AI-EIT

KI-EIT Evaluation des Potenzials künstlicher Intelligenz (KI) zur Erfassung von beginnenden Lungengewebsschädigungen mittels Elektrischer Impedanztomographie (EIT) durch Langzeitmonitoring

***F. H. Sinz, D. Becker, C. Blessing**, Campus Institute Data Science, University Göttingen*

In Short

- Electrical impedance tomography (EIT) is a non-invasive technique to continuously monitor lung properties.
- However, measurements can be distorted by systematic error that depend on the individual patient.
- We develop deep learning models to estimate properties of lungs from electric impedance tomography measurements that include additional information to yield a better and more interpretable prediction of lung properties.

Electrical impedance tomography (EIT) is a technique suitable for visualizing the distribution of ventilation, air filling and perfusion in the lungs. It was introduced in the early 1980s [1,2] and has been continuously developed in terms of hardware and software. Since the method can be used directly at the bedside and is not associated with radiation exposure, it has a high potential for application in monitoring regional lung function, e.g., in ventilated intensive care patients. It allows dynamic assessment of regional air and ventilation distribution and thus monitoring of therapeutic interventions. Furthermore, it is suitable for early diagnosis of lung diseases and for basic investigations of air and ventilation distribution [3].

So far, however, the so-called state-differentiated EIT has been established in clinical practice, which always requires a reference point in time and is therefore only suitable for short periods of a few days for long-term recording of temporal changes in impedance. Absolute EIT (a-EIT), on the other hand, does not require a reference measurement and continuously provides absolute scaled values of tissue impedance. Hopwever, a-EIT has been used much less frequently because its primary imaging properties can be influenced by systematic errors. These sources of error are not quantifiable a priori because they can depend on the individual patient.

Statistical algorithms and machine learning have been applied to problems in the context of EIT in the past [6]. However, most studies either do not address human measurements or limit their data to simulations or phantom organs designed to mimic human tissue. The few studies that do use human measurements mostly use machine learning (AI) either to post-process the images (post-processing with e.g. U-Nets [4,5]) or predict other diagnostic variables from EIT measurements [7–9] and mostly refer to state-differentiated EIT. AI algorithms that use additional sources of information for absolute EIT for tissue characterization, as proposed here, are not yet known.

However, the application of AI offers the possibility of incorporating prior statistical knowledge, such as the general location of organs, and additional information, such as body shape from images or body scans, into the image reconstruction. In this way, intelligent algorithms can learn better image reconstruction based on a larger amount of data. Deep neural networks are currently state of the art in all areas of image processing and have repeatedly demonstrated their superiority over manually designed algorithms in the past.

The aim of the project is to develop AI algorithms that can reconstruct lung properties from a-EIT measurements to monitor long-term changes in the electrical tissue impedance of the lung as an indicator of incipient, potentially pathological changes. The method of EIT enables the quantitative recording of changes in the electrical impedance of tissue in the form of tomographic sectional images. In contrast to computer tomography, it is not associated with radiation exposure and can therefore be used over longer periods without any problems. The use of artificial intelligence (AI) is expected to improve the analyzability of a-EIT so that it would be much more applicable to the aforementioned goal of early detection of damage to the lungs.

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https://sinzlab.org

More Information

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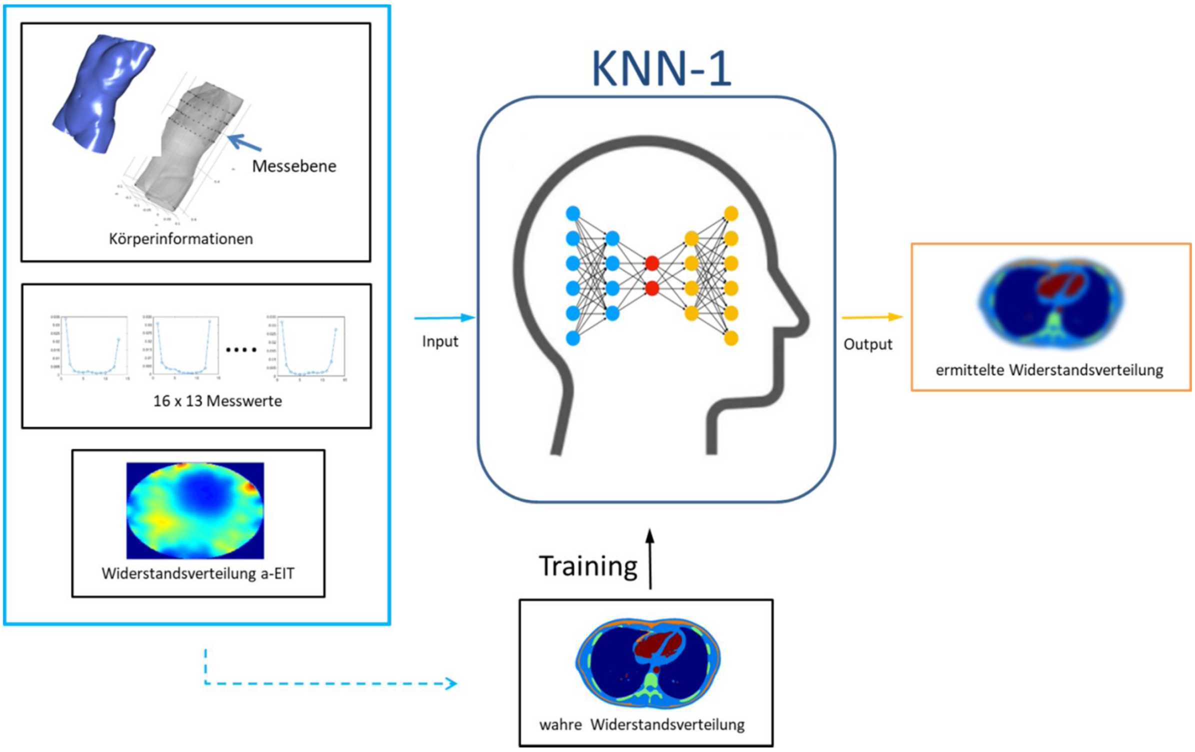

Figure 1: *Schematic of an exemplar model to predict lung properties from multi-modal measurements.*

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Project Partners

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