Vishnu S. Chipade

Senior Researcher

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🌐 Personal Webpage
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RESEARCH AREAS OF INTEREST

- Control, Planning and Coordination of Autonomous Multi-robot Systems; Decentralized/Distributed Planning and Control; Artificial Intelligence for Robotics; Human Robot Collaboration; Resiliency and Security in Autonomous Systems.

EDUCATION

- **Ph.D.** in Aerospace Engineering *(Aug 2022)*
  University of Michigan, Ann Arbor, USA
  Advisor: Prof. Dimitra Panagou
  (GPA: 3.9/4)

- **M.S.E.** in Aerospace Engineering *(Aug 2021)*
  University of Michigan, Ann Arbor, USA
  (GPA: 3.9/4)

- **B.Tech - M.Tech** in Aerospace Engineering *(May 2017)*
  Indian Institute of Technology Kanpur, India
  Advisors: Prof. Abhishek and Prof. Mangal Kothari
  (GPA: M.Tech - 10/10, B.Tech - 9.3/10)

PROFESSIONAL EXPERIENCE

- **Senior Researcher** *(Nov'23 - present)*
  Technology Innovation Institute, Abu Dhabi, UAE

- **Postdoctoral Research Associate** *(Apr'23 - Nov'23)*
  Northeastern University, Boston, MA, USA
  Advisor: Prof. Sze Zheng Yong

- **Motion Planning Engineer** *(Jun'22 - Feb'23)*
  ThorDrive, Cincinnati, OH, USA

JOURNAL PUBLICATIONS

7. **Vishnu S. Chipade**, Aravindaraja Puthiyavinayagam, "Large Language Model Powered Automated ROS2 Integration and Reliability Assessment Testbed for UAVs," (under preparation)

6. **Vishnu S. Chipade**, R. Kumar, S. Z. Yong, "Winding-Constrained Motion Planning for Tethered Robot using Hybrid A*: Admissibility and Performance Analysis," (under preparation)

5. **Vishnu S. Chipade**, Xinyi wang, D. Panagou, "IDCAIS: Inter-Defender Collision-Aware Interception Strategy against Multiple Attackers, (Conditionally Accepted)

4. **Vishnu S. Chipade**, D. Panagou, "Aerial Swarm Defense using Interception and Herding Strategies," IEEE Transactions on Robotics, vol. 39, no. 5, pp. 3821-3837, Oct. 2023, doi: 10.1109/TRO.2023.3292514

3. **Vishnu S. Chipade**, V. S. A. Marella, D. Panagou, "Aerial Swarm Defense by StringNet Herding: Theory and Experiments," Frontiers in Robotics and AI, 8, p-81, 2021.

2. **Vishnu S. Chipade**, D. Panagou, "Multi-Agent Planning and Control for Swarm Herding in 2D Obstacle Environments under Bounded Inputs," IEEE Transactions on Robotics, 38(2), pp.-, May 2021.

1. **Vishnu S. Chipade**, Abhishek, M. Kothari, R. Chaudhari, "Systematic design methodology for development and flight testing of a variable pitch quadrotor biplane VTOL UAV for payload delivery," Mechatronics, Vol. 55, pp. 94-114, Aug 2018.

CONFERENCE PUBLICATIONS

14. **Vishnu S. Chipade**, Ilia Loginov, Aravindaraja Puthiyavinayagam, "Aurora: Automated ROS2 Integration and Reliability Assessment Testbed for PX4-based UAVs," Accepted in 25th International Conference on Control, Automation, and Systems (ICCAS), Incheon, South Korea, 2025.

13. R. Kumar, **Vishnu S. Chipade**, S. Z. Yong, "THAMP-3D: Tangent-based Hybrid A* Motion Planning for tethered robots in sloped 3D terrains," 2025 IEEE International Conference on Robotics and Automation (ICRA), Atlanta, USA, 2025.

12. R. Kumar, **Vishnu S. Chipade**, S. Z. Yong, "Stability of Tethered Ground Robots on Extreme Terrains," 2024 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Abu Dhabi, UAE, 2024.

11. **Vishnu S. Chipade**, R. Kumar, S. Z. Yong, "WiTHy A*: Winding-Constrained Motion Planning for Tethered Robot using Hybrid A*," 2024 IEEE International Conference on Robotics and Automation (ICRA), Yokohama, Japan, 2024.

10. **Vishnu S. Chipade**, A. Gilbert, D. Panagou, Daniel Harari "Collaborative Control of Aerial Robots for Inferring Human Intent from Gaze Following," 2023 IEEE Conference on Control Technology and Applications, Bridgetown, Barbados, Aug 2023.

9. A. Gilbert, **Vishnu S. Chipade**, D. Panagou, "Robust Leader-Follower Formation Control for Human-Robot Scenarios," 2022 American Control Conference, Atlanta, Georgia, June 2022.

8. W. Zhang, **Vishnu S. Chipade**, D. Panagou, "Herding an Adversarial Swarm in Three-dimensional Spaces," 2021 American Control Conference, New Orleans, LA, May 2021.

7. **Vishnu S. Chipade**, D. Panagou, "Multi-Swarm Herding: Protecting against Adversarial Swarms," 59th IEEE Conference on Decision on Control, Jeju Island, Republic of Korea, December 2020.

6. R. Radmanesh, Z. Wang, **Vishnu S. Chipade**, G. Tschpenakis, D. Panagou, "LIV-LAM: LiDAR and Visual Localization and Mapping," 2020 American Control Conference, Denver, CO, July 2020.

5. **Vishnu S. Chipade**, D. Panagou, "Herding an Adversarial Swarm in an Obstacle Environment," 58th IEEE Conference on Decision on Control, Nice, France, December 2019.

4. **Vishnu S. Chipade**, D. Panagou, "Herding an Adversarial Attacker to a Safe Area for Defending Safety-Critical Infrastructure," 2019 American Control Conference, Philadelphia, PA, July 2019.

3. **Vishnu S. Chipade**, Shen Q., Huang L., Ozay N., S. Z. Yong, and D. Panagou, "Safe Autonomous Overtaking with Intention Estimation,"2019 European Control Conference, Napoli, Italy, June 2019.

2. **Vishnu S. Chipade**, D. Panagou, "Multiplayer Target-Attacker-Defender Differential Game: Pairing Allocations and Control Strategies for Guaranteed Intercept," AIAA Scitech 2019 Forum. 2019.

1. **Vishnu S. Chipade**, Abhishek, and M. Kothari, "Advanced Flight Dynamic Modelling of Variable Pitch Quadrotor," In 2018 AIAA Atmospheric Flight Mechanics Conference (p. 1763).

PATENTS

- "Safe autonomous overtaking with intention estimation," US Application No.: 16360572; Patent No.: US 12,304,487 B2; Dated: 21 Mar 2019.
  *N. Ozay, **Vishnu S. Chipade** , Q. Shen, L. Huang, S. Z. Yong, and D. Panagou*

- "An umannaed aerial vehicle having a fixed biplane wing," India Application No.: 201611015384; Patent No.: 507670; Dated: 03 May 2016.
  *Abhishek, M. Kothari, N. Gupta, **Vishnu S. Chipade**, N. Gupta, R. Chaudhari, and R. V. Singh*

TEACHING

- **U-M Graduate Teacher Certificate** *Dec 2022*
  - Awarded by the University of Michigan Center for Research on Learning & Teaching for formal training in college-level teaching, pedagogy and instructional practice (description).

- **Graduate Student Instructor**- Control of Aerospace Vehicles (University of Michigan) *(Sep'21- Dec'21)*
  - Conducted weekly office hours to help students with their doubts related to course material and assignments.

- **Graduate Student Instructor**- Fundamentals of Navigation & Guidance (University of Michigan) *(Sep'19- Dec'19)*
  - Developed and taught weekly supplementary sessions on course material. Designed assignments and final project and provided assignment support during office hours.

- **Teaching Assistant**- Experiments in Aerospace Engineering Lab (IIT Kanpur) *(Jul'16- Nov'16)*
  - Delivered instruction on photoelasticity fundamentals and facilitated the associated laboratory experiment

MENTORSHIP

- Supervised master's students on motion planning for a tethered robot operating in extreme planetary terrains and technical writing.

- Guided new Ph.D. students in getting started with research and technical paper writing.

- Supervised master's students in developing a multi-quadrotor hardware system to implement and demonstrate motion planning algorithms.

- Supervised master's students in integrating a companion computer, camera, and LiDAR on a DJI quadrotor, and developing scripts for autonomous trajectory tracking.

- Supervised a master's student's project on extending a 2D herding algorithm to 3D for coordinating a team of defenders to steer adversarial agents toward a safe zone.

PROFESSIONAL SERVICE

- Reviewer for Journal Publications
  - IEEE Transactions on Robotics (T-RO)
  - Autonomous Robots
  - IEEE Robotics and Automation Letters (RA-L)
  - IEEE Control Systems Letters (L-CSS)
  - IEEE Transactions on Aerospace and Electronic Systems (TAES)
  - IEEE Transactions on Automation Science and Engineering (T-ASE)
  - IEEE Transactions on Mechatronics (TMECH)
  - Automatica
  - Open Journal of Control Systems (OJ-CSYS)
  - Journal of Aerospace Information Systems (JAIS)
  - Nonlinear Dynamics
  - Nonlinear Analysis - Hybrid Systems
- Reviewer for Conference Publications
  - International Conference on Robotics and Automation (ICRA)
  - International Conference on Intelligent Robots and Systems (IROS)
  - Conference on Decision and Control (CDC)
  - American Control Conference (ACC)
  - European Control Conference (ECC)
  - International Conference on Control, Automation, and Systems (ICCAS)
  - International Conference on Hybrid Systems: Computation and Control (HSCC)
  - SciTech

SCHOLASTIC ACHIEVEMENTS

- Received **Academic Excellence Award** for three academic sessions (2012-13, 2014-15 and 2015-16) at IIT Kanpur

- Obtained **All India Rank 19** in **GATE** (Graduate aptitude test in engineering) 2016 in Aerospace Engineering

- Received **Merit-cum-Means Scholarship** (during B.Tech.) and **M. Tech. Fellowship** at IIT Kanpur.

TECHNICAL SKILLS

- **Programming Languages**: C++, Python, MATLAB, R;   **Platforms**: Windows, Ubuntu, Docker;

- **Softwares**: ROS, Git, Gurobi, AirSim, Gazebo, LabVIEW, LaTeX;   **Hardwares**: Pixhawk (PX4), Arduino,

RESEARCH PROJECTS

- **Postdoctoral Research** (*Advisor - Prof. Sze Zheng Yong, North Eastern University Boston*)   *(Apr 2023 - Nov 2023)*
  Motion Planning for Tethered Robots on Extreme Terrains

  - During my postdoctoral research, I addressed the challenging problem of motion planning for tethered robots navigating extreme terrains commonly encountered in planetary explorations, by developing tangent-based variants of hybrid A* that account for tether traction resulting from capstan effect to ensure stability of the robot on the extreme terrains.

- **Ph.D. Research** (*Advisor - Prof. Dimitra Panagou, UMich*)   *(Sep 2017 - Apr 2022)*
  Multi-Agent Autonomous Systems: Coordination, Collaboration and Motion Planning

  ○ My PhD research focused on the development of planning, coordination, and decision-making algorithms for multi-agent autonomous systems operating in complex and adversarial environments and human-in-the-loop environments. I addressed several challenging problems, including (1) swarm herding, (2) multi-swarm herding, (3) collaborative, inter-defender collision-aware interception of multiple attackers, and (4) area defense against diverse and intelligent swarms of attackers. To tackle these problems, I developed motion planning, task assignment, and mixed-integer optimization techniques, along with efficient and near-optimal heuristics, to enable scalable and high-performance operation in dynamic and adversarial settings. I developed coordination frameworks for aerial robots in human-robot collaboration scenarios in shared workspace by inferring human intent from gaze cues. I also contributed to intent-aware real-time implementable motion planning algorithm for autonomous driving.

- **M. Tech Thesis** (*Advisors - Prof. Abhishek and Prof. Mangal Kothari, IIT Kanpur*)   *(May 2016-May 2017)*
  Advanced Flight Dynamic Modelling and Adaptive Control of Variable Pitch Quadrotor

  ○ Developed advanced flight dynamics model for generalized motion of variable pitch quadrotor, and integral and adaptive backstepping control algorithms for variable pitch quadrotor which are robust toward sudden change in mass as a consequence of dropping a payload.

- **Independent Research Project** (*Mentor - Prof. Abhishek, IIT Kanpur*)   *(Jan-Apr 2015, May 2016-Jun 2017)*
  Design and Prototyping of a Hybrid VTOL Aerial Vehicle

  ○ Developed a novel VTOL aircraft integrating quadrotor hover capabilities with fixed-wing biplane aerodynamics to enhance efficiency and maneuverability. Designed a custom proprotor using a modified BEMT model, optimized wing structures, and demonstrated stable hover flight with a full-scale prototype.

- **Undergraduate Thesis** (*Mentor - Prof. Abhishek, IIT Kanpur*)   *(Jul 2015-Apr 2016)*
  Motion Planning for Variable Pitch (VP) Quadrotor using Feedback Controller Based Information RoadMap (FIRM)

  ○ Developed a belief-space motion planning framework for a variable-pitch quadrotor using Feedback-based Information RoadMap (FIRM), integrating both motion and sensing uncertainty. Constructed a PRM-based belief graph with LQG stabilizing controllers and computed optimal policies via dynamic programming.

- **Research Internship at Texas A&M University** (*Mentor - Prof. Suman Chakravorty*)   *(May-Jul 2015)*
  Graph Based Motion Planning for Quadrotor Helicopter

  ○ Simulated LQR/LQG controllers for quadrotor stabilization and computed optimal paths using a trajectory-based roadmap and dynamic programming.

RELEVANT COURSE PROJECTS

- **Safe Motion Planning for Multi-agent System using Distributed N-MPC**   *(Jan'18- Apr'18)*
  ○ Developed a **distributed motion planning** algorithm using nonlinear model predictive control (N-MPC) framework and **sequential quadratic programming (SQP)** for multiple robots with limited sensing capability to navigate safely from one point to another.

- **Cooperative motion planning for multiple UAVs to improve object detection**   *(Jan'21- Apr'21)*
  ○ Collaborated on developing a Python-based framework to evaluate cooperative motion planning for UAV teams, enhancing object detection performance with YOLO to improve situational awareness.