Vishnu Samadhan Chipade

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EDUCATION

Current (2017-present)
University of Michigan
Ph.D. Candidate, Aerospace Engineering
Advisor: Prof. Dimitra Panagou
GPA: 3.9/4.0

Past (2012-2017)
Indian Institute of Technology Kanpur
B.Tech - M.Tech, Aerospace Engineering
Advisors: Prof. Abhishek and Prof. Mangal Kothari
GPA: M. Tech - 10/10, B. Tech - 9.3/10

AREAS OF INTEREST

- Control, Decision and Motion planning for Multi-agent Systems; Computer Vision in Aerial Robotics.

JOURNAL PUBLICATIONS

3. **Chipade V. S.**, Marella V. S. A., Panagou D., "Aerial Swarm Defense by StringNet Herding: Theory and Experiments," (under review)
2. **Chipade V. S.**, Panagou D., "Multi-Agent Planning and Control for Swarm Herding in 2D Obstacle Environments under Bounded Inputs," (under review)
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

8. Zhang W., **Chipade V. S.**, Panagou D., "Herding an Adversarial Swarm in Three-dimensional Spaces," 2021 American Control Conference (under review).
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.*

RESEARCH EXPERIENCE

- Ph.D. Thesis (*Advisor - Prof. Dimitra Panagou, UofM*) *(Sep 2017 - till date)*
  Motion Planning for Multi-agent Systems in the presence of Adversaries
  - Multi-Swarm Herding: Developed an clustering-based assignment algorithm to assign defenders to attackers to ensure herding of multiple adversarial swarms to safe areas using 'StringNet Herding' approach.
  - Swarm Herding: Developed a herding method called 'StringNet Herding' which encloses a swarm of adversarial attackers inside a closed formation of the defenders and herds the attackers to a safe area through an obstacle populated environment.
  - Herding an attacker: Developed novel vector field based guidance control to safely herd an attacker away from a protected area to a safe area in the presence of obstacles.
  - Target-Attacker-Defender (TAD) games: Developed control strategies for defenders and attacker to defender pairing algorithm for multi player TAD games to ensure capture of maximum number of attackers.

- 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
- Course Project (*Instructor Prof. Gaurav Pandey, IIT Kanpur*) *(Jan-Apr 2016)*
  Moving Object Detection and Visual Odometry using Stereo Camera On-board a Vehicle
  - Estimated egomotion (3D motion of the camera) in an iterative manner using optical flow and disparity which are obtained by using SURF features. Used RANSAC algorithm to obtain maximum number of inliers (features on stationary background) and estimated final egomotion using least square approximation
  - Clustered the most probable outliers, obtained by the RANSAC algorithm, into separate moving objects based on their location in 2D image and their 3D distance from the vehicle using K-means method and also demonstrated visual odometry

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** (Python, C++); **Other Languages** (HTML, PHP, CSS); **Platforms** (Windows, Ubuntu)
- **Software and hardware tools** (MATLAB, Gazebo, AirSim, ROS, LaTeX, Pixhawk, Arduino, LabVIEW)

TEACHING EXPERIENCE

- **Graduate Student Instructor**- Fundamentals of Navigation and Guidance (AEROSP 584, University of Michigan, Sep-Dec 2019)
- **Teaching Assistant**- Experiments in Aerospace Engineering lab (AE 451A, IIT Kanpur, Jul-Nov 2016)

COCURRICULAR / EXTRACURRICULAR ACTIVITIES

- Participated in **ROBOCON 2013**, National robotics contest by Doordarshan and MIT academy of engineering, Pune
- Secured second position in **RoboPirates, Techkriti 2014**, Annual Technical and Entrepreneurial festival of IIT Kanpur
- Stood first in **ROBOGAMES, Takneek 2012**, Inter hostel Technical and Entrepreneurial festival of IIT Kanpur

HOBBIES

Writing poetry; Reading Novels; Playing Ukulele; Listening to Music; Playing Cricket, Badminton, Squash.