

# CURRICULUM VITAE

Michael I. Miga, Ph.D.

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VU Station B, #351631, Nashville, TN 37235

## PROJECTS:

- **Model-Updated Image-Guided Surgery:** This project is focused on integrating computational models within operating room to compensate for errors in image-guided surgery due to soft tissue deformation.
  - **Finite Element Modeling of Brain Tissue Mechanics:**
    - Biphasic, and viscoelastic models of tissue
    - Drug distribution dynamics
    - Hydrocephalus
    - Mechanics of Tumor Growth
  - **Cortical Surface Registration and Deformation Tracking Using Laser Range Technology**
- **Inverse Problems in Biomedical Imaging:** This project focus is on integrating computational models within novel imaging methods to develop new techniques for detection and diagnosis of diseased tissue.
  - **Modality Independent Elastography**
  - **Mechanical Imaging in Breast Cancer Detection**
  - **Source Localization for Epilepsy**
- **Other Areas of Interest:**
  - **General Material Property Determination**
  - **Co-registered Ultrasound for Image-Guided Neurosurgery**
  - **Computational Biofluid Mechanics**
  - **Immunological Modeling**

## EDUCATION:

- **Bachelor of Science in Mechanical Engineering with Applied Mechanics**, University of Rhode Island, Department of Mechanical Engineering, Kingston, RI. 1987-1992.
- **Master of Science in Mechanical Engineering with Applied Mechanics**, University of Rhode Island, Department of Mechanical Engineering, Kingston, RI. 1992-1994.
- **Doctor of Philosophy in Engineering (biomedical specialization)**. Dartmouth College, Thayer School of Engineering, Hanover, NH. 1994-1998.

## PROFESSIONAL EXPERIENCE:

- **Contracting Engineer**, Naval Undersea Warfare Center (NUWC), Newport, RI. 5/1991 – 8/1994.
- **Research Associate Scientist** (Post doctoral training), Dartmouth College, Thayer School of Engineering, Hanover, NH. 10/1998-3/2000.
- **Research Assistant Professor of Engineering**, Dartmouth College, Thayer School of Engineering, Hanover, NH. 4/2000-11/2000.
- **Assistant Professor of Biomedical Engineering**, Vanderbilt University, Department of Biomedical Engineering, Nashville, TN. 12/2000-present.

## **AWARDS:**

- **Army Commendation Medal** for meritorious service during Operation Desert Storm, 414<sup>th</sup> Civil Affairs Company, 1991.
- **Alma Hass Milhaum Fellowship in Biomedical Engineering**, Dartmouth College, Thayer School of Engineering, Hanover, NH. 1996-1997.
- **Thayer School Distinguished Fellow**, Dartmouth College, Thayer School of Engineering, Hanover, NH. 1997-1998.
- **Charles F. and Ruth D. Goodrich Prize**, Dartmouth College, Thayer School of Engineering, Hanover, NH. 1998.
- **Cum Laude: Medical Imaging 2003 Poster Award**, M. I. Miga and B. K. Lamprich, Vanderbilt University, Department of Biomedical Engineering, Nashville, TN. 2003.

## **OTHER EXPERIENCE:**

- **Persian Gulf War Veteran**, 443<sup>rd</sup> Civil Affairs Company attached to 414<sup>th</sup> Civil Affairs Company, U.S. Army, Warwick RI. 2/1987-2/1995.
- **Faculty/Student Adviser of the IEEE Engineering in Medicine and Biology Society Chapter**, Dartmouth College, Thayer School of Engineering, Hanover, NH. 1/1995-11/2000.
- **Faculty Mentor for the Women in Science Program**, Dartmouth College, Thayer School of Engineering, Hanover, NH. 1/2000-6/2000.

## **MEMBERSHIPS:**

- **Society of Photo-Optical Instrumentation Engineers (SPIE)**
- **Institute of Electronic and Electrical Engineers (IEEE) – Engineering and Medicine and Biology Society**

## **VANDERBILT SERVICE WORK:**

- **Graduate Program Committee for Department of Biomedical Engineering. 2002-present.**
- **High Performance Computing Representative for Biomedical Engineering Department. 2001-present.**
- **Graduate Faculty Assembly Delegate. 2002-present.**
- **Core Undergraduate Curriculum Committee**
- **Member of Biomathematics Study Group at Vanderbilt University**
- **Early Acceptance Program for Vanderbilt University Medical School (2003-present)**

## **SCIENTIFIC COMMUNITY SERVICE WORK:**

- **Member of Program Scientific Review Committee for 4<sup>th</sup> International Conference on Medical Image Computing and Computer-Assisted Intervention, 2001.**
- **Member of Program Scientific Review Committee for 5<sup>th</sup> International Conference on Medical Image Computing and Computer-Assisted Intervention, 2002.**

- **Member of Program Scientific Review Committee for International Symposium on Surgery Simulation and Soft Tissue Modeling Reviews, 2003.**
- **Conference Chair for Modeling I, Modeling II Sections for SPIE Medical Imaging 2003: Visualization, Display and Image-guided Procedures, 2/15-18/2003.**
- **Member of Program Scientific Review Committee for 6<sup>th</sup> International Conference on Medical Image Computing and Computer-Assisted Intervention, 2003.**

**PUBLICATIONS:** (Graduate and medical student authors advised or under the supervision of Dr. Miga are underlined)

**PEER REVIEWED JOURNALS PAPERS:**

1. D. W. Roberts, A. Hartov, F. E. Kennedy, **M. I. Miga**, K. D. Paulsen, 'Intraoperative brain shift and deformation: a quantitative analysis of cortical displacement in 28 cases', *Neurosurgery*, Vol. 32, No. 4, pp. 749-760, 1998.
2. **M. I. Miga**, K. D. Paulsen, F. E. Kennedy, 'Von Neumann stability analysis of Biot's general two-dimensional theory of consolidation', *International Journal of Numerical Methods in Engineering*, Vol. 43, No. 5, pp. 955-974, 1998.
3. K. D. Paulsen, **M. I. Miga**, F. E. Kennedy, P. J. Hoopes, A. Hartov, and D. W. Roberts, 'A computational model for tracking subsurface tissue deformation during stereotactic neurosurgery', *IEEE Transactions on Biomedical Engineering*, Vol. 46, No. 2, pp. 213-225, 1999.
4. H. Pallatroni, A. Hartov, J. McInernery, L. A. Platenik, **M. I. Miga**, F. E. Kennedy, K. D. Paulsen, D. W. Roberts, 'Coregistered ultrasound as a neurosurgical guide', *Stereotactic and Functional Neurosurgery*, Vol. 73, No.1-4, pp. 143-147, 1999.
5. A. Hartov, S. D. Eisner, D. W. Roberts, K. D. Paulsen, L. A. Platenik, **M. I. Miga**, 'Error analysis for a freehand 3D ultrasound system for neuronavigation', *Neurosurgical Focus*, Vol. 6, No. 3, Article 5, 1999.
6. E. E. W. Van Houten, K. D. Paulsen, **M. I. Miga**, F. E. Kennedy, J. B. Weaver, 'An overlapping subzone technique for MR based elastic property reconstruction', *Magnetic Resonance in Medicine*, Vol. 46, No. 2, pp.213-225, 1999.
7. **M. I. Miga**, D. W. Roberts, A. Hartov, S. Eisner, J. Lemery, F. E. Kennedy, K. D. Paulsen, 'Updated neuroimaging using intraoperative brain modeling and sparse data', *Stereotactic and Functional Neurosurgery*, Vol. 72, pp. 103-106, 1999.
8. **M. I. Miga**, K. D. Paulsen, J. M. Lemry, F. E. Kennedy, S. D. Eisner, A. Hartov, D. W. Roberts, 'Model-updated image guidance: Initial clinical experience with gravity-induced brain deformation', *IEEE Transactions on Medical Imaging*, Vol. 18, No. 10, pp. 866-874, 1999.
9. D. W. Roberts, **M. I. Miga**, S. D. Eisner, A. Hartov, J. Lemry, F. E. Kennedy, K. D. Paulsen, 'Intraoperative updated neuroimaging using brain modeling and sparse data', *Neurosurgery*, Vol. 45, No. 5, pp. 1199-1207, 1999.
10. **M. I. Miga**, K. D. Paulsen, P. J. Hoopes, F. E. Kennedy, A. Hartov, D. W. Roberts, 'In vivo analysis and modeling of interstitial pressure in the brain under surgical loading', *ASME Journal of Biomechanical Engineering*, Vol. 122, No. 4, pp. 354-363, 2000.
11. E. E. W. Van Houten, J. B. Weaver, **M. I. Miga**, F. E. Kennedy, K. D. Paulsen, 'Elasticity reconstruction from experimental MR displacement data: Initial experience with an overlapping subzone finite element inversion process', *Medical Physics*, Vol. 27, No. 1, pp. 101-107, 2000.
12. **M. I. Miga**, K. D. Paulsen, P. J. Hoopes, F. E. Kennedy, A. Hartov, D. W. Roberts, 'In-vivo analysis of heterogeneous brain deformation computations for model-updated image guidance', *Computer Methods in Biomechanics and Biomedical Engineering*, Vol. 3, No. 2, pp. 129-146, 2000.
13. **M. I. Miga**, K. D. Paulsen, P. J. Hoopes, F. E. Kennedy, A. Hartov, D. W. Roberts, 'In vivo quantification of a homogeneous brain deformation model for updating preoperative images during surgery', *IEEE Transactions on Biomedical Engineering*, Vol. 47, No.2, pp. 266-273, 2000.

14. **M. I. Miga**, D. W. Roberts, F. E. Kennedy, L. A. Platenik, A. Hartov, K. E. Lunn, K. D. Paulsen, 'Computational Modeling of Retraction and Resection for Updating Images During Surgery', *Neurosurgery*, Vol. 49, No. 1, pp. 75-84, 2001.
15. P. M. Meaney, K. D. Paulsen, B. W. Pogue, **M. I. Miga**, 'Microwave image reconstruction utilizing log-magnitude and unwrapped phase to improve high-contrast object recovery', *IEEE Trans. on Medical Imaging*, Vol. 20, No. 2, pp. 104-116, 2001.
16. E. E. W. Van Houten, **M. I. Miga**, J. B. Weaver, F. E. Kennedy, K. D. Paulsen, 'Three-dimensional subzone-based reconstruction algorithm for MR elastography', *Magnetic Resonance in Medicine*, Vol. 45, No. 5, pp. 827-837, 2001
17. J. B. Weaver, E. E. W. Van Houten, **M. I. Miga**, F. E. Kennedy, K. D. Paulsen, 'Magnetic resonance elastography using 3D gradient echo measurements of steady-state motion', *Medical Physics*, vol. 28, no. 8, pp.1620-1628, 2001.
18. **M. I. Miga**, T. E. Kerner, T. M. Darcey, 'Source localization using finite elements and targeted simulated annealing', *IEEE Trans. on Biomedical Engineering*, vol. 49, no. 7, pp. 743-745, 2002.
19. L. A. Platenik, **M. I. Miga**, D. W. Roberts, K. E. Lunn, F. E. Kennedy, A. Hartov, K. D. Paulsen, 'In Vivo quantification of retraction deformation modeling for updated image-guidance during neurosurgery', *IEEE Trans. on Biomedical Engineering*, vol. 49, no. 8, pp. 823-835, 2002.
20. **M. I. Miga**, 'A new approach to elastography using mutual information and finite elements', *Physics in Medicine and Biology*, vol. 48, no. 4, pp. 467-480, 2002.
21. **M. I. Miga**, T. K. Sinha, D. M. Cash, R. L. Galloway, and R. J. Weil, 'Cortical surface registration for image-guided neurosurgery using laser-range scanning', *IEEE Transactions on Medical Imaging*, (in press), 2003.
22. D. M. Cash, T. K. Sinha, W. C. Chapman, H. Terawaki, B. M. Dawant, R. L. Galloway, **M. I. Miga**, 'Incorporation of a laser range scanner into image-guided liver surgery: surface acquisition, registration, and tracking', *Medical Physics*, (in press), 2002.

#### PEER REVIEWED PAPERS IN SCIENTIFIC SERIES:

1. **M. I. Miga**, K. D. Paulsen, F. E. Kennedy, P. J. Hoopes, A. Hartov, and D. W. Roberts, 'Initial in-vivo analysis of 3D heterogeneous brain computations for model-updated image-guided neurosurgery', *Lecture Notes in Computer Science: Medical Image Computing and Computer-Assisted Intervention – MICCAI 1998*, Springer Verlag, New York, Vol. 1496, pp. 743-752, 1998.
2. **M. I. Miga**, K. D. Paulsen, F. E. Kennedy, A. Hartov, D. W. Roberts, 'Model-updated image-guided neurosurgery using the finite element method: Incorporation of the falx cerebri', *Lecture Notes in Computer Science: Medical Image Computing and Computer-Assisted Intervention – MICCAI 1999*, Springer Verlag, New York, Vol. 1679, pp. 900-909, 1999.
3. **M. I. Miga**, A. Staubert, K. D. Paulsen, F. E. Kennedy, V. M. Tronnier, D. W. Roberts, A. Hartov, L. A. Platenik, K. E. Lunn, 'Model-updated image-guided neurosurgery: Preliminary analysis using intraoperative MR', *Lecture Notes in Computer Science: Medical Image Computing and Computer-Assisted Intervention – MICCAI 2000*, Springer Verlag, New York, Vol. 1935, pp. 115-124, 2000.
4. T. K. Sinha, D. M. Cash, R. J. Weil, R. L. Galloway, **M. I. Miga**, 'Cortical surface registration using texture mapped point clouds and mutual information', *Lecture Notes in Computer Science: Medical Image Computing and Computer-Assisted Intervention – MICCAI 2002*, Springer Verlag, New York, Vol. 2488, Part 2, pp. 533-540, 2002.
5. V. Duay, T. K. Sinha, P. D'Haese, **M. I. Miga**, B. M. Dawant, 'Non-rigid registration of serial intra-operative images for automatic brain-shift estimation', *Lecture Notes in Computer Science: Second International Workshop on Biomedical Image Registration – WBIR 2003*, Springer Verlag, New York, (in press), 2003.

#### BOOK CHAPTERS:

- K. D. Paulsen, and **M. I. Miga**, 'Chapter 15: Biomechanical modeling for image registration: Applications in image-guided neurosurgery', *Medical Image Registration*, by editors: J. V. Hajnal, D. L. G. Hill, and D. J. Hawkes, CRC Press, pp. 332- 362, 2001.

## CONFERENCE PAPERS:

1. **M. I. Miga**, K. D. Paulsen, F. E. Kennedy, P. J. Hoopes, A. Hartov, and D. W. Roberts, 'A 3D brain deformation model experiencing comparable surgical loads', *Proceedings of the 19th Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, pp. 773-776, 1997.
2. **M. I. Miga**, K. D. Paulsen, F. E. Kennedy, P. J. Hoopes, A. Hartov, and D. W. Roberts, 'Modeling surgical loads to account for subsurface tissue deformation during stereotactic neurosurgery', *IEEE SPIE Proceedings of Laser-Tissue Interaction IX, Part B: Soft-tissue Modeling*, Vol. 3254, pp. 501-511, 1998.
3. **M. I. Miga**, K. D. Paulsen, F. E. Kennedy, P. J. Hoopes, A. Hartov, and D. W. Roberts, 'Quantification of a 3D brain deformation model experiencing a temporal mass expansion', *Proceedings of the 24th IEEE Northeast Bioengineering Conference*, pp. 68-71, 1998.
4. E. E. W. Van Houten, K. D. Paulsen, **M. I. Miga**, F. E. Kennedy, J. B. Weaver, 'A sweeping subzone nonlinear inversion scheme for viscoelastic tissue properties', *Medical Imaging 2000: Image Processing, Proceedings of the SPIE*, Vol. 3979, pp. 556-563, 2000.
5. **M. I. Miga**, J. M. Fitzpatrick, R. L. Galloway Jr., K. D. Paulsen, 'Incorporation of surface-based deformations for updating images intraoperatively', *Medical Imaging 2001: Visualization, Display, and Image-guided Procedures: Proc. of the SPIE*, Vol. 4319, pp.169-178, 2001.
6. K. D. Paulsen, **M. I. Miga**, D. W. Roberts, F. E. Kennedy, L. A. Platenik, K. E. Lunn, A. Hartov, 'Finite element modeling of tissue retraction and resection for preoperative neuroimage compensation concurrent with surgery', *Medical Imaging 2001: Visualization, Display, and Image-guided Procedures: Proc. of the SPIE*, Vol. 4319, pp. 13-21, 2001.
7. L. A. Platenik, **M. I. Miga**, D. W. Roberts, F. E. Kennedy, A. Hartov, K. E. Lunn, K. D. Paulsen, 'In vivo comparison of an incremental vs. single-step retraction model for intraoperative compensation', *Medical Imaging 2001: Visualization, Display, and Image-guided Procedures: Proc. of the SPIE*, Vol. 4319, pp. 358-365, 2001.
8. K. E. Lunn, A. Hartov, F. E. Kennedy, **M. I. Miga**, D. W. Roberts, L. A. Platenik, K. D. Paulsen, 'Intraoperative ultrasound as sparse data for brain deformation modeling', *Medical Imaging 2001: Ultrasonic Imaging and Signal Processing: Proc. of the SPIE*, Vol. 4325, pp. 326-332, 2001.
9. **M. I. Miga**, 'A new approach to elastographic imaging: Modality independent elastography', *Medical Imaging 2002: Image Processing: Image Processing: Proc. of the SPIE*, Vol. 4684, Part 1, pp. 604-611, 2002.
10. D. M. Cash, T. K. Sinha, W. Chapman, R. L. Galloway Jr., **M. I. Miga**, 'Fast, Accurate Surface Acquisition Using a Laser Range Scanner for Image-Guided Liver Surgery', *Medical Imaging 2002: Visualization, Display, and Image-guided Procedures: Proc. of the SPIE*, Vol. 4681, pp. 100-110, 2002.
11. T. K. Sinha, D. M. Cash, R. J. Weil, R. L. Galloway, **M. I. Miga**, 'Textured laser range scanning and registration of the cortical surface', *Proceedings of the Second Joint EMBS/BMES Conference*, pp.1183-1184, October 23-26, 2002.
12. B. K. Lamprich and **M. I. Miga**, 'Analysis of model-updated MR images to correct for brain deformation due to tissue retraction', *Medical Imaging 2003: Visualization, Display, and Image-guided Procedures: Proc. of the SPIE*, (in press), 2003.
13. **M. I. Miga**, D. M. Cash, Z. Cao, R. L. Galloway, B. Dawant, W. C. Chapman, 'Intraoperative registration of the liver for image-guided surgery using laser range scanning and deformable models', *Medical Imaging 2003: Visualization, Display, and Image-guided Procedures: Proc. of the SPIE*, (in press), 2003.
14. T. K. Sinha, D. M. Cash, R. J. Weil, R. L. Galloway, **M. I. Miga**, 'Laser range scanning for cortical surface characterization during neurosurgery', *Medical Imaging 2003: Visualization, Display, and Image-guided Procedures: Proc. of the SPIE*, (in press), 2003.
15. D. M. Cash, T. K. Sinha, R. L. Galloway, W. C. Chapman, H. Terawaki, **M. I. Miga**, 'Incorporation of a laser range scanner into an image-guided surgical system', *Medical Imaging 2003: Visualization, Display, and Image-guided Procedures: Proc. of the SPIE*, (in press), 2003.

**GENERAL PUBLIC PRESENTATIONS:**

1. Special Feature Article: Stuart M. Hutson, 'Laser range scanner helps surgeons navigate: Imaging technique moves from guiding neurosurgery to the liver', Biophotonics International, pp. 52-53, June 2002.
2. Special Feature News Story: Amy Marsalis, 'Laser-guided brain surgery', Medical Breakthroughs with Amy Marsalis: News Channel 5, 7/11/2002.