take advantage of my experience of my initial work on SPECT imaging gating on respiration. It is necessary to take into account the respiratory motion phases in longitudinal studies of 4D images. My approach is robust to variations, modifications, and non-reproducibility of respiratory rhythm for both inter- and intra- subject comparison.

In a second time, the acquisition gating (with respect to external motion signal and between modalities) will allow to reconstruct images without motion artefact, to detect small lesions or tumours in those images, and to measure with accuracy the volume and activity of these tumours.

These works will be focuses on the abdominal region that is a deformable environment. To a further extent, this work will permit to design a tumour growth model, that will help biologists and medicines to understand the effect of a treatment (e.g. radiotherapy) on tumour growth.

Study of tumour heterogeneity by a decomposition into metavoxel

This line of research corresponds to an observation that has been done on nuclear images of tumours at a latter stage: tumour are made of different kind of cells that are in different state (necrosis, proliferating, intermediate). The idea would be to study and quantify the tumour growth with nuclear imaging, by taking into account the fact that the tumour is structured by different functional units corresponding to the different kind of cells.

Indeed, some tumours are observed until a late stage. At this stage, basic tumour segmentation in nuclear images reveals that only a part of the tumour is active (e.g. activity uptake), the part that is vascular. On the other hand, the necrosis part of the tumour is not visible since their is no activity uptake. The heterogeneity of a tumour was mentioned by Umeda et al. in [UTT+12].

In this work, the idea is to apply a region-based segmentation approach to tumours that will allow to distinguish the different part of its structure and to understand the growth of the tumour. Quantification will be done on each subregion instead of the whole tumour. Each part will be identified according to the measures: necrosis, proliferating cells, ad intermediate cells. In the end, such an approach will allow a better understanding of the tumour growth. Moreover, the fusion of imaging modalities (SPECT-CT, PET-MRI) will bring additional information for the analysis, as well as for the medicine about cancer recurrence.

Longer term perspectives

On a longer term basis, I wish to take part to the transfer of skills developed on small animal studies toward concrete application on human and reverse. I believe my experience of working in close relationship with computer scientists, biologists and medicine, as well as the complementary between pre-clinical and clinical research will allow me to significantly contribute to the research in this domain. I think it is also crucial to set up new collaborations and to maintain collaborations with other laboratories (computer science, biology, hospital) in order to gather skills and data.

Bibliographic references

[UTT+12] IO Umeda, Kotaro Tani, Keisuke Tsuda, Masamitsu Kobayashi, Mayumi Ogata, Sadaaki Kimura, Mitsuyoshi Yoshimoto, Shuji Kojima, Kunikazu Moribe, Keiji Yamamoto, Noriyuki Moriyama, and Hirofumi Fujii. High resolution SPECT imaging for visualization of intratumoral heterogeneity using a SPECT/CT scanner dedicated for small animal imaging. *Annals of Nuclear Medicine*, 26(1):67–76, 2012.

[WGR+01] D Welti, G Gerig, EW Radü, L Kappos, and G Székely. Spatio-Temporal Segmentation of Active Multiple Sclerosis Lesions in Serial MRI Data. In *Information Processing in Medical Imaging*, pages 438–45. Springer, 2001.

Other teaching and scientific activities

Internship supervision

2009-2011 (3 half-days) Reception of equivalent-Year 10 students in Asclepios team and TIRO team. The goal was to introduce the research environment at the edge of computer science, with image processing applied to medicine and biology.

Seminars (oral presentations)

2014-04-03 Invited seminar - ICI seminar, UCP, Laboratoire ETIS, Cergy-Pontoise, FR. *Études longitudinales à partir de l'imagerie TEMP 4D du petit animal : estimation du respiratory motion and de la biodistribution de l'iode*

2014-04-02 Invited seminar - LITIS, équipe QuantIF, Rouen, FR. *Études longitudinales à partir de l'imagerie TEMP 4D du petit animal : estimation du respiratory motion and de la biodistribution de l'iode*

2012 Scientific retreat - Asclepios team seminar, INRIA, France. *Simulated breath-hold reconstruction in micro-SPECT - Application to peritoneal metastases expressing NIS as reporter gene*

2012 Colloquium MIBO, Nice, France. *Simulated breath-hold reconstruction in micro-SPECT: application to peritoneal metastases expressing NIS as reporter gene* [10]

2010 Scientific retreat - Asclepios team seminar, INRIA, France. *Tracking and quantification of tumour processes in rodents with the use of SPECT/CT imaging*

Publications

The whole list of my publications is available at the following address:
http://www-sop.inria.fr/members/Marine.Breuilly/publis.html

Thesis

[1] Marine Breuilly. *Small animal 4D SPECT imaging : assessment of respiratory motion and iodide biodistribution*. Thesis, University of Nice Sophia Antipolis, November 2013.

International peer-reviewed journal

[2] Marine Breuilly, Grégoire Malandain, Julien Guglielmi, Robert Marsault, Thierry Pourcher, R. Franken, Philippe, and Jacques Darcourt. Amplitude-based data selection for optimal retrospective reconstruction in micro-SPECT. *Physics in Medicine and Biology*, 58(8):2657–74, April 2013.

International conferences

[3] Marine Breuilly, Grégoire Malandain, Nicholas Ayache, Jacques Darcourt, Thierry Pourcher, and Philippe Franken. Simulated breath-hold reconstruction in micro-SPECT: Application to peritoneal metastases expressing NIS as reporter gene. *Journal of Nuclear Medicine Meeting Abstracts*, 53(1):2381, 2012.

[4] Marine Breuilly, Grégoire Malandain, Nicholas Ayache, Julien Guglielmi, Thierry Pourcher, R. Franken, Philippe, and Jacques Darcourt. Image-based motion detection in 4D images and application to respiratory motion suppression. In *Biomedical Imaging (ISBI), 2013 IEEE 10th International Symposium on*, pages 804–807, San Francisco, États-Unis, April 2013. IEEE. Poster.

National conferences

[5] Marine Breuilly, Aymeric Histace, Christophe Portefaix, Bogdan Matuszewski, and Frédéric Précioso. Segmentation des muscles oculomoteurs en IRM cérébro-orbitaire pour l'aide au diagnostic de l'exophtalmie. In Groupe d'Etudes du Traitement du Signal et des Images GRETSI, editor, *22ème Colloque GRETSI 2009*, September 2009. Oral.

[6] C. Portefaix, A. Histace, M. Breuilly, and B. Matuszewski. Segmentation semi-automatique en IRM3T des muscles oculomoteurs dans le suivi de la maladie de Grave-Basedow. In *Actes des Journées Françaises de Radiologie (JFR)*, October 2009. Poster.

[7] Marine Breuilly, Grégoire Malandain, Philippe Franken, Jacques Darcourt, and Thierry Pourcher. Prise en compte du mouvement respiratoire du petit animal pour la reconstruction 3D TEMP synchronisée: application aux métastases péritonéales. 50ème Colloque de médecine nucléaire, April 2012. Poster.

Miscellaneous

[8] Marine Breuilly. Investigation of medical active contour image segmentation techniques. Master's thesis, Université de Cergy-Pontoise, 2009.

[9] Marine Breuilly, Grégoire Malandain, Nicholas Ayache, Philippe Franken, Jacques Darcourt, and Thierry Pourcher. Definition of motionless phases for monitoring gated reconstruction of SPECT images in alive mice. ICVSS 2010, July 2010. Poster.

[10] Marine Breuilly, Grégoire Malandain, Nicholas Ayache, Philippe Franken, Jacques Darcourt, and Thierry Pourcher. Simulated breath-hold reconstruction in micro-SPECT: application to peritoneal metastases expressing NIS as reporter gene. 2ème colloque MIBO, January 2012. Poster and oral.

In submission

[11] Marine Breuilly, Kaouthar Chatti, Jacques Darcourt, Philippe Franken, Julien Guglielmi, Grégoire Malandain, and Thierry Pourcher. From extraction of physiological features with dynamic μ-spect imaging to modelling of iodide biodistribution in stomach. In *MICCAI - Medical Image Computing and Computer Assisted Intervention*, 2014.

References

Research

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Teaching

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