C-EIT – the Novel Cardiovascular Monitor

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CSEM has developed a novel monitoring technique based on the electrical impedance tomography (EIT) technology. So-called EIT virtual catheter, this technique assesses valuable cardiovascular parameters such as blood pressure, stroke volume variations and aortic pulse wave velocity as if a virtual catheter was placed within the aorta. Because of the fact that EIT is a non-invasive, non-occlusive and unobtrusive technique, the EIT virtual catheter opens the door to a revolutionary large range of cardiovascular monitors that can be used both at the bedside and in ambulatory.

Electrical impedance tomography (EIT) is a non-invasive monitoring technology generating tomographic images of body conductivity. By placing a set of electrodes around the thorax, EIT provides continuous and non-invasive measurements of physiological quantities. Because at each respiratory cycle the inhaled air increases the impedance at the lungs, EIT has traditionally been used to monitor the efficiency of ventilation in respiration-assisted patients [1].

CSEM is exploring the use of EIT to monitor, in addition to ventilation, cardiovascular parameters [2]. This research is based on the fact that at each cardiac cycle, a pressure pulse propagates along the arterial tree, thus increasing local blood volume and decreasing its impedance. Accordingly, the novel CSEM approach relies on the post-processing of sequences of EIT images (50 images/second) in order to track the propagation of pressure pulse travelling within the thorax. In particular, a novel technique has been developed monitoring the propagation of pressure pulses along the descending aorta. Such a technique (Figure 1) provides continuous and non-invasive pulsatility measurements of the aorta as if a virtual catheter had been placed into it. The main innovation is thus the introduction of a novel set of strategies to process EIT images in a fully unsupervised manner in order to provide clinicians with clinically-meaningful quantities, rather than raw tomographic images.

In 2011, CSEM published multiple scientific results [3,4,5,6,7] proving the feasibility of using the EIT virtual catheter to monitor cardiovascular parameters such as blood pressure, stroke volume variations and pulse wave velocity.

In the following the most important results of this research, and their potential applications are summarised.

Blood pressure estimation

- Bedside non-occlusive monitoring of blood pressure: clinical continuous monitoring, sleep studies, drug R&D, physiological research, …
- Ambulatory non-occlusive monitoring of blood pressure: ambulatory applications and studies, sports and sleep studies, drug R&D, …

Stroke volume variations estimation

- Bedside non-invasive assessment of central hemodynamics: mechanical ventilation, volume resuscitation, ICU monitoring, …
- Ambulatory non-invasive assessment of fluid responsiveness: emergency monitoring and triage, ambulance environment, …

Pulse wave velocity estimation

- Unsupervised monitoring of arterial stiffness: large population epidemiological studies, arthrosclerosis research and monitoring, …

In conclusion, the novel EIT virtual catheter technology opens the door to a new family of non-invasive and unsupervised monitoring devices that can be used at the bedside or in ambulatory to assess valuable cardiovascular parameters.

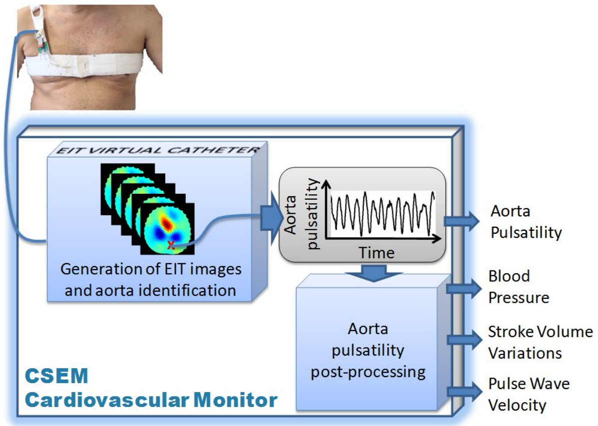

Figure 1: CSEM EIT-based technology for cardiovascular monitoring.

• Carleton University, Canada

•• Swisstom AG, a spin-off of CSEM, Switzerland

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