Vamshi Krishna Chillara

Acoustics and Sensors Team
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Education

Degree	GPA
Doctor of Philosophy, Engineering Science and Mechanics (2015)	4.00/4.00
The Pennsylvania State University, University Park	
PhD Dissertation: Towards improved NDE and SHM methodologies incorporating nonlinear structural features.	
Advisor: Prof. Cliff J. Lissenden	
Master of Arts, Mathematics (2015)	3.97/4.00
The Pennsylvania State University, University Park	
Report: Rough Polyharmonic splines for multi-scale problems and numerical homogenization.	
Advisor: Prof. Leonid V. Berlyand	
Master of Science, Engineering Mechanics (2012)	4.00/4.00
The Pennsylvania State University, University Park	
Thesis: Higher harmonic guided waves in isotropic weakly nonlinear elastic plates.	
Advisor: Prof. Cliff J. Lissenden	
Bachelor of Technology, Mechanical Engineering (2010)	9.06/10.00
Indian Institute of Technology Madras, Chennai, India	
Thesis: Phase-based methods for ultrasonic Non-Destructive Evaluation.	
Advisors: Prof. Krishnan Balasubramaniam and Prof. Chitti V. Krishnamurthy	

Research Interests

My research interests encompass theoretical and experimental aspects of ***developing ultrasonic sensors and sensing systems for structural, chemical, and biomedical applications.*** Some research problems of interest are outlined below.

Damage prognosis and structural health management.

- Explore efficient data-driven and physics-based damage sensing and prognosis methodologies for health monitoring and remaining useful life prediction of structures.

Acoustic metamaterials and nonlinear phononics.

- Design, fabricate and test acoustic metamaterials for applications in sensing, imaging, and energy harvesting. In particular, harness the potential of nonlinearities for targeted applications as in beam focusing, steering and collimation.

Wave propagation in complex media.

- Numerically and experimentally investigate important aspects of linear and nonlinear wave propagation in multi-scale heterogeneous materials.

Chemical sensing

- Develop chemical sensing systems for characterizing trace quantities of liquids, contaminants and other multiphase systems.

Biomedical imaging

- Develop novel sensor technology for imaging and characterizing biomaterials like tissues and bone.

Research Experience

UC/LANL Entrepreneurial Postdoctoral Fellow, LANL (Oct 2017-present)

- **Powering biomedical implants using sound**
  - The fellowship is focused on research and product development efforts towards a novel technology that enables wireless delivery of energy to biomedical implants using ultrasound. In addition, it encompasses market research for exploring appropriate technology transfer avenues for the proposed technology.

Postdoctoral Research Associate, Acoustics and Sensors group, LANL (Oct 2015-present)

- **Design of piezoelectric transducers for ultrasonic collimated beam generation.**
  - Employed a coupled electromechanical model to numerically study the frequency response characteristics of piezoelectric transducers.
  - Developed a novel transducer design that utilizes the natural vibration of radial modes of piezoelectric disc transducers to achieve ultrasonic collimated beam at low-frequencies (<500 kHz).
  - These transducers find applications in imaging highly attenuating materials like concrete, biological tissues, etc.
- **Coupled electromechanical model for Swept Frequency Acoutic Interferometry (SFAI) measurements**
  - Developed a coupled 1D model for modeling the SFAI measurements to characterize fluids.
  - The model results in efficient characterization of wave-speed, attenuation and density of fluids.
- **Non-invasive ultrasonic characterization of multiphase oil-water-gas flows in pipes**
  - Developed a new signal processing algorithm employing a Tikonov-regularization based Gaussian-reconstruction approach for in-situ characterization of multiphase oil-water-gas flows.
  - Implemented the above mentioned signal processing approach in MATLAB for analyzing large sets of field data.
  - The proposed algorithm increased the gas tolerance of non-invasive measurements from 5% to 25%.

Graduate Research Assistant, Ultrasonics Research and Development Laboratory, Penn State (2011-2015)

- **Nonlinear ultrasonic guided waves for early damage detection**
  - Developed a theoretical framework for analyzing nonlinear guided wave propagation in plates and pipes.
  - Carried out extensive numerical studies pertaining to nonlinear wave propagation in plates undergoing damage induced microstructural changes.

- Developed and implemented user-defined constitutive models in COMSOL for studying nonlinear wave propagation.
- Employed magnetostrictive transducers for experimental investigations concerning third harmonic generation in plates.

- **Frequency Domain Finite Elements (FDFE) for guided wave propagation**
  - Employed frequency domain finite element approach for guided wave mode selection in inhomogeneous waveguides.

- **Homogenization based approach for quantifying acoustic nonlinearity**
  - Developed a homogenization based framework to correlate micro-scale damage with acoustic nonlinearity.
  - Implemented the framework for quantifying acoustic nonlinearity from micro voids, micro-cracks and inclusions.

- **Effect of environmental/operating conditions on nonlinear ultrasonic methodologies**
  - Investigated and quantified the effect of operating conditions, namely load and temperature changes on nonlinear ultrasonic methodologies.

Graduate Researcher, Department of Mathematics, Penn State (2013-2015)

- **Rough Polyharmonic Splines (RPS) for multi-scale problems and numerical homogenization**
  - Implemented a numerical optimization scheme in MATLAB for constructing Rough Polyharmonic Splines for linear and nonlinear multi-scale PDE's.
  - Examined the relation between the Rough Polyharmonic Splines for continuous and discrete multi-scale problems.

- **Atomistic to Continuum Homogenization**
  - Extensively surveyed the homogenization schemes employed for multi-scale atomistic to continuum homogenization.

Undergraduate Researcher, Centre for Nondestructive Evaluation, IIT Madras (2008-2010)

- **Phase based methods for ultrasonic nondestructive evaluation**
  - Developed and employed phase-based ultrasonic signal analysis approaches to characterize multi-layered media and thin layers.

- **Genetic algorithm based signal reconstruction approach for analyzing overlapping ultrasonic signals**
  - Implemented a hybrid scheme consisting of gradient based optimization and genetic algorithm approach in MATLAB to extract individual ultrasonic signals from multiple overlapping signals in time-domain.

Teaching and Mentoring Experience

Teaching

- College of Engineering Distinguished Graduate Teaching Fellowship
  - I was the instructor for the course EMCH 211 (Statics) in Spring 2015. I prepared the lecture notes, organized weekly quizzes and scheduled and conducted mid-term/final exams for a class of about 70 students.
  - I organized theory and problem-solving review sessions in addition to lectures and office hours.

- Substitute instructor for EMCH 210H (Fall 2014)
  - I was the substitute instructor for 13 lectures of Statics and Strength of materials, a honors course in Engineering Mechanics. The class had about 50 students.
- Graduate teaching assistant for Statics (Fall 2010) and Strength of Materials (Spring 2011).
  - Taught recitation classes and tutoring sessions to sophomore-year undergraduate students.

Mentoring

Mentored a junior PhD student and a visiting graduate researcher from China on their research at Penn State.

- It resulted in two conference and one journal publication.

Patents

Cristian Pantea, Dipen N. Sinha, and **Vamshi Krishna Chillara**, "Simple Bessel-like collimated sound beam generator," provisional patent submitted (2016).

Publications

	All	Since 2012
Citations	296	295
h-index	8	8
i10-index	8	8

Journal

1. **Vamshi Krishna Chillara**, Cristian Pantea, and Dipen N. Sinha "Radial modes of laterally stiffened piezoelectric disc transducers for ultrasonic collimated beam generation," *Wave Motion*, in-press.
2. **Vamshi Krishna Chillara**, "A thermodynamic approach to nonlinear ultrasonics for material state awareness and prognosis," *Continuum Mechanics and Thermodynamics*, 1432-0959 (2017).
3. **Vamshi Krishna Chillara**, Cristian Pantea, and Dipen N. Sinha "Low-frequency ultrasonic Bessel-like collimated beam generation from radial modes of piezoelectric transducers," *Applied Physics Letters*, 110, 6, 064101 (2017).
4. Jinling Zhao, **Vamshi Krishna Chillara**, Baiyang Ren, Hwanjeong Cho, Jinhao Qiu, and Cliff J. Lissenden, "Second harmonic generation in composites: Theoretical and numerical analyses," *Journal of Applied Physics* 119, 6, 064902 (2016).
5. **Vamshi Krishna Chillara** and Cliff J. Lissenden, "Review of nonlinear ultrasonic guided wave nondestructive evaluation: Theory, numerics and experiments," *Optical Engineering*, 55, 1, 011002 (2016).
6. **Vamshi Krishna Chillara** and Cliff J. Lissenden,"Constitutive model for third harmonic generation in elastic solids," *International Journal of Nonlinear Mechanics*, 82, 69-74 (2016).
7. **Vamshi Krishna Chillara**, Baiyang Ren and Cliff J. Lissenden, "Guided wave mode selection in inhomogeneous elastic waveguides using frequency domain finite element approach," *Ultrasonics*, 67, 199-211 (2016).
8. **Vamshi Krishna Chillara** and Cliff J. Lissenden, "On some aspects of material behavior relating microstructure and ultrasonic higher harmonic generation," *International Journal of Engineering Science*, 94, 59-70 (2015).
9. **Vamshi Krishna Chillara** and Cliff J. Lissenden, "Nonlinear guided waves in plates: A numerical perspective," *Ultrasonics*, 54, 1553-1558 (2014).

10. Yang Liu, **Vamshi Krishna Chillara** and Cliff J. Lissenden , "Third harmonic shear horizontal and Rayleigh-Lamb waves in weakly nonlinear plates," *Journal of Applied Physics*, 114, 114908 (2013).

11. Yang Liu, **Vamshi Krishna Chillara** and Cliff J. Lissenden,"On selection of primary modes for strong internally resonant second harmonics in plates," *Journal of Sound and Vibration*, 33, 19, 4517-4528 (2013).

12. **Vamshi Krishna Chillara** and Cliff J. Lissenden, "Analysis of Second harmonic guided waves in pipes using a large-radius asymptotic approximation for axis-symmetric longitudinal modes," *Ultrasonics*, 53, 862-869 (2013).

13. **Vamshi Krishna Chillara** and Cliff J. Lissenden, "Interaction of guided wave modes in isotropic weakly nonlinear elastic plates:Higher harmonic generation," *Journal of Applied Physics*, 111, 124909 (2012).

14. Surya Kannajosyula, **Vamshi Krishna Chillara**, C.V. Krishna Murthy and Krishnan Balasubramaniam, "Simultaneous measurement of ultrasonic longitudinal wave velocities and thicknesses of a two layered media in the absence of interface echo," *Review of Scientific instruments*, Volume 81, Issue 10, 105101 (2010).

Conference proceedings

1. **Vamshi Krishna Chillara**, Cristian Pantea and Dipen N. Sinha, "Coupled electromechanical modeling of piezoelectric transducers for collimated beam generation," *SPIE Smart Structures and Materials and Nondestructive Evaluation and Health Monitoring* (2017).

2. **Vamshi Krishna Chillara**, Blake T. Sturtevant, Cristian Pantea and Dipen N. Sinha, "Ultrasonic sensing for noninvasive characterization of oil-water-gas flow in a pipe," *Proceedings of the Review of Progress in Quantitative Non-Destructive Evaluation* (2017).

3. Jinling Zhao,**Vamshi Krishna Chillara**, Hwanghjeong Cho, Jinhao Qiu and Cliff J. Lissenden, "Evaluation of fatigue damage accumulation in composites via linear and nonlinear guided wave methods," *Proceedings of the Review of Progress in Quantitative Non-Destructive Evaluation*, 1706, 120007(1)- 120007(9) (2016).

4. Jinling Zhao,**Vamshi Krishna Chillara**, Hwanghjeong Cho, Jinhao Qiu and Cliff J. Lissenden, "Cumumulative second harmonics in a nonlinear transversely isotropic plate," *Proceedings of ASME, In ASME Conference on Smart Materials, Adaptive Structures and Intelligent Systems* (2015).

5. Cliff J Lissenden, Yang Liu, **Vamshi Krishna Chillara**, Gloria Choi and Hwanghjeong Cho, "Nonlinear guided wave mixing for localized material state characterization," International Congress on Ultrasonics 2015, *Physics Procedia*, 70, 668-671 (2015).

6. **Vamshi Krishna Chillara**, Hwanghjeong Cho, Mostafa Hasanian and Cliff J. Lissenden, "Effect of load and temperature changes on nonlinear ultrasonic measurements: Implications for SHM," *Proceedings of International Workshop on Structural Health Monitoring* (2015).

7. **Vamshi Krishna Chillara** and Cliff J. Lissenden, " Towards a micro-mechanics based understanding of ultrasonic higher harmonic generation," *SPIE Smart Structures and Materials and Nondestructive Evaluation and Health Monitoring*, 94380R-94380R (2015).

8. Cliff J. Lissenden, Yang Liu, **Vamshi Krishna Chillara**, Gloria Choi and Xiaochu Yao, "Nonlinear Guided Waves for Continuous Material Microstructure State Awareness," *ASME 2014 International Mechanical Engineering Congress and Exposition*, pp. V013T16A033-V013T16A033. American Society of Mechanical Engineers (2014).

9. **Vamshi Krishna Chillara** and Cliff J. Lissenden, "Nonlinear guided waves in plates undergoing localized microstructural changes," *Proceedings of the Review of Progress in Quantitative Non-Destructive Evaluation*, 1650, 1561-1569 (2014).

10. **Vamshi Krishna Chillara** and Cliff J. Lissenden, "Guided wave mode conversions across waveguide transitions:A study using frequency domain finite element approach," *Proceedings of the Review of Progress in Quantitative Non-Destructive Evaluation*, 1581, 308-315 (2014).

11. **Vamshi Krishna Chillara** and Cliff J Lissenden,"Higher harmonic guided waves in isotropic weakly nonlinear elastic plates," *Proceedings of the Review of Progress in Quantitative Non-Destructive Evaluation*, 1511, 145-150 (2012).

Invited Talks/Presentations

1. "Coupled electromechanical modeling of piezoelectric transducers for collimated beam generation," *SPIE Smart structures/NDE,* Mar 24-29, Portland, Oregon, 2017.
2. "Ultrasonic sensing for noninvasive characterization of oil-water-gas flow in a pipe," *Review of progress in Quantitative Non-Destructive Evaluation (QNDE)*, Jul 16-20, Atlanta, Georgia, 2016.
3. "Effect of load and temperature changes on SHM methodologies using nonlinear ultrasound," *International Workshop on Structural Health Monitoring, Stanford University,* September 2, 2015.
4. "Nonlinear ultrasonic guided waves for early damage detection in structures," *invited talk at Materials Physics and Applications division, Los Alamos National Laboratory,* July 1, 2015.
5. "Towards a micro-mechanics based understanding of ultrasonic higher harmonic generation," *SPIE Smart structures/NDE,* Mar 8-12, San Diego, CA, 2015.
6. "Nonlinear ultrasonics for materials characterization: understanding relationship between microstructure and higher harmonic generation," *Rustum Roy Symposium on Processing and Performance of Materials using Microwaves, Electric and Magnetic Fields, Ultrasound, Lasers, and Mechanical Work*, Oct 12-16, Pittsburgh, PA, 2014.
7. "Nonlinear guided waves in plates undergoing localized microstructural changes," *invited talk at Idaho National Lab*, July 17, Idaho Falls, Idaho, 2014.
8. "Nonlinear guided waves in plates undergoing localized microstructural changes," *Review of progress in Quantitative Non-Destructive Evaluation (QNDE)*, Jul 20-25, Boise, Idaho, 2014.
9. "Guided wave mode conversions across waveguide transitions: A study using frequency domain finite element approach," *Review of progress in Quantitative Non-Destructive Evaluation (QNDE)*, Jul 22-26, Baltimore, Maryland, 2013.
10. "Nonlinear guided waves in plates," in the Department of Mechanical Engineering, Indian Institute of Technology (IIT), Hyderabad, May, 2013.
11. "Higher harmonic guided waves in isotropic weakly nonlinear elastic plates," *Review of progress in Quantitative Non-Destructive Evaluation (QNDE)*, Jul 15-20, Denver, Colorado, 2012.

Relevant coursework

Graduate: Continuum mechanics, Elasticity, Nonlinear Elasticity, Mechanical behavior of materials (Fracture Mechanics), Multi-scale modeling of materials, Nonlinear finite elements, Stress waves in solids, Ultrasonic NDE and Structural health monitoring, Advanced dynamics, Numerical optimization.

Undergraduate: Strength of materials, Materials and Design, Fluid Mechanics, Heat transfer, IC engines, Compressible and incompressible flows.

Skills

Programming: C/C++, Python, MATLAB, LABVIEW.

Finite element software: COMSOL, ABAQUS.

Numerical methods: Frequency domain fintie element method, Spectral element method for wave propagation, Angular spectrum approach for wavefields, Multi-scale methods for wave propagation.

Constitutive modeling of materials: Nonlinear elasticity, Weakly nonlinear elastic and viscoelastic models for wave propagation.

Signal processing: Fast-Fourier Transform, Hilbert Transform, Auto and Cross correlation methods, Deconvolution and Statistical methods.

Experimental techniques: Mechanical testing of materials (monotonic and cyclic loading), Ultrasonic bulk and guided wave NDE of materials, Swept Frequency Acoustic Interferometry (SFAI).

Transducer design: Ultrasonic phased arrays for bulk and guided waves; EMATs; Piezo-electric transducers; Magnetostrictive transducers.

Scholastic achievements and Awards

- LANL postdoctoral publication prize for best paper in experimental sciences (2015-2017)—a biennial prize awarded to the best paper in experimental sciences across the laboratory.
- "Most fundable technology" pitch at DISRUPTECH (2017)—an annual entrepreneurial pitch event held in Los Alamos, NM.
- Univeristy of California/ Los Alamos National Laboratory (UC/LANL) entrepreneurial postdoctoral fellowship (2017-2018).
- Longenecker and associates scholarship from the Department of Engineering Science and Mechanics (2015-2016) (declined).
- Penn State College of Engineering Distinguished Teaching Fellowship (2014-2015).
- Longenecker and associates scholarship from the Department of Engineering Science and Mechanics, Penn State (2014-2015).
- Third prize in poster presentation in ESM Today 2015 — an annual graduate research symposium in the department of Engineering Science and Mechanics, Penn State.
- Wherry memorial graduate fellowship (2010-2011, Penn State).
- One among top 5 students of the graduating class of Mechanical Engineering, IIT Madras, 2010.
- Merit-cum-Means scholarship, IIT Madras.
- Placed among top 0.2% in Joint Entrance Examination (IIT-JEE), 2006, among about 400,000 candidates.
- Placed among top 1% in the country in National Physics Olympiad 2005.
- Won merit certificates in Regional Mathematics Olympiads 2004 and 2005.

Peer-reviewing services

Reviewer of articles for the following journals

- Smart Materials and Structures
- Structural Health Monitoring–An International Journal
- Journal of Applied Physics.
- Experimental Mechanics.
- Ultrasonics.
- International Journal of Computational Methods.
- International Journal of Solids and Structures.
- Measurement Science and Technology