Perfecting Brain Scans: New Horizons

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ABSTRACT

Magnetic Resonance Imaging is a widely used neuroimaging technique used to probe brain tissues, their structure and provide diagnostic insights on the functional organization as well as the layout of brain vessels. However, MRI relies on an inherently slow imaging process.

Reducing acquisition time has been a major challenge in high-resolution MRI and has been successfully addressed by Compressed Sensing (CS) theory. However, most of the Fourier encoding schemes under-sample existing k-space trajectories which unfortunately will never adequately encode all the information necessary. Recently, my team has addressed this crucial issue by proposing the Spreading Projection Algorithm for Rapid K-space sampLING (SPARKLING) for **2D/3D non-Cartesian T2* and susceptibility weighted imaging at 3 and 7Tesla (T**) [1,2]. In the first half of my presentation, I will present these advancements, show interesting clinical applications and demonstrate how we have even adapted this approach to address high-resolution functional and metabolic (Sodium ^{23}Na) MR imaging at 7T – a very challenging feat. Additionally, I will explain how the SPARKLING under-sampling strategy can be used to internally estimate the static B0 field inhomogeneities a necessary component to avoid the need for additional scans prior to correcting off-resonance artifacts due to these inhomogeneities.

Although CS is used extensively, this approach suffers from a very slow image reconstruction process, which is detrimental to both patients and rapid diagnosis. To counteract this delay and improve image quality, deep learning is used. To develop this further, in the second half of my talk, I will share our own deep-learning architecture, XPDNet (Primal Dual Network where X plays the role of a magic card), This truly innovative process was ranked second in the 2020 brain fastMRI challenge (1.5 and 3T data) [3]. I will illustrate XPDNet's transfer learning capacity on 7T NeuroSpin T2 images. Finally, I will share how we have further improved this approach in the NC-PDNet architecture [4] to handle 3D non-Cartesian imaging settings associated with the SPARKLING encoding scheme, in order to more accurately perfect brain scanning for the future.

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