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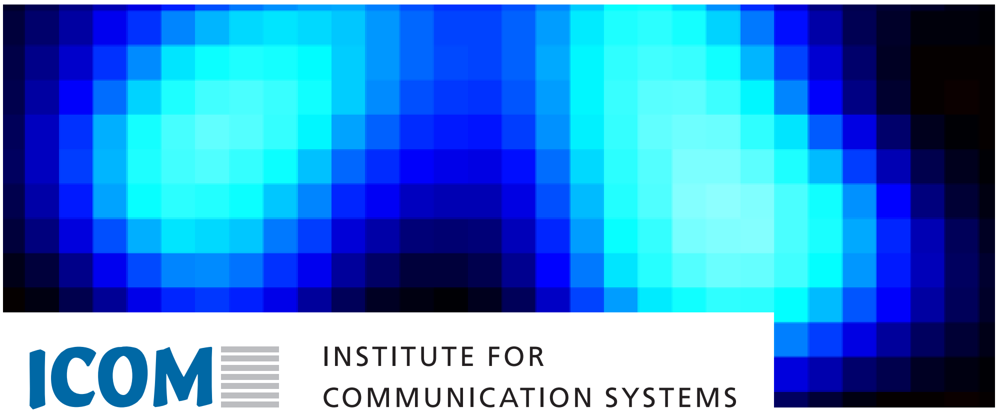

# Intuitive and reliable representation of lung ventilation by Electrical Impedance Tomograpgy

KTI-Projekt Nr. 12888.1 VOUCH-LS

**Mechanical ventilation therapy:** Fortyfive million patients undergo general anaesthesia every year. These patients need to be mechanically ventilated since anaesthetic agents suppress spontaneous breathing. In addition, 3.8 million intensive care unit patients worldwide will be mechanically ventilated each year. Out of all patients on mechanical ventilation, 15% develop acute lung injury and up to 46% of them die. This happens since the physiological condition of the lung can currently not be measured in real-time, and hence treatment cannot be customized to an individual patient's need.
Swisstom AG presents an innovative and convenient product that opens a window into the human thorax. The use of electrical impedance tomography (EIT) and the associated, protective ventilation technique could save the lives of several ten thousand people each year.

**EIT Principle:** EIT uses an electrode belt to apply small alternating currents and to measure the resulting voltages at the body surface. Using those data, tomographic images of the impedance change, enclosed within the body circled by the belt, can be continuously produced and thus allowing the real-time visualization of lung and heart functions as an EIT image stream. These abstract and complex images must be interpreted by an algorithm to understandable data for the doctors and nursing staff. The Embedded Software Engineering Lab was commissioned to develop this image interpretation in the context of a CTI project. The problem consists of several domains:

**Image interpretation:** Each pixel of the EIT image can be described by a temporal change in impedance, which depends on the physiological condition of that voxel within the lung. The Embedded Software Engineering Lab developed an algorithm that combines pixels with similar characteristics and accordingly similar physiological condition into clusters (see Figure 1d). The column-wise clustering process is depicted in Figure 1. Such a process usually demands a lot of computational power due to its combinatorial nature.

**Performance optimization:** To be able to run the clustering algorithm on an embedded system, the implemented algorithm must be efficient in terms of computational complexity.
The state of knowledge of medicine assumes, that the lung collapses along the gravity vector and thus, the clusters are always contiguous and in sequence. By this assumption, the entire optimization problem can be subdivided into several identical sub problems. The solution is subsequently made up of these partial solutions.

**Target implementation:** The algorithms has been developed and tested within a MATLAB framework. In order to run the algorithms on Swisstom's dedicated hardware platform, the MATLAB-Code has been ported to manually optimized C++ code.

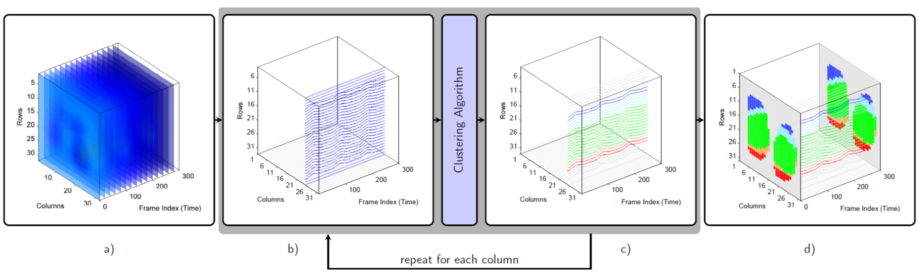


Figure 1: Column-wise Clustering process; a) EIT image frame buffer, b) input vectors of an individual column, c) clustered output vectors and d) resulting lung condition map after all columns has been clustered

**Further information**

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