Dr. Steve McGuire

Assistant Professor
Department of Electrical and Computer Engineering
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Education

The University of Colorado at Boulder Boulder, CO • PhD, Aerospace Engineering Systems

Thesis: Autonomous On-Line Learning of Assistant Selection Policies for Fault Recovery

Robotics Interests: Human-Robot Interaction · Decision making under uncertainty · Perception · Camera Calibration · Estimation

The University of Colorado at Boulder Boulder, CO • MS, Aerospace Engineering Systems

The Pennsylvania State University University Park, PA • Bachelor of Science, major in Computer Engineering, minor in Math, 2003

Honors and Awards

- 3rd Place, DARPA Subterranean Challenge, Team MARBLE (Multi-Agent Radar Based Localization and Exploration)
- NASA Science and Technology Research Fellowship, 2015, *Augmented Reality Telepresence for Robotic Exploration*
- Selected for a NASA Science and Technology Research Fellowship, 2013
- Recipient of Air Medal, with Strike/Flight Numeral 1 for combat missions flown in support of Operation Iraqi Freedom

Selected Projects

Role: **Principal Investigator**

- Highly Mobile Robotic Platforms for Semantic Scene Understanding : A platform development project to enable multi-modal semantic scene understanding using quadrupedal robots. This project facilitiates advancements in autonomous system perception capabilities, human aware teaming and task allocation, and humanaware command and control infrastructure. ONR, $250k/ 1 year.
- Live Cognitive State Estimation for Adaptive Guidance in Autonomous Systems. This project develops unprecedented insights into autonomous system operator's mental states using passive biosensor measurements. These insights form the basis of a decision support tool to enable more efficient human-robot teaming. Internal funding.
- Online Plant Disease Detection via Hyperspectral UAV Imaging: A platform development project to enable early detection of plant stress indicating disease using airborne hyperspectral imaging to aid in precision agriculture management. $40k, 1 year development grant.

Role: **Co-Investigator**

- DARPA Subterranean Challenge: A competition designed to have a human-robot team exploring complex underground environments, with autonomous robotic exploration a primary operating modality. $4.5 million dollar, 3 year award culminating in 3rd place finish earning $500,000 in prize money.
- Evaluating On-Base Deployment of Autonomous Vehicles: A collaboration with the US Army to expand the role of autonomous vehicles to solve transportation problems on military bases.

Role: **Lead Researcher**

- Autonomous Fault Recovery via Online Assistant Learning: A reinforcement-learning approach to better understand the potential humans that might aid a robot in distress and make better decisions about which human to request assistance from.
- TRAADRE: TRust in Autonomous ADvisors for Robotic Exploration: A human factors study investigating user response to advice sourced from either an autonomous agent or a human operator.
- Sythetic immersive vision for UAV operations: A prototype of a synthetic vision system for UAV pilots that immerses the pilot into a full VR environment, with camera views stitched into a photosphere locally rendered to avoid latency issues.

Role: **Technical Mentor**

- DRAGON: Deployed RF Antennas for GPS-denied Optimization and Environmental Navigation: Aerospace senior design project to build a fully autonomous solution to GPS-denied navigation using deployable RF ranging beacons.
- RAVEN: Rover and Air Visual Environment Navigation: Aerospace senior design project that mutually visually servoed between a ground vehicle and a UAV asset with narrow-FOV cameras.

Role: **ROS/Open Source Contributor**

- *camera_aravis*: A pipeline for using an open-source USB3Vision stack; contributions included adding support for machine vision cameras and features such as triggering, including ROS updates.
- *gs_pipeline*: A pipeline for image processing operations capable of using hardware blocks commonly present on systems-on-chips via a GStreamer framework; the end product was implemented as a ROS node.

Pilot Certifications

- *Fixed wing*: Commercial single and multiengine land
- *Rotary wing*: Commercial rotorcraft helicopter
- *Instrument*: Instrument airplane and helicopter
- *Instructor*: Rotorcraft helicopter
- *UAS*: Remote pilot

Work History

The University of California Santa Cruz (July 2020 - present)
Assistant Professor
Research Interests:

- Human-robot interaction informed by biometric signals
- Semantic scene understanding through multi-modal sensor fusion
- Practical challenges in field robotics deployments

The University of Colorado at Boulder (August 2019 - present)
Postdoctoral Research Associate
Research Interests:

- Human-robot interaction informed by biometric signals
- Reliable communications in extreme environments
- Practical challenges in field robotics deployments

The University of Colorado at Boulder (August 2015 - August 2019)
Graduate Research Fellow
Research Interests:

- Human-robot teaming with particular focus on issues in planetary exploration
- Statistical methods of recovering from autonomy failures
- Self-calibration of intrinsic and extrinsic properties of sensors

The University of Colorado at Boulder (January 2015 - July 2015)
Graduate Student / Research Assistant

- Assisted with practical requirements of conducting field tests of research algorithms on actual mobile robots
- Reverse engineered a Linux acquisition layer for a newly released depth camera where the vendor only supports Windows 8.1
- Designed and implemented an integration layer between standalone vision research code and a ROS-based control system for entry into the Amazon Picking Challenge
- Designed a prototype system for exploring the use of miniature hydraulic controls in mobile robotics

The University of Colorado at Boulder (August 2014 - December 2014)
Graduate Student / Teaching Assistant

- Created assignments, grading rubrics, and instructional materials in support of a sophomore aerospace Matlab class
- Conducted several hours of one-on-one and small group instruction per week teaching basic techniques in Matlab

Astrobotic Technology, Inc. (November 2012 - August 2014)
Avionics Engineer

- Designed integrated hardware and software solutions needed to develop a Moon landing system, culminating in four months of field testing aboard a propulsive lander sponsored by NASA
- Flew local helicopter testing missions as precursors to propulsive lander testing
- Designed, implemented, and field tested a ARM7-based landing sensor data acquisition hardware system, including custom interface hardware and custom software extensions to a bare-metal RTOS written in C++
- Designed and implemented a 20'x30'x20' robotic gantry crane for simulating sub-Terran gravity, requiring authoring of specifications, interaction with external contractors, and custom software creation
- Co-authored several NASA proposals and served as technical contributor for Moon landing efforts
- Designed, implemented, and field tested a pit exploration robot for creating 3D models of lunar sinkholes via a suspended scanning lidar
- Earned rotorcraft certified flight instructor certificate

United States Marine Corps (January 2005 - July 2012)
Captain, Helicopter Pilot

- Qualified as a CH-53E Super Stallion heavy lift helicopter pilot
- Deployed in support of Operation Iraqi Freedom, 2009
- Served as squadron computer support personnel, responsible for system upkeep and creative computer problem solving
- Earned three individual decorations for custom software work, including a squadron flight schedule presentation system, a remote-site training support system, and a document management package

- Earned civilian flight qualifications in airplane single engine, airplane multi-engine, rotorcraft, and instrument privileges

ENSCO, Inc. (April 2004 - January 2005)
Software Engineer

- Designed sensor support software for ENSCO, Inc.'s DARPA Grand Challenge 2004 entry, including high-speed lidar and obstacle avoidance
- Created board-specific Linux kernel drivers to support a data acquisition requirement
- Diagnosed and improved a problematic networked remote-sensor application, enabling live monitoring of remote sensors via long-range networks
- Developed Geographic Information System workflows for data analysis using ESRI ArcGIS components under Java

Selected Papers and Publications

- Wilson, R. and **McGuire S**. Online Passive Cognitive Load Modeling in a Data-Derived Probabilistic Framework. In review.
- Ohradzansky T, Rush E, et al, **McGuire S**, et al. Multi-Agent Autonomy: Advancements and Challenges in Subterranean Exploration. *Journal of Field Robotics*. Accepted, Sep 2021.
- **McGuire S**, Furlong PM, Heckman C, Julier S, Ahmed N. Learning About the Learner: Reinforcement Learning for Fault Recovery Using Gaussian Processes With Contextual Measurements. *AIAA Journal of Aerospace Information Systems*, Special Issue on Machine Learning in Aerospace. Vol 18, No 7, July 2021, pp 429–441.
- Michael Kasper, **Steve McGuire**, and Christoffer Heckman. *A Benchmark for Visual-Inertial Odometry Systems Employing Onboard Illumination*. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2019, pp 5256-5263.
- **Steve McGuire**, Padraig Michael Furlong, Terry Fong, Christoffer Heckman, Daniel Szafir, Simon Julier, and Nisar Ahmed. *Everybody Needs Somebody Sometimes: Validation of Adaptive Recovery in Robotic Space Operations*, IEEE Robotics and Automation Letters, Jan 21 2019, DOI: 10.1109/LRA.2019.2894381.
- **Steve McGuire**, Padraig Michael Furlong, Christoffer Heckman, Simon Julier, and Nisar Ahmed, *Failure is Not an Option: Policy Learning for Adaptive Recovery in Space Operations*. IEEE Robotics and Automation Letters, July 2018, vol 3, issue 3, pp 1639-1646, DOI: 10.1109/LRA.2018.2801468.
- Lu Ma, Juan M. Falquez, **Steve McGuire**, and Gabe Sibley. *Large Scale Dense Visual Inertial SLAM*. Field and Service Robotics (FSR), 2015

Service

- Department Student Club liason, UCSC Department of Electrical and Computer Engineering
- Organizing committee member, *Autonomous Space Robotics* Workshop, Robotics Science and Systems Conference 2018.
- Technical advisor, CU Boulder Aerospace Engineering Sciences Department, *DRAGON: Deployed RF Antennas for GPS-denied Optimization and Environmental Navigation*, 2018-2019.