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)*
  Secure Systems Research Center, 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

6. **Chipade V. S.**,Kumar R., Yong S. Z., "Winding-Constrained Motion Planning for Tethered Robot using Hybrid A*: Admissibility and Performance Analysis," (under review)
5. **Chipade V. S.**, Panagou D., "IDCAIS: Inter-Defender Collision-Aware Interception Strategy against Multiple Attackers," (under review)
4. **Chipade V. S.**, Panagou D., "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. **Chipade V. S.**, Panagou D., "Multi-Agent Planning and Control for Swarm Herding in 2D Obstacle Environments under Bounded Inputs," IEEE Transactions on Robotics, 38(2), pp.-, May 2021.
2. **Chipade V. S.**, Marella V. S. A., Panagou D., "Aerial Swarm Defense by StringNet Herding: Theory and Experiments," Frontiers in Robotics and AI, 8, p-81, 2021.
1. **Chipade V. S.**, Abhishek, Kothari M., Chaudhari R., "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. Kumar, R., **Chipade, V. S.**, Yong, S. Z., "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. Kumar, R., **Chipade, V. S.**, Yong, S. Z., "Stability of Tethered Ground Robots on Extreme Terrains," 2024 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Abu Dhabi, UAE, 2024.
11. **Chipade, V. S.**, Kumar, R., Yong, S. Z., "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. **Chipade, V. S.**, Gilbert A., Panagou D., 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. Gilbert A., **Chipade, V. S.**, Panagou D., "Robust Leader-Follower Formation Control for Human-Robot Scenarios," 2022 American Control Conference, Atlanta, Georgia, June 2022.
8. Zhang W., **Chipade V. S.**, Panagou D., "Herding an Adversarial Swarm in Three-dimensional Spaces," 2021 American Control Conference, New Orleans, LA, May 2021.
7. **Chipade V. S.**, Panagou D., "Multi-Swarm Herding: Protecting against Adversarial Swarms," 59th IEEE Conference on Decision on Control, Jeju Island, Republic of Korea, December 2020.
6. Radmanesh R., Wang Z., **Chipade V. S.**, Tsechpenakis G., Panagou D., "LIV-LAM: LiDAR and Visual Localization and Mapping," 2020 American Control Conference, Denver, CO, July 2020.
5. **Chipade V. S.**, Panagou D., "Herding an Adversarial Swarm in an Obstacle Environment," 58th IEEE Conference on Decision on Control, Nice, France, December 2019.
4. **Chipade V. S.**, Panagou D., "Herding an Adversarial Attacker to a Safe Area for Defending Safety-Critical Infrastructure," 2019 American Control Conference, Philadelphia, PA, July 2019.
3. **Chipade V. S.**, Shen Q., Huang L., Ozay N., Yong S. Z., and Panagou D., "Safe Autonomous Overtaking with Intention Estimation,"2019 European Control Conference, Napoli, Italy, June 2019.
2. **Chipade V. S.**, Panagou D., "Multiplayer Target-Attacker-Defender Differential Game: Pairing Allocations and Control Strategies for Guaranteed Intercept," AIAA Scitech 2019 Forum. 2019.
1. **Chipade V. S.**, Abhishek A. and Kothari M., "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
  Ozay N., ***Chipade, V. S.*** *, Shen Q., Huang L., Yong S. Z., and Panagou D.*
- "A VTOL Unmanned Aerial Vehicle," India Application No.: 201611015384, Dated: 19 Jul 2019
  Abhishek, Kothari, M., Gupta, N., ***Chipade, V.*** *, Gupta, N., Chaudhari, R., and Singh, R. V.*

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 student for a project on building a system of multiple autonomous small quadrotor vehicles to demonstrate motion planning algorithms on real hardware platforms
- Supervised a master 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 student in developing a 3D extension of 2D herding strategy for a team of defending agents to herd a swarm of adversarial agents to a safe area

PROFESSIONAL SERVICE

- Reviewer for Journal Publications
  - IEEE Transactions on Robotics (T-RO)
  - IEEE Transactions on Mechatronics (TMECH)
  - Automatica

- Autonomous Robots
- Journal of Aerospace Information Systems (JAIS)
- Nonlinear Dynamics
- Nonlinear Analysis - Hybrid Systems
- IEEE Robotics and Automation Letters (RA-L)
- IEEE Control Systems Letters (L-CSS)

- Reviewer for Conference Publications
  - Conference on Decision and Control (CDC) [2019, 2020]
  - American Control Conference (ACC) [2019, 2020, 2021, 2022]
  - International Conference on Robotics and Automation (ICRA) [2019, 2020, 2022]
  - International Conference on Intelligent Robots and Systems (IROS) [2018, 2021]
  - European Control Conference (ECC) [2019, 2020]
  - International Conference on Hybrid Systems: Computation and Control (HSCC) [2020]
  - SciTech [2020]

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

RESEARCH PROJECTS

- **Ph.D. Research** (*Advisor - Prof. Dimitra Panagou, UofM*) *(Sep 2017 - Apr 2022)*
  - 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.
  - **Multi-agent Planning for Human Robot Interaction**: Developed a motion planning algorithm for a team of aerial robots equipped with cameras to navigate in the scenes with human actors simulated in AirSim, a photo-realistic simulation environment, to: 1) identify objects or areas of interest by accurately estimating human gaze direction, and 2) **assign tasks** and move robots based on the identified areas of interest.
- **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 of a Variable Pitch Quadrotor Biplane Vertical Takeoff and Landing UAV
  - Proposed a design combining helicopter characteristics of a quadrotor and fixed-wing characteristics of a biplane
  - Designed a proprotor using modified blade element theory (BEMT) for performance predictions.
  - Designed wings using a typical monoplane design approach while optimizing the benefits of biplane configuration
  - Designed other aspects of the design such as power plant selection, transmission mechanism, Avionics kit etc.
  - Fabricated a prototype of the design and tested the vehicle in hover flight

- **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)
  - Simulated motion planning for a variable pitch quadrotor using Feedback controller-based Information-state RoadMap (FIRM) that takes into account motion and sensing uncertainty in planning.
  - Constructed FIRM, a roadmap in belief space, with its nodes as small subsets of belief space and the edges as Markov chains in belief space, by associating FIRM nodes to sampled PRM nodes and constructing edges by invoking stabilizing feedback controller (LQG) corresponding to the PRM nodes.
  - Assigned edge costs based on the estimation error during belief propagation and the time taken for stabilizing to the next node. Calculated transition probabilities using a particle based approach and searched optimal policy by solving 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, time varying LQR, stationary LQG, time varying LQG controller for stabilization of quadrotor
  - Generated a roadmap by sampling random points from a configuration space for quadrotor i.e. 3d coordinates and heading angle. Connected these points called nodes by edges generated by invoking LQR controllers corresponding to these nodes and solved for shortest path using 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.