Robert D. Throne
Professor of Engineering

Rose-Hulman Institute of Technology
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Research Interests

Numerical solution of inverse problems, control systems, and digital signal processing. Current application areas include inverse problems in early detection of breast cancer.

Education

Ph.D., Electrical Engineering, June 1990, University of Michigan, Ann Arbor, MI.

M.S., Electrical Engineering, June 1987, University of Michigan, Ann Arbor, MI.

B.S., Electrical Engineering, June 1985, Massachusetts Institute of Technology, Cambridge, MA.

B.S., Mathematics, June 1980, Massachusetts Institute of Technology, Cambridge, MA.

Work Experience

Founding Chair of the Department of Engineering and Professor of Engineering, Drury University, July 2023 - present.

Professor of Electrical and Computer Engineering, Rose-Hulman Institute of Technology, September 2007 - May 2023. (Professor Emeritus, May 2023.)

Lawrence J. Giacoletto Endowed Chair in Electrical and Computer Engineering, Rose-Hulman Institute of Technology, September 2018 - August 2021.

Department Head, Department of Electrical and Computer Engineering, Rose-Hulman Institute of Technology, Summer 2011 - June 2016.

Interim Department Head, Department of Electrical and Computer Engineering, Rose-Hulman Institute of Technology, Summer 2010 - Spring 2011.

Associate Professor of Electrical and Computer Engineering, Rose-Hulman Institute of Technology, September 2002 - August 2007.

Associate Professor of Electrical Engineering, University of Nebraska, Lincoln, Nebraska, September 1997 - August 2002.

Associate Professor (Courtesy), Internal Medicine, University of Nebraska Medical Center, Omaha, Fall 1997 - Fall 2002.

Assistant Professor of Electrical Engineering, University of Nebraska, Lincoln, Nebraska, August 1991 - August 1997.

Visiting Assistant Professor, Pritzker Institute of Medical Engineering, Illinois Institute of Technology, Chicago, IL, September 1990 - July 1991.

Research Assistant and Teaching Assistant, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, September 1985 - June 1989.

Engineer, Raytheon Company, Sudbury, MA, 1981-1983.

ABET Experience

Wrote both the Electrical Engineering and Computer Engineering Self Studies for the 2012-2013 ABET accreditation cycle (both programs received a next general review).

Became and ABET Program Evaluator in 2013.

Recognition

Rose-Hulman Board of Trustees Outstanding Scholar Award 2021

University of Nebraska EE Department Outstanding Faculty Award 1993, 1996, 2001 (voted by EE students)

University of Nebraska College of Engineering and Technology Faculty Teaching Award (Assistant Professor), 1996.

University of Nebraska College of Engineering and Technology Faculty Teaching Award (Associate Professor), 1998.

University of Nebraska Tau Beta Pi Outstanding College of Engineering and Technology Teacher Award, 1998 (voted by college of engineering students)

Certificate of Recognition for Contribution to Students, (University of Nebraska Parent's Association and Teaching Council), 1996 and 2000.

Rose-Hulman Undergraduate Student Investigators

Research: Allison Crump, Matthew Billingsley, Matthew Conrad, Emily Cottingham, Caitlin Douglas, Robert Fleishel, Jonathan Gannon, Kaelyn Griffin, Tianhong Han, Andrew Hubbard, Matthew Hummel, Wanli He, Nicolae Iovanac, Thomas Janssen, Michael Jones, Tressa Lauer, Xiaoyin Ling, Emily Macak, Haley O'Neil, Gustavo Romo, Emily Rusnak, Geoffrey Tan, Ryan Tarr, Michael Samp, Brendan Smyth, Justin Speedy, Griffin Steffy, James Tumavich, and Jiaojiao Wang.

Capstone: Allison Bromenschenkel, Logan Caldwell, Taylor Graham, and Erin Minervi; Peter Garnache, Carson Stone, and Dayong (Ray) Tong.

Courses Taught

At Rose-Hulman

- *Circuits and Systems*
- *Electrical Systems*
- *Signals and Systems*
- *Linear Control Systems*
- *Discrete-Time Control Systems*
- *Modern Control Systems*
- *Probability and Random Processes*

- *Optimal Control*
- *Applied Biomedical Signal Processing*
- *Inverse Problems in Engineering*
- *Analysis and Design of Engineering Systems*
- *Senior Design (ECE and Robotics)*
- *DSP First*
- *Freshman Design*

At the University of Nebraska

- *Electrical Circuits I*
- *Electrical Circuits II*
- *Electronic Circuits I*
- *Signals and Systems*
- *Classical Control Systems*
- *Modern Control Systems*

- *Linear Systems Theory*
- *Optimal Control*
- *Inverse Problems in Engineering*
- *Communication Systems*
- *Probability and Statistics*
- *Random Processes and Estimation Theory*

Funding Directly Related to Education

"Developing an Integrated Dynamical Systems Modeling Experience", National Science Foundation, July 2003 - August 2006, $184,787. R. Throne, B. Burchett, F. Berry, and D. Purdy.

"An Integrated Signals and Systems Laboratory Experience at the University of Nebraska", National Science Foundation, January 2002 - December 2004, $200,000. L. Perez, R. Palmer, R. Throne, J. Boye, and M. Anderson.

Professional Service

National

Associate Editor for *Inverse Problems in Science and Engineering*, Fall 2002 - Fall 2008.

Reviewer for

- *The Institute of Physics: Physiological Measurement*
- *Annals of Biomedical Engineering*
- *IEEE Transactions on Biomedical Engineering*
- *IEEE Transaction on Medical Imaging*
- *Pacing and Clinical Electrophysiology (PACE)*
- *Medical, Biological, and Engineering Computation*
- *International Journal for Numerical Methods in Engineering*
- *Inverse Problems in Science and Engineering*
- *IEEE Transactions on Education*
- *Computers and Structures*
- *1994 American Control Conference*

NSF Reviewer/Panelist for

- *Division of Bioengineering and Environmental Systems (1996)*
- *Division of Biomedical Engineering and Environmental Systems (1999)*
- *Division of Undergraduate Education (2003)*
- *Division of Undergraduate Education (2004, Panel Chair)*
- *Division of Undergraduate Education (2009, 2010)*

Rose-Hulman

ECE Department Faculty Search Committee (multiple years, chair 2021-2022)

ECE Department Administrative Assistant Search Committee (summer 2021)

Institutional Reviewer (IR) for Human Subjects Research

Member of Indiana State University's Institutional Review Board

IEEE Student Chapter Advisor

Quality of Education Committee (Chair)

Graduate Committee

Performing Arts Committee

University of Nebraska

University of Nebraska Life Sciences Taskforce

College of Engineering Committee on Recruitment/Retention of Graduate Students

Electrical Engineering Student Paper Competition

Electrical Engineering Advisory Committee

Electrical Engineering Departmental Chair Search Committee

Departmental Graduate Committee

Departmental Curriculum Committee

Departmental Faculty Development Leave Committee

Tau Beta Pi advisor

Societies and Other Awards

Senior Member, IEEE

Member Eta Kappa Nu, Tau Beta Pi, ASEE

Rackham Fellow July 1989-May 1990.

UNL Graduate Faculty Fellow (1995)

Patents

"Scatter Diagram Analysis Method and System for Discriminating Ventricular Tachyarrhythmias", R. D. Throne, U.S. patent # 5,404,880 (Issued 4/11/95).

"Method and System for Monitoring Electro-Cardiographic Signals and Detecting a Pathological Cardiac Arrhythmia Such as Ventricular Tachycardia", R. D. Throne, J. M. Jenkins, L. A. DiCarlo, U.S. Patent # 5,000,189 (Issued 3/19/91).

Book Chapters

R. D. Throne and L. G. Olson, *Generalized Eigensystem Algorithms for the Inverse Problem of Electrocardiography,* **Computational Methods in Biophysics, Biomaterials, Biotechnology, and Medical Systems** Vol. 1, (C. T. Leondes editor), Kluwer Academic Publishers, 2003, pp. 29-92.

Refereed Journal Articles

L. Olson and R. Throne. Stiffness mapping for early detection of breast cancer: Combined force and displacement measurements, *Engineering with Computers*, Vol. 38, pp. 4023-4041, 2022. https://doi.org/10.1007/s00366-022-01741-3.

L. Olson, R. Throne, E. Rusnak, and J. Gannon. Force-based stiffness mapping for early detection of breast cancer. *Inverse Problems in Science and Engineering*,Vol. 29, pp. 2239-2273, 2021. https://doi.org/10.1080/17415977.2021.1912036.

L. Olson, R. Throne, A. Nolte, A. Crump, K. Griffin, T. Han, N. Iovanac, T. Janssen, M. Jones, X. Ling, and M. Samp. An inverse problem approach to stiffness mapping for early detection of breast cancer: Tissue Phantom Experiments. *Inverse Problems in Science and Engineering*, Vol. 27, pp. 1006-1037, 2019. https://doi.org/10.1080/17415977.2018.1538367.

L. Olson and R. Throne. An inverse problem approach to stiffness mapping for early detection of breast cancer. *Inverse Problems in Science and Engineering*, Vol. 21, pp. 314-338, 2013.

L. Olson and R. Throne. Numerical simulation of an inverse method for tumor size and location estimation. *Inverse Problems in Science and Engineering*, Vol. 18, pp. 813-834, 2010.

L. Olson, R. Throne, and E. Rost. Improved inverse solutions for on-line machine tool monitoring. *ASME Journal of Manufacturing Science and Engineering*, Vol. 126, pp. 311-316, 2004.

R. D. Throne, L. G. Olson, and J. R. Windle. A new method for incorporating weighted temporal and spatial smoothing in the inverse problem of electrocardiography. *IEEE Transactions on Biomedical Engineering*, Vol. 49, No. 9, pp. 1054-1059, 2002.

R. D. Throne, L. G. Olson, and J. R. Windle. Improved parameter choice methods and temporal filtering for the generalized eigensystem method applied to the inverse problem of electrocardiography. *Inverse Problems in Engineering*, Vol 9, pp. 339-365, 2001.

L. G. Olson and R. D. Throne. Estimation of tool/chip interface temperatures for on-line tool monitoring: An inverse problem approach. *Inverse Problems in Engineering*, Vol. 9, pp. 367-388, 2001.

R. D. Throne and L. G. Olson. The steady inverse heat conduction problem: A comparison of methods with parameter selection. *ASME Journal of Heat Transfer*, Vol. 123, pp. 633-644, 2001.

L. G. Olson and R. D. Throne. A comparison of generalized eigensystem, truncated singular value decomposition, and Tikhonov regularization for the steady inverse heat conduction problem. *Inverse Problems in Engineering*, Vol. 8, 2000, pp. 193-227.

R. D. Throne and L. G. Olson. Fusion of body surface potential and body surface Laplacian data for electrocardiographic imaging. *IEEE Transactions on Biomedical Engineering*, Vol. 47, 2000, pp. 452-462.

R. D. Throne, L. G. Olson. and T. J. Hrabik. A comparison of higher-order generalized eigensystem techniques and Tikhonov regularization for the inverse problem of electrocardiography. *Inverse Problems in Engineering*, Vol. 7, 1999, pp. 143-193.

L. G. Olson, R. D. Throne, and J. R. Windle. Performance of generalized eigensystem and truncated singular value decomposition methods for the inverse problem of electrocardiography, *Inverse Problems in Engineering*, Vol. 5, 1997, pp. 239-277.

R. D. Throne, L. G. Olson, T. J. Hrabik, and J. R. Windle. Generalized eigensystem techniques for the inverse problem of electrocardiography applied to a realistic heart-torso geometry. *IEEE Transactions on Biomedical Engineering*, Vol. 44, No. 6, 1997, pp. 447-454.

R. D. Throne and L. G. Olson. The effects of errors in assumed conductivities and geometry on numerical solutions to the inverse problem of electrocardiography. *IEEE Transactions on Biomedical Engineering*, Vol. 42, No. 12, 1995, pp. 1192-1200.

L. G. Olson and R. D. Throne. Computational issues arising in multidimensional elliptic inverse problems: The inverse problem of electrocardiography *Engineering Computations*, Vol. 12, No. 4, 1995, pp. 343-356.

R. D. Throne, J. R. Windle, A. R. Easley, B. Olshansky, D. Wilber. Scatter diagram analysis: A new technique for discriminating ventricular tachyarrhythmias, *Pacing and Clinical Electrophysiology (PACE)*, Vol. 17, No. 7, 1994, pp. 1267-1275.

R. D. Throne and L. G. Olson. A generalized eigensystem approach to the inverse problem of electrocardiography. *IEEE Transactions on Biomedical Engineering*, Vol. 41, No.6, 1994, pp. 592-600.

R. D. Throne. Detecting ventricular fibrillation using efficient techniques for computing a normalized autocorrelation. *Computers in Biology and Medicine*, Vol. 23, No. 4, 1993, pp. 317-325.

R. D. Throne, D. Wilber, B. Olshanski, B. Blakeman, and R. Arzbaecher. Autoregressive modeling of epicardial electrograms during ventricular fibrillation. *IEEE Transactions on Biomedical Engineering*, Vol. 40, No. 4, 1993, pp. 379-386.

R. D. Throne, J. M. Jenkins, and L. A. DiCarlo. A comparison of four new time-domain techniques for discriminating monomorphic ventricular tachycardia from sinus rhythm using ventricular waveform morphology. *IEEE Transactions on Biomedical Engineering*, Vol. 38, No. 6, 1991, pp. 561-570.

S. E. Greenhut, L. A. DiCarlo, J. M. Jenkins, R. D. Throne, and S. A. Winston. Identification of ventricular tachycardia using intracardiac electrograms: A comparison

of unipolar versus bipolar waveform analysis. *Pacing and Clinical Electrophysiology (PACE)*, Vol. 14, No. 3, 1991, pp. 427-433.

R. D. Throne, J. M. Jenkins, and L. A. DiCarlo. Intraventricular electrogram analysis for ventricular tachycardia detection: statistical validation. *Pacing and Clinical Electrophysiology (PACE)*, Vol. 13, No. 12, 1990, pp. 1596-1601.

R. D. Throne, J. M. Jenkins, and L. A. DiCarlo. The bin area method: a computationally efficient technique for analysis of ventricular and atrial intracardiac electrograms. *Pacing and Clinical Electrophysiology (PACE)*, Vol. 13, No. 10, 1990, pp. 1286-1297.

R. D. Throne, L. A. DiCarlo, J. M. Jenkins, and S. A. Winston. Paroxysmal bundle branch block of supraventricular origin: a possible source of misdiagnosis in detecting ventricular tachycardia using ventricular electrogram morphology. *Pacing and Clinical Electrophysiology (PACE)*, Vol. 13, No. 4, 1990, pp. 453-468.

R. D. Throne, J. M. Jenkins, S. A. Winston, C. J. Finelli, and L. A. DiCarlo. Discrimination of retrograde from anterograde atrial activation using intracardiac electrogram waveform analysis. *Pacing and Clinical Electrophysiology (PACE)*, Vol. 12, No. 8, 1989, pp. 1622-1630.

Conference Presentations

L. Olson and R. Throne. Stiffness mapping for early detection of breast cancer: sensitivity to errors in modulus. *2022 Summer Biomechanics, Bioengineering, and Biotransport Conference*, June 2022.

L. Olson and R. Throne. Stiffness mapping for early detection of breast cancer: combined force and displacement data. *16th U. S. National Congress on Computational Mechanics*, July 2021.

L. Olson, R. Throne, E. Rusnak, and J. Gannon. Early detection of breast cancer through an inverse problem approach to stiffness mapping: simulations and experimental validation with force data. *2020 Summer Biomechanics, Bioengineering, and Biotransport Conference*, June 2020.

L. Olson and R. Throne. Early detection of breast cancer through an inverse problem approach to stiffness mapping: Tissue phantom experiments with improved cost functions, *15th U.S. National Congress on Computational Mechanics*, July 2019.

L. Olson and R. Throne. Early detection of breast cancer through an inverse problem approach to stiffness mapping: Simulations with force data, *Inverse Problems 2019*, May 2019.

L. Olson, R. Throne, A. Nolte. An inverse problem approach to early detection of breast cancer, *14th U.S. National Congress on Computational Mechanics*, July 2017.

L. Olson, R. Throne, A. Nolte. An inverse problem approach to early detection of breast cancer, *Inverse Problems Symposium 2016*, June 2016.

L. Olson, R. Throne, A. Nolte, A. Crump, W. He, M. Jones, C. Douglas, M. Conrad, and E. Cottingham. Early detection of breast cancer through an inverse problem approach to stiffness mapping: Preliminary results from tissue phantom experiments, *13th U.S. National Congress on Computational Mechanics*, July 2015.

L. Olson and R. Throne. Early detection of breast cancer through an inverse problem approach to stiffness mapping: Fitness optimization, *17th U.S. National Congress of Theoretical and Applied Mechanics*, June 2014.

L. Olson and R. Throne. Early detection of breast cancer through an inverse problem approach to stiffness mapping: 3D results and variations in properties, *12th U.S. national Congress on Computational Mechanics*, July 2013.

L. Olson and R. Throne. An inverse problem approach to stiffness mapping for early detection of breast cancer, *2012 Inverse Problems Symposium*, June 2012.

L. Olson and R. Throne. Early detection of breast cancer through an inverse problem approach to stiffness mapping: Improved formulation and parallelization, *11th U.S. National Congress on Computational Mechanics*, July 2011.

L. Olson and R. Throne. Estimation of tumor size and location for early detection of breast cancer, *10th U.S. National Congress on Computational Mechanics*, July 2009.

L. Olson and R. Throne. Estimation of tumor size and location for early detection of breast cancer, *Inaugural International Conference of the Engineering Mechanics Institute (EM08)*, May 2008.

L. Olson, R. Throne, and J. Butcher. Early detection of breast cancer: Feasibility of inverse estimation of tumor size and location, *U. S. National Congress on Computational Mechanics*, July 2007.

L. Olson and R. Throne. Exploring the principle components of time method for estimating potentials from a noncontact probe, report to St. Jude Medical, November 2006.

L. Olson, R. Throne, J. Windle, J. Schweitzer, and E. Voth. Inverse electrocardiography: Endocardial potential estimates from non-contact intracavitary probes with special treatments for valve/hole regions. *7th World Congress on Computational Mechanics*, July 2006.

L. Olson and R. Throne. Estimating potentials from a noncontact probe, report to St. Jude Medical, January 2006.

R. Throne. Modeling, simulation, and control of a real system. *National Science Foundation CCLI Conference*, April 2004.

L. Olson, R. Throne, and J. Windle. Estimating endocardial (heart surface) potentials from a non-contact probe. *Seventh U.S. National Congress on Computational Mechanics*, July 2003.

L. Olson, R. Throne, and J. Windle. Estimating endocardial potentials from a non-contact probe. *Second MIT Conference on Computational Solid and Fluid Mechanics*, June 2003. Text in Computational Fluid and Solid Mechanics 2003, Volume 2, K.J. Bathe, ed, Elsevier, Oxford, UK, 2003, pp 1782-1785.

L. G. Olson, R. D. Throne, and J. R. Windle. Recent advances in the inverse problem of electrocardiography. *6th U.S. National Congress on Computational Mechanics*, August 2001.

E. A. Rost, L. G. Olson, and R. D. Throne. Improved solutions for on-line tool monitoring. *6th U.S. National Congress on Computational Mechanics*, August 2001.

L. G. Olson and R. D. Throne. Estimation of tool/chip interface temperatures for on-line tool monitoring: An inverse problem approach. *First MIT Conference on Fluid and Solid Mechanics*, June 2001.

L. G. Olson and R. D. Throne. Data fusion for the steady inverse heat conduction problem. *5th U. S. National Congress on Computational Mechanics*, August 1999.

L. G. Olson and R. D. Throne. Inverse electrocardiography: Source of performance improvements for generalized eigensystem methods. *Fourth U. S. National Congress on Computational Mechanics*, 1997.

L. G. Olson and R. D. Throne. Computational issues arising in multidimensional inverse problems. 6th *Annual Inverse Problems in Engineering Seminar*, June 1994.

L. G. Olson and R. D. Throne. The inverse problem of electrocardiography: A finite element approach employing a truncated eigenvector expansion. *Proceedings of the Twenty Third Midwestern Mechanics Conference*, 1993, pp. 200-202.

R. D. Throne, J. M. Jenkins, S. A. Winston, and L. A. DiCarlo. Statistical validation of new ventricular tachycardia detection schemes. *Journal of Electrocardiology.*

L. A. DiCarlo, J. M. Jenkins, R. D. Throne, C. J. Mays, and D. Lin. Classification of arrhythmias using atrial and ventricular endocardial electrograms. *Journal of Electrocardiology*, April 1989.

K. G. Shin and R. D. Throne. Communication and control of an integrated multi-robot system. *First Annual Workshop on Space Operations Automation and Robotics*, August 1987.

Refereed Conference Proceedings

R. Throne, L. Olson, J. Windle, J. Schweitzer, and E. Voth. Estimates of endocardial potentials from non-contact intracavitary probes. *28th Annual Conference of the IEEE Engineering in Medicine and Biology Society* (EMBS), September 2006 (on CD).

R. Throne. Developing models and understanding their limitations. *American Society of Engineering Education*, June 2006 (on CD).

L. G. Olson, R. D. Throne, J. R. Windle, J. A. Schweitzer, and E. J. Voth. Special treatments for valve/hole regions in endocardial potential estimates from non-contact intracavitary probes. *Rocky Mountain Bioengineering Symposium*, April 2006.

R. Throne. Frequency domain identification of one, two, and three degree of freedom systems in an introductory controls class. *American Society of Engineering Education*, June 2005 (on CD).

E. Bender, L. G. Olson, R. D. Throne, J. R. Windle. Effect of intracavitary probe size on the accuracy of inverse endocardial potential estimates. *IEEE Computers in Cardiology*, September 2004, pp. 581-584.

Y. Zaghoul, R. Throne, L. Olson, and J. Windle. Automating the selection of expansion modes using the principal components of time method for solving the inverse problem of electrocardiography. *IEEE Computers in Cardiology*, September 2004, pp. 401-404.

R. Throne. Modeling, simulation, and control of a real system. *American Society of Engineering Education*, June 2004 (on CD).

G. Bu, R. Throne, L. Olson, and J. Windle. The maximum a posteriori approach to the inverse problem of electrocardiography. *Rocky Mountain Bioengineering Symposium*, April 2003, pp. 158-162.

R. Throne, L. Olson, G. Bu, and J. Windle. A comparison of methods for estimating endocardial potentials from a noncontact probe. *IEEE Computers in Cardiology Conference*, September 2002, pp. 309-312.

G. Bu, R. Throne, L. Olson, and J. Windle. Analysis of the maximum a priori method to the inverse problem of electrocardiography for different depolarization sequences. *Computers in Cardiology*, September 2002, 493-496.

R. Throne, L. Olson, and J. Windle. Parameter choice methods and temporal filtering for the generalized eigensystem method applied to the inverse problem of electrocardiography. *Rocky Mountain Bioengineering Symposium*, April 2001, pp. 37-42.

D. Lowther, R. Throne, L. Olson, and J. Windle. A comparison of zero and first order Tikhonov regularization for an inhomogeneous volume. *Computers in Cardiology*, October 2001, pp. 541-544.

R. Throne, L. Olson, and J. Windle. The use of a single continuous regularization parameter for the generalized eigensystem method. *Computers in Cardiology*, October, 2001, pp. 517-520.

R. D. Throne and L. G. Olson. A comparison of spatial regularization with zero and first order Tikhonov regularization for the inverse problem of electrocardiography. *IEEE Computers in Cardiology*, September 2000, pp. 493-496.

L. G. Olson and R. D. Throne. The steady inverse heat conduction problem: A comparison of methods for inverse parameter selection. *ASME National Heat Transfer Conference 2000.*

R. D. Throne and L. G. Olson. Fusion of body surface potential and body surface Laplacian signals for electrocardiographic imaging. *IEEE Engineering in Medicine and Biology (EMBS)*, October 1999.

L. G. Olson and R. D. Throne. Regularization matrices for inverse electrocardiography. *ASME IMECE*, 1998. Text in *Computational Methods for Solution of Inverse Problems in Mechanics*, AMD-Vol. 228, ASME Press, New York, 1998.

R. D. Throne and L. G. Olson. Higher order regularization techniques for the inverse problem of electrocardiography. *Rocky Mountain Bioengineering Symposium*, April 1998, pp. 257-262.

L. G. Olson and R. D. Throne. A comparison of five methods for construction of regularization operators for higher order Tikhonov regularization. *IEEE Computers in Cardiology*, September 1998, pp. 357-360.

L. G. Olson and R. D. Throne. Alternative generalized eigensystem vectors which minimize the epicardial surface Laplacian for a given area-weighted amplitude. *IEEE Computers in Cardiology*, September 1998, pp. 685-688.

R. D. Throne, L. G. Olson, and Terry J. Hrabik. The minimum distance to origin: A method for choosing the number of expansion modes for the generalized eigensystem method. *IEEE Computers in Cardiology*, September 1998, pp. 697-700.

R. D. Throne and L. G. Olson. Generalized eigensystem techniques and Tikhonov regularization for a spherical heart/torso model with an intracavitary probe. *IEEE Computers in Cardiology*, September 1998, pp. 361-364.

R. D. Throne, L. G. Olson, and T. J. Hrabik. Higher order generalized eigensystem and Tikhonov regularization techniques for inverse electrocardiography. *IEEE Computers in Cardiology*, September 1997, pp. 17-20.

L. G. Olson, R. D. Throne, and J. R. Windle. A comparison of techniques for the inverse problem of electrocardiography applied to data from six isolated rabbit heart experiments. *IEEE Computers in Cardiology*, September 1997, pp. 437-440.

T. J. Hrabik, R. D. Throne, L. G. Olson, and J. R. Windle. Eigenvector expansion techniques for the inverse problem of electrocardiography applied to a realistic heart-torso geometry. *IEEE Computers in Cardiology*, September 1996, pp. 721-724.

J. Hoppner, R. D. Throne, L. G. Olson, and J. R. Windle. An open environment for reconstructing 2D images into 3D finite element models. *IEEE Computers in Cardiology*, September 1996, pp. 429-432

J. Schelert, L. G. Olson, M. Muff, and R. D. Throne. Accelerating eigenvector computations for inverse electrocardiography applications. *IEEE Computers in Cardiology*, September 1996, pp. 385-388.

R. D. Throne, L. G. Olson, and J. R. Windle. Vector expansion techniques for the inverse problem of electrocardiography: Application to a realistic heart-torso geometry. *Rocky Mountain Bioengineering Symposium*, April 1996, pp. 101-106.

R. D. Throne and L. G. Olson. The effects of noise and errors in heart size on numerical techniques for the inverse problem of electrocardiography. *Rocky Mountain Bioengineering Symposium*, April 1995, pp. 71-76.

S. Cary and R. D. Throne. Neural network approach to the inverse problem of electrocardiography. *IEEE Computers in Cardiology*, September 1995, pp. 87-90.

R. D. Throne. Scatter diagram analysis for distinguishing sinus rhythm from monomorphic ventricular tachycardia. *IEEE Computers in Cardiology*, September 1995, pp. 425-428.

R. D. Throne. Evaluation of computationally efficient algorithms for detecting changes in electrogram morphology. *Rocky Mountain Bioengineering Symposium*, April 1994, pp. 15-20.

L. G. Olson, R. D. Throne. Reducing the computational effort required for generalized eigensystem techniques applied to the inverse problem of electrocardiography. *International Mechanical Engineering Congress and Exposition*, Vol. AMD-186, 1994, pp. 1-7.

R. D. Throne and L. G. Olson. Computational issues arising in models of the inverse problem of electrocardiography. *IEEE Engineering in Medicine and Biology (EMBS)*, October 1994, pp. 131-132.

R. D. Throne and S. Gupta. Effects of short duration signal analysis for detecting ventricular fibrillation. *IEEE Engineering in Medicine and Biology (EMBS)*, October 1994, pp.1312-1313.

R. D. Throne and L. G. Olson. A modified generalized eigensystem approach for the inverse problem of electrocardiography. *IEEE Computers in Cardiology*, September 1994, pp. 797-799.

R. D. Throne and L. G. Olson. A generalized matrix eigensystem approach to the inverse problem of electrocardiography. *IEEE Computers in Cardiology*, September 1993, pp. 301-303.

R. D. Throne and L. G. Olson. A truncated eigenvector solution to the inverse problem of electrocardiography. *IEEE Engineering in Medicine and Biology (EMBS)*, October 1993, pp. 771-772.

R. D. Throne, D. Wilber, B. Olshansky, B. Blakeman, and R. Arzbaecher. Characterizing ventricular fibrillation using direct and seasonal autoregressive modeling. *IEEE Computers in Cardiology*, September 1991, pp. 197-200.

R. D. Throne, J. M. Jenkins, and L. A. DiCarlo. Evaluation of area-of-difference algorithms for detecting ventricular tachycardia using electrogram morphology. *IEEE Engineering in Medicine and Biology (EMBS)*, October 1990, pp. 584-585.

R. D. Throne, J. M. Jenkins, and L. A. DiCarlo. Statistical validation of new template matching methods for detecting ventricular tachycardia. *IEEE Computers in Cardiology*, September 1990, pp. 569-570.

R. D. Throne, J. M. Jenkins, and L. A. DiCarlo. Area-of-difference methods for detection of ventricular tachycardia using morphology. *IEEE Computers in Cardiology*, September 1990, pp. 569-570.

C. J. Finelli, P. C. Li, J. M. Jenkins, R. D. Throne, and L. A. DiCarlo. Intraventricular electrogram morphology: Effect of increased heart rate with and without accompanying changes in sympathetic tone. *IEEE Computers in Cardiology*, September 1990, pp. 115-118.

R. D. Throne, J. M. Jenkins, S. A. Winston, and L. A. DiCarlo. Use of tachycardia templates for recognition of recurrent monomorphic ventricular tachycardia. *IEEE Computers in Cardiology*, September 1989, pp 171-174.

R. D. Throne, J. M. Jenkins, S. A. Winston, C. J. Finelli, and L. A. DiCarlo. A comparison of correlation waveform analysis with a bin area method for recognition of retrograde activation in atrial electrograms. *IEEE Computers in Cardiology*, September 1989, pp 113-116.

R. S. MacDonald, J. M. Jenkins, R. Arzbaecher, and R. D. Throne. A software trigger for intracardiac waveform detection with automatic threshold adjustment. *IEEE Computers in Cardiology*, September 1989, pp 167-170.

A. Greene, J. Samson, and R. Throne. The AOSP (advanced onboard signal processor) in a communication system application. *IEEE MILCOM*, 1984, section 34.3 (classified).

R. Kasevich, D. Odom, and R. Throne. Eccentrically insulated Antenna theory applied to beverage antenna. *IEEE National Radio Science Symposium*, May 1983.

Refereed Abstracts

R. D. Throne, J. Windle, A. Easley, G. Kabell, D. Wilber, B. Olshansky. Scatter diagram analysis: A new method for discriminating ventricular tachyarrhythmias. *Circulation*, Vol. 86, No. 4, 1992, page I-657.

R. D. Throne, J. M. Jenkins, and L. A. DiCarlo. Impact of amplitude, baseline, and alignment on area algorithms for intraventricular electrogram analysis. *Circulation*, Vol. 82, No. 4, 1990, page III-167.

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R. D. Throne, J. M. Jenkins, S. A. Winston, C. J. Mays, and L. A. DiCarlo. Correlation waveform analysis of intraatrial electrograms: an accurate method for discriminating anterograde from retrograde atrial activation. *Pacing and Clinical Electrophysiology (PACE)*, Vol. 12, 1989, page 640.

Funding

"Automated Palpation System: A Novel Technique for Early Detection of Breast Cancer", Rose-Hulman Summer Professional Grants Program, June 1 - August 31, 2008, $10,000. R. D. Throne and L. G. Olson.

"Inverse Electrocardiography", Endocardial Solutions Inc, St. Paul, MN, July 17 - August 31, 2006, $17,070. L. G. Olson and R. D. Throne.

"Inverse Electrocardiography", Endocardial Solutions Inc, St. Paul, MN, June 1 - August 31, 2005, $37,956. L. G. Olson and R. D. Throne.

"Data Fusion for Inverse Electrocardiography: Synthesis of Signals from Multiple Sensor Types and Locations", National Science Foundation, September 2000 - August 2003, $207,015. R. D. Throne, L. G. Olson, and J. R. Windle

"Computational Support for Engineers and Scientists", National Science Foundation EP-SCoR program, January 1998 - December 2000, $700,000. *Three PI's. I was one of 20 Co-PI's.*

"Engineering Research Equipment: Advanced Computing and Mapping Facilities for Inverse Electrocardiography Research", National Science Foundation, August 1996 - August 1998, $34,600. R. D. Throne, L. G. Olson, and J. R. Windle.

"The Inverse Problem of Electrocardiography: New Computational Approaches, Numerical Simulations, and Experimental Verification", National Science Foundation, September 1994 - August 1998, $237,882. R. D. Throne, J. R. Windle, L. G. Olson.

> "Research Experiences for Undergraduates Supplement", National Science Foundation, September 1996-August 1997, $10,000. R. D. Throne and L. G. Olson.
>
> "Research Experiences for Undergraduates Supplement", National Science Foundation, September 1995-August 1996, $10,000. R. D. Throne and L. G. Olson.
>
> "Research Experiences for Undergraduates Supplement", National Science Foundation, September 1994-August 1995, $10,000. R. D. Throne and L. G. Olson.

"Realistic Human Torso Models for Study of the Inverse Problem of Electrocardiography", Layman Foundation, May 1994 - May 1995, $16,823, L. G. Olson and R. D. Throne.

"A new system for detecting cardiac arrhythmias", Layman Foundation, May 1992-May 1993, $19,740, R. D. Throne.

Supercomputing Grants

"An Inverse Stiffness Mapping Approach to the Early Detection of Breast Cancer", XSEDE, October 2021 - September 2022, 21504 node-hours. L. G. Olson and R. D. Throne, *submitted.*

"An Inverse Stiffness Mapping Approach to the Early Detection of Breast Cancer", XSEDE, April 2019 - September 2021, 10210 node-hours. L. G. Olson and R. D. Throne.

"An Inverse Stiffness Mapping Approach to the Early Detection of Breast Cancer", XSEDE, October 2017 - March 2019, 6745 node-hours. L. G. Olson and R. D. Throne.

"An Inverse Stiffness Mapping Approach to the Early Detection of Breast Cancer", XSEDE, January 2015 - September 2017, 675K SU units. L. G. Olson and R. D. Throne.

"An Inverse Stiffness Mapping Approach to the Early Detection of Breast Cancer", XSEDE, January 2014 - December 2014, 108K SU units. L. G. Olson and R. D. Throne.

"An Inverse Stiffness Mapping Approach to the Early Detection of Breast Cancer", XSEDE, January 2013 - December 2013, 240K SU units. L. G. Olson and R. D. Throne.

"An Inverse Stiffness Mapping Approach to the Early Detection of Breast Cancer", XSEDE, January 2012 - December 2012, 800K SU units. L. G. Olson and R. D. Throne.

"Early Detection of Breast Cancer through an Inverse Problem Approach to Stiffness Mapping", TeraGrid, January 2011 - December 2011, 380K SU units. L. G. Olson and R. D. Throne.

"TG Startup Renewal: Automated Palpation System: A Novel Technique for Early Detection of Breast Cancer", TeraGrid, September 2009 - December 2010, 90K SU units. L. G. Olson and R. D. Throne.

"TG DAC: Automated Palpation System: A Novel Technique for Early Detection of Breast Cancer", TeraGrid, September 2008 - August 2009, 30K SU units. L. G. Olson and R. D. Throne.

"Improved Numerical Techniques for the Inverse Problem of Electrocardiography", National Center for Supercomputing Applications, June 2000 - June 2001, 5000 SU units. L. G. Olson and R. D. Throne.

"Improved Numerical Techniques for the Inverse Problem of Electrocardiography", National Center for Supercomputing Applications, July 1999 - June 2000, 1000 SU units. L. G. Olson and R. D. Throne.

"Improved Modal Techniques for the Inverse Problem of Electrocardiography", National Center for Supercomputing Applications, November 1997 - October 1998, 660 SU units. L. G. Olson and R. D. Throne.

"Improved Modal Techniques for the Inverse Problem of Electrocardiography", National Center for Supercomputing Applications, April 1996 - October 1997, 340 SU units. L. G. Olson and R. D. Throne.

"Improved Modal Techniques for the Inverse Problem of Electrocardiography", National Center for Supercomputing Applications, April 1995 - March 1996, 350 SU units. L. G. Olson and R. D. Throne.

"Improved Modal Techniques for the Inverse Problem of Electrocardiography", National Center for Supercomputing Applications, June 1993 - August 1994, 86 SU units. L. G. Olson and R. D. Throne.