SAND2019-4191C

Autonomy for Hypersonics Field Day

Welcome and Introduction

Alex Roesler, PhD
Deputy Director, Integrated Military Systems
Sandia National Laboratories

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Will AI tech be plug-n-play for defense?

- Andrew Ng,
Harvard Business Review

The AI community is remarkably open, with most top researchers publishing and sharing ideas and even open-source code. In this world of open source, the scarce resources are therefore:

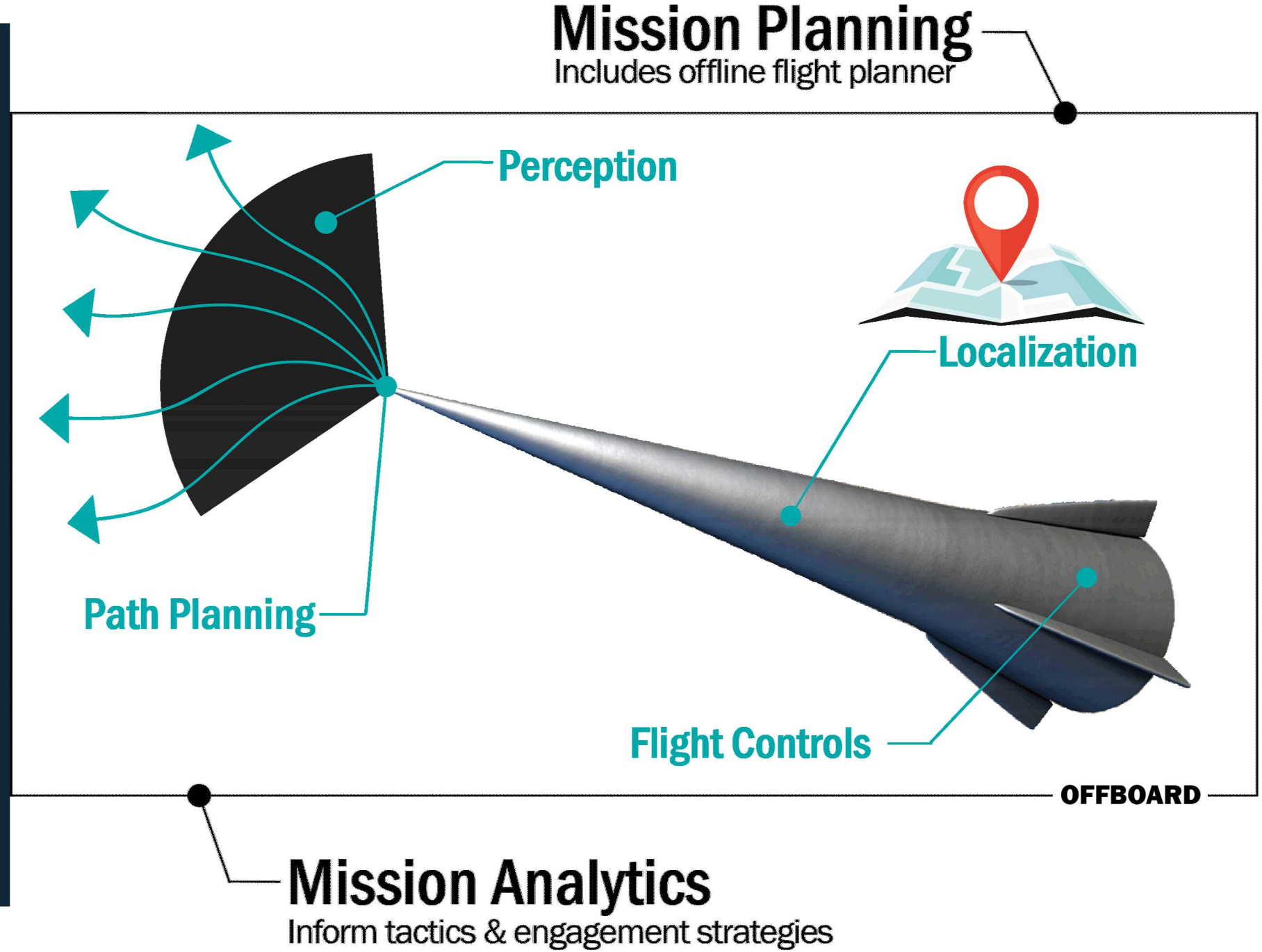
Data.

Among leading AI teams, many can likely replicate others' software in, at most, 1–2 years. But it is exceedingly difficult to get access to someone else's data. ***Thus data, rather than software, is the defensible barrier for many businesses.***

Talent.

Simply downloading and "applying" open-source software to your data won't work. ***AI needs to be customized to your business context and data.*** This is why there is currently a war for the scarce AI talent that can do this work.

A4H Research Areas



Creating a mechanism to "spin-in" ideas that provide transformative autonomy solutions, opportunities for commercialization, and a pipeline of AI and autonomy talent

A4H initiated AutonomyNM, with the goal of promoting and attracting collaborative R&D with Academic Alliance (AA) and university partners

- Helps SNL expand its innovation network in this critical technology area
- Venture track for AA Collaborators: The program will allow SNL and AA researchers to work side-by-side to help university innovators transition their research into end-use applications
- Internship track: AutonomyNM is incorporated under TITANS and provide students an opportunity to research autonomy solutions for advanced flight and space systems
- AutonomyNM Facility: A cutting-edge, modern research environment will promote open communication and innovation, foster creativity, and enable agile creation of startups

External Partnership Plan: AutonomyNM

AutonomyNM Gauntlet

- A state-of-the-art research testbed that supports the spin-in and spin-out of autonomous flight and space system technologies, aka the AutonomyNM Gauntlet

- Incorporate Design Reference Missions (DRMs) and low-cost COTS technology
- Will allow users to prove performance of AI/autonomy algorithms – ultimately demonstrating utility for spin-in and spin-out
- Visiting faculty can use the testbed to support their research, and the testbed will help enable a "semester at the Labs" program with AA schools

Current University Research Partnerships

Illinois

Naresh Shanbhag + Craig Vineyard
Neural-Inspired Approaches and Implementations for Automatic Target Recognition

Girish Chowdhary + David Kozlowski
Optimal Elevon Control Allocation and Fault Detection/Recovery for Hypersonic Flight Vehicles

Alex Scwing + Josh Coon
Synthetic High Forward Squint SAR Images Using Generative Adversarial Networks

Rakesh Nagi + Keith LeGrand
Autonomous Multi-Platform Sensor Scheduling

Georgia Tech

Jennifer Hasler + Craig Vineyard
Neural-Inspired Approaches and Implementations for Automatic Target Recognition

Ani Mazundar + Mary Rose Sena
Using Generative Models to Generate Hypersonic Boost-Glide Vehicle Trajectories

Evangelos Theodorou + David Kozlowski
An Optimization and Robust Control Technique for use in Flight Control Design for Hypersonic Vehicles

Jonathan Rogers + Julie Parish
Robust, Rapid, Autonomous Mission Planning for Hypersonic Flight Vehicles

UT Austin

Renato Zanetti + Scott Jenkins
SAR Image Formation and Feedback to Navigation Subsystem in GPS Denied and Degraded Environments

Ufuk Topcu + David Kozlowski
An Optimization and Robust Control Technique for use in Flight Control Design for Hypersonic Vehicles

Maruthi Akella + Mike Grant
Autonomy-Enabled, Real-Time, Rapid Trajectory Generation for Highly Dynamic Hypersonic Missions

Karen Willcox + Kevin Carlberg
Rapid High-Fidelity Aerothermal Responses with UQ via Reduced-Order Modeling

Purdue

[redacted]

Stanford

Stephen Boyd + Mike Grant
Convex Optimization using Geometric Programming on Field-Programmable Gate Arrays

Utah State

Randall Christensen + Scott Jenkins
SAR Image Formation and Feedback to Navigation Subsystem in GPS Denied and Degraded Environments

Kansas State

Bill Hsu + Jason Searcy
Magnetometer-Aided GPS-Denied Navigation

UNM

Meeko Oishi + John Richards
Autonomous Multi-Platform Sensor Scheduling

Texas A&M

John Hurtado + Julie Parish
Robust, Rapid, Autonomous Mission Planning for Hypersonic Flight Vehicles

John Hurtado + Jason Searcy
Magnetometer-Aided GPS-Denied Navigation

Desired Outcomes

- Build an enduring community: we seeks connections between the faculty at all universities (not just with SNL), for example to enable opportunities for students to go to graduate school at other partner institutions etc.

- We want enduring relationships that enable other partnership opportunities
- Transition A4H-funded research to other government programs
- Customizing autonomous system solutions for other national security platforms beyond hypersonics

Agenda

DAY ONE: THURSDAY, APRIL 18th

9:00-9:30	Opening Keynote	*Mica Endsley, SA Technologies, Inc.*
9:30-9:50	Neural-Inspired Approaches for ATR	*Craig Vineyard, SNL*
9:50-10:10	Deep In-Memory Architectures	*Naresh R. Shanbhag, UIUC*
10:10-10:40	**Networking Break**	
10:40-11:00	Field Programmable Analog Arrays	*Jennifer Olson Hasler, GT*
11:00-11:20	Rapid High-Fidelity Aerothermal Responses with UQ via Reduced-Order Modeling	*Kevin Carlberg, SNL*
11:20-11:40	Closed-Loop Navigation Using SAR	*Renato Zanetti, UT*
11:40-12:50	**Lunch provided on-site**	
12:50-1:10	Precision Nav for Challenging Operational Environments	*John Hurtado, TAMU*
1:10-1:30	Autonomous Multi-Platform Sensor Scheduling	*John Richards, SNL*
1:30-1:50	Reliability of Autonomous Systems via Stochastic Reachability	*Meeko Oishi, UNM*
1:50-2:10	New Approaches to Resilient Distributed Hypothesis Testing with Networked Platforms	*Shreyas Sundaram, Purdue*
2:10-2:30	Multi-Dimensional Assignment Problems in Multi-Sensor, Multi-Target Tracking & Data Association	*Rakesh Nagi, UIUC*
2:30-2:50	**Networking Break**	
2:50-3:20	Control-Oriented Learning on the Fly	*Ufuk Topcu, UT*
3:20-3:40	Adaptive and Fault Tolerant Flight Control with Deep Learning	*Girish Chowdhary, UIUC*
3:40-4:00	Physics-Based Control Algorithms for High Speed Autonomy	*Evangelos Theodorou, GT*
4:00-4:20	Firestarter: Deep Learning Methods for Autonomous Hypersonics Guidance	*Roberto Furfaro, UA*
5:00-7:00	**Networking Reception at Glorieta Station**	

Agenda

DAY TWO: FRIDAY, APRIL 19TH

9:00-9:15	Firestarter: Learning-Based Predictive Control for Autonomous Vehicles *Hyeongjun Park, NMSU*
9:15-9:30	Firestarter: Payload & Mission Management for ISR Missions *John Valasek, TAMU*
9:30-9:50	Autonomous Trajectory Planning Based on Motion Primitives *Ani Mazumdar, GT*
9:50-10:10	Trajectory Generation using Indirect Methods & Machine Learning *Maruthi Akella, UT*
10:10-10:40	**Networking Break**
10:40-10:55	Firestarter: Data-Driven Decision Making *Huiping Cao, NMSU*
10:55-11:10	Firestarter: Distributed Dynamic Task Allocation for Sensor Management *Liang Sun, NMSU*
11:10-11:30	Probabilistic Algorithms for Mission Planning *Jon Rogers, GT*
11:30-11:50	AI-Enabled Mission Analysis *Ali Raz, Purdue*
11:50-12:00	Closeout *Alex Roesler, SNL*
12:00-1:30	**Lunch provided on-site**