QUIERO

Newsletter n.4
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EMPIR EURAMET

QUantitative Imaging Enables Reproducible Outcomes

18HLT05 – Quantitative MR-based Imaging of Physical Biomarkers

Welcome to the fourth (and final) 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 final meeting of the project, hosted by PTB Berlin, took place on 24-25 November 2022. At the meeting, the partners discussed the last technical activities, summarized all achievements of the project, and planned further actions for their dissemination.

Formally, QUIERO ended on 30 November 2022, but we are currently working on new scientific papers and our website will be regularly updated in the next months. Moreover, the work performed in the project originated new ideas and we will carry on further research activities on EPT and MRF. Keep on following us!

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

In July 2022 our consortium organized a one-day online workshop, open to external attendees, focused on cardiac applications of quantitative MRI. Moreover, with seven technical presentations and one educational lecture held by consortium members, QUIERO was one of the protagonist of the "Joint Workshop on MR phase, magnetic susceptibility and electrical properties mapping", which took place in Lucca (Italy) in October 2022.

Contacts

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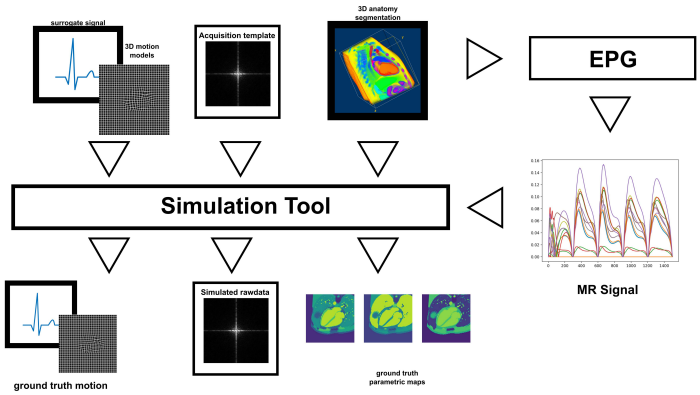
WP 1

Development of the reconstruction techniques

The virtual environment developed to simulate MRF signals in the cardiac region has been made available as an **open-source software** on GitHub, along with a range of different **tutorials** written as Jupyter Notebooks. Moreover, the consortium implemented a motion-correction approach that minimizes motion-related artefacts in the MRF maps for a wide range of different heart rates, allowing for quantitative assessments of the myocardium. These tools have been used to study the effect of different cardiac and respiratory motion types on the accuracy and precision of the estimation of the relaxation times.



Simulation environment for cardiac MRF

WP 3

Experimental characterisation of EPT and MRF in phantoms

A triphasic phantom composed of white matter, grey matter and a solution mimicking the cerebrospinal fluid has been built using the 3D-printer developed by the consortium. In addition, a biphasic brain phantom obtained starting from a 3D-printed mould has been prepared.

These phantoms have been used to perform MRF and EPT experiments in MRI scanners, with special focus on their repeatability and reproducibility. Very good stability of the dielectric and relaxation properties of the phantoms produced during the whole project has been observed.

WP 4

In vivo quantitative differentiation of tissue

The acquisition of MRI data on healthy volunteers and patients has concluded. Cardiac MRF measurements have been performed and compared to conventional T1/T2 mapping strategies. Brain EPT maps deduced from the water fraction have been also reconstructed. They put in evidence an exponential decay of the conductivity of white and grey matter with the age. Physiological ranges of variability have been determined for both the relaxation times of the myocardium and the conductivity of the white matter, thus providing thresholds for the possible use of these parameters as biomarkers.

WP 2

Metrological characterisation of reconstruction techniques in silico

Our consortium has investigated the use of the quantitative maps to spot the presence of pathological anomalies simulated in virtual human models. For cardiac MRF, both traditional statistical approaches and a convolutional neural network have showed good efficacy of classification. For brain EPT, a smart post-processing approach based on the consilience between Helmholtz and convection-reaction EPT has reached promising results. Moreover, an exploratory study on the possibility to perform subject-specific assessments of the local SAR based on B1-mapping and EPT measurements, combined with suitable correction factors, has been published.

Recent publications

- S. Metzner et al., *A comparison of two data analysis approaches for quantitative magnetic resonance imaging*, Measurement Science and Technology, 2022.
- J. Ludwig et al., *Pilot tone-based prospective correction of respiratory motion for free-breathing myocardial T1 mapping*, Magnetic Resonance Materials in Physics, Biology and Medicine, 2022.
- D. Kilian et al., *3D Extrusion Printing of Biphasic Anthropomorphic Brain Phantoms Mimicking MR Relaxation Times Based on Alginate-Agarose-Carrageenan Blends*, ACS Applied Materials & Interfaces, 2022.
- S. Hufnagel et al., *3D model-based super-resolution motion-corrected cardiac T1 mapping*, Physics in Medicine and Biology, 2022.
- J. Martinez et al., *Evaluation and Correction of B+1-Based Brain Subject-Specific SAR Maps Using Electrical Properties Tomography*, IEEE Journal of Electromagnetics, RF, and Microwaves in Medicine and Biology, 2023.
- C. Gatefait et al., *Optimisation of data acquisition towards continuous cardiac Magnetic Resonance Fingerprinting applications*, Physica Medica, 2023.

QUIERO will participate at the first international EPT reconstruction **challenge**.
Go to **https://www.emtphub.org/events/** to find more information on this initiative.

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