Biomedical Applications of Electrical Impedance Tomography

2003 Physiol. Meas. 24

(http://iopscience.iop.org/0967-3334/24/2/001)

INSTITUTE OF PHYSICS PUBLISHING PHYSIOLOGICAL MEASUREMENT

Physiol. Meas. **23** (2002) issue 2 www.iop.org/Journals/pm

EDITORIAL

Biomedical Applications of Electrical Impedance Tomography

Electrical Impedance Tomography (EIT), the imaging of internal structure from external electric measurements, is a challenging problem. Designing and building high-precision measurement hardware for this error-sensitive modality requires state-of-the-art electrical engineering. The mathematical problem of reconstructing the image of unknown electrical parameter distributions from measured data is very complicated since the problem is nonlinear and ill-posed. And finally, the interpretation of the resulting images in medical, geophysical or industrial applications is not yet fully understood and needs application-oriented research.

The First Mummy Range Workshop on Electrical Impedance Tomography (see http://www.eitworkshop.org) was held during 1–7 August 2002, at the Pingree Park of Colorado State University at an altitude of 9000 feet. The monumental Rocky Mountains created an exhilarating atmosphere for the 60 participants of the meeting. This Workshop was part of a series of meetings in EIT, the first of which was held in Sheffield, UK, in 1986 under the sponsorship of the European Community. Since then meetings have been held nearly annually in the UK, but this was the first to be held in the US. Papers from many of the previous meetings, including those held during 1999, 2000 and 2001, have been published in special issues of *Physiological Measurement*.

The mixed audience in the Mummy Range Workshop consisted of experts in electrical engineering, mathematics, physics, medicine and geophysics. This allowed the exchange of ideas across the boundaries of traditional fields of study, which resulted in the broad range of topics presented, and a different atmosphere from traditional conferences for a single academic field. The diversity amongst the Workshop participants is evident in the collection of papers on pages 391–638 of this special issue. All three viewpoints on EIT mentioned above are covered. New contributions to hardware design are presented. Studies on the reconstruction problem include new algorithms and examples of anisotropic conductivity distributions that cannot be detected by EIT. Clinical applications to human head imaging and imaging of pulmonary perfusion are addressed in this issue, and electrical properties of tissues relevant for EIT imaging are discussed. Another significant feature in this collection is that there are five papers addressing new EIT technology, three of them on MREIT, a new technique combining EIT with MRI.

The advantages of an interdisciplinary workshop were probably most evident in the evening discussion sessions in Pingree Park's fireplace lounge. Three discussion sessions were held addressing issues of hardware, reconstruction algorithms, and the future of EIT. These were well-attended and provoked lively debate on issues such as 2D versus 3D reconstruction algorithms and the effects of electrode position and the precision of electrode placement. The discussion session on the future of EIT included a serious discussion about the clinical applications of the field. Many applications were discussed including the detection of breast cancer, the location of the focus of an epiliptic seizure, the imaging of action potentials in the brain, monitoring cardiac function, monitoring mechanical ventilation, detection of pulmonary embolus, and high altitude pulmonary edema. Challenges were also brought up by the physicians present, such as the possibility of using no electrodes whatsoever for EIT

Participants at the First Mummy Range Workshop on Electrical Impedance Tomography at the Pingree Park of Colorado State University, 1–7 August 2002.

and the possibility of grafting EIT on an existing apparatus such as an ultrasound probe or mammography. It was agreed that EIT's greatest potential lies in its portability and convenience as a bedside monitoring device. It has a unique advantage when patients cannot remain still, such as is the case with neonates or epileptic seizure patients.

The future of EIT looks very healthy indeed, and the collection of papers in this special issue provides further evidence of the significant advances that are being made in all aspects of the field. We thank the participants of the First Mummy Range Workshop, the authors of the papers published herein, and the many reviewers of those papers, for their contributions to the success of this special issue of *Physiological Measurement*.

David Isaacson
Department of Mathematics, Rensselaer Polytechnic Institute, Troy, NY 12180, USA
Jennifer Mueller
Department of Mathematics, Colorado State University, Fort Collins, CO 80525, USA
Samuli Siltanen
Imaging Division, Instrumentarium Corporation, Tuusula, FIN-04301, Finland
Guest Editors