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EXPERIENCE

January 2010-Present University of Washington

Affiliate Associate Professor, William E. Boeing Department of Aeronautics & Astronautics

May 2000-Present OptiNav, Inc.

President

Developing technology for aeroacoustic phased arrays and biomedical imaging. Recent efforts include serving as the principal investigator for the NASA NRA task "Improved Phased Array Techniques to Account for Extended Sources of Fan and Jet Noise," the Navy SBIR project "Predictions of the acoustic nearfield on a carrier deck, and the NASA SBIR project "Phased Array Technique for Low Signal-to-Noise Ratio Wind Tunnels."

1986-2000 The Boeing Company, Seattle area

January 1995-May 2000: Fluid Dynamics and Aeroacoustics Research, Boeing Commercial Airplane group.

December 1992-December 1994: Large Airplane Development Program, Boeing Commercial Airplane Group.

September 1990-November 1992: Acoustics Technical Staff, Boeing Commercial Airplane Group.

August 1986-August 1990: Electromagnetics Technical Staff, Boeing Military Airplanes.

EDUCATION

Ph.D. Applied Mathematics, Iowa State University, 1986

Graduate Study, Computer Science, Iowa State University, 1982

M.S. Physics, Iowa State University, 1982

B.A. Physics, Rice University, 1979

PATENTS

US 5,702,231 "Apparatus and method for reducing noise emissions from a gas turbine engine inlet," Dougherty, Robert P. Assignee: The Boeing Company. Filed: August 9, 1996.

US 5,838,284 "Spiral-shaped array for broadband imaging," Dougherty, Robert P. Assignee: The Boeing Company, Filed: March 6, 1997.

US 5,915,403 "Biplanar scarfed nacelle inlet," McConachie; James M., Curtin, Margaret M.; Dougherty, Robert P.; Sangwin; Michael L. Assignee: The Boeing Company. Filed: April 14, 1998.

US 6,616,347 "Camera with rotating optical displacement unit" Sept. 9, 2003.

PUBLICATIONS

"Mutual Incoherence of Broadband Duct Acoustic Modes", AIAA Paper 2016-3032, Lyon, France, 2016.

"Cross spectral matrix diagonal optimization", BeBeC 2016, S2, Feb 29, 2016.

"Improved Phased Array Measurement Techniques for Jet Noise Understanding", R.P. Dougherty, K. Brentner, A.B. Cain, P.J. Morris, and C.C. Nelson, Plenary lecture, Conference on Modelling Fluid Flow (CMFF '15), Budapest, Hungary, September 1-4, 2015.

"Improved Method for Estimating Noise Level Reduction of Residential Houses", R.P. Dougherty, T. Robinson, and M. Kurosaka, Internoise 2015, San Francisco, CA, August 9-12, 2015.

"Functional Beamforming for Aeroacoustic Source Distributions", AIAA Paper 2014-3066, Atlanta, 2014.

"Validation of Beamforming Analysis Methodology with Synthesized Acoustic Time History Data: Sub-Scale Fan Rig System", T.R. Marotta, L.S. Lieber, and R.P. Dougherty, AIAA Paper 2014-3068, Atlanta, 2014.

"Functional Beamforming" R.P. Dougherty, Berlin Beamforming Conference BeBeC-2014-01, Feb. 2014.

"SODIX in Comparison with various deconvolution methods", S. Funke, R.P. Dougherty and U. Michel, Berlin Beamforming Conference BeBeC-2014-11, Feb. 2014.

"Wind turbine noise measurement using a compact microphone array with advanced deconvolution algorithms", R.C. Ramachandran, G. Raman and R.P. Dougherty, *Journal of Sound and Vibration*, Vol. 333 No. 14. pp. 3058-3080, Jan. 2014.

"Deconvolution of Sources in Aeroacoustic Images from Phased Microphone Arrays Using Linear Programming," R.P. Dougherty, R.C. Ramachandran and G.Raman, AIAA Paper 2013-2210, Berlin, Germany, 2013.

"Wavepacket noise source model for microphone array data analysis of hot supersonic jets", P. Morris, R. Dougherty, C. Nelson, A. Cain, and K. Brentner, *JASA* 1/2013; 134(5):4127.

"Linear Programming Acoustic Beamforming Versus Other Deconvolution Methods For A Full Scale 1.5 MW Wind Turbine", R.C. Ramachandran, G. Raman and R.P. Dougherty, AIAA Paper 2013-2057, Berlin, Germany, 2013.

"Application of Synthetic Phased Array Techniques to Hot Supersonic Jet Noise", C.C. Nelson, A.B. Cain, R.P. Dougherty, K.S. Brentner, and P.J. Morris, AIAA Paper 2013-0327, Grapevine, TX, 2013.

"Improved generalized inverse beamforming for jet noise," *International Journal of Aeroacoustics*, Vol. 11 No. 3-4, Sept. 2012.

"Deconvolution Beamforming Analysis of Low Frequency Wind Turbine Noise", Low Frequency 2012, Stratford upon Avon UK 22nd – 24th May 2012.

"Directional acoustic attenuation of planar foam rubber windscreens for phased arrays," R.P. Dougherty, Berlin Beamforming Conference BeBeC-2012-05, Feb. 2012.

"Localization of wind turbine noise sources using a compact microphone array with advanced beamforming algorithms," R.C. Ramachandran, H. Patel, G. Raman and R. Dougherty, Berlin Beamforming Conference BeBeC-2012-25, Feb. 2012.

"Studies of a wind turbine using OVERFLOW and PSU-WOPWOP," C. Nelson, A. Cain, G. Raman, T. Chan, M. Saunders, J. Noble, R. Engeln, R. Dougherty, K. Brentner and P. Morris, AIAA Paper 2012-6, Nashville, TN, 2012.

"Predicting Turbulent Decorrelation in Acoustic Phased Arrays", L. Pires, R. Dougehrty, S. Gerges, and F. Catalano, AIAA Paper 2012-387, Nashville, TN, 2012.

"Improved generalized inverse beamforming for jet noise," R.P. Dougherty. AIAA Paper 2011-2769 Portland, OR, June 2011.

"Evaluating the Acoustic Effect of Over-the-Rotor Foam-Metal-Liner Installed on a Low Speed Fan Using Virtual Rotating Microphone Imaging," D.L. Sutliff, R.P. Dougherty, B.E. Walker, and AIAA Paper AIAA 2010- 3800.

"Locating and Quantifying Broadband Fan Sources using In-Duct Microphones," R.P. Dougherty, B.E. Walker, and D.L. Sutliff, AIAA Paper AIAA 2010-3736.

"Jet noise beamforming with several techniques," Berlin Beamforming Conference (BeBeC) Feb. 2010.

"Acoustic Phased Array Videos from a Large Construction Site," *Internoise 2009*, Ottawa, Canada, August 2009.

"State of the art beamforming software and hardware for applications," S.N.Y. Gerges, W.D. Fonseca, and R. P. Dougherty, **Keynote Lecture** at ICSV 16, Krakow, Poland, July 2009.

"Phased Array Beamforming for Aeroacoustics," AIAA Professional Development course taught in 1999, 2003, and 2009.

"Phased Array Technology Applied to Aeroacoustics," **Keynote Lecture** at the 2009 AIAA Aeroacoustics Conference, Miami, FL, May 2009.

"Improved Phased Array Imaging of a Model Jet," R.P. Dougherty and G.G. Podboy, AIAA Paper 2009-3186, Miami, FL, May 2009.

"Virtual Rotating Microphone Imaging of Broadband Fan Noise," R.P. Dougherty and B.E. Walker, AIAA Paper 2009-3121, Miami, FL, May 2009.

"Pass-By Noise Measurements Using Beamforming Technique," W.D. Fonseca, S.N.Y. Gerges, and R. P. Dougherty, INTER-NOISE 2008.

"Object based colocalization analysis using ImageJ," R.P. Dougherty and A.M. Weiss, ImageJ User and Developer Conference, Nov. 6-7, 2008.

"Measurement of muscle disease by quantitative second-harmonic generation imaging," S.V. Plotnikov, A.M. Kenny, S.J. Walsh, B. Zubrowski, C. Joseph, V.L. Scranton, V.A. Kuchel., D. Dauser, M. Xu, C.C. Pilbeam, D.J. Adams, R.P. Dougherty, P.J. Campagnola and W.A. Mohler, *J. Biomed. Opt.*, 2008, Jul-Aug;13(4):044018.

"Beamforming in reflecting environments: an experiment in a reverberation chamber," R.P. Dougherty, W.D. Fonseca, and S.N.Y. Gerges, ASME Paper NCAD2008-73020, NoiseCon2008, Dearborn MI, July 28-30, 2008.

"Nacelle in-duct beamforming using modal steering vectors," R. Dougherty and J. Mendoza, AIAA Paper AIAA-2008-2812, Vancouver, British Columbia, May 5-7, 2008.

"Noise source imaging by beamforming" SAE Paper 2008-360518, SAE Brazil Noise and Vibration Conference – NVH, Florianopolis SC, April 2008. **Distinguished Lecture.**

"What is beamforming?" Berlin Beamforming Conference (BeBeC) Feb. 2008. **Keynote Lecture.**

"Phased array beamforming with 100-foot polar arc microphones in a static engine noise test," R. Dougherty and J. Mendoza, AIAA Paper AIAA-2008-51, Reno, Nevada, Jan. 2008.

"Quantification of the 3D microstructure of SC surfaces," G. Chinga, P.O. Johnsen, R.P. Dougherty, E.L. Berli, and J. Walter, *J. of Microscopy*, 227 (3), Sept. 2007, pp. 254-265.

"Computing Local Thickness of 3D Structures with ImageJ," R.P. Dougherty and K-H Kunzelmann, Microscopy & Microanalysis 2007 Meeting, Ft. Lauderdale, Florida, August 5-9, 2007. **Received the 2008 Macres Award for the Best Instrumentation or Software Paper presented at Microscopy & Microanalysis 2007.**

"A 3D Fast Hartley Transform Plugin for ImageJ," Proceedings of the ImageJ User and Developer Conference, Centre de Recherche Public Henri Tudor, Luxembourg, May, 2006.

"Deconvolution approach for the mapping of acoustic sources applied to enhance turbofan engine duct mode measurements," *J. Acoust. Soc. Am.* Vol. 118, p. 1864, 2005. (Conference presentation)

"Extensions of DAMAS and benefits and limitations of deconvolution in beamforming," AIAA Paper 2005-2961, Monterey, CA, May 2005.

"Non-intrusive jet noise study combining Rayleigh scattering and phased array measurement techniques," R. Dougherty, J. Panda, and S. Lee, AIAA Paper 2005-2843, Monterey, CA, May 2005.

"Aircraft wake vortex measurements at Denver International Airport," R.P. Dougherty, F. W. Wang, E. R. Booth, M. E. Watts, N. Fenichel, and R. E. D'Errico, AIAA/CEAS Paper 2004-2880, Manchester UK, May, 2004.

"Advanced time-domain beamforming techniques," AIAA Paper 2004-2955, Manchester UK, May, 2004.

"Paper surface characterisation by laser profilometry and image analysis," Chinga, G, Ø. Gregersen and Bob Dougherty, *Journal of Microscopy and Analysis*, September, 2003.

"Beamforming for aircraft noise measurements," *J. Acoust. Soc. Am.* Vol. 114, p. 2339, 2003. (Conference presentation)

"Turbulent decorrelation of aeroacoustic phased arrays: lessons from atmospheric science and astronomy," AIAA/CEAS Paper 2003-3200, Hilton Head, SC, May, 2003.

"Beamforming in acoustic testing." Chapter 2 in *Aeroacoustic Measurements*, T.J. Mueller, ed., Springer-Verlag, 2002.

"Source Identification and Location Techniques," D. Weir, J. Bridges, F. Agboola and R. Dougherty in "Proceedings of the Jet Noise Workshop," Dennis Huff, compiler, NASA/CP—2001-211152. <http://gltrs.grc.nasa.gov/reports/2001/CP-2001-211152.pdf> NASA/CP—2001-211152, Nov. 2001.

"A parabolic approximation for flow effects on sound propagation in nonuniform, softwall ducts," AIAA Paper 99-1822, Bellevue, WA, May 1999.

"Sidelobe suppression for phased array aeroacoustic measurement," R.P. Dougherty and R.W. Stoker, AIAA Paper 98-2242, Toulouse, France, May, 1998.

"An aeroacoustic study of an unswept wing with a three-dimensional high-lift system," B.L. Storms, J.C. Ross, W.C. Horne, J.A. Hayes, R.P. Dougherty, J.R. Underbrink, D.F. Scharpf and P.J. Moriarty, NASA/TM-1998-11222, Feb. 1998.

"Source Location with Sparse Acoustic Arrays; Interference Cancellation," CEAS-ASC Workshop, "Wind Tunnel Testing in Aeroacoustics" DNW, Noordoostpolder, the Netherlands, November 5-6, 1997.

"A wave-splitting technique for nacelle acoustic propagation," AIAA Paper 97-1652, Atlanta, GA, May 1997.

"Inlet shape effects on the far-field sound of a model fan," R.L. Clark, F. Farassat, C.H. Gerhold R.H. Thomas and R.P. Dougherty, AIAA Paper 97-1589, Atlanta, GA, May 1997.

"Trailing-edge flap noise reduction by porous acoustic treatment," J.D. Revell, H.L. Kuntz, F.J. Balena, C. Horne, B.L. Storms and R.P. Dougherty, AIAA Paper 97-1646, Atlanta, GA, May 1997.

"Array design for non-intrusive measurement of noise sources," J.R. Underbrink and R.P. Dougherty Noise-Con 96, Bellevue, WA, September 1996.

"Flap-tip treatments for the reduction of lift-generated noise," B.L. Storms, T.T. Takahashi, C. Horn, J.C. Ross, R.P. Dougherty and J.R. Underbrink, NASA CDTM-21006, March 1996.

"Nacelle acoustic design by ray tracing in three dimensions," AIAA Paper 96-1773, State College, PA, May 1996.

"Test Report Boeing/NASA Ames Flap-Edge Noise Test: Phased-Array Development," R.P. Dougherty, D. F. Scharpf, and J. R. Underbrink, NASA CDCR 21-000, Feb 16, 1995.

Direct and Inverse Scattering of Classical Waves at Oblique Incidence to Stratified Media via Invariant Imbedding Equations, doctoral dissertation, Iowa State University, 1986.

"A new parabolic approximation to the Helmholtz equation," H. McMaken, R. Dougherty and J. Coronas in *Review of Progress in Quantitative Nondestructive Evaluation*, 3A, 123-131, D. Thompson and D. Chimenti, editors (Plenum, New York, 1984).

Superconductivity and Low Temperature Phases of $Cu_xMo_6Se_8$, master's thesis, Iowa State University, 1982.

"Pressure induced phase transformations in superconducting $Cu_xMo_6Se_8$," R.N. Shelton and R.P. Dougherty, *Physica*, 107B, 1981. 475-476.