Sandesh Thapa

CONTACT INFORMATION

Research Engineer- Vehicle Controls
Ford Motor Company
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CURRENT RESEARCH INTERESTS

Control and planning of autonomous systems, nonlinear, adaptive and optimal control, distributed control and estimation, robot autonomy, decision making under uncertainty, aerial robotics, multi-vehicle coordination and control, aerial robotics, real time optimization and motion planning.

APPLICATION AREAS

Autonomous systems, aerospace, mobile robots, aerial robots, self-driving cars, bipedal robots.

EDUCATION

Oklahoma State University, Stillwater, OK — August 2016 – Dec 2018
Masters of Science, Mechanical and Aerospace Engineering — (GPA 3.89/4.00)
Concentration: **Controls & Robotics**
Advisor: Dr. He Bai, Co-Advisor: **Jose.A. Acosta** , Committee: **Rushikesh Kamalapurkar**
Thesis: Cooperative Aerial Manipulation with Force Control and Attitude Stabilization.
Best Graduate Research, MAE Research Symposium 2018, Oklahoma State University

McNeese State University, Lake Charles, LA. — August 2011 – May 2015
Bachelors of Science, Mechanical Engineering — (GPA 3.66/4.00)
Minor: Mathematics

NANO DEGREE

Intro to Self-Driving Cars (C++, Python, A*) — July 2019
Flying Car & Autonomous Flight Engineer (Control, Planning, Estimation) — Nov 2021(exp)

TECHNICAL SKILLS

Languages: C/C++, Python, MATLAB/Simulink, Java, Fortran
Platforms: Windows, Linux, Robot Operating Systems (ROS), Jetson-TX2, Xavier, PX4
Software: Arduino, AutoCAD, SOLIDWORKS, Inventor, LabVIEW, ANSYS, Gazebo. dSpace, CAN

PROFESSIONAL EXPERIENCE

Ford Motor Company, Dearborn, MI.
Research Engineer - Autonomous Vehicle Controls & Planning — Jan 2021– Present

- Ford Research and Controls team - Low speed path planning and controls for L2 Autonomous driving
- Developed and implemented clothoid based continuous curvature based planner and nonlinear rear wheel feedback controller for auto hitch.

The Drone Racing League, New York, NY.
Senior Flight Controls Engineer, Autonomy — July 2019 – Jan 2021

- R&D on control, estimation, motion planning and autonomy of autonomous drones.
- Led the controls research and development efforts.
- Developed cascaded PID, State Dependent LQR for Quadrotor in MATLAB/Simulink, implemented in C++/Gazebo/ROS using simulation platform (Flightmare, PX4 SITL, RotorS)
- Developed self-contained solver for state dependent LQR using eigenvalue decomposition, schur decomposition and Newton-Raphson solver to solve the Algebraic Ricatti Equations for LQR in real time. (Matlab and C++).
- Simulation, test, debug and tunning PX4 Firmware controllers for different flight scenarios in flight lab and SITL (PX4/C++)

- Research and developed different control (PID, nonlinear, adaptive, geometric, MPC), planning (minimum jerk, snap) and estimation (Kalman Filter, complimentary filter) (Matlab and C++)
- Exposed to full autonomy architecture (perception, planning, control), PX4, QGroundControl, Offboard velocity control, gazebo, MAVlink
- Implemented nonlinear adaptive Control and Model Reference Adaptive Control Design using non-linear control theory for quadrotors with variable payload (Matlab/Simulink)
- Development of modular autonomy development kit involving different control alogrithms, trajectory generation, path planning and perception modules in ROS/Gazebo and autopilot in SITL
- Successfully converted C++ Optical flow algorithm to MATLAB to generate code for CUDA which is used for vision based collision avoidance.

DEKA Research and Development, Manchester, NH.
Control System Engineer March 2019 – July 2019

- Reconstructing trajectories from sensor data (ROS, C++). Tools used: exact time synchronizer in ROS, Occupancy grid, Model Predictive Control
- Got familiar with Control and planning of autonomous robots
- Worked on Unit Testing in VECTORCAST for different C++ files.

Meta Horizon INC, Irving, TX.
Software Engineer–Internship August 2015 – Dec 2015
Developed login web-page using OOP in Java, JavaScript, Spring Framework and HTML.

Research Experience

Oklahoma State University , Stillwater, OK.
Graduate Research Assistant August 2016 – March 2019
Worked on Aerial Robotics, UAV Dynamics and Control with focus on cooperative aerial manipulation and control of muti-agents. State-of-art work in cooperative payload transport with force synthesis and dynamic interaction using quadcopter UAVs (Published 3 peer-reviewed conference paper and 2 journal)

McNeese State University, Lake Charles, LA.
Undergraduate Research Assistant Jan 2014 – August 2015
Worked on multi-disciplinary ROV design projects, Computational Fluid Dynamics Lab and 3D Printing Lab

Relevant Projects

Robotics and Controls (OSU):

- Developed the dynamic model of an UAV with a robotic arm and developed linear (**PD, PID, LQR, LQ**), **non-linear** (**lyapunov based, sliding mode, backstepping, perturbation theory, Cartesian impedance**) and decentralized **adaptive control** for transporting a payload with multiple aerial robots.
- Developed force, attitude control algorithms to balance the motion and orientation of the payload.
- Developed adaptive force consensus algorithm to transport the payload of unknown mass by multiple aerial robots
- Cooperative manipulation of payload with an unknown mass with concurrent mass and drag force estimation.
- Performed stability analysis using **Lyapunov stability** and **singular perturbation**.
- **Trajectory Generation and Control** of quadrotors based on differential flatness.
- Simulation and navigation of differential drive robot in ROS
- Implemented **geometric control** for quadcopter attitude control.
- Developed quadcopter dynamic simulation in Matlab/Simulink using current position and attitude.

Mechatronics (OSU:)

- Design of a two link robotic arm with gripper in Solidworks, development using 3D printer and control and actuation using servomotors.
- Control and integration of a two-link robot arm with a quadrotor and some basic experiment(Arduino and C).

Robotics Design (McNeese): Nautilus Engineering Design Challenge 2014/2015, Ocean Exploration Trust, Citgo Petroleum. Reduced Recoil Sampling Tool for a Deep Sea Remotely Operated Vehicle (ROV) was designed to collect geological samples of dense, firmly deep-sea rock formation. **Won the 2015 Design Competition**, the structure was successfully build, tested and shipped to OET, Citgo facility to collect the samples of hard rock under sea bed (4000 m deep). `http://www.mcneese.edu/engineering/engineering_students_win_national_competition`.

Computational Mechanics (McNeese): Incorporated the effect of wetland vegetation on hydrodynamic simulation of wetlands in Lake Charles. User interface based on FORTRAN and C++ language.

3D Printing (McNeese): Designed bio-assay chamber for mosquito control in Solidworks and AutoCAD and printed the prototype for mosquito control.

Publications

J1. **Thapa S.**, Self R., Bai H. and Kamalapurkar, R. *Cooperative Manipulation of an Uknown Payload with Concurrent Mass and Drag Force Estimation.* IEEE Control Systems Letters (L-CSS) with an option to present in CDC, 2019.

J2. **Thapa S.**, Bai H. and Acosta J.A. *Cooperative Aerial Manipulation with Decentralized Adaptive Force-Consensus Control.* Journal of Intelligent & Robotic Systems, Jan, 2020

C1. **Thapa S.**, Bai H. and Acosta J.A. *Cooperative Aerial Load Transport with Attitude Stabilization.* 2018 American Control Conference (ACC).

C2. **Thapa S.**, Bai H. and Acosta J.A. *Force Control in Cooperative Aerial Manipulation.* IEEE International Conference on Unmanned Aircraft Systems (ICUAS), June 12-15, 2018

C3. **Thapa S.**, Bai H. and Acosta J.A. *Cooperative Aerial Load Transport with Force Control.* IFAC Workshop on Networked & Autonomous Air & Space Systems, June 12-14, 2018

C4. Stratton N., Yadav K.P., **Thapa S.**, Soileau G., Decareaux D., Li Z.,[1] *Reduced Recoil Sampling Tool for A Deep Sea Remotely Operated Vehicle*, 23rd International Congress on Sound & Vibration, July 10-14, 2016, Athens, Greece. (**Winner of Nautilus Engineering Design Challenge 2014/2015, Ocean Exploration Trust, Citgo Petroleum.**)

C5. Yadav K.P., **Thapa S.**,Han X., Richmond C., Zhang N., *Investigation Of The Effects Of Wetland Vegetation On Coastal Flood Reduction Using Hydrodynamic Simulation.* ASME-JSME-KSME Joint Fluids Engineering Conference, July 26-31,2014 Seoul, Korea

Graduate Coursework

Linear Systems	Non-Linear System Analysis & Control
Robotics: Kinematics, Dynamics & Control	Digital Control Systems
Atmospheric Flight Control	Guidance & Control of Aerospace Vehicles
Stochastic Systems	Intro to Modern Analysis
Optimal Control (Audit)	Adaptive Control (Audit)

[1] Equal Contribution

Relevant Undergraduate and other Coursework

Aerial Robotics	Finite Element Method and Simulation
System Dynamics	Automatic Control Systems
Mechatronics Design	Measurement & Instrumentation
Dynamics of Machinery	Machine Design
Mechanical Vibrations	Intro to Computer Science (C/C++)
Linear Algebra	Differential Equations
Calculus I-III	Probability & Statistics

Teaching Experience

Oklahoma State University , Stillwater, OK.
Graduate Teaching Assistant Aug 2016-Dec 2017 & Aug 2018-Dec 2018

- Fall 2016, 2017 and 2018-Elementary Dynamics ENSC 2123 (Discussion session, partial lecture, and grading) -Honors Section Lectures and Experiments.
- Spring 2017- Mechatronics Design MAE 4733 (Conducting Lab, grading for a group of 28 seniors undergrad and graduate students)

Certification

NATIONAL COUNCIL OF EXAMINERS FOR ENGINEERING AND SURVEYING (NCEES)
Fundamentals of Engineering (FE) Certification- Louisiana April 2015

Awards and Fellowships

- **Best Graduate Research, MAE Research Symposium 2018, Oklahoma State University**,
- **Winner of 2014/2015 National Nautilus Engineering Design Challenge, Ocean Exploration Trust, awarded $14k for design, build and test of initial prototype.**
- First Place, 2015 McNeese Alumni Association Undergraduate Scholar Program Research Competition
- H.R. Smith Engineering Scholarship, McNeese State University.

Leaderships and Volunteer Activities

- Senator, Student Government Association at McNeese (Jan 2012 - Dec 2012).
- Tour guide, Engineering E-Week, College of Engineering, McNeese State University (Aug 2011-May 2015).
- Actively participated to restore to plant 4 miles of grasses near Gulf coast, Cameroon Parish, LA (Sept 2014)
- Taught CAD skills to local High School students during *Summer Engineering Academy* held by the College of Engineering for local high students (June 2014).
- Assisted for "High School Robotics Competition" organized by College of Engineering at McNeese (Aug 2013) .

Reviewer

- American Control Conference (ACC) 2017, 2018, 2019, 2020
- IEEE Conference on Decision and Control (CDC), 2018, 2019
- International Conference on Unmanned Aircraft Systems (ICUAS) 2018
- International Conference on Robotics and Automation (ICRA) 2018, 2020
- Journal of Intelligent & Robotic Systems, 2020

References

Dr. He Bai (MS Advisor), Oklahoma State University, MAE, he.bai@okstate.edu
Dr. Rushikesh Kamlapurkar (MS Thesis Comm.), Oklahoma State University, MAE, rushikesh.kamalapurkar@okstate.edu
Dr. J.A. Acosta (M.S Co-Advisor), University of Sevilla, ECE, Spain, jaar@us.es.
Dr. Gary Yen, Oklahoma State University, ECE, gyen@okstate.edu