SAI TEJ PARUCHURI

Postdoctoral Research Associate

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EDUCATION

Ph.D. in Mechanical Engineering, Fall 2015 – Present

Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg.
Dissertation: **Topics on Modeling and Estimation of Linear and Nonlinear Piezoelectric Systems**
GPA: **4.0/4.0** | Advisor: **Dr. Andrew J. Kurdila**
Research Focus: **Dynamics and Controls, Smart Materials and Adaptive Structures, Data-driven Modeling of Smart Material Systems, Estimation & Control, Nonlinear Systems.**

M.S. in Mathematics, Spring 2019 – Spring 2020

Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg.
Thesis: **Output Regulation of Systems Governed by Delay Differential Equations: Approximations & Robustness**
GPA: **4.0/4.0** | Advisor: **Dr. John Burns**
Research Focus: **Robust Geometric Control, Delay-differential Equations, Output Regulation.**

B.E. in Mechanical Engineering, Fall 2010 – Spring 2014

Thiagarajar College of Engineering (TCE), Madurai, India.
GPA: **9.52/10** | **Rank:** 2nd in the Mechanical Engineering department.

POSITIONS

Postdoctoral Research Associate, Mechanical Engineering, Lehigh University Nov 2020 – Current

- Solving profile control problems arising in advanced scenarios of tokamaks
- Working on DIII-D and NSTX-U tokamak-based scenario design and control problems
- Developing novel nonlinear control algorithms for current profile control with moving ECCD
- Guiding doctoral students in conducting research on
  - model-based optimal control of plasma parameters in NSTX-U
  - fast model-based scenario optimization in NSTX-U
  - electron temperature neural network design in DIII-D

RESEARCH INTERESTS

Nuclear Fusion Plasma Control – Nonlinear profile control, Control of local properties of safety factor, Control with moving ECCD, Optimization for scenario planning

Machine Learning – Kernel Methods, Neural Networks, Radial Basis Function Networks, Kohonen Self-Organizing Maps, Unsupervised learning, RKHS, Lloyd's Algorithm and Voronoi Tessellations

Data-Driven Modeling - RKHS, Koopman Operator Theory, DMD/EDMD Methods, Vector Fitting, Matrix Pencil Approach

Dynamics and Controls - Dynamical Systems Theory, Nonlinear Systems & Control Theory, Robust Output Regulation, Infinite-dimensional Systems and Control Theory, Delayed Systems Control Theory

Estimation - Adaptive Estimation, Infinite-Dimensional Estimation, Approximation and Estimation in RKHS

Applied Mathematics - Functional Analysis, Dynamical System Theory, Approximation Theory, Reduced-order Modeling

RESEARCH, TEACHING, WORK AND LEADERSHIP EXPERIENCE

Research Experience

Graduate Research Assistant, Mechanical Engineering, Virginia Tech — Fall 2016 – Spring 2017

Project: Distribution Consensus Learning & Approximation for Geometric and Abstract Surfaces

- Investigated RKHS methods for approximation of surfaces

Teaching Experience

Graduate Teaching Assistant, Engineering Education, Virginia Tech — Fall 2019 – Spring 2020

- Taught some of the lectures in the freshman introductory course "Foundations of Engineering."
- Assisted the course instructor with creating course exams and assignments.

Graduate Teaching Assistant, Mechanical Engineering, Virginia Tech — Fall 2017 – Spring 2019

- Assisted course instructor with creating assignments, revising course material and rubrics.
- Created and analyzed peer evaluation data of students required by the Accreditation Board for Engineering and Technology (ABET).
- Guided and evaluated the progress of 9 senior design projects with more than 70 students.

Grader, Virginia Tech

- Differential Equations, Mathematics department, — Spring 2016
- System Dynamics, Mechanical Engineering Dept., — Fall 2017

Industry Experience

Design Engineer (Full-time employee), Amritha Tool Crafts Pvt. Ltd., India — Sep 2014 - May 2015

Service

Session Chair, IDETC 2017, international ASME conference, Cleveland, Ohio — 2017
Peer Reviewer, Nonlinear Dynamics, and IEEE Transactions on Automatic Control
Peer Reviewer, ASME SMASIS, IFAC World Congress, IEEE CDC.
Head Graduate Teaching Assistant, Mechanical Engineering, Virginia Tech — Fall 2018 – Spring 2019
Academic Coach, Student Transition Engineering Program, Virginia Tech, — Summer 2017 & 2018
Peer Mentor, Virginia Tech's Early Engineering Mentoring (VTEEM) program, — Summer, Fall 2018

PUBLICATIONS

Journal Articles

Published and Accepted

1. **Paruchuri, S.T.**, Sterling, J., Malladi, V.V.S., Kurdila, A., Vignola, J., and Tarazaga, P., 2019. "**Passive piezoelectric subordinate oscillator arrays,**" Smart Materials and Structures, 28(8), p.085046 https://doi.org/10.1088/1361-665X/ab2f5a.

2. Guo, J., Dadashi, S., Bender, M., **Paruchuri, S.T.**, et al., 2019. "**Probabilistic error bounds on constraint violation for empirical-analytical Lagrangian models of motion,**" Nonlinear Dyn (2019) 98: 195. https://doi.org/10.1007/s11071-019-05183-3.

3. Sterling, J. A., Vignola, J. F., Ryan, T. J., & **Paruchuri, S. T.,** 2019. "**Analysis of increased damping in arrays of attached resonators.**" The Journal of the Acoustical Society of America, 145(3), 1824-1824, https://doi.org/10.1121/1.5101664.

4. Sterling, J., Vignola, J., Gietl, J., Ryan, T., Sonne, N., & **Paruchuri, S. T.,** 2018. "**Effect of Increased Damping in Subordinate Oscillator Arrays.**" In Journal of Physics: Conference Series (Vol. 1149, No. 1, p. 012006). IOP Publishing, https://doi.org/10.1088/1742-6596/1149/1/012006.

5. **Paruchuri, S.T.**, Guo, J., Kurdila, A.J., 2020. "**Reproducing kernel Hilbert space embedding for adaptive estimation of nonlinearities in piezoelectric systems,**" Nonlinear Dynamics (2020), https://doi.org/10.1007/s11071-020-05812-2.

6. **Paruchuri, S.T.**, Malladi, V.V.S., Tarazaga, P., Kurdila, A.J., 2020. "**Expanding the Teaching of Single Frequency Vibration Absorption to Broadband Attenuation using Subordinate Oscillator Arrays via Fettuccine Pasta,**" Engineering Structures (2020), engrxiv preprint https://doi.org/10.31224/osf.io/qb4up.

7. **Paruchuri, S.T.**, Guo, J., Kurdila, A.J., 2022. "**Kernel center selection techniques for RKHS Adaptive Estimation,**" International Journal of Adaptive Control and Signal Processing, accepted, arxiv preprint https://doi.org/10.48550/arXiv.2009.02867.

8. **Paruchuri, S.T.**, Guo, J., Kurdila, A.J., 2022. "Sufficient Conditions for Parameter Convergence over Embedded Manifolds using Kernel Techniques," IEEE Transactions on Automatic Control, https://doi.org/10.1109/TAC.2022.3148716.

Submitted and Preprints

9. Kurdila, A.J., Guo, J., **Paruchuri, S.T.,** and Bobade, P., 2019. "**Persistence of Excitation in Reproducing Kernel Hilbert Spaces, Positive Limit Sets, and Smooth Manifolds,**" arXiv preprint arXiv:1909.12274.

10. Guo, J., **Paruchuri, S.T.**, and Kurdila, A.J., 2020. "**Persistence of Excitation in Uniformly Embedded Reproducing Kernel Hilbert (RKH) Spaces,**" arxiv preprint arXiv:2002.07963.

11. Sterling, J., **Paruchuri, S.T.**, Vignola, J., Kurdila, A.J., Teresa Ryan, 2020. "**Subordinate Oscillator Arrays: Design and Mitigation of Disorder,**" engrxiv preprint https://engrxiv.org/kpv3r/

Conference Proceedings

Presented

1. **Paruchuri, S.T.,** et al., 2021. "**Minimum Safety Factor Control in Tokamaks via Optimal Allocation of Spatially Moving Electron Cyclotron Current Drive,**" IEEE CDC, page. 454 - 459, https://doi.org/10.1109/CDC45484.2021.9683130.

2. **Paruchuri, S.T.,** et al., 2021. " **Control of the Local Gradient and the Minimum Value of the Safety Factor Profile by Using Moving ECCD,**" APS DPP.

3. **Paruchuri, S.T.,** Kurdila, A.J., Vignola, J., 2018. "**Estimation of Distribution Errors in Piezoelectric Subordinate Oscillator Arrays,**" Nov. SMASIS, doi:10.1115/SMASIS2018-8065. url: https://doi.org/10.1115/SMASIS2018-8065.

4. **Paruchuri, S.T.,** et al., 2017. "**Piezoelectric composite subordinate oscillator arrays and frequency response shaping for passive vibration attenuation,**" IEEE CCTA, page. 702 - 707, https://doi.org/10.1109/CCTA.2017.8062544.

5. **Paruchuri, S.T.,** et al., 2017. "**Thermodynamic Variational Formulations of Subordinate Oscillator Arrays (SOA) With Linear Piezoelectrics,"** ASME. IDETC/CIE, Volume 8: 29th Conference on Mechanical Vibration and Noise, https://doi.org/10.1115/DETC2017-68056.

6. Guo. J., **Paruchuri S.T.,** Kurdila, A.J., 2020. "**Persistence of Excitation in Uniformly Embedded Reproducing Kernel Hilbert (RKH) Spaces,**" IEEE American Control Conference (ACC) (pp. 4539-4544), https://doi.org/10.23919/ACC45564.2020.9147851.

7. Sterling, J., **Paruchuri, S. T.**, Tarazaga, P., Vignola, J., Kurdila, A., Malladi, V. V., & Ryan, T., 2019. "**Piezoelectric Subordinate Oscillator Arrays: Performance Recovery and Robustness to Uncertainty.**" In ASME International Design Engineering Technical Conferences and Computers and Information in Engineering Conference. American Society of Mechanical Engineers Digital Collection, https://doi.org/10.1115/DETC2019-98092.

8. Vignola, J., Judge, J., Sterling, J., Ryan, T., Kurdila, A., **Paruchuri, S. T.**, & Glean, A., 2016. "**On the Use of Shunted Piezo-Actuators for Mitigation of Distribution Errors in Resonator Arrays,"** In Proceedings of the 22nd International Congress on Acoustics, Buenos Aires, link.

9. Neighborgall C.R., Kothari, K., Malladi V.V.S., Tarazaga, P., **Paruchuri, S.T.,** Kurdila, A.J., 2020. "**Shaping the Frequency Response Function (FRF) of a Multi-Degree-of-Freedom (MDOF) Structure Using Arrays of Tuned Vibration Absorbers (TVA),**" 2019 IMAC, BT - Topics in Modal Analysis & Testing, Volume 8, pp. 317–326. ISBN: 978-3-030-12684-1, https://doi.org/10.1007/978-3-030-12684-1_33.

10. Burns, J.A., **Paruchuri, S.T.,** Schmidt. M., 2020. "**Output Regulation of Systems Governed by Delay Differential Equations: Approximations and Robustness,**" IFAC-PapersOnLine 54.9: 422-427, https://doi.org/10.1016/j.ifacol.2021.06.099.

Submitted

11. **Paruchuri, S.T.,** et al., 2022. "**Local Control of the Safety Factor Profile Gradient in Tokamaks via Feedback Linearization,**" IEEE CCTA (under peer review).

12. **Paruchuri, S.T.,** et al., 2022. "**Safety Factor Control in Tokamaks via Lyapunov-based Controller with Actuator Constraints,**" IEEE CCTA (under peer review).

13. **Paruchuri, S.T.,** et al., 2022. "**Model Predictive Current Profile Control in Tokamaks by Exploiting Spatially Moving Electron Cyclotron Current Drives,**" 32nd Symposium on Fusion Technology.

SKILLS

Programming: MATLAB, Python, C++, ROS, LabVIEW.

Analysis and CAD Tools: ANSYS, CATIA, PTC Creo, Autodesk Inventor, SolidWorks, AutoCAD.

Publishing & Graphics Editor Software: Latex, Overleaf, MS Word, MS Publisher, Adobe Illustrator, Inkscape.