Vishnu Samadhan Chipade

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EDUCATION

- **Ph.D.** in Aerospace Engineering, University of Michigan, Ann Arbor, USA *(Aug 2022)*
  (GPA: 3.9/4)
- **M.S.E.** in Aerospace Engineering, University of Michigan, Ann Arbor, USA *(Aug 2021)*
  (GPA: 3.9/4)
- **B.Tech - M.Tech** in Aerospace Engineering, Indian Institute of Technology Kanpur, India *(May 2017)*
  (GPA: M.Tech - 10/10, B.Tech - 9.3/10)

WORK EXPERIENCE

- **Senior Researcher** *(Nov'23 - present)*
  Technology Innovation Institute, Abu Dhabi, UAE
- **Postdoctoral Research Associate** *(Apr'23 - Nov'23)*
  Northeastern University, Boston, MA, USA
- **Motion Planning Engineer** *(Jun'22 - Feb'23)*
  ThorDrive, Cincinnati, OH, USA

RESEARCH AREAS OF INTEREST

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

JOURNAL PUBLICATIONS

7. **Vishnu S. Chipade**, Aravindaraja, "Large Language Model Powered Fully Automated ROS2-GZ Testbed for UAV Integration Testing," (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**, D. Panagou, "IDCAIS: Inter-Defender Collision-Aware Interception Strategy against Multiple Attackers," (under review)
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

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. Tsechpenakis, 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, Dated: 24 Sep 2020.
  *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 EXPERIENCE

- **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 and Guidance (University of Michigan) *(Sep'19- Dec'19)*
  - Designed and delivered a weekly one hour discussion session on course related material and conducted weekly office hours to guide students with their assignment problems.
- **Teaching Assistant**- Experiments in Aerospace Engineering Lab (IIT Kanpur) *(Jul'16- Nov'16)*
  - Explained the fundamentals of an experiment on 'photoelasticity' and helped students perform the experiment.

MENTORSHIP

- Supervised a master's student for a project on motion planning for tethered robot on extreme planetary terrains.
- Supervised master's students in building a hardware system of multiple autonomous small quadrotors to implement and demonstrate motion planning algorithms on physical platforms.
- Supervised a master's student to integrate a companion computer, camera and Lidar on a DJI quadrotor and to write scripts to make the DJI track user defined trajectories autonomously
- 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 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 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** during M.Tech.

TECHNICAL SKILLS

- **Programming Languages**: C++, Python, MATLAB, R;
- **Softwares**: ROS, Git, Gurobi, AirSim, Gazebo, LabVIEW, LaTeX;
- **Platforms**: Windows, Ubuntu;
- **Hardwares**: Pixhawk (PX4), Arduino,

RESEARCH PROJECTS

- **Ph.D. Research** (*Advisor - Prof. Dimitra Panagou, UMich*) *(Sep 2017 - Apr 2022)*
  - Multi-agent Planning for Human Robot Interaction: Developed a coordination protocol for a team of aerial robots, operating in a shared workspace with human, to infer the intention of the human based on what the human is interested in, by visually following the human gaze and head orientation. The intention is then shared with ground robots to assist the human in way that aligns with the human's goal.
  - Swarm Herding: Developed and experimentally demonstrated *'StringNet Herding'*, a **multi-agent motion planning** method, in which a swarm of risk-averse, adversarial attackers is enclosed inside a closed formation of defenders and herded to a safe area through an obstacle environment to protect a safety-critical area (see **experiments** here).
  - Multi-Swarm Herding: Developed a clustering-based **task assignment** algorithm using **mixed integer programs** to optimally assign defenders to the tasks of herding multiple adversarial swarms to safe areas using *'StringNet Herding'*.
  - Multi-agent Interception: Developed a time-optimal, collaborative strategy for a team of defending robots consisting of collision aware **task assignment** to **safely intercept** as many of the **multiple adversarial robots** (attackers) and as quickly as possible.
  - Multi-agent Defense (Herding + Interception): Combined the multi-swarm herding and multi-agent interception strategies together using mixed integer programs and **computationally efficient heuristics** to provide a defense strategy against wide range of behaviors of the attackers.
  - LiV-LAM: LiDAR-Visual Localization and Mapping: Collaborated with a team of researchers to develop a **simultaneous localization and mapping (SLAM)** method with better accuracy that combines Lidar data with discovered objects from the camera using an unsupervised, proposal matching based object detection algorithm.
  - Safe Autonomous Overtaking: Collaborated with a team of researchers to develop a vector- field based, **real-time implementable motion planning** algorithm for safe autonomous overtaking while taking into account the online inferred intent of other vehicles on road.

- **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
  - Developed 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
  - Proposed and developed a novel VTOL (Vertical Take-Off and Landing) aircraft combining quadrotor-like hovering with fixed-wing biplane aerodynamics for improved efficiency and maneuverability.
  - Designed a proprotor using a modified Blade Element Momentum Theory (BEMT) model for accurate performance estimation and wing structures based on monoplane design methods, optimized for the aerodynamic benefits of a biplane configuration.
  - Fabricated a full-scale prototype and successfully demonstrated stable hover flight in preliminary testing.
- **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), incorporating both motion and sensing uncertainty. Constructed a FIRM by linking Probabilistic Roadmap (PRM) samples with belief nodes and connecting them via LQG-based stabilizing controllers. Edge costs were computed using estimation error and stabilization time, with transition probabilities estimated via particle methods, and the optimal policy obtained through 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 and LQG (stationary and time-varying) controllers for quadrotor stabilization; constructed a roadmap in configuration space using LQR-based trajectories and computed optimal paths via 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 with a team of students to develop our own python implementation to evaluate the performance of a **cooperative motion planning** algorithm for a team of unmanned areal vehicles (UAVs) to improve quantity and quality of objects detected by YOLO object detection algorithm to improve situational awareness of the UAVs.