

**Control and Imaging for Devices and Systems in Medicine: Models,
Identification and Clinical Application**

Organisers: There are several organisers for the track to ensure a broad range of expertise to help organise what we expect to be a large track of 40-60 papers. In an effort to bring new ideas and energy to the TC there is a mixture of organisers who have or have not led the organisation of sessions for the TC at past world congresses.

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Special Note: This proposal is to organise an *open invited track* (OIT) due to the very strong response received to our CFP among colleagues, and prior World Congresses, where we had 20+ papers in this area in invited sessions and open sessions. We already have expressions of interest for several papers from colleagues.

Main goals: of the OIT and its organisation include:

1. **Balance and Emerging Research Areas:** Create a spread of papers in the OIT to ensure balance across modeling, system ID, and clinical applications of medical devices and hardware/software systems based on feedback from the IFAC TC 8.2 BMS 2015 symposium where sessions with specific topics and focuses resulted in a more unbalanced programme and lack of spread across geographic areas and universities.

This approach should spread the works better and enable new, emerging research areas and topics to appear in these sessions and help reinvigorate the TC and broaden its appeal.

2. **New Researchers:** Attract a range of new topics and efforts from Asia, N. America and S. America where the TC has been weak in recent years, without targeting very specific focus areas of work. Thus, we are hoping a mixture of “shoulder tapping” invitations and the advertisement of an OIT will serve to attract “new blood” and new ideas to our TC

IFAC Technical Area:

This OIT is one of two sponsored by IFAC TC 8.2 “Biological and Medical Systems” and captures a major central focus within the TC’s far broader, overall research focus to meet the main goals stated above. This one focuses on the modeling and control of hardware/software medical devices, including imaging, where the second focuses on the physiological and biological modeling and control and their application. Both are clinical application focused.

Session Description:

As computational, control and sensor technologies advance the potential in application to medical and biological systems has increased exponentially. As a result, there has been an increasingly tight inter-relation between engineering and clinical medicine. This session thus focuses on modeling, system identification and control of physiological systems in medicine, including clinical applications.

A secondary goal of the session is to provide a broad cross section of the area, focusing on the use of modeling and control across a range of clinical devices, systems, imaging and their applications. More specific sessions focusing on one topic, such as imaging only, tend to narrow the focus to specific research groups and thus a limited number of people, where a broader session will draw better numbers and be less exclusive.

As such, this session has another main goal of providing a broader overview of this application area to any “outsiders” who may attend, as well as to attracting new areas of TC relevant research that are only now emerging.

The overall goal is to provide a range of sessions in this OIT, focused with respect to being clinically applicable, but broad with respect to area of clinical application and to engineering sciences (modeling, system ID, control, theory, computation, application and so on).

Paper topics are not necessarily limited and could thus include:

- Rehabilitation systems: Functional Electrical Stimulation (FES), Robotics and Sensors
- Medical Imaging for diagnosis or treatment, including algorithms to extract novel diagnostics or results
- Modeling and control of novel medical devices or novel modeling/control of existing medical devices for (new) clinical application
- Control of ECMO or circulatory assist devices
- Artificial organ systems
- Novel imaging methods and modalities, such as electro-tomographic imaging
- Inverse problems for medical imaging
- Biomechanics systems, such as for gait analysis or modeling.

Overall, this session focuses, broadly, on model-based applications of dynamic systems modeling, control and system identification to clinical medicine, emphasising the novelty in the hardware/software of medical devices. The application areas are broad, but include current and emerging applications, as well as a broad array of potential application spaces.

Note that at WC 2011 in Milan, there were 4 invited sessions comprising 24 papers in this area, which was 7 sessions and 42 papers in WC 2014 in S. Africa from the TC including these topics among several. From a broader, OIT (versus invited session) approach the TC hopes to benefit from:

- Greater strength and broader research areas at the next IFAC BMS Symposium in 2018
- Greater geographic breadth including particularly Asia and S. America
- Greater inclusion of younger and women researchers

Session Theme and Rationale:

This session focuses on the convergence of technological advance and aging population demographics as they impact clinical medical practice. Aging populations have put increased stress on medical resources with a greater demand for critical care and other acute care treatment starting to exceed availability in many first world nations. At the same time, the past 20 years have seen a tremendous growth in the application of technology to clinical practice, as well as in the computing power available in every-day and medical devices.

However, despite these changes, the practice of medicine, particularly in the diagnostic and therapy selection parts of practice have seen little change in the past 30 years. At the same time clinical practice is under increasing strain due to limited resources. Hence there is significant opportunity to augment and (partially) automate diagnosis and therapy selection using patient specific modeling. This opportunity is particularly relevant in high cost acute care wards, such as the intensive care unit (ICU), where significant clinical decisions must be made rapidly by staff under increasing demand for their time. However applications can spread across a variety of clinical wards and outpatient settings, as well as across a variety of biological systems not restricted just to humans.

Hence, there has been some recent growth in the use of models to help test and evaluate new hypotheses in the physiological development of diseases. This trend has been most notable in the analysis of drug therapy pharmacokinetics and in the study of metabolic disorders. This session therefore examines the application of models to medical practice, in both research and clinical practice, through all critical modeling steps from model derivation to patient specific parameter identification to the clinical validation with a focus on the medical devices and systems used to provide that care.

Given the growing potential for the clinical use of such model-based methods, it is a good time to examine them in greater detail. This session thus takes a very clinical applications oriented approach, including examining problems that arise from different types of clinical data, as well as the impact on outcomes.

The overall goal is to provide a range of sessions in this OIT, focused with respect to being clinically applicable, but broad with respect to area of clinical application and to engineering sciences (modeling, system ID, control, theory, computation, application and so on).