BIOGRAPHICAL SKETCH

Name: Jeffrey A. Fessler, Ph.D.

eRA Commons User Name: `fessler`

Position Title: Professor, Dept. of Electrical Engineering and Computer Science, Dept. of BME, Dept. of Radiology

Education/Training

Institution, Location	Degree	Completion Date	Field of Study
Purdue University, W. Lafayette, IN	B.S.	05/1985	Electrical Engineering
Stanford University, Stanford, CA	M.S.	08/1986	Electrical Engineering
Stanford University, Stanford, CA	M.S.	06/1989	Statistics
Stanford University, Stanford, CA	Ph.D.	08/1990	Electrical Engineering

A. Personal Statement

My research group and I have been developing, implementing, analyzing and evaluating image reconstruction methods for over 25 years in the fields of SPECT, PET, X-ray CT, and MRI. Iterative cardiac SPECT reconstruction methods that we developed have been implemented on UM SPECT scanners for routine clinical use and applied to thousands of patients. Aspects of regularization design methods that our group developed have been used in GE's CT iterative reconstruction method. Another algorithm from our group was adopted by Philips for their SPECT-CT system. A regularized PET image reconstruction algorithm we published was incorporated into GE's clinical PET system. MR reconstruction methods we have developed, including the nonuniform FFT (NUFFT) for non-Cartesian k-space samples, have been used widely in the MR research field. My group maintains a large collection of image reconstruction software tools on our web site to benefit the research community.

B. Positions and Honors

1986-1989	Research Assistant for A. Macovski, Electrical Engineering Dept., Stanford University, Stanford, CA
1990-1992	Research Fellow, Nuclear Medicine Division, University of Michigan, Ann Arbor, MI
1993-1995	Asst. Professor, Nuclear Medicine Division, University of Michigan, Ann Arbor, MI
1995-1997	Asst. Professor, Electrical Engin. and Comp. Sci. Dept., University of Michigan, Ann Arbor, MI
1998-2004	Assoc. Professor, Electrical Engin. and Comp. Sci. Dept., University of Michigan, Ann Arbor, MI
2006-2008	Associate Chair, ECE Division, EECS Dept., University of Michigan, Ann Arbor, MI
2004-	Professor, EECS Dept., BME Dept., Dept. of Radiology, University of Michigan, Ann Arbor, MI

Honors

2016	William L. Root Collegiate Professor of EECS
2016	IEEE EMBS Technical Achievement Award
2016	UM HKN ECE Professor of the Year Award
2015	UM Distinguished Faculty Achievement Award
2013	IEEE Edward J. Hoffman Medical Imaging Scientist Award
2013	UM College of Engineering David E. Liddle Research Excellence Award
2012	UM Rackham Distinguished Graduate Mentor Award
2010	Prize for New Advances in CT & 3D Imaging, Chinese Society of Stereology, for separable footprint method with Yong Long and James Balter
2009	10th Intl. Meeting on Fully Three-Dimensional Image Reconstruction in Radiology and Nuclear Medicine, Poster Award, for "A 3D forward and back-projection method for X-ray CT using separable footprint" by Yong Long, J A Fessler and J M Balter.
2007	University of Michigan Faculty Recognition Award
2007	Cum laude poster award for "A simplified motion model for estimating respiratory motion from orbiting views" by Rongping Zeng, J A Fessler, James M Balter, at SPIE Medical Imaging Conference. Co-authored posters with students Ram Narayanan and Yingying Zhang also received honorable mention poster awards.
2006	IEEE Fellow, for contributions to theory and practice of image reconstruction
2005	UM College of Engineering Education Excellence Award
2003	UM EECS Department Outstanding Achievement Award
2002-5	AIMBE Fellow (American Institute for Medical and Biological Engineering)
2000	UM Henry Russel Award (university level award for scholarship and teaching)
1998	UM Biomedical Engineering Department Teaching Excellence Award
1993	Francois Erbsmann Investigator Award, Information Proc. in Medical Imaging Conf.
1991-1992	Dept. of Energy Alexander Hollaender Distinguished Postdoctoral Fellowship

1990-1991 National Institutes of Health National Cancer Institute Postdoctoral Training Fellowship
1985-1988 National Science Foundation Graduate Fellowship

C. Contribution to Science

For the past 26 years, the primary focus of my research group has been developing and analyzing image reconstruction algorithms. Traditional (non-iterative) image reconstruction methods are usually fast, but iterative methods based on models for system physics and measurement statistics often can improve image quality. Iterative methods require more computation, so a primary focus of my group is developing faster iterative algorithms to facilitate practical use of model-based methods.

Building on the work of many others, my group collaborated with UM Nuclear Medicine researchers to develop attenuation-corrected statistical reconstruction for triple-headed SPECT systems. The method was implemented clinically for cardiac SPECT, validated with an observer study, and used for thousands of patients [1]. Subsequent work refined the system model [2] and the regularizers [3], including using anatomical side information [4].

[1] E. P. Ficaro, J. A. Fessler, P. D. Shreve, J. N. Kritzman, P. A. Rose, and J. R. Corbett, "Simultaneous transmission/emission myocardial perfusion tomography: Diagnostic accuracy of attenuation-corrected 99m-Tc-Sestamibi SPECT," *Circulation*, vol. 93, no. 3, 463–73, Feb. 1996.

[2] A. Yendiki and J. A. Fessler, "A comparison of rotation- and blob-based system models for 3D SPECT with depth-dependent detector response," *Phys. Med. Biol.*, vol. 49, no. 11, 2157–68, Jun. 2004.

[3] J. W. Stayman and J. A. Fessler, "Compensation for nonuniform resolution using penalized-likelihood reconstruction in space-variant imaging systems," *IEEE Trans. Med. Imag.*, vol. 23, no. 3, 269–84, Mar. 2004.

[4] Y. K. Dewaraja, K. F. Koral, and J. A. Fessler, "Regularized reconstruction in quantitative SPECT using CT side information from hybrid imaging," *Phys. Med. Biol.*, vol. 55, no. 9, 2523–9, May 2010.

My group developed methods for analyzing the spatial resolution and noise properties of PET image reconstruction methods [5] [6] and used that analysis to design regularizers. One of these methods was incorporated in the USC software for MAP reconstruction of microPET data that is available commercially from Siemens. Numerous small animal imaging studies have benefited from the resolution properties provided by these methods. Another algorithm from my group [7] is the foundation for GE's Q.Clear product for clinical PET reconstruction [8].

[5] J. A. Fessler and W. L. Rogers, "Spatial resolution properties of penalized-likelihood image reconstruction methods: Space-invariant tomographs," *IEEE Trans. Im. Proc.*, vol. 5, no. 9, 1346–58, Sep. 1996.

[6] J. A. Fessler, "Mean and variance of implicitly defined biased estimators (such as penalized maximum likelihood): Applications to tomography," *IEEE Trans. Im. Proc.*, vol. 5, no. 3, 493–506, Mar. 1996.

[7] S. Ahn and J. A. Fessler, "Globally convergent image reconstruction for emission tomography using relaxed ordered subsets algorithms," *IEEE Trans. Med. Imag.*, vol. 22, no. 5, 613–26, May 2003.

[8] S. Ahn, S. G. Ross, E. Asma, J. Miao, X. Jin, L. Cheng, S. D. Wollenweber, and R. M. Manjeshwar, "Quantitative comparison of OSEM and penalized likelihood image reconstruction using relative difference penalties for clinical PET," *Phys. Med. Biol.*, vol. 60, no. 15, 5733–52, Aug. 2015.

My group has developed several accelerated iterative methods for low-dose X-ray CT image reconstruction. An early ordered-subsets algorithm we developed [9] is used clinically in the Philips BrightView SPECT-CT system [10]. More recent algorithms provide much faster convergence [11], [12], facilitating wider adoption of iterative methods for X-ray CT image reconstruction.

[9] H. Erdoğan and J. A. Fessler, "Ordered subsets algorithms for transmission tomography," *Phys. Med. Biol.*, vol. 44, no. 11, 2835–51, Nov. 1999.

[10] E. Hansis, J. Bredno, D. Sowards-Emmerd, and L. Shao, "Iterative reconstruction for circular cone-beam CT with an offset flat-panel detector," in *Proc. ieee nuc. sci. symp. med. im. conf.*, 2010, 2228–31.

[11] D. Kim, S. Ramani, and J. A. Fessler, "Combining ordered subsets and momentum for accelerated X-ray CT image reconstruction," *IEEE Trans. Med. Imag.*, vol. 34, no. 1, 167–78, Jan. 2015.

[12] H. Nien and J. A. Fessler, "Fast X-ray CT image reconstruction using a linearized augmented Lagrangian method with ordered subsets," *IEEE Trans. Med. Imag.*, vol. 34, no. 2, 388–99, Feb. 2015.

Where possible, my group aims to develop methods that improve certain motivating applications while also providing general data processing tools that have broader impact. A generalization of the expectation-maximization (EM) algorithm that we developed initially for PET [13] has been cited over 860 times, often for applications in wireless digital communications [14]. The min-max optimal nonuniform FFT (NUFFT) algorithm that we developed for non-Cartesian MRI has been cited over 480 times for numerous other applications [15]. Our accelerated convex optimization method was motivated by X-ray CT but has numerous applications [16].

[13] J. A. Fessler and A. O. Hero, "Penalized maximum-likelihood image reconstruction using space-alternating generalized EM algorithms," *IEEE Trans. Im. Proc.*, vol. 4, no. 10, 1417–29, Oct. 1995.

[14] ——, "Space-alternating generalized expectation-maximization algorithm," *IEEE Trans. Sig. Proc.*, vol. 42, no. 10, 2664–77, Oct. 1994.

[15] J. A. Fessler and B. P. Sutton, "Nonuniform fast Fourier transforms using min-max interpolation," *IEEE Trans. Sig. Proc.*, vol. 51, no. 2, 560–74, Feb. 2003.

[16] D. Kim and J. A. Fessler, "Optimized first-order methods for smooth convex minimization," *Mathematical Programming*, vol. 159, no. 1, 81–107, Sep. 2016.

In collaboration with Doug Noll, my group also develops RF pulse design algorithms [17], [18] and image reconstruction methods [19], [20] for MRI.

[17] C. Yip, J. A. Fessler, and D. C. Noll, "Iterative RF pulse design for multidimensional, small-tip-angle selective excitation," *Mag. Res. Med.*, vol. 54, no. 4, 908–17, Oct. 2005.

[18] W. Grissom, C. Yip, Z. Zhang, V. A. Stenger, J. A. Fessler, and D. C. Noll, "Spatial domain method for the design of RF pulses in multi-coil parallel excitation," *Mag. Res. Med.*, vol. 56, no. 3, 620–9, Sep. 2006.

[19] B. P. Sutton, D. C. Noll, and J. A. Fessler, "Fast, iterative image reconstruction for MRI in the presence of field inhomogeneities," *IEEE Trans. Med. Imag.*, vol. 22, no. 2, 178–88, Feb. 2003.

[20] M. J. Muckley, D. C. Noll, and J. A. Fessler, "Fast parallel MR image reconstruction via B1-based, adaptive restart, iterative soft thresholding algorithms (BARISTA)," *IEEE Trans. Med. Imag.*, vol. 34, no. 2, 578–88, Feb. 2015.

Publications are online here (over 160 journal papers, 220 conference proceedings papers, and 240 abstracts):
`http://web.eecs.umich.edu/~fessler/papers/index.html`
`http://www.ncbi.nlm.nih.gov/sites/myncbi/jeffrey.fessler.1/bibliography/40334497/public`
`http://scholar.google.com/citations?user=J5f4Gq8AAAAJ&hl=en`

D. Research Support

Ongoing:

UM M-Cubed PI: Jeffrey A. Fessler, Jon Nielsen, Doug Noll, Roger Albin 1/1/16-4/29/17
Quantitative MRI for early detection and monitoring of movement disorders
Topic: MRI relaxometry.

GE Medical Systems N020874 PI: Jeffrey A. Fessler 9/1/15-8/31/16 (NCX to 12/31/16)
X-ray CT image reconstruction using statistical methods: 2015-16
Topic: Iterative X-ray CT reconstruction.

UM-SJTU Collaboration on Applications of Nanotechnology and Data Science PI: Jeffrey A. Fessler, with Yong Long 9/1/15-8/31/17
Ultra-low dose CT image reconstruction based on big data priors
Topic: training corpus based regularizers

NIH NIBIB 1 U01 EB018753-01 PI: Jeffrey A. Fessler 8/1/14-7/31/18
Accelerated statistical image reconstruction methods for X-ray CT
Topic: Image reconstruction for sub-mSv CT scans.

NIH R01 EB022075-01A1 PI: Yuni Dewaraj 9/15/16-6/30/20
Imaging and dosimetry of Yttrium-90 for personalized cancer treatment
Role: Co-investigator
Topic: Y90 quantification

W M Keck Foundation Phase II 16-PAF00466 PI: Zhaohui Zhong, Ted Norris, and Jeff Fessler 1/1/16-12/31/18
Transformative light-field nanophotonics
Role: Co-investigator
Topic: Light field imaging using nanophotonic sensors

NIH R21 PI: Jon-Fredrik Nielsen 4/1/15-1/31/17
Toward layer-specific BOLD fMRI in human cortex at 3T using 3D zoomed-EPI and small-tip fast-recovery imaging
Role: Co-investigator
Topic: RF pulse design for high-resolution fMRI.

DNDO Sandia PO 1511621 PI: Zhong He 2/13/15-9/30/17
Advance integrated gamma-ray imaging and spectroscopy for directional isotope ID using Polaris systems
Role: Co-investigator
Topic: Reconstruction for gamma-ray imaging.

NIH P01 CA 059827 PI: Randall Ten Haken / Theodore Lawrence 5/15/14-4/30/19
Optimization of high dose conformal therapy
Role: Co-investigator
Topic: Radiation oncology

NSF CBET 1402707 PI: Volker Sick 6/1/14-5/31/17
Volumetrically resolved single-shot single-access-point imaging of translucent objects
Role: Co-investigator
Topic: Image reconstruction for light-field imaging of combustion.

Completed:

GE Medical Systems N004789-14 PI: Jeffrey A. Fessler 9/1/13-8/31/14
X-ray CT image reconstruction using statistical methods: 2013-14
Topic: Iterative X-ray CT reconstruction.

Intel PI: Jeffrey A. Fessler 11/1/13-12/31/13
Accelerating medical image reconstruction using Xeon Phi Co-processor
Topic: Computing equipment

UM M-Cubed PI: Jeffrey A. Fessler, Anna Gilbert, Doug Noll 9/1/13-8/31/14
Imaging fleeting thoughts
Topic: Dynamic fMRI reconstruction.

GE Medical Systems N004789-13 PI: Jeffrey A. Fessler 9/1/12-8/31/13
X-ray CT image reconstruction using statistical methods: 2012-13
Topic: Iterative X-ray CT reconstruction.

NIH F32-EB-015914 PI: Jeff Fessler / Dan Weller 8/1/12-7/31/14
Adaptive techniques for robust high-resolution functional magnetic resonance imaging
Topic: F32 postdoctoral fellowship for Dan Weller.

NASA STTR phase II T7.01-9931 PI: Jeffrey A. Fessler 9/15/11-9/15/13
One-sided 3D imaging of non-uniformities in non-metallic materials
Topic: UM subcontract to Picometrix for limited angle THz imaging.

NIH BRP R01 CA 151443 PI: Heang-Ping Chan 9/2/11-7/31/16, NCX 7/31/17
Improvement of microcalcification detection in digital breast tomosynthesis
Role: Co-investigator
Topic: Digital breast tomosynthesis detection methods.

NIH NCI 2 R01 EB001994-12 PI: Yuni Dewaraja 5/1/11-4/30/15
Imaging based dosimetry for individualized internal emitter therapy
Role: Co-investigator
Topic: Quantitative SPECT/CT imaging and dosimetry.

NIH R21 EB-012674-01 PI: Jon-Fredrik Nielsen 12/15/10-11/30/12, NCX to 11/30/14
Improved functional MRI using balanced SSFP and parallel transmission
Role: Co-investigator
Topic: RF pulse design for SSFP for fMRI.

NIH 1-R01-HL-098686-01-A1 PI: Jeffrey A. Fessler & Bruno De Man 8/1/10-5/31/13, NCX to 5/31/14
Model-based image reconstruction for X-ray CT in lung imaging
Topic: CT reconstruction methods for low-dose lung scans.

NIH/NCI 1P01 CA87634-06A2 PI: Charles R. Meyer; Project 3 director: J. A. Fessler 01/12/09-02/28/14, NCX to 2/28/15
Automatic 3D registration for enhanced cancer management / Project 3
Role: Co-investigator
Topic: Image reconstruction methods for dynamic contrast-enhanced (DCE) MRI of breast cancer.

NIH NS R01 NS 058576 PI: Doug Noll 01/01/08-12/31/12, NCX to 12/31/14
MRI parallel excitation for neuroimaging applications
Role: Co-investigator
Topic: RF pulse optimization for parallel imaging.