



MR-Based Electrical Property Reconstruction Using Physics-Informed Neural Networks

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BACKGROUND

Electrical properties (EP), such as permittivity and conductivity, dictate the interactions between electromagnetic waves and biological tissue. EP are biomarkers for pathology characterization, such as cancer. Imaging of EP helps monitor the health of the tissue and can provide important information in therapeutic procedures. Magnetic resonance (MR)-based electrical properties tomography (MR-EPT) uses MR measurements, such as the magnetic transmit field B_1^+ , to reconstruct EP. These reconstructions rely on the calculations of spatial derivatives of the measured B_1^+ . However, the numerical approximation of derivatives leads to noise amplifications introducing errors and artifacts in the reconstructions. Recently, a supervised learning-based method (DL-EPT) has been introduced to reconstruct robust EP maps from noisy measurements. Still, the pattern-matching nature of this method does not allow it to generalize for new samples since the network's training is done on a limited number of simulated data pairs, which makes it unrealistic in clinical applications. Thus, there is a need for a robust and realistic method for EP map construction.

DESCRIPTION

Researchers at the University of California, Santa Barbara, have created a physics-informed deep learning framework that can accurately reconstruct EP at an arbitrarily high spatial resolution from incomplete, noisy MR measurements. This invention applies Fourier neural network algorithms constrained by the Helmholtz equation to effectively de-noise magnetic field measurements. Two separate Fourier neural networks efficiently estimate the magnetic field and EP at any location. This technology marks the first time that EP and magnetic field values can be reconstructed simultaneously from incomplete noisy measurements, indicating further potential to improve other MR-based reconstruction methods, such as Helmholtz-EPT and convection-reaction EPT. Greater success in generating these EP maps translates to better diagnostic/prognostic tools and better-informed treatment options.

ADVANTAGES

- ▶ Accurately reconstructs EP maps using physics-informed deep learning from incomplete, noisy MR measurements
- ▶ Instrumental for further improvements in MR-based reconstruction methods

APPLICATIONS

- ▶ Biotech

CONTACT

Pasquale S. Ferrari
ferrari@tia.ucsb.edu
tel: .

INVENTORS

- ▶ Liu, Ziyue
- ▶ Yu, Xinling
- ▶ Zhang, Zheng

OTHER INFORMATION

KEYWORDS

MRI, cancer, neural network, de-noise, EP maps, Diagnostic/prognostic tools, Magnetic field measurements, Pathology characterization, Electrical properties tomography (MR-EPT), Magnetic transmit field B1+

CATEGORIZED AS

- ▶ **Computer**
 - ▶ Software
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RELATED CASES

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PATENT STATUS

Country	Type	Number	Dated	Case
Patent Cooperation Treaty	Published Application	WO 2024/081966	04/18/2024	2023-860

Additional Patent Pending

RELATED MATERIALS

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University of California, Santa Barbara
Office of Technology & Industry Alliances
342 Lagoon Road, Santa Barbara, CA 93106-2055 |
www.tia.ucsb.edu
Tel: 805-893-2073 | Fax: 805.893.5236 | padilla@tia.ucsb.edu



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