TECHILA TURNS MEDICAL IMAGING RESEARCH INTO PRACTICAL APPLICATIONS

There are many non-invasive medical imaging methods available today, allowing unprecedented possibilities to detect medical problems. Some of the methods are harmful to patients while others are not. Another issue that these methods involve is financial, because some machinery, such as MRI, Magnetic Resonance Imaging, is hugely expensive. EIT, Electrical impedance tomography is both safe and inexpensive. It is an emerging imaging method that with some more research and more rapid data delivery will gain ground.

- During the development of the EIT, researchers around the world have worked to combine theory and practice. EIT is an exceptionally challenging topic because the related clinical, engineering, and mathematical image formation problems are all difficult. On the practical side a challenge has been computation time. In a case of an emergency, several hours of computing to get an image has not been a relevant option, says Samuli Siltanen, Professor of Industrial Mathematics at the University of Helsinki, Finland.

- Today we have access to Techila, a distributed high-performance computing system that has cut down our computing times up to from four hours to 2 minutes. This thus makes a revolutionary difference in comparison with executing the computation with a single PC as is currently done in research in mathematics. When this technology is more readily available, we can take a huge leap forward in the applicability of our development projects.

Practical value

EIT is a method in which electric currents are fed through electrodes and voltages are measured. With several current patterns, the electric conductivity distribution is looked into by turning it in to an image, a two-dimensional slice. The time-consuming part is the creation of each pixel by solving a d-bar equation. In mathematics the task of interpreting EIT measurements is an inverse boundary-value problem called ‘inverse electric conductivity problem’.

- Although I have studied physics and mathematics, I have always been motivated in my work by a vision of practical and tangible applications. For EIT we have created a new imaging algorithm to ultimately build accurate, cheap and even portable devices that save people’s lives, says Samuli Siltanen.

- I can easily see a product come out of the work of EIT researchers that monitors the heart and lungs of unconscious patients. This is probably also the future method for detecting pulmonary edema. The device could be in ambulances and it would make better medical care accessible to the developing countries once manufacturers get to volume production and thus lower costs.

Inversion math is highly applicable

Another practical example of how easier and faster imaging made possible by inversion mathematics can help in medical issues is dental care.

- Dentists always aim at implants that stay safely in place. The screw needed for that should be drilled in a deep as possible. The challenge is how to fix the screw

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TECHILA

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firmly while not touching a nerve that runs very close to the attachment place, Samuli Siltanen explains.

- So far dentists have had access to two dimensional images, while they would really need them in 3D. They would certainly benefit from combining our technology and Techila.

Techila is based on distributed computing. This means that it uses the idle PC and server capacity of a number devices for doing computing simultaneously – hence the speed. Thus no single private dental practice would have such computing performance. However, with specifically creating a joint distributed computing environment would solve this issue.

- With easy-to-use distributed computing we have access to methods never feasible before. On the practical level we now need fresh thinking to make the best of both the outcome of years of research and new technology like Techila.

A positive message to computation-oriented research

Samuli Siltanen participates a number of research groups around the world. He has worked in Japan, and knows well in which countries research into tomography and x-ray technology are most advanced. Yet, he has never run into a technology like the Techila Distributed Computing Solution.

- I first came across Techila while working and doing research at the Tampere University of Technology. When I transferred to University of Helsinki, I simply needed the distributed computing technology there as well, says Samuli Siltanen.

- Now that the awareness of Techila has increased in Helsinki, there will be other researchers and departments to share that capacity. It helps in so many types of research where less theory and more computing is used.

Professor Siltanen has also taken on the role of a technology evangelist.

- Obviously I would like to see the international medical research community to take research to the next level. One tool certainly is Techila. Using it, computation efficiency will be multiplied at a reasonable cost. When I travel and meet up with my colleagues, I am frankly quite open about how we compute nowadays. The responses are more or less envious.

Personal Profile: Dr. Samuli Siltanen

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•Senior Scientist of the Finnish Centre of Excellence in Inverse Problems Research

Selected Publications

•Nuutti Hyvönen, Martti Kalke, Matti Lassas, Henri Setälä and Samuli Siltanen, “Three-dimensional X-ray imaging using hybrid data collected with a digital panoramic device.” To appear in Inverse Problems and Imaging.

•Kim Knudsen, Matti Lassas, Jennifer L. Mueller and Samuli Siltanen 2009, “Regularized D-bar method for the inverse conductivity problem.” Inverse Problems and Imaging 3(4), pp. 599-624.

•Takanori Ide, Hiroshi Isozaki, Susumu Nakata, Samuli Siltanen and Gunther Uhlmann 2007, “Probing for electrical inclusions with complex spherical waves.” Communications on Pure and Applied Mathematics

•Ville Kolehmainen, Antti Vanne, Samuli Siltanen, Seppo Järvenpää, Jari Kaipio, Matti Lassas and Martti Kalke 2006, “Parallelized Bayesian inversion for three-dimensional dental X-ray imaging”, IEEE Transactions on Medical Imaging 25(2), pp. 218-228

Personal Research Web Pages

http://www.siltanen-research.net/

Techila in use since 2008

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