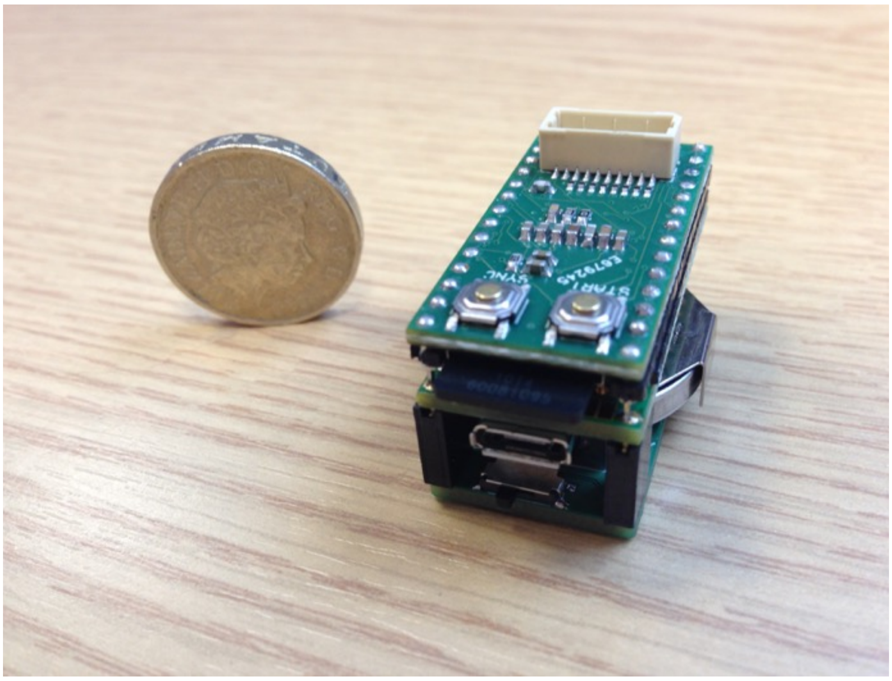
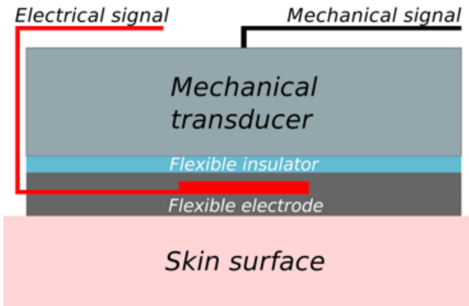
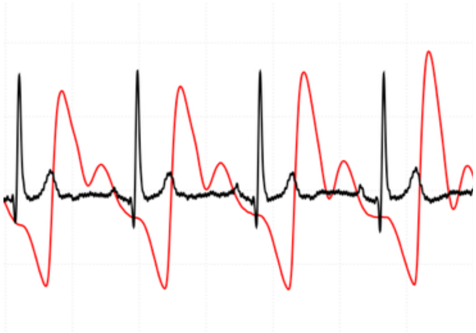
Computational Intelligence For Wearable Physiological Sensing







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Given the ageing, but computer-savvy population and the government policies for out-of-clinic health monitoring, we feel that it is timely and important to address the extent to which hardware-conscious developments in computational intelligence can provide a paradigm-shift in this area.

Indeed, the modern low-power and high-capability microcontrollers, together with an emergence of cheap but imprecise physiological sensors, open up new avenues for the use of computational intelligence in pervasive health. On the other hand, this poses significant challenges that need to be addressed for pervasive 24/7 sensing to become a reality.

This tutorial will bring together the latest advances in computational intelligence and signal processing for body sensor networks, focusing on real-world applications for next-generation personalised healthcare, where the sensors must be unobtrusive, self-operated and discreet. To this end, we will discuss an open-source biosensing platform, equipped with multimodal miniatuarised sensors (ECG, EEG, respiration, etc.) and will use this platform to generate our real-world examples.

Computational intelligence is, in principle, well equipped to deal with the issues arising from the requirements of 24/7 unobtrusive and user-operated physiological sensing, but the community is still lacking a coherent approach to this problem. To this end, this tutorial will cover the following aspects:

- Biophysics behind data acquisition on the human body
- Current technologies: clinical, ambulatory, tele-operating
- Multimodal sensors - next generation space-saving and unobtrusive solutions
- Challenges to data analysis arising from the miniature size of sensors and supporting electronics, such as data power levels and artefacts
- An example of a fully integrated ultra-wearable sensing platform
- Signal processing solutions for wearable physiological sensing (data conditioning, detection, estimation)
- Computational intelligence solutions (data fusion, association, classification)
- Putting this all together: in-the-ear wearable sensing and ultra-wearable sensing in an orthopedic clinic
- Application examples: auditory and visual brain computer interfaces, fatigue, sleep and physiological stress
- Links with big data, point-of-care healthcare, and distributed systems

The presenters are a perfect match for the topic of this tutorial, and have been working together in the last two years on the links between Computational Intelligence and Embedded systems; they are pioneers of in-the-ear and multimodal physiological sensing, and have three patents in this area.

Danilo P. Mandic is a Professor in signal processing with Imperial College London, UK, and has been working in the area of nonlinear adaptive signal processing and bioengineering. He is a Fellow of the IEEE, member of the Board of Governors of the International Neural Networks Society (INNS), member of the Big Data Chapter within INNS, and has received several best paper awards in Brain Computer Interface. Prof Mandic runs the Smart Environments Lab at Imperial, has more than 300 publications in journals and conferences, and has received President's Award for excellence in postgraduate supervision at Imperial.

Valentin Goverdovsky received the M.Eng. in electronic engineering and his Ph.D. in communications from Imperial College London, UK. He is currently a Rosetrees Fellow at the Department of Electrical and Electronic Engineering of Imperial College London. His research focuses on biomedical instrumentation, analog integrated circuits and radio frequency communications. Dr Goverdovsky has won the Eric Laithwaite Award at Imperial College for best research in the year 2014. His recent work has been on the development of wearable biosensing platforms for 24/7 monitoring of brain and body functions in the context of traumatic brain injury.