

Timothy Devon Morris

ROBOTICIST · ELECTRICAL ENGINEER · APPLIED MATHEMATICIAN

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Education

Brigham Young University

PHD CANDIDATE IN ELECTRICAL ENGINEERING

- Passed oral competency exams - November 2018

Provo, Utah

April 2011 - Present

Brigham Young University

B.S. IN APPLIED AND COMPUTATIONAL MATHEMATICS

- Emphasis in Electrical Engineering - Signals and Systems
- Graduated Cum Laude

Provo, Utah

August 2011 - April 2017

Academic Employment

Avian Search and Rescue project

GRADUATE RESEARCH ASSISTANT

- Developed simulation of high speed UAV flying at 10,000 ft.
- Performed flight tests and tracked small ground targets using visual data.

Provo, Utah

February 2019 - Present

GPS Denied Handoff project

GRADUATE RESEARCH ASSISTANT

- Incorporated Arduplane SIL into Gazebo simulation.
- Designed and programmed a fixed-wing geometric complementary filter on $SO(3)$.
- Designed and programmed a geometric homography filter on $SL(3)$.
- Participated in flight tests at BYU and Air Force facilities.

Provo, Utah

October 2017 - April 2019

BYU Electrical & Computer Engineering

TEACHER ASSISTANT

- Gave lectures on ROS
- Designed labs to test students knowledge on controls and estimation
- Mentored students in controller and estimator design for a 3-DoF multirotor

Provo, Utah

September 2014 - April 2017

Multi-Mission Project

GRADUATE RESEARCH ASSISTANT

- Developed a Monte Carlo Tree Search algorithm for a multi-mission multi-vehicle environment.

Provo, Utah

April 2017 - October 2017

BYU Mathematics

TEACHER ASSISTANT

- Taught a few classes on differential calculus
- Graded assignments for calculus I, linear algebra, and multivariable calculus

Provo, Utah

September 2014 - April 2017

Professional Employment

Aurora Flight Sciences

GRADUATE ENGINEERING INTERN

Cambridge, Massachusetts

May 2019 - August 2019

BWX Technologies

ENGINEERING INTERN

- Developed a full matrix capture algorithm to analyze ultrasonic phased-array data.
- Performed defect detection on large naval nuclear components.

Lynchburg, Virginia

May 2014 - August 2016

Genworth Financial

IT INTERN

- Built software binaries and deployed them to the company.
- Imaged and set up new machines for employees.

Lynchburg, Virginia

May 2011 - August 2011

- Performed safety analysis calculations for common steam generator failures.
- Practiced primary and secondary side inspection of steam generators using UT, ECT and mobile robotics.
- Won the annual sumo robot competition.

Research Interests

Geometric Estimation & Control Developing control and estimation algorithms on Lie groups and Riemannian manifolds. Design of complementary filters on $SO(3)$, $SL(3)$ and $SE(3)$. Quantifying uncertainty of estimators on Lie groups and Riemannian manifolds. Geodesic path planning in crowded environments. Analyzing Lyapunov convergence properties of geometric controllers and estimators. Geometric visual SLAM. Second or higher order filtering on Lie groups.

Machine Learning & Deep Learning for UAVs Using classification data from DNNs to infer data about surroundings. Path planning based on known objects and inferred scale factors from those objects. Depth from monocular camera. Distillation of neural networks and transfer learning. Real-time inference and control for smaller distilled networks. Controllers and path planners based on reinforcement learning and deep reinforcement learning.

Publications

Skyler Tolman, T. Devon Morris, Randal W. Beard, Cameron K. Peterson, "Robust Moving Target Handoff in GPS-Denied Environments," *IEEE Transactions on Aerospace and Electronic Systems* (Draft in progress).

Projects

Attitude Controller for Apollo 11 CSM Developed a quaternion geometric attitude controller for the Apollo 11 Command and Service module. Using feedback linearization, found the commanded angles for the control moment gyros to drive the system to any desired attitude.

Robotic Arm Inverted Pendulum Designed an operational space controller for inverted pendulum control on an arm of Rethink Robotics' Baxter unit. Implemented this controller in ROS and Gazebo using Rethink Robotics' Baxter SDK.

Multiplicative Unscented Kalman Filter Developed an unscented kalman filter for fixed-wing attitude estimation. Implemented this estimator on a ROS simulation of a micro unmanned air vehicle with noisy accelerometers and gyros.

Autopilot Implementation Implemented the autopilot from *Small Unmanned Aircraft: Theory and Practice* in C++ using the ROS framework. This includes an implementation of the controller, estimator, path planner and path manager.

Deep Q Network Replicated Google Deepmind's work on the Deep Q Network by training a reinforcement learning algorithm to play space invaders using only visual data.

Heartbeat Segmentation & Anomaly Detection Segmented phonocardiograms and electrocardiograms into four states: S1, systole, S2 and Diastole. This was done using a hidden semi-markov model and the associated viterbi algorithm. Used these segmented heartbeats in anomaly detection using various classifiers: SVM, GDA, and MLP.

Technical Skills

Programming C++, Python, Matlab, Latex, Bash

Technologies ROS, Gazebo, Git, Tensorflow, OpenCV, Linux (Debian, Ubuntu, Arch, Gentoo)

Honors & Awards

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| 2017 | Outstanding Senior , BYU Mathematics | Provo, Utah |
| 2011 | Valedictorian , E.C. Glass High School | Lynchburg, Virginia |
| 2011 | Faculty Award of Excellence , Central Virginia Governor's School | Lynchburg, Virginia |
| 2010 | Participant , International Science and Engineering Fair | San Jose, California |