QUIERO

Newsletter n.2
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EMPIR EURAMET

QUantitative Imaging Enables Reproducible Outcomes

18HLT05 – Quantitative MR-based Imaging of Physical Biomarkers

Welcome to the second newsletter of the European EMPIR project 18HLT05 QUIERO, whose aim is to evaluate the suitability of two MR-based emerging techniques, Electrical Properties Tomography (EPT) and Magnetic Resonance Fingerprinting (MRF), to contribute to the "quantitative revolution" in MRI. Our consortium is composed of six European metrology institutes, two clinical centres and three universities.

The mid-term meeting of the project, initially planned to be hosted by the University of Ljubljana, took place on November 30th and December 1st, 2020, as an online event. Despite this, it was a successful meeting, attended by 30 people. In order to ensure the full achievement of the project results, mitigating the drawbacks associated with the recent lockdown, the consortium members decided to ask for a 6-month extenstion of the project, whose conclusion is therefore postponed to November 2022.

We are on the web!

Visit our website, consult our community on Zenodo, and take a look at our pages on LinkedIn and ResearchGate

Watch the video that explains QUIERO's work plan.

Highlights

EPTlib is the library of EPT methods developed within the project and made available on GitHub. Shortly after its publication, EPTlib has been used to develop an example of uncertainty evaluation, applied to EPT, in the framework of the EMPIR project 17NRM05 EMUE.

Contacts

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Consortium

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WP 1

Development of the reconstruction techniques

Helmholtz EPT, convection-reaction EPT and gradient EPT have been implemented within EPTlib, where the users can find a stand-alone executable file that works on the results of B1-mapping sequences, with the possibility to set the relevant parameters. The EPT results can be refined through a post-processing filter that could exploit a contrast image or a segmentation as an additional information. A method to estimate the relaxation times directly from k-space data has been developed and its performances have been compared, for different sampling schemes, to those of the dictionary-based MRF previously implemented. In addition, a Bayesian approach to estimate the uncertainty of MRF has been developed. Finally, an MRF-based B1-map-ping, suitable to provide input for EPT in the presence of physiological motion, has been developed.

WP 2

Metrological characterisation of reconstruction techniques in silico

Realistic electromagnetic and Bloch simulations, required to feed virtual EPT/MRF experiments, have been carried out. A virtual measurement system, which allows producing synthetic B1-mappings including non-ideal spoiling and possible off-resonance RF pulses, has been developed. It can be used to study the intrinsic bias and the propagation of uncertainty, associated with noisy input, of EPT algorithms, in the framework of a Monte Carlo method. The metrological characterization (accuracy and precision) of both the EPT algorithms and the MRF techniques has started.

WP 3

Experimental characterisation of EPT and MRF in phantoms

The consortium has produced a number of homogeneous and heterogeneous tissue mimicking phantoms, with independent tuning of relaxation times and dielectric parameters. These properties have been characterized in more than one site. From now on, repeatability and reproducibility tests will be periodically performed on the phantoms. A first 3D-printed biphasic grey/white matter anthropomorphic prototype, whose stability has been verified over several weeks, has been prepared. Finally, work has commenced in view of the realization of a new low-cost soft-matter 3D printer for large volumes.

WP 4

In vivo quantitative differentiation of tissue

Data accrual for the clinical study of brain diseases is in progress and a first dataset of MRF maps collected in eight different sites on twelve healthy volunteers has been published. The clinical study for heart diseases has been approved and the trial has been prospectively registered. Work on the possibility to exploit information about the input uncertainty for the use of artificial intelligence to semi-automatically detect clinical anomalies has started.

QUIERO supports the first ***Joint Workshop on MR Phase, Magnetic Susceptibility and Electrical Properties Mapping***.

...see you in Lucca!

Latest publications

- J. Mayer et al., Flexible numerical simulation framework for dynamic PET-MR data, *Physics in Medicine and Biology*, 2020.
- P. A. Gomez et al., Rapid three-dimensional multiparametric MRI with quantitative transient-state imaging, *Scientific Reports*, 2020.
- G. Buonincontri et al., Three dimensional MRF obtains highly repeatable and reproducible multi-parametric estimations in the healthy human brain at 1.5T and 3T, *NeuroImage*, 2020.

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