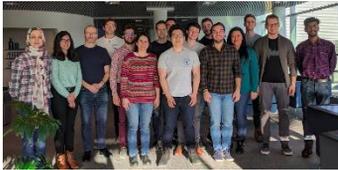Welcome

1 year before Corona came to Europe

TRABIT 2020

This year is very special for all of us. We are facing a pandemic with all its tragedies and challenges for our healthcare systems and societies. This pandemic showed us that the intelligent use of digital tools and international collaboration are keys to the efficient and precise management of health.

Our TRABIT doctoral students have of course also been affected by the pandemic. Many of the planned secondments were shortened, postponed or completely cancelled. The training school in Munich planned for August 2020 has been postponed as well and will now hopefully take place in the beginning of 2021.

With this newsletter we would like to share our latest developments and publications with you. Please enjoy reading.

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Andrey Zhylka

Secondments at Klinikum rechts der Isar and remote cooperation with EPFL

Hello, my name is Andrey Zhylka and I am working on fiber tractography for neurosurgery planning at Eindhoven University of Technology.

I had two short visits to Klinikum rechts der Isar in Munich to start a project on clinical evaluation of the newly developed tractography approach. Those visits also resulted in the involvement in an additional project with local PhD students.
I am also currently remotely cooperating with a group from EPFL on analyzing the effect of a tumor on certain fiber bundles.

Luca Canalini

Secondments at icometrix and at Klinikum rechts der Isar

My name is Luca Canalini and I am working in the area of ultrasound and MRI registration for neurosurgical planning and intraoperative decision support.

In the first half of 2020, I spent 3 months at icometrix (Leuven, Belgium) for my first secondment. There, I focused on the segmentation of resection cavities in MRI images acquired at subsequent neurosurgical stages. It has been a great opportunity to broaden my career horizons and to get in contact with new colleagues working in the medical imaging fields.

With the knowledge and the results acquired during my first secondment, I continued working on a similar topic in my second short stay that took place at the Klinikum Rechts der Isar, in Munich. There, I focused on a novel deep learning approach to register MRI volumes acquired at subsequent stages of neurosurgical procedures. Thanks to the expertise of neuroradiologists and other colleagues I met, I had the chance to get a deeper understanding of the clinical challenges related to my research topics.

Stefano Cerri

Secondment at Klinikum rechts der Isar

My name is Stefano Cerri and I am working on developing brain segmentation methods, with a focus on methods that work on multiple sclerosis patients.

In spring 2019, I spent five weeks at the Klinikum rechts der Isar in Munich, supervised by Prof. Dr. Mark Mühlau, a leading expert in multiple sclerosis. During this period, I had the chance to test a method I developed for the simultaneous segmentation of white-matter lesions and anatomical structures on a large clinical dataset. This experience had greatly enhanced my knowledge of multiple sclerosis, as well as gave me insights into the challenges of working with clinical neuroimaging data.
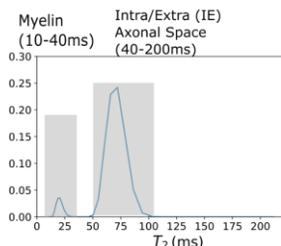
TRABIT Newsletter

Multi-Echo
MR Signal
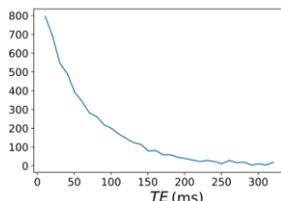
Inverse
Reconstruction

T2 Distribution

Inverse Problems for Diffusometry / Relaxometry

In recent years, quantitative MRI (QMRI) has taken on increasing importance with respect to research and clinical applications. Examples include estimating the diffusion and/or transverse relaxation parameters of different water pools in the brain. One particular parameter of interest for quite some time is the water fraction of the water trapped in the myelin sheath, as this has been shown to be highly correlated to various neuro-degenerative disorders such as multiple sclerosis. Recovery of such parameters is typically done through solution of inverse problems.

Thomas Yu is working on using optimization, stochastic methods such as Monte Carlo methods, and machine learning in order to robustly and accurately solve inverse problems which arise from diffusometry and/or relaxometry.

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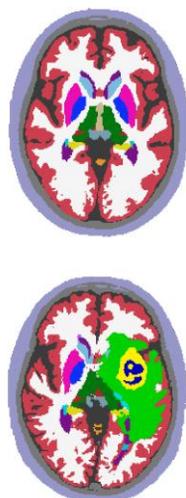
Atlas based whole brain and tumor segmentation of multi contrast MRI

One of the main challenges in segmentation of MR images is to make the algorithm robust to variations in the data. Most existing methods for brain tumor segmentation are developed and tested on very specific imaging protocols only, and their segmentation performances degrade substantially when applied to data from different scanners and acquisition protocols.

Sveinn Pálsson is working on a modality adaptive whole-brain and tumor segmentation for multi-modal MRI. The method uses a generative image model combined with a deformable atlas and a tumor shape model. The tumor shape is modeled with a variational autoencoder. The method builds on a similar method developed within TRABIT for MS lesions. The method will be made publicly available as part of Freesurfer.

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Short Report ESR 10

Clinical workflow optimization for surgical neuro-oncology

Tractography from diffusion magnetic resonance (MR) images aids in the localization of nerve fiber bundles to guide neurosurgeons in brain tumor surgery. However, owing to suboptimal data processing and visualization workflow, use of poor fiber-tracking models in clinical (research) applications, and low credibility in estimated nerve fiber representations, tractography has been infrequently utilized for planning and guidance in neurosurgery.
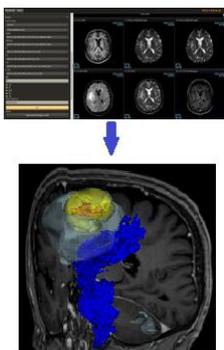
Daniel Krahulec is designing a fast, fully automated clinical research software application for optimized workflow in presurgical planning. Using anatomical and diffusion MR images, he develops a data processing pipeline and deploys it on a Philips-proprietary research platform. He integrates advanced tractography algorithms to compensate for commonly known fiber-tracking problems, such as crossing fibers. Results are visualized as 3D maps in an interactive viewer. Final solution is evaluated by medical professionals, and cross-validated with other fiber-tracking software.

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Short Report ESR 14

Assessing Blood Brain Barrier Integrity using Contrast Agent-free MRI (ASL)

The blood brain barrier (BBB) is a dynamic structure that regulates and maintains the microenvironment in the brain. As a direct blood-tissue interface, the assessment of BBB integrity is of utmost interest for several diseases, including neurodegenerative diseases, tumors and stroke. Interest in the assessment of the functionality and integrity of the BBB using MRI is increasing, but measuring the BBB integrity in humans is not straight forward.

Amnah Mahroo is working on Multi-echo Arterial Spin Labeling (ASL) which is a non-invasive, contrast agent-free MRI method to assess the leakiness of BBB by estimating the exchange time – the time taken by the labelled water molecules to move across the BBB. She is testing different strategies like two-stage analysis to improve the estimation process and to decrease the scan time, making it feasible to introduce this MRI method in a clinical setting. Her goal is to develop, test and validate this approach which can act as an imaging biomarker for early diagnosis of neurovascular diseases, such as Alzheimer's disease and dementia.

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Recent TRABIT Publications
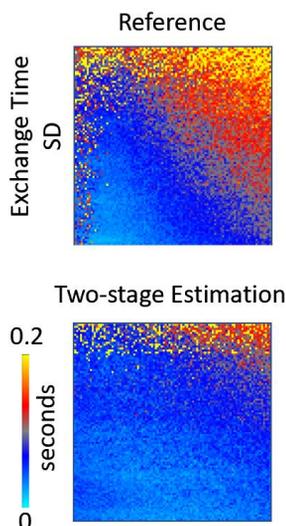
TRABIT Publications

The following publications are first-authored by an ESR of TRABIT.

S. Cerri et al. A contrast-adaptive method for simultaneous whole-brain and lesion segmentation in multiple sclerosis. NeuroImage, 2020

L. Canalini et al. Segmentation-based registration of ultrasound volumes for glioma resection in image-guided neurosurgery. IJCARS, 2019

F. La Rosa et al., Multiple sclerosis cortical and WM lesion segmentation at 3T MRI: a deep learning method based on FLAIR and MP2RAGE, NeuroImage: Clinical, 2020.

L. Canalini et al., Enhanced Registration of Ultrasound Volumes by Segmentation of Resection Cavity in Neurosurgical Procedures, International Journal of Computer Assisted Radiology and Surgery, 2020

L. Canalini et al., Comparison of different automatic solutions for resection cavity segmentation in postoperative MRI volumes including longitudinal acquisitions, to appear: Proc. Vol SPIE, Medical Imaging 2021

F. La Rosa et al., Automated Detection of Cortical Lesions in Multiple Sclerosis Patients with 7T MRI, International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI) 2020.

S. Cerri et al. A Longitudinal Method for Simultaneous Whole-Brain and Lesion Segmentation in Multiple Sclerosis, MLCN 2020

A. Mahroo et al. Exchange time as a proxy measure of blood brain barrier integrity – A two-stage estimation, ISMRM 2020

A. Mahroo et al. Assessing Repeatability of Blood Brain Barrier Permeability Measure Using Contrast-free MRI, ISMRM 2020

A. Zhylka et al., Anatomically informed multi-level fiber tractography for improved sensitivity of white matter bundle reconstruction in diffusion MRI, ISMRM 2020.

A. Zhylka et al., Multi-level fiber tracking: evaluation on clinical data, ISMRM 2020.

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