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Digital technologies for healthcare

Theme B: Biomedical signal and image processing

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Abstract

This paper presents an overview of the main actions and projects of the theme B 'Biomedical Signal and Image Processing' of the GdR Stic-Santé. Several scientific meetings have been organized during the 2011–2012 period. They are always devoted to advanced signal and image processing that could bring innovative solutions to relevant medical applications. The theme has strong relationships with other GdRs and also organizes meetings in close coordination with these GdRs. It also supports two working groups with well-identified research projects. Prospects includes reinforcing communication and cooperation with the other GdRs, involving labs from other countries, and attracting private companies that could also share their needs in terms of developments for which the theme participants could offer solutions. The whole motivation is to enhance the fit between academic research, needs from the medical community and impact for medical research and applications.

1. Aims

The importance of imaging and signal processing in life sciences has been growing in recent years. A large variety of physiological signals of different nature are now accessible via a broad range of sensors or imaging systems. Processing, analysis and interpretation methods can become very complex and powerful tools have to be developed to extract the information provided by these sensors or imaging devices. The objective of theme B of the GDR Stic-Santé is to strengthen the links between the research and engineer's community and the medical application actors so that innovative methods in signal processing and image can be adapted, evaluated and optimized for solving specific medical problems. In a reciprocal manner, problems encountered in the biomedical field raise new challenges for engineers yielding to the developments of new efficient and dedicated approaches based on innovative concepts.

In the context of the GdR Stic-Santé, theme B organizes scientific meetings to bridge the gap between innovative signal and image processing tools and medical applications.

In particular, meetings often address the following questions:

- what signals or images modalities should be used to solve a medical problem (modality, resolution, . . .)?
- which acquisition protocols should be favored, or how to best combined different approaches?
- which information should be extracted?
- which methods are most suited to access the most relevant information?

Answers to these questions can only be discussed through a strong interaction between the different actors (medical doctors, medical researchers, scientists). The need for pluridisciplinary exchanges also explains why theme B has strengthened its links with others themes of GdR STIC-Santé (mostly theme A) but also with others GdRs such as Imaging in Life sciences (ImagIV), Information, Signal Image and Vision (ISIS) or Modeling and Instrumentation for Medical Imaging (MI2B).

2. Results for the period 2011–2012

In 2011–2012, seven scientific meetings were organized. Each one focused on a specific research topic involving

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various scientific communities. Some were organized in cooperation either with others groups of GdR Stic-Santé (Themes A and C) or with other GdR (ISIS, Imagiv). The objectives and detailed contents of these meetings can be downloaded from the website of GdR Stic-Santé (<http://stic-sante.org/calendrier>). Here, we give examples of the meetings organized in 2011–2012 to illustrate the range and variety of domains covered by our theme:

- December 11–13, 2012: “new methods in life imaging¹”. This meeting was co-organized with GdR “Imagiv” and GdR “Microscopic imaging”. The scientific meeting introduced the most recent imaging and signal processing methods in life science across scales (from molecular to macroscopic) and imaging modalities. New interactions between scientists involved in different imaging modalities, biologists and physicians are expected;
- November 16, 2012: “sparse representations and compressed sampling”. These new signal processing methods [1,2] appear today as an active area of research in medical imaging. The aim of this scientific meeting, in collaboration with the GdR ISIS, was to present the state of the art, underlining the potential of these methods and identifying open questions in different applications such as microscopic image denoising, ultrasound imaging and tomography;
- October 22–24, 2012: “interoperability in Image processing” – third edition of the European workshop VPH NOE Toolkit Hands-on Training [3,4]. This meeting focused on presenting an exhaustive view of several initiatives addressing interoperability of workflows. A tentative benchmark was designed during this meeting, in order to test and validate the current tools;
- May 10, 2012: “indexation and Analysis of Medical Images and Videos”. Indexation is increasingly entering the field of medical imaging and medical diagnosis. The follow-up of cohorts with several imaging modalities such as MRI, CT, PET, SPECT, Ultrasounds, ECG, or even optical imaging produces huge amounts of data for which recognition, classification, and sorting strategies have to be developed. This meeting gathered the current community working in this field to share experiences and ideas;
- October 10, 2011: “auricular fibrillation” [5]. The aim of this meeting was to strengthen the collaborations between clinicians and researchers by better identifying needs and technical solutions. Half a day was devoted to clinical applications with a focus on the radio-ablation of the fibrillation sites while the genesis of this pathology has been also introduced. The rest of the day was dedicated to the presentation of novel signal processing researches in this context, including modeling and simulations. A round table discussion concluded the day with the objective of sharing data and methods;
- Oct 13 2011 color and multispectral image analysis in biology: color imaging and more generally multispectral imaging

¹ <http://imagerie-vivant.sciencesconf.org/>.

are becoming part of the tools offering new insights into biological tissues. Access to the analysis of the visible and infrared spectra improves tissue characterization. This meeting focused on the sensors and processing tools used in this emerging field.

The theme also currently supports two working groups (called “actions”) with well-identified research projects:

- the Sigmund action: SIGNAL-processing and Modeling methods Useful in Neonatology. This working group, gathering 10 teams, focuses on the prematurity in neonatology (which represents among 55,000 births in France and is the major cause of neonatal death in France). This action has been developed in collaboration with Theme A where a detailed description is reported;
- the MEDIEVAL Action, coordinated by M. Garreau (LTSI-INSERM 1099), gathers nine laboratories. The aim of the project was to conduct a multicentric evaluation of segmentation methods operating on cardiac structures using an MRI database. This action resulted in two main results: first, a software dedicated to the evaluation of estimation methods in the absence of a gold standard has been developed. Second, the respective performance of eight methods dedicated to the segmentation of left ventricle for estimating the ejection fraction from cardiac cine MRI images. The work was recently published [6].

3. Prospects

In the next future, theme B will carry on the collaborative work started during the past year in close relationship with others GdRs. Several Theme B specific scientific meetings have been already planned, such as Sport and Health, Flutter and auricular fibrillation, or analytic imaging. Others meetings will also be organized in collaboration with other themes or GdRs, including a follow-up meeting on the indexation of medical information and a meeting dedicated to Brain Computing Interface, both in collaboration with GdR ISIS. The theme will also continue to invite some international leaders in order to reinforce the international visibility of GdR and possibly open it to labs from other countries. Last, involvement of companies will be encouraged, so as to broaden our view of the bottlenecks currently faced by the companies involved in signal and image processing for medical applications, favor the valorization process of our research, and enhance the impact of academic research on medical end-users.

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