NMR-based magnetic field sensor with active frequency control

Encapsulation method for sensors with enhanced flexibility and reduced system cost.

Technology

The ideal magnetic field sensor for magnetic resonance imaging (MRI) applications can measure the field changes with sufficient sensitivity and temporal resolution at a precise spatial location, but without disturbing the imaging process. Traditional hydrogen-based NMR-magnetic field sensors provide the highest signal-to-noise ratio (SNR) but can interfere with the imaging process if concurrent field monitoring during the actual imaging experiment is desired. Therefore, fluorine, deuterium, or chemically shifted field sensors have been proposed, which have the drawbacks of reduced sensitivity and requiring additional transmit-receive electronics.

The developed sensor design solves these issues by enabling hydrogen-based NMR-field sensors whose operating frequency can be actively controlled. Besides the additional flexibility, the design offers the advantage that the receive chain that is available for the main MRI measurement can be used for the acquisition of the frequency sensor data. Besides the system cost optimization, utilizing the already available transmit and receive hardware of the MRI system has the additional advantage that the data of the sensor is processed with the same filter and measurement clock as the imaging data, leading to the improved reliability of the results.

Innovation

- Novel encapsulation method for NMR magnetic field sensors
- Enables positioning of additional B_0-field modification coil
  - Allows for active control of operating frequency
- Frequency adjustable field sensors enable new measurement scenarios
  - Utilize the same receive chain as the main MR imaging process

Application

- MRI with reduced manufacturing costs and improved image quality
- Integrated concurrent field monitoring during MR imaging
- Gradient system characterization

Developmental Status

- 2019: Design and Manufacturing of sensor demonstrator
- 2020: Publication “Frequency-adjustable magnetic field probes“ https://doi.org/10.1002/mrm.28444
- 2021: Manufacturing of sensor array

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Patent Status

DE 102009109062
Filed (PRD) April 5th 2019

WO 2020/201417

Reference Number

ZEE2018110700

Status: Jun-21

CTF – The R&D Company of the
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