Hui Han

Web Bio

Information

Biography

Biographical Statement

Hui Han, Ph.D. is MRI Hardware Physicist in the newly established Cornell MRI Facility (CMRIF) and works as an independent investigator in the Department of Human Development at Cornell University. He is mostly responsible for the RF laboratory within CMRIF. His previous PhD study at Canada UNB MRI Research Center and postodoctoral research at Brain Imaging and Analysis Center (BIAC) in Duke University Medical Center focused on the development of novel MRI hardware and methodologies for in vivo and material applications (e.g., fluids in porous media). His research outcome has led to three US patents (filed by universities) on MRI instrumentation that are currently under considerations for the commercialization by leading corporations in both medical device and petroleum industries.

Dr. Han is continuing the so-called 'iPRES' concept (*i*ntegrated *P*arallel *R*eception, *E*xcitation, and *S*himming), which is a new concept for an MRI hardware platform combining B0 shimming and RF into one integrated coil array. The new technique can provide dramatically improved image resolution and accuracy for functional and structural imaging (e.g., at prefrontal cortex and temporal lobes in human and animal brain). He is also interested in other new techniques and hardware that can provide a variety of MRI practitioners with improved in vivo spatial and temporal image resolution.

Department Website Summary

N/A

Teaching

Teaching and Advising Statement

Involves the instruction of graduate students.

Visiting scholars and exchange PhD students are welcome including volunteers.

Professional

Current Professional Activities

As defined by Cornell academic policy on Senior Research Associate, Dr. Han is responsible for independently designing and implementing research projects or programs. Specific duties may include, but are not limited to, planning, conducting, and reporting on original research; designing, constructing, or operating state-of-the-art research apparatus; and supervising the overall research operations of a laboratory or facility. May serve as Principal Investigator on a grant or contract. May serve as minor members on graduate students' special committees. Have extensive contacts with graduate students and guide their research.

Awards and Professional Service:

ISMRM Junior Fellow
2013

ISMRM (International Society for Magnetic Resonance in Medicine)

Annual Meeting Program Committee, Observer
2013-2014

Overseas talent into the Academy of Week, Chinese Academy of Sciences 2012

Canada NSERC Visiting Fellowship (VF) Inventory in Government Laboratories
2010

Canada NSERC Industrial R&D Fellowship (IRDF) Inventory 2010

Chinese Government Award for Outstanding Students Abroad
2009

Research

Current Research Activities

integrated Parallel Reception, Excitation and Shimming (iPRES) for MRI

Integrated shim and RF array

The interesting knowledge learned during my PhD, on RF and DC working in one single RF coil for MR imaging an operational fuel cell (1), together with encouraging discussions with my colleagues, have recently stimulated me to propose the idea so-called 'iPRES' for *i*ntegrated *P*arallel *R*eception, *E*xcitation and *S*himming (2-4). This concept uses a single coil array rather than separate arrays for parallel RF reception and B0 shimming. It relies on a novel circuit design that allows a radiofrequency current (for excitation/reception) and a direct current (for B0 shimming) to coexist independently in the same coil. The underlying principle is simple and found widespread in electrophysics and communications that currents or waves at different frequencies can coexist independently in the same conductor or media without undesired interference between them.

By taking advantage of multi-channel receivers (e.g., 32) commonly available on modern scanners, the new concept integrateds localized multi-coil B0 shimming into a conventional RF phased array (5) by innovated coil design. Therefore, conventional muti-channel receive arrays can be replaced by the new integrated shim-RF array. Compared to a conventional RF coil, the integrated coil provides the add-on ability for multi-coil local B0 shimming without compromising the RF sensitivity in principle (2,4).

Compared to B0 shimming coils equipped on modern MRI scanners, the multi-coil local shimming has already been proven as a powerful strategy achieving unprecedented homogeneous main field in the human and mouse brain (2,6,7), which paves the way for high field MR applications for which excellent magnetic field homogeneity is a prerequisite. Compared to recently innovated multi-coil shimming methodology using separate shim and RF arrays (6,7), iPRES provides dramatically increased signal-to-nose ratio in RF reception particularly at brain cortices and more effective local shimming simply because of the closest proximity of the integrated coil to the subject (2,4).

Such an integrated shim-RF array is a new hardware platform that can provide a variety of MRI practitioners with improved image spatial and/or temporal resolution in vivo for both anatomical and functional imaging (e.g., at prefrontal cortex and temporal lobes of human and animal brain). It is also expected to require minimal modifications to the architecture of state-of-the-art MRI systems.

For the first time, the idea of integrated RF/Shim array was filed for a US patent (4) and published in a rapid communication (2), in both which the technical challenges were outlined and solutions were also given. What's exciting, the same idea was proposed by another prestigious MR group almost at the same time (8) and is currently under further development and applied to human brain studies by different large groups (9-11).

References:

1. Zhang Z, Martin J, Wu J, Wang H, Promislow K, Balcom BJ. Magnetic resonance imaging of water content across the Nafion membrane in an operational PEM fuel cell. J Magn Reson 2008;193:259–266.

2. **Han H**, Song AW, Truong TK. Integrated parallel reception, excitation, and shimming (iPRES). Rapid communication, Magn Reson Med 2013;70:241–247.

3. **Han H**, Song AW, Truong TK. Integrated parallel reception, excitation, and shimming (iPRES). 2013. Proc. Int. Soc. Magn. Reson. Med. 21, 664.

4. **Han H**, Truong TK, Song AW. Magnetic resonance imaging systems for integrated parallel reception, excitation and shimming and related methods and

devices. United States provisional patent application no. 61/665,517 on June 28, 2012. United States patent applicatoin publication no. US 2014/0002084 on Jan. 2, 2014. International WIPO patent application publication no. WO 2014/003918 on Jan. 3, 2014

5. Roemer PB, Edelstein WA, Hayes CE, Souza SP, Mueller OM. The NMR Phased Array. Magn Reson Med 1990;16:192-225.

6. Juchem C, Brown PB, Nixon TW, McIntyre S, Rothman DL, de Graaf RA. Multi-coil shimming of the mouse brain. Magn Reson Med 2011;66:893–900.

7. Juchem C, Brown PB, Nixon TW, McIntyre S, Boer VO, Rothman DL, de Graaf RA. Dynamic multi-coil shimming of the human brain at 7T. J Magn Reson 2011;212:280–288.

8. Stockmann JP, Witzel T, Blau J, Polimeni JR, Zhao W, Keil B, Wald LL. Combined shim-RF array for highly efficient shimming of the brain at 7 Tesla. 2013. Proc. Int. Soc. Magn. Reson. Med. 21, 665.

9. Stockmann JP, Witzel T, Keil B, Mareyam A, Polimeni J, LaPierre WC, Wald LL. A 32ch combined RF-shim brain array for efficient B0 shimming and RF reception at 3 T. 2014. Proc. Int. Soc. Magn. Reson. Med. 22, 400.

10. Truong TK, Darnell D, Song AW. Integrated RF/shim coil array for parallel reception and localized B0 shimming in the human brain at 3 T. 2014. Proc. Int. Soc. Magn. Reson. Med. 22, 4849.

11. Truong TK, Darnell D, Song AW. Integrated RF/shim coil array for parallel reception and localized B0 shimming in the human brain. NeuroImage 103 (2014) 235–240.

Extension

Education

Courses

Websites

Related Websites

http://mri.cornell.edu/

http://www.ismrm.org

http://www.human.cornell.edu/hd/

Administration

Publications

Selected Publications

Patents

1. **Hui Han**, Trong-Kha Truong, Allen Song, Magnetic Resonance Imaging Systems for Integrated Parallel Reception, Excitation and Shimming and Related Methods and Devices. Patents filed by Duke University:

United States provisional patent application no. 61/665,517 on June 28, 2012.

United States patent application publication no. US 2014/0002084 on Jan. 2, 2014.

International WIPO patent application publication no. WO 2014/003918 on Jan. 3, 2014

2. **Hui Han**, Bruce J. Balcom, Magnetic field gradient monitor apparatus and method(MFGM). Patents filed by University of New Brunswick in Canada:

International WIPO patent application publication no. WO/2010/003237 on Jan. 14, 2010.

United States Patent No. US 8,717,022 awarded on May 6, 2014.

3. Bruce J. Balcom, Derrick Green, **Hui Han**, Magnetic resonance (imaging) apparatus and method (High pressure MRI system with metallic enclosures). Patents filed by University of New Brunswick:

Canadian patent application publication no. CA 2,683,411 on Feb. 28, 2011.

United States Patent No. US 8,791,695 awarded on July 29, 2014.

Papers

1. W. Li, N. Wang, F. Yu, **H. Han**, W. Cao, R. Romero, B. Tantiwongkosi, T.Q. Duong, C.L. Liu. A method for estimating and removing streaking artifacts in quantitative susceptibility mapping, NeuroImage 108 (2015) 111–122.

2. W. Cao, W. Li, **H. Han**, S.K. O'Leary-Moore, K.K. Sulik, G.A. Johnson, C.L. Liu. Prenatal alcohol exposure reduces magnetic susceptibility contrast and anisotropy in the white matter of mouse brains, NeuroImage 102 (2014) 748–755.

3. F. Goora, **H. Han**, B. Colpitts, B.J. Balcom. Investigation of magnetic field gradient waveforms in the presence of a metallic vessel in magnetic resonance imaging through simulation, IEEE Transactions on Magnetics 49 (2013) 2920-2932.

4. **H. Han**, A.W. Song, T.K. Truong. Integrated parallel reception, excitation, and shimming (iPRES), rapid communication, Magnetic Resonance in Medicine, 70(2013) 241–247.

5. M. Ouellette, **H. Han**, B. MacMillan, F. Goora, R. MacGregor, M. Hassan, B.J. Balcom. Design of a magnetic resonance imaging compatible metallic pressure vessel, Journal of Pressure Vessel Technology, 135 (2013) 045001 (7pp).

6. F. Goora, **H. Han**, B. Colpitts, B.J. Balcom, Simulation and verification of magnetic field gradient waveforms in the presence of a metallic vessel in magnetic resonance imaging, IEEE Transactions on Magnetics, 48 (2012) 2440–2448.

7. **H. Han**, M. Ouellette, B. MacMillan, F. Goora, R. MacGregor, D. Green, B.J. Balcom. High pressure magnetic resonance imaging with metallic vessels, Journal of Magnetic Resonance, 213 (2011) 90–97.

8. **H. Han**, B.J. Balcom, Magnetic resonance imaging inside cylindrical metal containers with an eddy current self-compensated method, Measurement Science and Technology (J. Phys. E: Sci. Instrum), 22 (2011) 115501 (7pp), IOPselect article. Highlight of the journal in 2011-2012.

9. K. Shi, K. Zhou, X.M. Niu, B. Luo, **H. Han**, S.L. Bao, J.F. Ma, Investigation of motion artifacts associated with fat saturation technique in 3D FLASH imaging, Medical Physics, 38 (2011) 4556-4562.

10. **H. Han**, A.V. Ouriadov, E.J. Fordham, B.J. Balcom, Direct measurement of magnetic field gradient waveform, Concepts in Magnetic Resonance Part A, 36 (2010) 349-360.

11. **H. Han**, D. Green, M. Ouellette, R. MacGregor, B.J. Balcom, Non-Cartesian sampled centric scan SPRITE imaging with magnetic field gradient and B0(t) field Measurements for MRI in the vicinity of metal structures, Journal of Magnetic Resonance, 206 (2010) 97-104.

12. **H. Han**, B.J. Balcom, Magnetic resonance imaging inside metallic vessels,

Measurement Science and Technology (J. Phys. E: Sci. Instrum.), rapid communication, 21 (2010) 103001 (5pp).

13. **H. Han**, R. MacGregor, B.J. Balcom, Pure phase encode magnetic field gradient monitor, Journal of Magnetic Resonance 201 (2009) 212-217.

14. L. Lin, **H. Han**, B.J. Balcom, Spin echo SPI methods for quantitative analysis of fluids in porous media, Journal of Magnetic Resonance, 198 (2009) 252-260.