BIOGRAPHICAL SKETCH

Provide the following information for the Senior/key personnel and other significant contributors.
Follow this format for each person. **DO NOT EXCEED FIVE PAGES.**

NAME: Royston, Thomas James

eRA COMMONS USER NAME (credential, e.g., agency login): ROYSTONTHOMAS

POSITION TITLE: Professor and Head, Department of Bioengineering

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Ohio State University, Columbus, OH	B.S.	08/1990	Mechanical Engineering
Ohio State University, Columbus, OH	M.S.	08/1992	Mechanical Engineering
Ohio State University, Columbus, OH	Ph.D.	08/1995	Mechanical Engineering

A. Personal statement.

I have directed the UIC Acoustics and Vibrations Laboratory (AVL) since 1995, which specializes in the development of novel medical imaging technology rooted in vibrations and acoustics. I am currently focused on two related efforts, the Audible Human Project® (AHP) and high-resolution magnetic resonance elastography (MRE). The goal of the AHP, sponsored by the NIH through an R01 grant, is to develop a comprehensive understanding and computational simulation model of how sound and vibration are generated and travel throughout the body, with our current focus on the torso and cardio-pulmonary systems, and how this is altered by disease and injury. We are also focused on incorporating multiscale modeling/capability into the AHP. The outcomes of this project could impact both medical education, through improved training technology, and research by catalyzing the development of new acoustic imaging methods. My work in MRE, supported by grants from NIH and NSF, involves vibrating a subject or specimen in an MRI to produce an image of the propagating vibratory waves. From these images, one tries to quantify stiffness and damping, properties often altered by disease or trauma. MRE has potential applications for identifying anomalies in virtually every organ and soft tissue region in the body. When coupled with advanced multiscale modeling approaches, for example using fractal and fractional calculus methods, for reconstruction of tissue mechanical properties based on MRE measurements, microscopic information about tissue changes may be discernible from macroscopic measurements. Also, I am a founding member of the recently established International Society for Magnetic Resonance in Medicine (ISMRM) MRE Guidelines Committee. One task this committee is undertaking is to establish a series of phantom models that will be circulated globally to MRE research groups, and eventually ultrasound elastography (USE) research groups, to promote consistency in measurement methods and interpretation, and validation of new approaches.

B. Positions and Honors.

Positions and Employment

1) The University of Illinois at Chicago, Department of Bioengineering. Chicago, Illinois. Professor & Head: 2011 – present, Interim Head: 2009 – 2011. Adjunct Professor, 1999 – present.
2) The University of Illinois at Chicago, Department of Mechanical Engineering. Chicago, Illinois. Professor: 2004 – present. Associate Professor: 2000 – 2004. Assistant Professor: 1995 – 2000.
3) Naval Research Laboratory, Washington, D.C. Summer Faculty Appointment with Physical Acoustics Branch, 1997 & 1998. Contact: Dr. Brian Houston.
4) Argonne National Laboratory, Argonne, Illinois. Summer Faculty Position with the Advanced Photon Source Experimental Facilities Division, 1996, 2001. Contact: Dr. Deming Shu.
5) Naval Surface Warfare Center, Carderock Division, Carderock, Maryland. Office of Naval Research Graduate Intern with Structural Acoustics Division, Summer, 1993.

Selected Honors and Awards

1) **NIH NIBIB Nagy New Investigator Award (2014)**.
2) **University Scholar Award – University of Illinois System (2009)**.
3) **Fellow of the American Society of Mechanical Engineers - ASME (2007)**.
4) **The Acoustical Society of America: R. Bruce Lindsay Award (2002).**
5) **UIC College of Engineering Faculty Research Award (2002).**
6) **NSF Faculty Early Career (CAREER) Development Award (1998).**

Other Experience and Professional Activities

1) *Associate Editor*, American Society of Mechanical Engineers (ASME) J. of Vib. Acous. (6/08 – 6/14).
2) *Associate Editor*, Journal of the Acoustical Society of America (6/14 – present).
3) *Member*, ASME Technical Committee on Vibration and Sound (7/00 – 6/06, 6/09 – 6/14).
4) *Member*, ASA Technical Committee on Biomedical Ultrasound/ Bioresponse to Vibration (7/01 – present).
5) *Member,* International Society for Magnetic Resonance in Medicine (ISMRM) MRE Guidelines Committee (2015 – present)

Predoctoral & Postdoctoral Student Mentorship

1) Ipek Basdogan, PhD, 1997, *Placement: NASA Jet Propulsion Laboratory, Current position: Assoc. Professor, Mechanical Engineering, Koc University, Istanbul, Turkey.*
2) Soon-Hong Lee, PhD, 2000, *Placement: Argonne National Laboratory APS XFD, R&D.*
3) Xiangling Zhang, PhD, 2002, *Placement: GM Electromotive, R&D.*
4) Mehmet B. Ozer, PhD, 2004, *Placement: Postdoctoral Student, UIC.*
5) Yigit Yazicioglu, PhD, 2005, *Placement: Asst. Professor, Faculty of METU, Ankara, Turkey.*
6) Z. Koray Kusculuoglu, PhD 2005, *Placement: CBI, IL.*
7) Todd Spohnholtz, PhD 2005, *Placement: Northrup Grumman Corp., IL.*
8) Serhan Acikgoz, PhD 2007, *Placement: Baxter Healthcare Corporation, Deerfield, IL.*
9) Curt Preissner, PhD 2009, *Placement: Argonne National Laboratory APS XFD, R&D.*
10) F. Can Meral, PhD 2009, *Placement: Postdoctoral Student, Harvard University.*
11) Zoujun Dai, PhD 2012, *Placement: Postdoctoral Student, UIC.*
12) T. K. Yasar, PhD 2014, *Placement: Postdoctoral Student, Icahn School of Medicine at Mount Sinai (NY*).
13) Y. Peng, PhD 2015, *Placement: TRW*.
14) Y. Liu, PhD 2015, *Placement: GE Healthcare*.
15) S. Kearney, PhD 2015, *Placement: Argonne National Laboratory APS XFD, R&D*.
16) Five PhD in progress: J. Anton, B. Henry, A. Khan, H. Paltnikar, V. Suryadevara
17) Tarek El-Bialy, PhD 2001. Postdoc appt: 2001 – 2002. *Present position: Faculty of Medicine and Dentistry, University of Alberta, Canada.*
18) Mehmet B. Ozer, PhD, 2004, Postdoc appt: 2004 – 2006. *Present position: Asst. Professor, Faculty of METU, Ankara, Turkey.*
19) Dieter Klatt, PhD 2010, Postdoc appt: 2011 – 2013*. Present position: Asst. Professor, UIC Bioengineering.*
20) Zoujun Dai, PhD 2012, Postdoc appt: 2013 – 2015.

C. Contributions to Science

1. **Audible Human Project: pulmonary acoustics/elastography**. I, with my students and clinical and engineering collaborators, have been developing an improved understanding and ability to computationally model acoustic transmission through the pulmonary system that is relevant to diagnosis and training. Clinical collaborators, Richard S. Sandler, MD and Robert A. Balk, MD, have facilitated experimental validation studies, with engineering collaborator, Hansen Mansy, PhD, performing those validation studies. This is pioneering research; we believe our acoustic model is more advanced than any other and will aid and be a part of improved pulmonary diagnostic imaging in the future. This research has been supported by NIH R01 grant EB012142. This project was recently recognized with the NIH NIBIB Nagy New Investigator Award (2014). Key deliverables for this grant include development of a free shareware computer simulation program of pulmonary system acoustics, available at: http://acoustics.mie.uic.edu/AHP/htdocs/interactive_UI.php. Below are four recent journal publications in this area.

a) Dai Z, Peng Y, Mansy HA, Sandler RH, Royston TJ. Comparison of Poroviscoelastic Models for Sound and Vibration in the Lungs. Journal of vibration and acoustics. 2014; 136(5):0510121-5101211. PubMed [journal] PMID: 25278740, PMCID: PMC4112928

b) Dai Z, Peng Y, Henry BM, Mansy HA, Sandler RH, Royston TJ. A comprehensive computational model of sound transmission through the porcine lung. The Journal of the Acoustical Society of America. 2014; 136(3):1419. PubMed [journal] PMID: 25190415, PMCID: PMC4165230

c) Peng Y, Dai Z, Mansy HA, Sandler RH, Balk RA, Royston TJ. Sound transmission in the chest under surface excitation: an experimental and computational study with diagnostic applications. Medical & biological engineering & computing. 2014; 52(8):695-706. NIHMSID: NIHMS611727 PubMed [journal] PMID: 25001497, PMCID: PMC4160106

d) Mansy HA, Balk RA, Warren WH, Royston TJ, Dai Z, Peng Y, Sandler RH. Effect of pneumothorax on pulmonary acoustic transmission. J. Applied Physiology. 119(3), 250-7 (2015). doi: 10.1152/japplphysiol.00148.2015.

2. **SLIM/SDP/ULTIMATE MRE**. I have been involved in the development of three patented pulse sequences that greatly reduce the time needed to conduct an MR elastography study (by up to a factor of 3) while at the same time improving the accuracy of the measurement. This work was initiated with my PhD student, T Kaya Yasar, and postdoctoral student and now colleague and Co-I, Dieter Klatt. While we first implemented and validated these developments on preclinical MRI systems, they are translatable to clinical systems. This translation is already occurring (see d). As MRE spreads to more clinical applications beyond staging liver fibrosis, we expect that all implementations of it will eventually incorporate our algorithmic improvements, which both reduce imaging time (improving patient comfort and saving money) while at the same time improving accuracy. Articles and patent information on these techniques are provided below.

a) Klatt D, Yasar TK, Royston TJ, Magin RL. Sample interval modulation for the simultaneous acquisition of displacement vector data in magnetic resonance elastography: theory and application. Physics in medicine and biology. 2013; 58(24):8663-75. NIHMSID: NIHMS545020 PubMed [journal] PMID: 24256743, PMCID: PMC4048719. International Patent Application PCT/US13/71830. Filed: 11/26/2013.

b) Yasar TK, Klatt D, Magin RL, Royston TJ. Selective spectral displacement projection for multifrequency MRE. Physics in medicine and biology. 2013; 58(16):5771-81. NIHMSID: NIHMS513538 PubMed [journal] PMID: 23912182, PMCID: PMC3799856. International Patent Application PCT/US14/15294. Filed: 02/07/2014.

c) Yasar TK, Liu Y, Klatt D, Magin RL, Royston TJ. Optimal Motion Encoding Scheme for MR Elastography. Proceedings of the International Society for Magnetic Resonance in Medicine (ISMRM) 23rd Annual Meeting and Exhibition (Toronto, CA, May 30 – June 5, 2015). Provisional patent filed on 8/28/2014; UIC OTM Identification number 2015-023 (DI023).

d) Klatt D, Johnson CL, Yasar TK, Holtrop JL, Sutton BP, Royston TJ, Magin RL. Simultaneous Acquisition of the 3D Displacement Vector in Magnetic Resonance Elastography of the In Vivo Human Brain. Proceedings of the International Society for Magnetic Resonance in Medicine (ISMRM) 22nd Annual Meeting and Exhibition (Milan, Italy, May 10-14, 2014).

3. **Ultra High field & Wideband MR Elastography**. I, with colleague Richard Magin, and our students have pioneered the implementation of MR elastography (MRE) in ultra high field MRI systems and devised methods, such as use of a geometrically focused wave front, to greatly extend the frequency band over which MRE can be applied. Our application of MRE up to 16 kHz is unprecedented. Wideband (broad frequency range) MRE enables a more accurate and robust multiscale quantification of viscoelastic properties of the material/ specimen/ region of interest being studied that can improve diagnostic ability. This work also enables a more direct comparison between animal models of disease and the clinical condition, accounting for changes in dimensions between, for example, a rodent model and human subject, which necessitates conducting MRE over widely varying frequency ranges. Three publications illustrative of this work are provided.
   a) Liu Y, Yasar TK, Royston TJ. Ultra wideband (0.5-16 kHz) MR elastography for robust shear viscoelasticity model identification. Physics in medicine and biology. 2014; 59(24):7717-7734. PubMed [journal] PMID: 25419651
   b) Yasar TK, Royston TJ, Magin RL. Wideband MR elastography for viscoelasticity model identification. Magnetic resonance in medicine : official journal of the Society of Magnetic Resonance in Medicine / Society of Magnetic Resonance in Medicine. 2013; 70(2):479-89. NIHMSID: NIHMS403388 PubMed [journal] PMID: 23001852, PMCID: PMC3556381
   c) Othman SF, Xu H, Royston TJ, Magin RL. Microscopic magnetic resonance elastography (microMRE). Magnetic resonance in medicine : official journal of the Society of Magnetic Resonance in Medicine / Society of Magnetic Resonance in Medicine. 2005; 54(3):605-15. PubMed [journal] PMID: 16088876

4. **Dynamic tissue viscoelasticity modeling**. Complementary to topic 3 above, I have been involved in developing improved models of soft tissue viscoelasticity based on our ability to measure tissue shear wave behavior over an unprecedented frequency range and based on utilization of concepts in fractional calculus. Much of this development can be found in the publications listed under topic 2. Additional publications related to this and which highlight our use of wideband optical elastography, in addition to wideband MR elastography, are provided here.
   a) Kearney SP, Khan AA, Dai Z, Royston TJ. Dynamic viscoelastic models of human skin using optical elastography. Phys. Med. Biol. In Press (2015).
   b) F. C. Meral, T. J. Royston, R. L. Magin, “Rayleigh-Lamb wave propagation on a fractional order viscoelastic plate,” J. of the Acoustical Society of America 129 (2), 1036 – 1045 (2011). PMID: 21361459; PMCID: PMC3063611
   c) Meral FC, Royston TJ, Magin RL. Surface response of a fractional order viscoelastic halfspace to surface and subsurface sources. The Journal of the Acoustical Society of America. 2009; 126(6):3278-85. PubMed [journal] PMID: 20000941, PMCID: PMC2803725

5. **Hysteresis modeling**. Earlier on in my career I made some key contributions to the area of hysteresis modeling and experimental model identification. This has broad potential impact in many different science and technology areas, including soft tissue and muscle mechanics. Four publications, highlighting the application of a rigorous approach to modeling and model identification of hysteresis in four very different applications, are listed below.
   a) Preissner C, Royston TJ, Shu D. A High Fidelity Harmonic Drive Model. ASME Journal of Dynamic Systems, Measurement and Control. 2012; 134(1):011002-1 –011002-13.
   b) Magin RL, Royston TJ. Fractional-Order Elastic Models of Cartilage: A Multi-scale Approach. Communications in Nonlinear Science & Numerical Simulation. 2010; 15(3):657-664.
   c) Royston TJ. Leveraging the equivalence of hysteresis models from different fields for analysis and numerical simulation of jointed structures. ASME J. Computational and Nonlinear Dynamics 2008; 3:031006-1–031006-8.
   d) M. B. Ozer and T. J. Royston, “Passively minimizing structural sound radiation using shunted piezoelectric materials,” Journal of the Acoustical Society of America 114 (4), 1934 – 1946 (2003). PMID: 14587594.

List of Published Work in MyBibliography:
http://www.ncbi.nlm.nih.gov/myncbi/browse/collection/44076849/?sort=date&direction=descending

D. Research Support (in last 3 years).

Ongoing Research Support

R01 EB012142 Royston (PI) 08/01/10 - 07/31/15
The Audible Human Project (Competitive renewal pending)
This research is to develop and experimentally validate a patient-specific accurate acoustic simulation model of sound transmission in the lungs and upper torso region. It will be applied to the Visible Human Male data set of the National Library of Medicine and will be relevant to both medical research and education. It could catalyze the development of improved medical diagnostic techniques and provide a more effective educational paradigm for teaching stethoscopic skills.
Role: PI

NSF 1302517 Royston (PI) 06/01/13 – 05/31/16
HCC: Medium: Collaborative Research: Force Feedback for Fingertips
The purpose of our proposed research is to bring true force feedback to touch screens. We call this force feedback for fingertips (F^3). From a technological standpoint, the challenge is essentially to make the fingertip into the rotor of a motor, and the top surface of the touch screen into a stator.
Role: PI

R01 HL113057 Lewandowski (PI) 01/16/13 – 11/30/16
Gender Effects on Remodeling of Lipid and Sarcomere Dynamics in Hypertrophy
This research examines the potential for gender to influence dysregulation of long chain fatty acid (LCFA) metabolism in the heart through both mechanical and biochemical effects of lipid changes on heart muscle. The outcome will produce new information for early diagnosis and eventual treatment of hearts exhibiting metabolic changes that may contribute to cardiac dysfunction.
Role: Co-Investigator

R25 EB018239 Kotche (PI) 4/15/14 – 3/31/19
Translational Design of Medical Devices
This project supports specific activities to improve our undergraduate bioengineering curriculum
Role: Co-Investigator

Completed Research Support in past 3 years

R01 EB007537 Magin (PI) 05/01/09 - 02/28/14
MR Technologies for Monitoring Engineered Tissues
The objective of this study is to develop new techniques for monitoring engineered chondrogenic tissues using magnetic resonance imaging and magnetic resonance elastography. Magnetic resonance imaging provides three dimensional views of developing tissue at all stages of growth without the need to sacrifice the animal or to biopsy the tissue. Magnetic resonance elastography gives a direct measure of the strength and stiffness of regenerating tissue: critical information needed to guide the design of new methods of tissue engineering and to assess the success of tissue implants for restoring tissue damaged by disease, injury or cancer treatment.
Role: Co-Investigator

NSF 0821313 Magin (PI) 09/01/09 - 08/31/13
MRI: Acquisition of a High Field Magnetic Resonance Imaging System for Science and Engineering Research
This is a major research instrumentation grant solely for the purpose of purchasing the named equipment.
Role: Co-Investigator