Gowtham **Garimella**

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Goal: Develop planning and control techniques to enable autonomous operation of robotic systems in natural environments

Education

Johns Hopkins University — *Baltimore, USA*
Ph.D. in Mechanical Engineering — *Expected end of 2018*

Johns Hopkins University — *Baltimore, USA*
M.S.E. in Mechanical Engineering — *2012-2014*
GPA 3.91/4.0

Indian Institute of Technology Bombay — *Bombay, India*
B.Tech. in Mechanical Engineering — *2008-2012*
GPA 9.63/10.0

Research Projects

Tube Model Predictive Control [1] — *2017 - Present*

- Computed approximate disturbance invariant tubes in state space for general nonlinear systems
- Showed safe obstacle avoidance in simulation for a simple car model and a quadrotor system
- Currently, improving the real-time performance of the algorithm by using sparsity in trajectory optimization

Learning based Control - Aerial Manipulator [2] — *2017 - Present*

- Implemented a hybrid Recurrent Neural Network (RNN) model to predict the dynamics of an aerial manipulator
- Showed improved prediction performance as compared to LSTM models and simple feedforward models
- Applied NMPC optimization to track reference trajectories accurately using RNN model

Learning based Control - Autonomous Car [3] — *2016 - 2017*

- Designed a Recurrent Neural Network (RNN) to learn lateral dynamics of a passenger car
- Improved prediction performance and reduced network size by incorporating residual dynamics
- Showed improved steering performance using RNN model as compared to standard PID controller

Robust Obstacle Avoidance - Quadrotors [4] — *2015 - 2016*

- Implemented Nonlinear Moving Horizon Estimator (NMHE) for quadrotor dynamics
- Propagated parametric noise to state space using Unscented Kalman Filter (UKF)
- Applied NMPC optimization to compute safe obstacle avoidance trajectories subject to model uncertainty
- Performed obstacle avoidance on quadrotor platform with speeds up to 4m/s

Aerial Manipulation [5, 6] — *2014 - 2015*

- Formulated Nonlinear Model Predictive Control (NMPC) on a quadrotor platform with a 2 DOF arm
- Demonstrated picking and placing packages using the aerial manipulator in indoor and outdoor settings
- Developed a state machine framework that combines simple robot behaviors into complex applications
- Implemented an industrial package sorting application that transports packages to designated shelves

Professional Experience

Zoox

SOFTWARE INTERN *2016 June - December*

- Identified feedforward model for vehicle's power steering and feedforward model
- Improved velocity tracking and steering tracking performance using improved models
- Created a GUI interface to visualize car trajectories and sensor data online and offline for debugging

Teaching Experience

Teaching assistant

NONLINEAR CONTROL AND PLANNING *2017 Fall*

- Taught a graduate class of 25 students twice a month for a semester
- Conducted extra teaching sessions to revise lectures and cover background topics

Mentoring

OUTREACH PROGRAM *2014 - 2015*

- Mentored high school student to learn basic robotics for a year as part of JHU outreach program
- Guided the student in learning Arduino programs and developing Java applications
- The student implemented an application to drive a hobby car using input from keyboard

Software Experience

Optimal Control of Multi Body Systems *gcop*

- Optimal control package developed in our lab covering several nonlinear systems, optimization solvers
- Fast dynamics and optimization solvers written in C++ with Eigen library

Fast Control Bridge Gazebo Matlab *gazebo_matlab_bridge*

- Sends controls from Matlab to Gazebo physics engine using a plugin with shared memory map
- Receive sensor data from Gazebo at controlled simulation frequency
- Simple interface to attach servo controls to robot joints

Aerial Autonomy *aerial_autonomy*

- Easily extendable package for interacting with and defining state machines for autonomous aerial systems
- Provides robustness to hardware failures in the form of state transition guards
- Adds a high fidelity physics simulator for testing control algorithms
- Implements a unit-testing framework to verify the convergence properties of control algorithms

Skills

Programming Expert in C/C++, Python; Competent in Tensorflow, MATLAB, and Embedded C
Robotics Planning and Controls for nonlinear systems, System Identification, Machine Learning, Computer Vision
Design Competent in SolidWorks, Eagle, Blender, PyQt

Honors & Awards

2013 **Dean's Fellowship Mechanical Engineering Department**
2014,2015 **Creel Family Teaching Assistant Award**

Publications

[1] Gowtham Garimella, Matthew Sheckells, Joseph Moore, and Marin Kobilarov. Robust obstacle avoidance using tube nmpc. In *Robotics Science and Systems*, volume 14, 2018.

[2] Gowtham Garimella, Matthew Sheckells, and Marin Kobilarov. Nonlinear model predictive control of an aerial manipulator using a r ecurrent neural network model [pre-print]. 2018.

[3] Gowtham Garimella, Joseph Funke, Chuang Wang, and Marin Kobilarov. Neural network modeling for steering control of an autonomous vehicle. In *Intelligent Robots and Systems (IROS), 2017 IEEE/RSJ International Conference on*, pages 2609–2615. IEEE, 2017.

[4] Gowtham Garimella, Matthew Sheckells, and Marin Kobilarov. Robust obstacle avoidance for aerial platforms using adaptive model predictive control. In *Robotics and Automation (ICRA), 2017 IEEE International Conference on*, pages 5876–5882. IEEE, 2017.

[5] Gowtham Garimella, Matthew Sheckells, and Marin Kobilarov. A framework for reliable aerial manipulation[pre-print]. 2018.

[6] Gowtham Garimella and Marin Kobilarov. Towards model-predictive control for aerial pick-and-place. In *International Conference on Robotics and Automation*, pages 4692–4697, 2015.

[7] Gowtham. Garimella, S. Mishra, and M. Kobilarov. Application of near global optimization methods to receding horizon control of unmanned ground vehicles on 3d unstructured terrain. In *Optimal Robot Motion Planning Workshop at IEEE International Conference on Robotics and Automation (ICRA)*, May 2015.

[8] Gowtham Garimella, Matthew Sheckells, and Marin Kobilarov. A stabilizing gyroscopic obstacle avoidance controller for underactuated systems. In *Decision and Control (CDC), 2016 IEEE 55th Conference on*, pages 5010–5016. IEEE, 2016.