Shumon Koga

E-mail: shumonkoga@gmail.com, Phone: +1-(858)-245-3541, Web: https://shumon0423.github.io

EDUCATION

Ph.D. in Mechanical and Aerospace Engineering **Sep. 2014-June 2020**

University of California San Diego, La Jolla, CA

Doctoral Thesis: "Control and State Estimation for Materials Phase Change: Design, Analysis, Applications, and Experiments"

Advisor: Miroslav Krstic

M.S. in Mechanical and Aerospace Engineering **Sep. 2014-Mar. 2016**

University of California San Diego, La Jolla, CA

B.S. in Applied Physics **Apr. 2010-Mar. 2014**

Keio University, Tokyo, Japan

PROFESSIONAL APPOINTMENTS

Staff Engineer **July 2023-**

Honda Research and Development, Co. Ltd., Tokyo, Japan

Postdoctoral Scholar **July 2020-June 2023**

University of California San Diego, Electrical and Computer Engineering, La Jolla, CA

Advisor: Nikolay Atanasov

Research Intern **June 2018-Sep. 2018**

Mitsubishi Electric Research Laboratories (MERL), Cambridge, MA

Mentor: Mouhacine Benosman

VISITING APPOINTMENTS

Visiting Student Researcher **Oct. 2017-Nov. 2017**

NASA Jet Propulsion Laboratory (JPL), Pasadena, CA

Mentor: Ian Fenty

Visiting Researcher **June 2017-Aug. 2017**

Rensselaer Polytechnic Institute, Albany, NY

Advisor: Mamadou Diagne

RESEARCH INTERESTS

I am broadly interested in **control theory, optimization, machine learning**, and their applications to **robotics** and **complex dynamics**. Specifically, I have been focused on the following two main themes along with listed subdomains, techniques, and applications:

- **Robot Active Perception**: autonomous exploration, simultaneous localization and mapping (SLAM), vision-based control, safety-critical systems, optimal control, reinforcement learning, Bayesian optimization, model predictive control
- **PDE Control**: backstepping control, extremum seeking, event-triggered control, lithium-ion batteries, global climate system, thermal energy storage, transportation systems, advanced manufacturing, neuroscience

TEACHING EXPERIENCE

- **Teaching Assistant**, MAE 281A: Nonlinear Systems, UC San Diego Winter 2017
- **Teaching Assistant**, MAE 281A: Nonlinear Systems, UC San Diego Winter 2016
- **Teaching Assistant**, Numerical Methods of Dynamical Systems, University of Tokyo Spring 2014

AWARDS

2020: Robert E. Skelton Systems and Control Dissertation Award, UCSD Center for Control Systems and Dynamics.

2019: O. Hugo Schuck Best Paper Award, American Automatic Control Council (AACC).

2018: Outstanding Graduate Student Award, UC San Diego Mechanical and Aerospace Engineering (MAE).

2013: Best Presentation Award, Keio University Department of Applied Physics.

PROFESSIONAL ACTIVITY

Workshop Organization

1. Co-organizer, "2nd Workshop on Safe Robot Control with Learned Motion and Environment Models," IEEE International Conference on Robotics and Automation (ICRA), Yokohama, Japan, May 2024 (submitted proposal)
2. Co-organizer, Workshop on "Safe Robot Control with Learned Motion and Environment Models," IEEE International Conference on Robotics and Automation (ICRA), Xi'an, China, June 2021. https://scl-icra2021.github.io/

Conference Organization

1. Session Co-Chair, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2022, "Intelligent Transportation Systems 1".
2. Session Co-Chair, American Control Conference (ACC) 2022, "Sensor Networks".
3. Session Co-Chair, IEEE International Conference on Robotics and Automation (ICRA) 2022, "Mapping".

Invited Talks

1. "Policy Learning for Active Target Tracking over Continuous SE(3) Trajectories", spotlight talk at L4DC 2023, (selected as one of top 16 papers from 115 accepted papers).
2. "Active Sensing and Safe Stabilizing Control for ODE and PDE Systems", faculty candidate seminars at NYU (ECE) and UC Merced (CSE), Feb.-Mar. 2023.
3. "Active Sensing and Safe Stabilizing Control for ODE and PDE Systems", seminar at MIT AeroAstro, December 2022.
4. "Active Exploration and Mapping with Mobile Robots over Continuous SE(3) Trajectories", seminar at Tokyo Institute of Technology, April 2022.
5. "Active Exploration and Mapping with Mobile Robots under Continuous Trajectory and Control", faculty candidate seminar at San Diego State University (SDSU), Feb. 2022.
6. "Future Perspectives on Control of Parabolic PDEs with Moving Boundaries", DPS Online Seminar, June 2021.
7. "Output Feedback Control of the One-Phase Stefan Problem", 30th Southern California Control Workshop, University of California San Diego, June 2016.

Review

Journals: IEEE Transactions on Automatic Control; IEEE Transactions on Control Systems Technology; IEEE Transactions on Robotics; IEEE Transactions on Control of Network Systems; IEEE Transactions on Industrial Electronics; IEEE Transactions on Systems, Man and Cybernetics; Automatica; ASME Journal of Dynamic Systems, Measurement, and Control; Journal of The Franklin Institute; International Journal of Adaptive Control and Signal Processing; IEEE Control Systems Letters; IEEE Robotics and Automation Letters; Systems and Control Letters.

Conferences: IEEE Conference on Decision and Control (CDC), American Control Conference (ACC), IEEE International Conference on Robotics and Automation (ICRA), IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), IEEE Conference on Control Technology and Applications (CCTA), Conference on Learning for Dynamics and Control (L4DC), IFAC International Workshop on Adaptation and Learning in Control and Signal Processing (ALCOS).

Mentoring

PhD Students: Arash Asgharivaskasi (UCSD), Cenk Demir (UCSD), Kehan Long (UCSD), Zhichao Li (UCSD).

Master Students: Minnan Zhou (UCSD), Vatsalya Chaubey (UCSD), Mustafa Shaikh (UCSD), Yuhan Liu (UCSD), Pengzhi Yang(UCSD), Yinzhuang Yi (UCSD), David Straub (University of Stuttgart), Jan Feiling (University of Stuttgart), Ji Wang (Chongqing University)

Undergraduate Students: Mona Buisson-Fenet (MINES ParisTech), Peter Stratton (UCSD)

PUBLICATIONS

Book

1. **S. Koga** and M. Krstic, "*Materials Phase Change PDE Control and Estimation: From Additive Manufacturing to Polar Ice*", Springer, 2020.

Journal Papers

1. C. Demir, **S. Koga**, and M. Krstic, "Neuron Growth Control and Estimation by PDE Backstepping", *Automatica*, under review.
2. **S. Koga** and M. Krstic, "Safe PDE Backstepping QP Control with High Relative Degree CBFs: Stefan Model with Actuator Dynamics", *IEEE Transactions on Automatic Control*, early access, 2023.
3. Y. Yi, **S. Koga**, B. Gavrea, and N. Atanasov, "Control Synthesis for Stability and Safety by Differential Complementarity Problem", *IEEE Control Systems Letters*, vol. 7, pp. 895-900, 2022.
4. **S. Koga** and M. Krstic, "State Estimation of the Stefan PDE: A Tutorial on Design and Applications to Polar Ice and Batteries", *Annual Reviews in Control*, 2022, vol. 53, pp. 199-223, 2022.
5. **S. Koga** and M. Krstic, "Control of Stefan system and applications: A tutorial", *Annual Reviews in Control, Robotics, and Autonomous Systems*, 2021, vol. 5, pp. 547-577, 2022.
6. **S. Koga,** M. Benosman, and J. Borggaard, "Extremum Seeking-Based Robust Observer Design for Coupled Thermal and Fluid Systems", *International Journal of Adaptive Control and Signal Processing*, vol. 35, no. 7, pp. 1316-1335, 2021.
7. **S. Koga**, M. Makihata, R. Chen, M. Krstic, and A.P. Pisano, "Energy Storage in Paraffin: a PDE Backstepping Experiment", *IEEE Transactions on Control Systems Technology*, vol. 29, no. 4, pp. 1490-1502, 2021.
8. **S. Koga**, I. Karafyllis, and M. Krstic, "Towards Implementation of PDE Control for Stefan System: Input-to-State Stability and Sampled-Data Design", *Automatica*, vol. 127, p. 109538, 2021.
9. **S. Koga,** L. Camacho-Solorio, and M. Krstic, "State Estimation for Lithium-Ion Batteries with Phase Transition Materials via Boundary Observers", *ASME Journal of Dynamic Systems, Measurement, and Control*, vol. 143, no. 4, p. 041004, 2021.
10. H. Yu, **S. Koga,** T.R. Oliveira, M. Krstic, "Extremum Seeking Control for Traffic Congestion Control with a Downstream Bottleneck", *ASME Journal of Dynamic Systems, Measurement, and Control*, vol. 143, no. 3, p. 031007, 2021.
11. T. R. Oliveira, J. Feiling, **S. Koga**, M. Krstic, "Multivariable Extremum Seeking for PDE Dynamic Systems", *IEEE Transactions on Automatic Control*, vol. 65, no. 11, pp. 4949-4956, 2020.
12. **S. Koga**, M. Krstic, and J. Beaman, "Laser Sintering Control for Metal Additive Manufacturing by PDE Backstepping", *IEEE Transactions on Control Systems Technology*, vol. 28, no. 5, pp, 1928-1939, 2020.
13. J. Feiling, **S. Koga**, M. Krstic, T. R. Oliveira, "Extremum Seeking for Unknown Scalar Maps in Cascade with a Class of Parabolic Partial Differential Equations", *International Journal of Adaptive Control and Signal Processing*, pp. 1-26, 2020.
14. **S. Koga**, D. Bresch-Pietri, and M. Krstic, "Delay-Compensated Control of the Stefan Problem and Robustness to

Delay Mismatch", *International Journal of Robust and Nonlinear Control*, vol. 30, no. 6, pp. 2304-2334, 2020.

15. **S. Koga,** D. Straub, M. Diagne, and M. Krstic, "Stabilization of Filament Production Rate for Screw Extrusion-Based Polymer 3D-Printing", *ASME Journal of Dynamic Systems, Measurement, and Control*, vol. 142, no. 3, p. 031005, 2020.
16. **S. Koga** and M. Krstic, "Arctic Sea Ice State Estimation from Thermodynamic PDE Model", *Automatica*, vol. 112, p. 108713, 2020.
17. **S. Koga** and M. Krstic, "Single-Boundary Control of the Two-Phase Stefan System", *Systems & Control Letters*, vol. 135, p. 104573, 2020.
18. **S. Koga**, M. Diagne, and M. Krstic, "Control and State Estimation of the One-Phase Stefan Problem via Backstepping Design", *IEEE Transactions on Automatic Control*, vol. 64, no. 2, pp. 510-525, 2019.
19. J. Feiling, **S. Koga**, M. Krstic, T. R. Oliveira, "Gradient Extremum Seeking for Static Maps with Actuation Dynamics Governed by Diffusion PDEs", *Automatica*, vol. 95, pp. 197-206, 2018.
20. J. Wang, **S. Koga**, Y. Pi, and M. Krstic, "Axial Vibration Suppression in a PDE Model of Ascending Mining Cable Elevator", *ASME Journal of Dynamic Systems, Measurement, and Control*, vol. 140, no. 11, pp. 111003, 2018.

Conference Proceedings

1. P. Yang, **S. Koga**, A. Asgharivaskasi, and N. Atanasov, "Policy Learning for Active Target Tracking over Continuous *SE(3)* Trajectories", *Learning for Dynamics and Control (L4DC)*, 2023.
2. **S. Koga**, C. Demir, and M. Krstic, "Event-Triggered Safe Stabilizing Boundary Control for the Stefan PDE System with Actuator Dynamics", *American Control Conference (ACC)*, 2023.
3. P. Yang, Y. Liu, **S. Koga**, A. Asgharivaskasi, and N. Atanasov, "Learning Continuous Control Policies for Information-Theoretic Active Perception", *IEEE International Conference on Robotics and Automation (ICRA)*, 2023.
4. Y. Yi, **S. Koga**, B. Gavrea, and N. Atanasov, "Control Synthesis for Stability and Safety by Differential Complementarity Problem", *American Control Conference (ACC)*, 2023.
5. A. Asgharivaskasi, **S. Koga**, and N. Atanasov, "Active Mapping via Gradient Ascent Optimization of Shannon Mutual Information over Continuous *SE(3)* Trajectories", *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2022.
6. **S. Koga**, A. Asgharivaskasi, and N. Atanasov, "Active SLAM over Continuous Trajectory and Control: A Covariance-Feedback Approach", *American Control Conference (ACC)*, 2022.
7. C. Demir, **S. Koga**, and M. Krstic, "Neuron Growth Output Feedback Control by PDE Backstepping", *American Control Conference (ACC)*, 2022.
8. **S. Koga** and M. Krstic, "Safe PDE Backstepping QP Control with High Relative Degree CBFs: Stefan Model with Actuator Dynamics", *American Control Conference (ACC)*, 2022.
9. **S. Koga**, A. Asgharivaskasi, and N. Atanasov, "Active Exploration and Mapping via Iterative Covariance Regulation over Continuous *SE(3)* Trajectories", *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2021.
10. C. Demir, **S. Koga**, and M. Krstic, "Neuron Growth Control by PDE Backstepping: Axon Length Regulation by Tubulin Flux Actuation in Soma", *IEEE Conference on Decision and Control (CDC)*, 2021.
11. **S. Koga**, M. Krstic, and J. Beaman, "Laser Sintering Control for Metal Additive Manufacturing by PDE Backstepping", *IEEE Conference on Decision and Control (CDC)*, 2019.

12. **S. Koga,** M. Benosman, and J. Borggaard, "Learning-Based Robust Observer Design for Coupled Thermal and Fluid Systems", *American Control Conference (ACC)*, 2019.
13. **S. Koga** and M. Krstic, "Control of the Two-Phase Stefan Problem via Single-Boundary Heat Input", *IEEE Conference on Decision and Control (CDC)*, 2018.
14. T. R. Oliveira, J. Feiling, **S. Koga**, M. Krstic, "Scalar Newton-based Extremum Seeking for a Class of Diffusion PDEs", *IEEE Conference on Decision and Control (CDC)*, 2018.
15. M. Buisson-Fenet, **S. Koga**, and M. Krstic, "Control of Piston Position in Inviscid Gas by Bilateral Boundary Actuation", *IEEE Conference on Decision and Control (CDC)*, 2018.
16. H. Yu, **S. Koga,** and M. Krstic, "Stabilization of Traffic Flow with a Leading Autonomous Vehicle", *ASME Dynamic Systems and Control Conference (DSCC)*, 2018.
17. **S. Koga**, I. Karafyllis, and M. Krstic, "Input-to-State Stability for the Control of Stefan Problem with Respect to Heat Loss", *American Control Conference (ACC)*, 2018 (O. Hugo Schuck Best Paper Award).
18. **S. Koga,** D. Straub, M. Diagne, and M. Krstic, "Thermodynamic Modeling and Control of Screw Extruder for 3D Printing", *American Control Conference (ACC)*, 2018.
19. **S. Koga** and M. Krstic, "Delay-Compensated Control of the Stefan Problem", *IEEE Conference on Decision and Control (CDC)*, 2017.
20. **S. Koga** and M. Krstic, "Arctic Sea Ice Temperature Profile Estimation via Backstepping Observer Design", *IEEE Conference on Control Technology and Applications (CCTA)*, 2017.
21. **S. Koga,** L. Camacho-Solorio, and M. Krstic, "State Estimation for Lithium-Ion Batteries with Phase Transition Materials", *ASME Dynamic Systems and Control Conference (DSCC)*, 2017.
22. **S. Koga**, R. Vazquez, and M. Krstic, "Backstepping Control of the Stefan Problem with Flowing Liquid", *American Control Conference (ACC)*, 2017.
23. **S. Koga**, M. Diagne, and M. Krstic, "Output Feedback Control of the One-Phase Stefan Problem", *IEEE Conference on Decision and Control (CDC)*, 2016.
24. **S. Koga**, M. Diagne, S. Tang, and M. Krstic, "Backstepping Control of the One-Phase Stefan Problem", *American Control Conference (ACC)*, 2016.

Workshop Papers

1. **S. Koga**, M. Zhou, D. Panagou, and N. Atanasov, "Hide and Seek with Visibility Constraints using Control Barrier Functions", IROS Workshop on Integrated Perception, Planning, and Control for Physically and Contextually-Aware Robot Autonomy, 2023.
2. C. Demir, **S. Koga**, and M. Krstic, "Input Delay Compensation for Neuron Growth by PDE Backstepping", IFAC Workshop on Time Delay Systems, 2022.

REFERENCES

- Dr. Miroslav Krstic, (email: krstic@ucsd.edu, phone: (858) 822-1374), Distinguished Professor in Department of Mechanical and Aerospace Engineering, University of California San Diego.
- Dr. Nikolay Atanasov, (email: natanasov@ucsd.edu, phone: (858) 534-4105), Assistant Professor in Department of Electrical and Computer Engineering, University of California San Diego.
- Dr. Dimitra Panagou, (email: panagou@umich.edu, phone: (734) 763-2355), Associate Professor in Department of Robotics and Department of Aerospace Engineering, University of Michigan.
- Dr. Mouhacine Benosman, (email: benosman@merl.com, phone: (617) 621-7532), Senior Principal Research Scientist, Mitsubishi Electric Research Laboratories.