Docket #: S18-437

Simultaneous acquisition of Qualitative and Quantitative MRI (Q2MRI) using deep learning

Stanford researchers at the Xing Lab have developed a novel method using deep neural networks called "Q^2MRI" to simultaneously acquire qualitative MR image and quantitative MRI parametric maps without changing the clinical imaging protocol or elongating MRI scan time. Currently, quantitative MRIs are obtained from a series of qualitative MRI, which takes prohibitively long scan times. The new method automatically derives quantitative MRI from a single qualitative MRI with an established prediction model. In addition, the proposed approach suppresses measurement errors caused by RF inhomogeneity and eliminates the possibility of inter-scan motion. This invention will enable broader use of quantitative MRIs which provides more information about tissue characterization and tissue response assessment than qualitative MRIs.

Figure 1

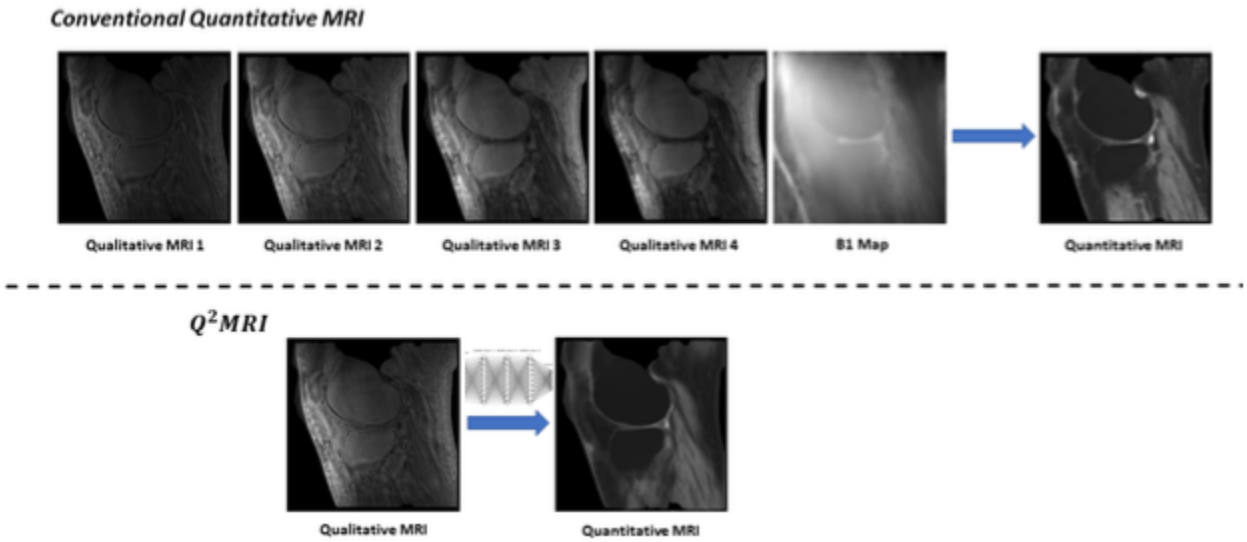


Figure 1 description - Generating quantitative T_1 map and proton density map

from qualitative T_1 weighted MRI (a) using conventional model fitting and (b) using a deep convolutional neural network.

Figure 2

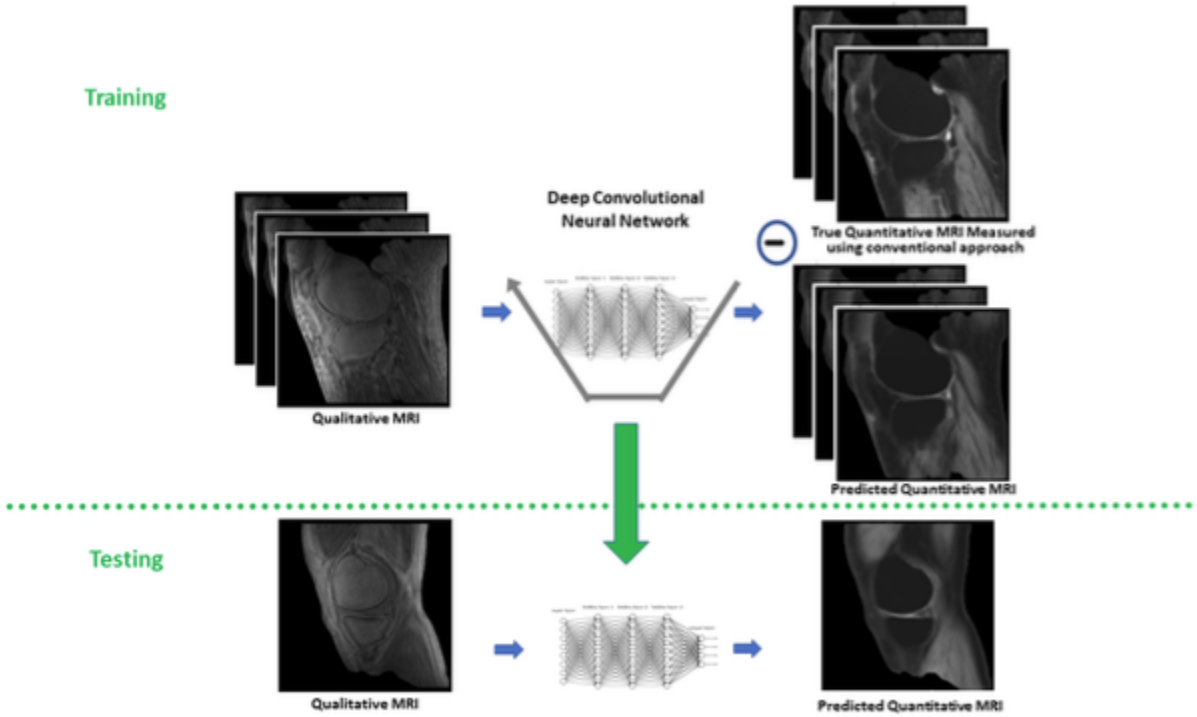


Figure 2 description - Training and testing of a neural network for the derivation of quantitative MRI from a single qualitative MRI. Notice that the ground truth image is obtained using conventional quantitative MRI.

Stage of Research:

- **Completed simulations** - (using digital phantoms) derived various quantitative MR maps from a single qualitative MR image
- **Completed experiments on T1 mapping** of cartilage MRI - predicted quantitative T1 map from a single qualitative T1 weighted MR image (that was acquired using a UTE sequence) with B1 inhomogeneity compensated
- **Continued experiments on T2 mapping**

Applications

- **Quantitative MRI can be used for**:
  - Characterizing pathology/tumors

- Predicting treatment response
- Diagnosis of diseases with higher specificity than qualitative MRI
- Providing noninvasive surrogate for biopsy in some applications
- Data sharing across different medical centers that prescribe different imaging protocols
- Generating of electron density in MRI-only radiation therapy treatment planning
- Facilitating more accurate and robust segmentation

Advantages

- **Simultaneous acquisition** of qualitative and quantitative MRIs
- **Significant savings in scan time, image processing time, and corresponding costs:**
  - No extra scan time is required for the derivation of quantitative maps. The only input image is qualitative, obtained for routine clinical purpose.
  - Provides data-driven end-to-end mapping from a conventional qualitative MR image to the corresponding quantitative MR parametric maps.
- **Suppresses measurement errors caused by RF inhomogeneity.**
- **Eliminates possibility of inter-scan motions** which commonly occur in conventional quantitative MRI between the acquisition of different qualitative images. Image registration is no longer needed.
- **Enables broader use of quantitative MRIs**

Patents

- Published Application: 20210313046
- Issued: 11,948,676 (USA)

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