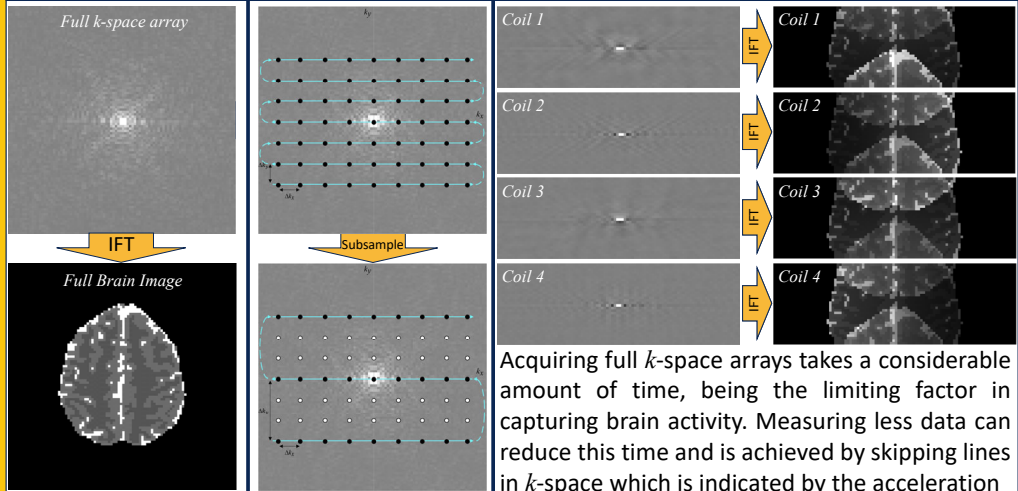# Formal Bayesian Approach to a Fused GRAPPA and SENSE Parallel Imaging Technique Augmenting Task Detection Power

Chase J. Sakitis[1] and Daniel B. Rowe[1]

[1]Department of Mathematical and Statistical Sciences, Marquette University, Milwaukee, WI, USA
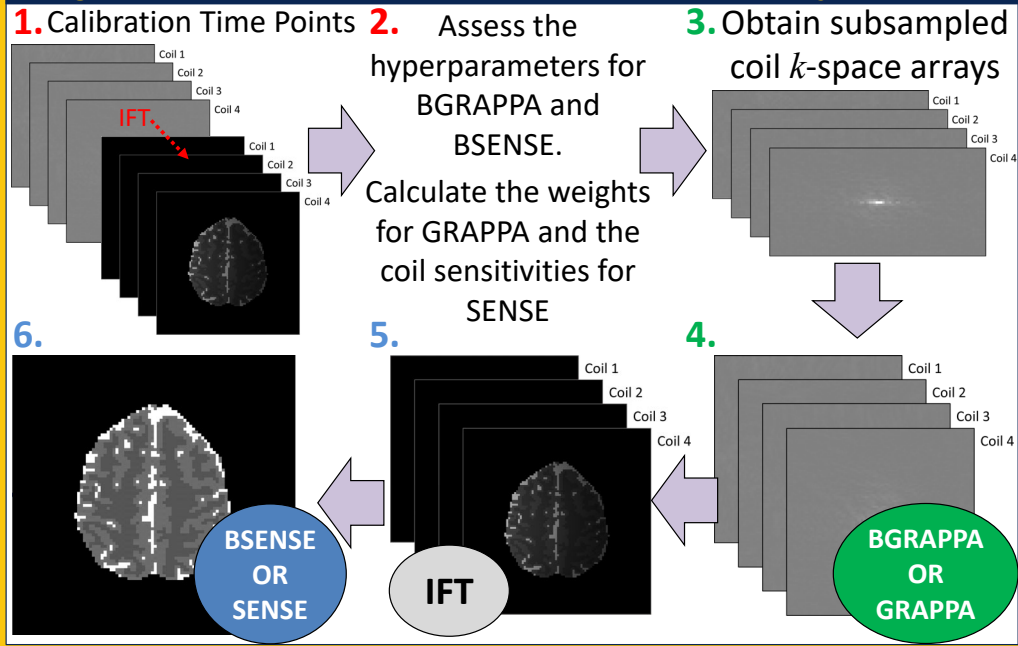
FMRI Background

Full k-space array

Full Brain Image

IFT

Subsample

Coil 1 — IFT — Coil 1
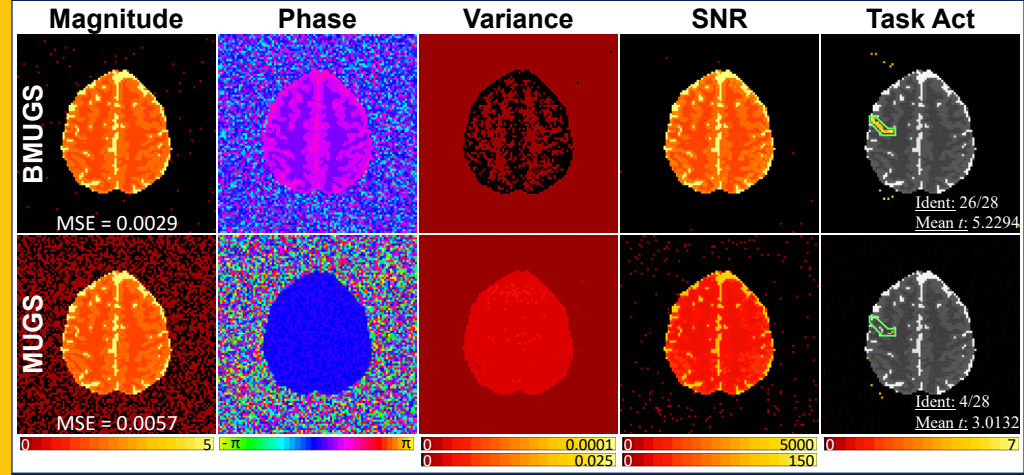Coil 2 — IFT — Coil 2
Coil 3 — IFT — Coil 3
Coil 4 — IFT — Coil 4

Acquiring full k-space arrays takes a considerable amount of time, being the limiting factor in capturing brain activity. Measuring less data can reduce this time and is achieved by skipping lines in k-space which is indicated by the acceleration factor. To accomplish this, multiple receiver coils are utilized in parallel to obtain the subsampled k-space arrays. However, subsampling causes the images to be aliased or appear "folded over."
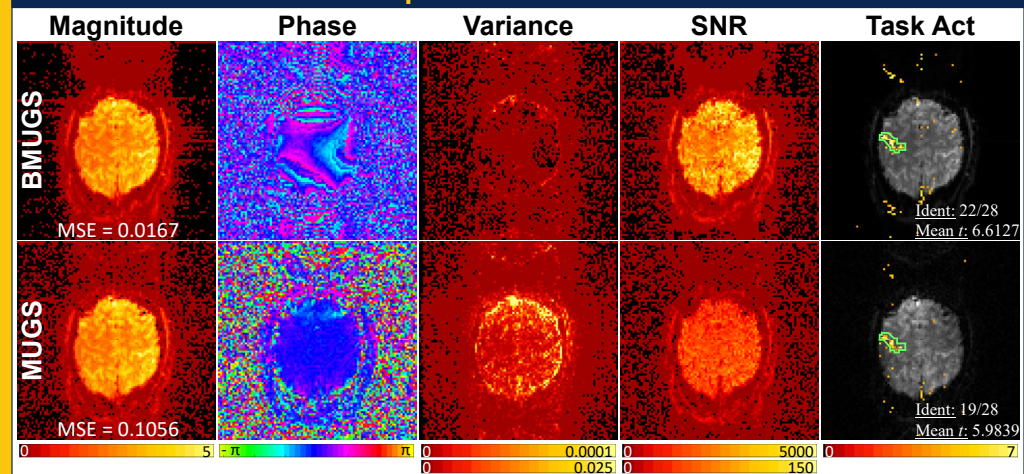
Merged Utilization of GRAPPA and SENSE (MUGS) vs. Bayesian MUGS

1. Calibration Time Points
Coil 1
Coil 2
Coil 3
Coil 4
IFT

2. Assess the hyperparameters for BGRAPPA and BSENSE.
Calculate the weights for GRAPPA and the coil sensitivities for SENSE

3. Obtain subsampled coil k-space arrays
Coil 1
Coil 2
Coil 3
Coil 4

4.
Coil 1
Coil 2
Coil 3
Coil 4

5.
Coil 1
Coil 2
Coil 3
Coil 4

6.

BGRAPPA OR GRAPPA

IFT

BSENSE OR SENSE

Simulated Study Results

	Magnitude	Phase	Variance	SNR	Task Act
BMUGS	MSE = 0.0029				Ident: 26/28 Mean t: 5.2294
MUGS	MSE = 0.0057				Ident: 4/28 Mean t: 3.0132

0 — 5 | $-\pi$ — π | 0 — 0.0001 / 0 — 0.025 | 0 — 5000 / 0 — 150 | 0 — 7

Experimental Results

	Magnitude	Phase	Variance	SNR	Task Act
BMUGS	MSE = 0.0167				Ident: 22/28 Mean t: 6.6127
MUGS	MSE = 0.1056				Ident: 19/28 Mean t: 5.9839

0 — 5 | $-\pi$ — π | 0 — 0.0001 / 0 — 0.025 | 0 — 5000 / 0 — 150 | 0 — 7

References

(1) Griswold MA, Jamob PM, Heidemann RM, Nittka M, Jellus V, Wang J, Kiefer B, Haase A. *Generalized autocalibrating partially parallel acquisition (GRAPPA)*. Mag. Res. Med, 47:1202–1210, 2002.
(2) Pruessman KP, Weiger M, Scheidegger MB, Boesiger P. SENSE: sensitivity encoding for fast MRI. Mag. Res. Med. 42:952-962, 1999.
(3) Bandettini P, Jesmanowicz A, Wong E, Hyde J. *Processing strategies for time-course data sets in functional MRI of the human brain*. Mag. Res. Med 30:161–173, 1993.
(4) O'Hagen A. *Kendall's Advanced Theory of Statistics*, vol. 2B. Bayesian Inference. John Wiley and Sons Inc., New York, 1994
(5) Lindley DV, Smith AFM. *Bayes estimates for the linear model*, J Royal Stat Soc B, 34:1-18, 1972.
(6) Geman S, Geman D. *Stochastic Relaxation, Gibbs Distributions, and the Bayesian Restoration of Images*. IEEE Trans Pat. Anal. Mach Intell, 6:721-41, 1984

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