Sandeep Banik,

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 Sandeep Banik | baniksan@illinois.edu | +1-517-703-4044

SUMMARY

Postdoctoral researcher developing theoretical and algorithmic foundations for safe interactive autonomy. My work integrates dynamic game theory, robust control, and machine learning to address decision-making under distribution shift and strategic interaction. Core contributions include resource takeover games, shared autonomy frameworks, and system-theoretic hazard analysis for learning-enabled systems.

EDUCATION

2019 – 2023	Ph.D. in Electrical & Computer Engineering, **Michigan State University**, USA, Advisor: Shaunak D. Bopardikar
	Dissertation title: Adversarial Modeling in Game-Theoretic Frameworks for Securing Cyber-Physical Systems, GPA: 4.0/4.0
2015 – 2017	M.Sc. in Mechanical Engineering, **KU Leuven**, Belgium
2010 – 2014	B.Eng. in Mechanical Engineering, **Visvesvaraya Technological University**, India

WORK EXPERIENCE

Postdoctoral Research Associate, UIUC, IL, USA (PI: Prof. Naira Hovakimyan) — Jan 2024 - present

– Developed a *shared-autonomy* framework to address the human–AI handover problem, enhancing *AI alignment* and improving safety, alignment, and robustness in interactive systems (1 publication).

– Improved robustness of *imitation learning* by integrating $\mathcal{L}_1$- *distributionally robust adaptive control*, yielding planner with a priori robustness and performance guarantees (1 publication).

– Designed *potential-function* learning methods for multi-agent games, advancing the theory and practice of AI alignment and improving collaborative strategies (in preparation).

– Integrated System-Theoretic Process Analysis (STPA) with vision-based UAV operations, formalizing perception–control hazards and improving reliability in deployment (1 publication).

– Incorporated $\mathcal{L}_1$ *adaptive control* into neural networks to ensure a priori performance and robustness in learning-enabled systems, improving reliability (1 publication).

– Contributed to multiple large-scale interdisciplinary proposals (MURI, NASA ULI, NSF CPS, NSF M3X), synthesizing methods in machine learning, game theory, and feedback control.

Research Assistant (PhD), MSU, MI, USA (Advisor: Prof. Shaunak D. Bopardikar) — Aug 2019 - Dec 2023

– Published 6 peer-reviewed papers (2 journals, 4 conferences) on dynamic games, control, adversarial resilience and reinforcement learning.

– Created adversary-in-the-loop evaluation pipelines to stress-test learned policies, informing automated safety tests and mitigation strategies.

– Transitioned research prototypes into deployable ROS2 modules for real-time ground-robot platforms, bridging simulation-to-real under adversarial conditions.

– Led collaborations with Pacific Northwest National Laboratory (PNNL), producing joint work on multi-robot adversarial reasoning and goal inference.

PhD Intern - Machine Learning, PNNL, WA, USA, (Advisor: Dr. Arnab Bhattacharya) — Jun - Aug 2022

– Integrated graph neural networks into multi-agent reinforcement learning for adversarial goal inference and coordinated mitigation, contributing to the MARS research program (1 publication).

Research Assistant, IIIT-D, Delhi, India (Advisor: Prof. Sanjit K. Kaul, Prof. P.B.Sujit) — Jul 2018 - Jul 2019

– Designed a gateway-based system for sensor scheduling using Age of Information (AoI) optimization, published at ISIT 2019.

– Collaborated with Texas A&M and LSTS (Portugal) on multi-vehicle path planning algorithms, resulting in a conference paper at IEEE/OES AUV 2018.

Master Thesis & Research Intern, Siemens Industry Software NV & Ford Proving Grounds, Belgium — May 2016 - May 2017

– Modeled and estimated internal states in continuously variable transmissions, improving real-time monitoring and fault detection.

– Developed parameter estimator for vehicle center-of-gravity and moment of inertia under varying loads.

– Designed an extended Kalman filter–based fault detection system for K&C rigs, improving accuracy of vehicle testing.

SKILLS & TECHNICAL EXPERTISE

Machine Learning & AI	Reinforcement learning (online/offline), multi-agent learning, potential-based RL, imitation learning, robust and distributionally robust learning, NeuralODEs.
Control & Optimization	LQR, MPC, $\mathcal{L}_1$ adaptive control, dynamic games, convex/SDP/QP optimization, robust control, state estimation.
Software and Tools	Python, PyTorch, JAX, ROS2, MATLAB, C++, Turtlebot.

AWARDS

- IEEE Technical Committee on Security and Privacy — **Best Student Paper Award**, CDC 2023
- **Jackson Computing and Data Impact Award**, Michigan State University Research Symposium 2022

PUBLICATIONS

Journals

1. **S. Banik**, and S. D. Bopardikar, *"`FlipDyn` with Control: Resource Takeover Games with Dynamics,"* in IEEE Transactions on Automatic Control.[*link*]

2. **S. Banik**, T. Ramachandran, A. Bhattacharya, and S. D. Bopardikar, *"Automated Adversary-in-the-Loop Cyber-Physical Defense Planning"*, in ACM Transactions on Cyber-Physical Systems (TCPS), vol. 7, no. 3, Article 18 (July 2023), 25 pages, doi: 10.1145/3596222. [*link*]

3. **S. Banik**, and S. D. Bopardikar, *"Attack-Resilient Path Planning Using Dynamic Games With Stopping States,"* in IEEE Transactions on Robotics, vol. 38, no. 1, pp. 25-41, Feb. 2022, doi: 10.1109/TRO.2021.3123896.[*link*]

Conference

1. E. Pathak, A. Aboudonia, **S. Banik**, and N. Hovakimyan. "A Robust Task-Level Control Architecture for Learned Dynamical Systems". in: *Learning for Dynamics and Control Conference.* 2026.

2. A. Gahlawat, A Aboudonia, **S. Banik**, N. Hovakimyan, N. Matni, A. D. Ames, G. Zardini and A. Speranzon, *"Distributionally Robust Imitation Learning: Layered Control Architecture for Certifiable Autonomy"*, in AIAA SCITECH 2026 Forum.

3. T. Q. Nguyen, M. Kim, **S. Banik**, J. Kim , and N. Hovakimyan, *"Moving-Horizon State Estimation for Unmanned Aerial Vehicles: An $\mathcal{L}_1$ Adaptive Optimization Approach,"* in AIAA SCITECH 2026 Forum.

4. M. Aramyan, **S. Banik**, T. Bakaryan, N. Hovakimyan, *"PACT: Potential differential game-based multi-Agent Coordination for Time-critical missions"* in AIAA SCITECH 2026 Forum.

5. **S. Banik**, J. Kim, N. Hovakimyan, L. Carlone, J. Thomas, and N. G. Leveson, *"Integrating Vision Systems and STPA for Robust Landing and Take-Off in VTOL Aircraft,"* AIAA SCITECH 2025 Forum, 2025, p. 1324, doi: 10.2514/6.2025-1324 [*link*]

6. **S. Banik**, S. D. Bopardikar, and N. Hovakimyan, *"`FlipDyn` in Graphs: Resource Takeover Games in Graphs,"* International Conference on Decision and Game Theory for Security, 2024, pp. 220-239, Springer, doi: 10.1007/978-3-031-74835-6-11 [*link*]

7. **S. Banik**, and S. D. Bopardikar, *"`FlipDyn`: A game of resource takeovers in dynamical systems,"* 2022 IEEE 61st Conference on Decision and Control (CDC), Cancun, Mexico, 2022, pp. 2506-2511, doi: 10.1109/CDC51059.2022.9992387.[*link*] (**IEEE TCSP Best Student Paper Award**)

8. **S. Banik**, and S. D. Bopardikar, *"Stochastic Games with Stopping States and their Application to Adversarial Motion Planning Problems,"* 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Kyoto, Japan, 2022, pp. 13181-13188, doi: 10.1109/IROS47612.2022.9982011.[*link*]

9. **S. Banik**, and S. D. Bopardikar, *"Secure Route Planning Using Dynamic Games with Stopping States,"* 2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Las Vegas, NV, USA, 2020, pp. 2404-2409, doi: 10.1109/IROS45743.2020.9340884. [*link*]

10. A. Bhattacharya, T. Ramachandran, **S. Banik**, C. P. Dowling and S. D. Bopardikar, *"Automated Adversary Emulation for Cyber-Physical Systems via Reinforcement Learning,"* 2020 IEEE International Conference on Intelligence and Security Informatics (ISI), Arlington, VA, USA, 2020, pp. 1-6, doi: 10.1109/ISI49825.2020.9280521. [*link*]

11. **S. Banik**, S. K. Kaul and P. B. Sujit, "Minimizing Age in Gateway Based Update Systems," 2019 IEEE International Symposium on Information Theory (ISIT), Paris, France, 2019, pp. 1032-1036, doi: 10.1109/ISIT.2019.8849367. [*link*]

12. **S. Banik**, P. B. Sujit and S. Rathinam, "Multi-AUV Coverage with Functional Constraints and Currents," 2020 IEEE/OES Autonomous Underwater Vehicles Symposium (AUV), St. Johns, NL, Canada, 2020, pp. 1-2, doi: 10.1109/AUV50043.2020.9267937. [*link*]

13. **S. Banik**, S. Rathinam and P. B. Sujit, "Min-Max Path Planning Algorithms for Heterogeneous, Autonomous Underwater Vehicles," 2018 IEEE/OES Autonomous Underwater Vehicle Workshop (AUV), Porto, Portugal, 2018, pp. 1-6, doi: 10.1109/AUV.2018.8729714. [*link*]

Under Review

1. **S. Banik** and N. Hovakimyan, *`Flip-Team`: Game-Theoretic Takeover with Stochastic Human Intent.*Under review in: *Robotics: Science and Systems*, 2026.

Selected Works in Progress

1. **S. Banik** and N. Hovakimyan, `Flip Co-op`: *Cooperative Takeovers in Shared Autonomy.* arXiv - https://arxiv.org/abs/2509.09281

2. **S. Banik** and N. Hovakimyan, *"Flip-AltL: Learning Value of Cooperative Takeovers in Shared Autonomy"*.

3. **S. Banik**, E. Pathak, S. Agarwal, and N. Hovakimyan, *"Deep Potential Matching: Learning Markov Potential Functions to Align Multi-Agent Systems"*.

4. **S. Banik**, and S. D. Bopardikar, *"Budget based Stochastic Games with Stopping States"*.

SERVICE & OUTREACH

Journal Reviewer: IEEE Transactions on Automatic Control, IEEE Transactions on Robotics, IEEE Transactions on Intelligent Transportation Systems, IEEE Transactions on Control of Network Systems

Conference Reviewer: IEEE IROS, IEEE ACC, IEEE CDC, IEEE ICCSN, IEEE ICRA, Robotics: Science and Systems.

Organizing committee of IEEE Control Systems Society Technical Committee on Security and Privacy (TCSP), **Technical Program Chair** on GameSec 2026.

Outreach: Presenter at Detroit Area Pre-College Engineering Program (DAPCEP), 2022–2023

MENTORING & ADVISING

University of Illinois Urbana-Champaign   2024–present

- Advised 8 students (4 PhD, 2 MS, 2 undergrad) on reinforcement learning, shared autonomy, and learning-enabled control
- PhD students: M. Yeghiazaryan, M. Aramyan, E. Pathak, J. Li
- Masters students: R. Madhavan, T.Q. Nguyen.
- Undergraduate researchers: N. J. Wijas, S. Gummadapu

Michigan State University   2019–2023

- Supervised 5 undergraduate/masters students on dynamic games and adversarial reasoning
- Students: A. Debaker, I. Kapale, B. Ganeshbabu, A. Bodea, M. Viswanath