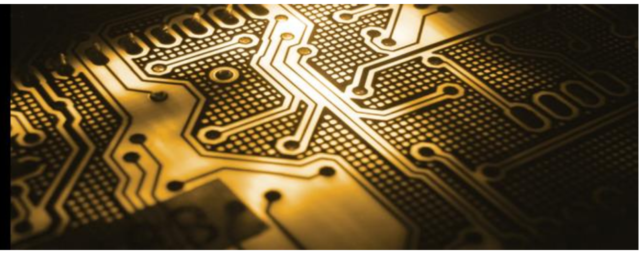
UWM RESEARCH FOUNDATION **Technology Overview**



Accelerating Parallel MRI with Compressed Sensing

OTT ID# 1188

TECHNOLOGY

This invention addresses the long-standing issue of low imaging speed in MRI by utilizing the complementary benefits of CS and pMRI. The technology has the potential to revolutionize MRI speed, making real-time, high-resolution imaging possible. It has important applications in dynamic and functional imaging, such as cardiac imaging, functional imaging, and dynamic contrast-enhanced (DCE) imaging, especially in three-dimensional imaging.

Magnetic resonance imaging (MRI) has revolutionized radiology for the last three decades because of its unique capabilities for structural, physiological, and functional imaging. However, its applications are still rather limited due to its relatively low imaging speeds. To accelerate conventional MRI, both parallel magnetic resonance imaging (pMRI) and compressed sensing MRI (CS-MRI) are advanced techniques to reduce the number of acquired data. In pMRI, due to the availability of multi-channel coils, the MR images can be reconstructed from multi-channel data sampled below the Nyquist sampling rate. CS-MRI is based on CS theory, a new framework for data sampling and signal recovery. The MR images can be reconstructed using a nonlinear convex program from data sampled at a rate close to their intrinsic information rate which is well below the Nyquist rate.

Because pMRI and CS-MRI reduce sampling based on different ancillary information (channel sensitivities for pMRI and image sparseness for CS), it is desirable to combine pMRI and CS for further reduction. Existing methods have been proposed to combine both methods in a straightforward way (e.g., SparseSENSE). The method is similar to CS-MRI except that the Fourier encoding is replaced by the sensitivity encoding. However, the prerequisites of CS in the existing method have not been explored. In this invention, we propose a novel method to combine CS and pMRI for the Cartesian case with the prerequisites guaranteed. The new method sequentially carries out CS reconstruction for the aliased image of each channel and pMRI for the final unfolded image. Because the encoding matrix in the first CS reconstruction is the Fourier matrix as in conventional MR imaging, the CS conditions have been proven to satisfy. Simulation and experimental results show that the proposed method can achieve a reduction factor being the product of the factors achieved by CS-MRI and pMRI individually and can outperform the existing methods that combine CS and pMRI directly.

FEATURES/BENEFITS

- **Faster** – The invention achieves at least 4x acquisition speed.
- **Better quality** – The images will have higher resolution.
- **Lasting market** – There is already a large market for MRI. MRI will continue to play an important role in non-invasive diagnosis. There will be lasting demands for MRI equipment.
- **Larger market** – The invention will likely create a larger market of MRI due to improved speed.
- **Ease to Implement** – Can employ the existing data acquisition sequences.

INTELLECTUAL PROPERTY

US Notice of Allowance for application **12/833,355**

This technology is available for licensing under exclusive or non-exclusive terms.

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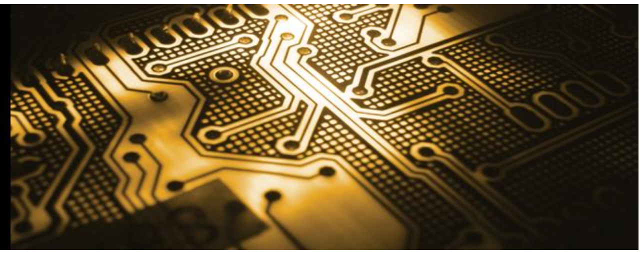

MARKETS

The MRI global market is about $4.1 billion and is expected to reach $5.2 billion by 2018, and functional imaging capabilities are expected to drive the future market. The requirement for more advanced technologies and enhanced capabilities is driving healthcare providers to upgrade and replace existing equipment. High speed MRI has the potential to revolutionize the field making real-time, high-resolution imaging possible for breast imaging, cardiology, brain surgery, cancer detection, and stroke diagnosis.

This invention addresses the long-standing issue of low imaging speed in MRI by combining two emerging fast imaging techniques, compressed sensing and parallel imaging. The imaging speed can be accelerated by a factor being the product of the factors achieved by compressed sensing and parallel imaging individually.

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INVENTORS

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Lei Ying was an Assistant and then Associate Professor in the Department of Electrical Engineering and Computer Science at University of Wisconsin-Milwaukee from 2003 -2012. She is now an Associate Professor in the Department of Biomedical Engineering at the State University of New York at Buffalo. Dr. Ying received her Ph.D. from the University of Illinois at Urbana–Champaign in 2003. Dr. Ying's research has focused on magnetic resonance image reconstruction and has resulted in numerous publications. Dr. Ying's research is well funded by the federal agencies such as National Science Foundation (NSF) and National Institute of Health (NIH). She also received the prestigious NSF CAREER award in 2009.

PUBLICATIONS

Dong Liang, Bo Liu and Leslie Ying, "Accelerating Sensitivity Encoding Using Compressed Sensing," Proceedings of IEEE Engineering in Medicine and Biology Conference, pp. 1667-1670, 2008.

D. Liang, K. King, B. Liu, L. Ying, "Accelerating SENSE using distributed compressed sensing", Proceedings of International Society of Magnetic Resonance in Medicine Scientific Meeting, 2009.

D. Liang, B. Liu, J. Wang, L. Ying. "Accelerating SENSE using compressed sensing", *Magnetic Resonance in Medicine*, vol. 62, No. 6, pp. 1574-1584, December 2009.

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