



Robots in the Wild: Challenges in Deploying Robust Autonomy for Robotic Exploration

RSS 2019 Workshop

June 23, 2019

*Organizers: Yoonchang Sung, Pratap Tokekar (Virginia Tech),
Jnaneshwar Das, Sarah Bearman (Arizona State University)*

*Technical Committee: Volkan Isler, (University of Minnesota)
James Bell (Arizona State University), Amy Tabb (USDA)*



Alan Turing
23 June 1912 - 7 June 1954

Motivation

Challenges in autonomy for robots and AI, working unattended in unstructured environments, with human in the loop

Precision agriculture

Physical oceanography

Geology and geodesy

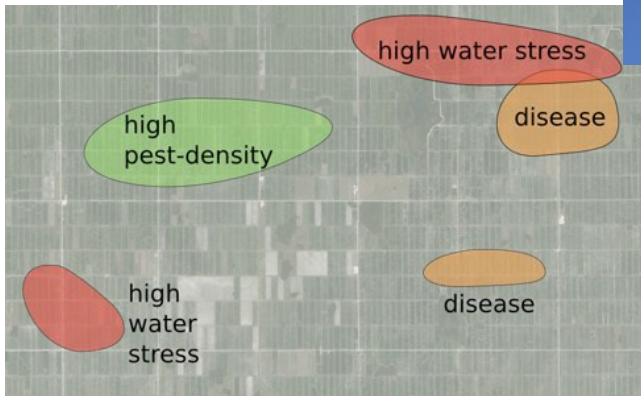
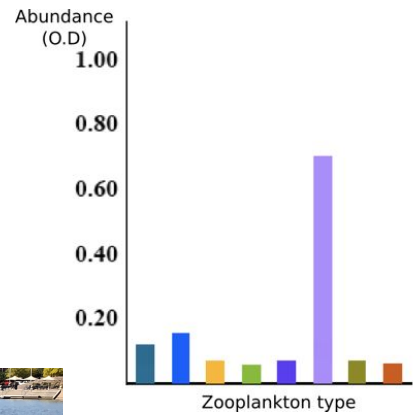
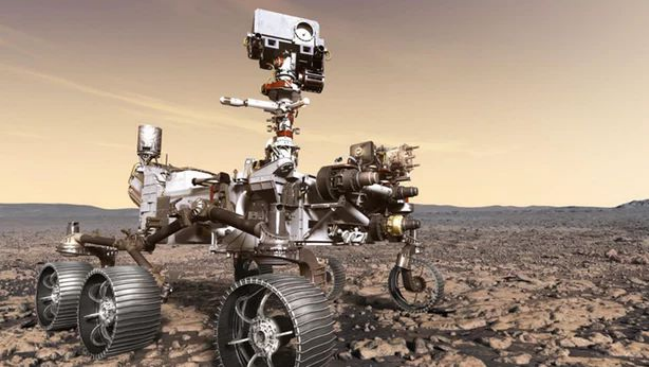
Environmental monitoring

Marine ecology

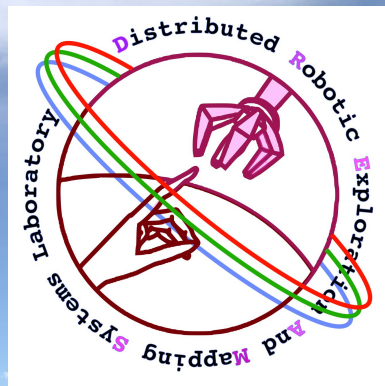
Wildlife ecology

Space science

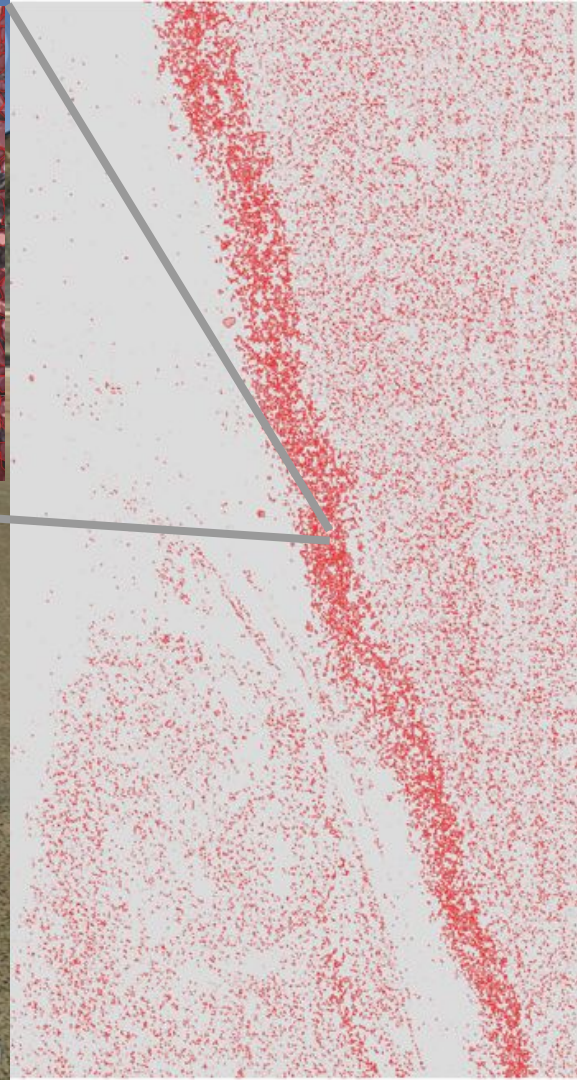
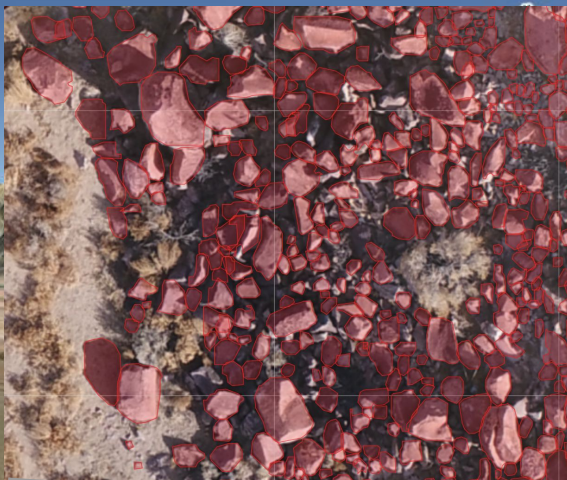
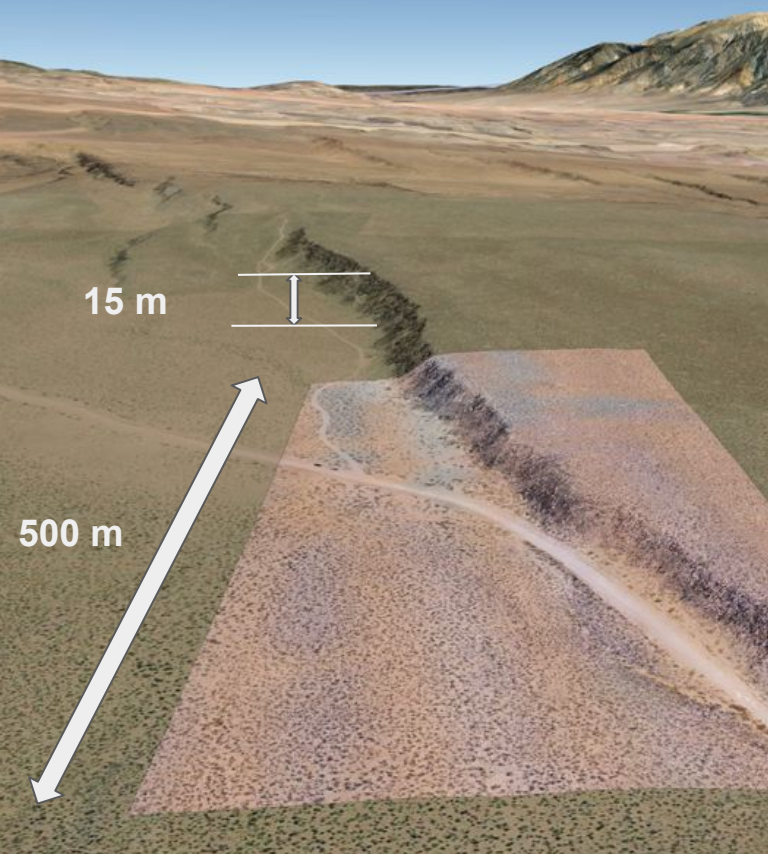
Volcanology



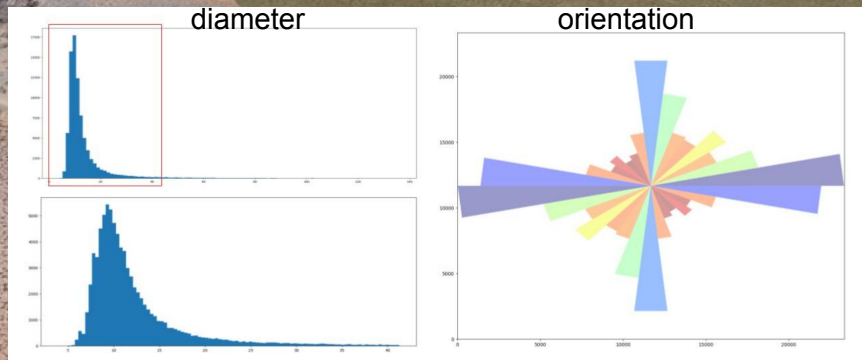
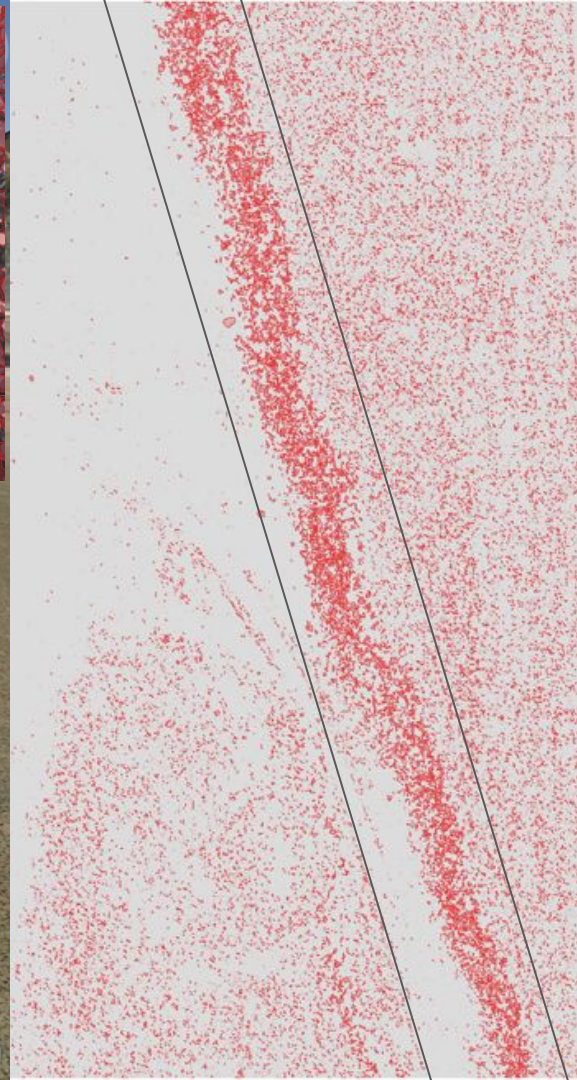
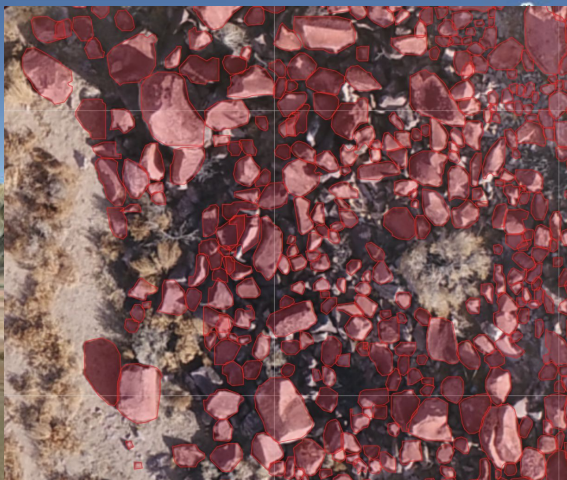
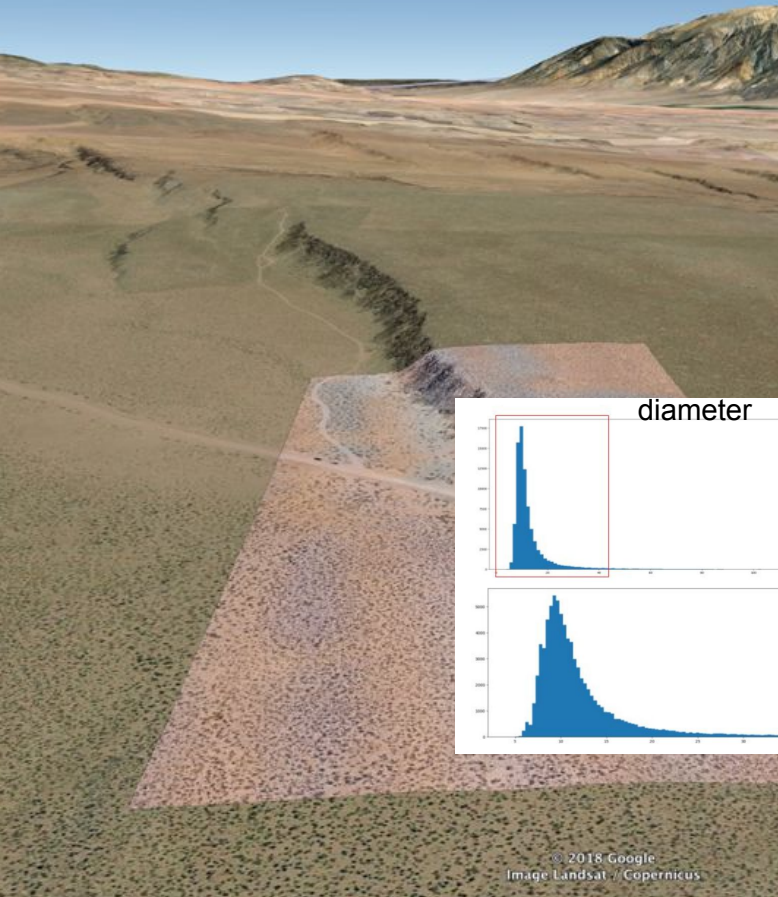
Volcanic Tablelands
Bishop, CA

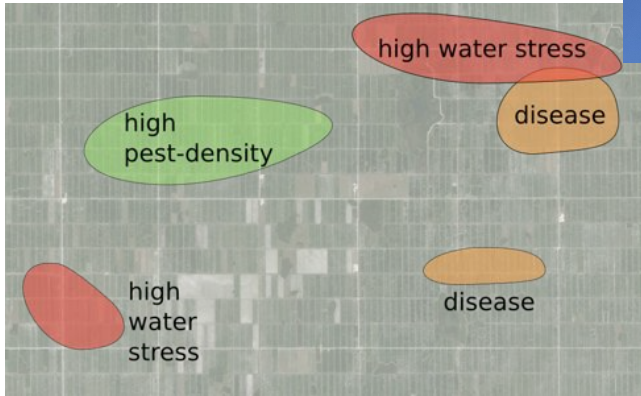
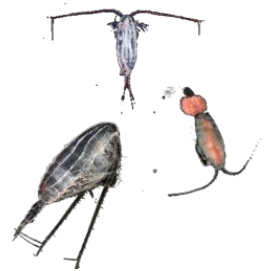
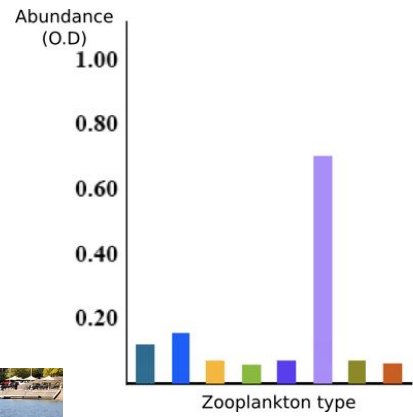
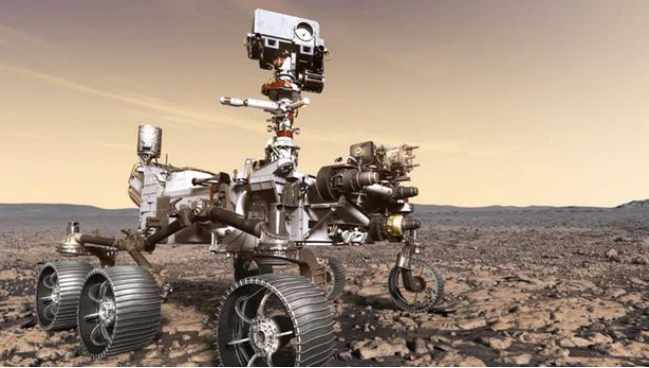


Volcanic Tablelands Bishop, CA



Volcanic Tablelands Bishop, CA

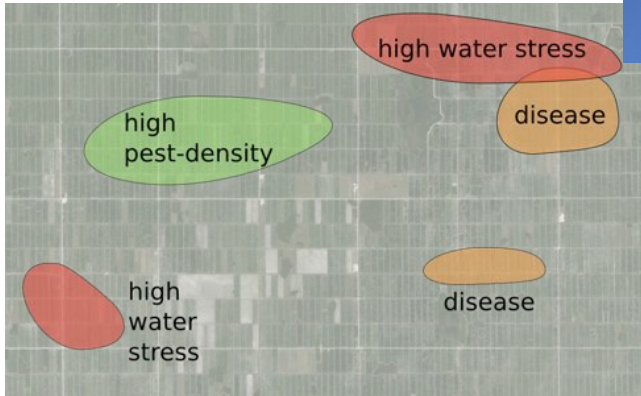
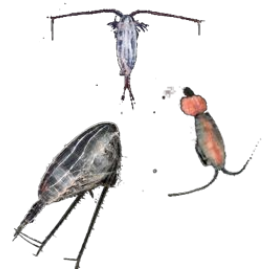
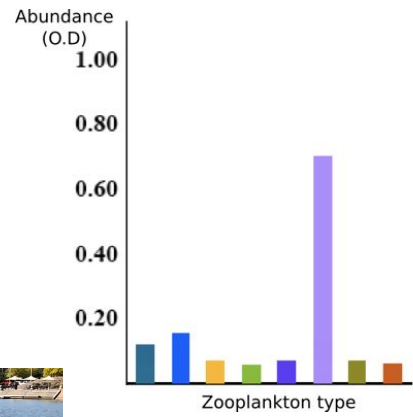
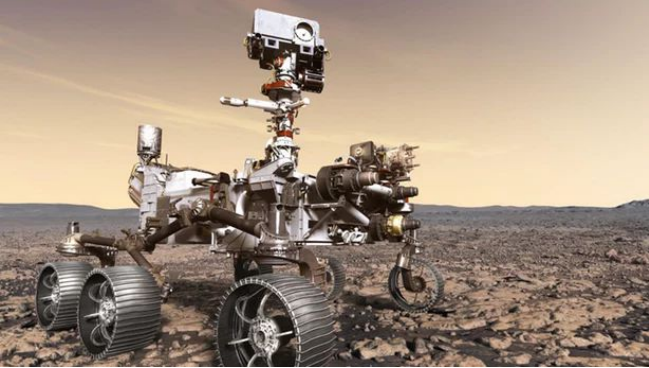


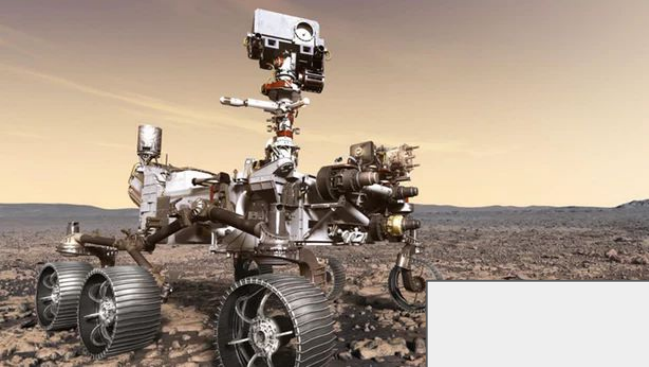


Beyond Data Association: Landmarks Improve Detections

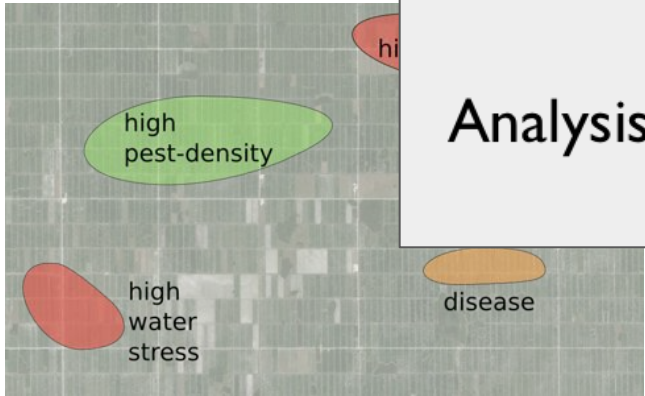
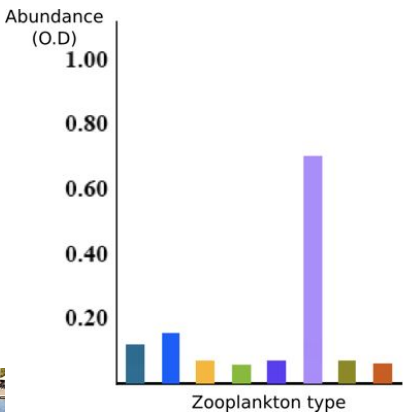


Landmark projections reversely improve
detection results of highly occluded fruits





	In-situ	Ex-situ
Sampling	measurement	specimen
Analysis	features	big-data

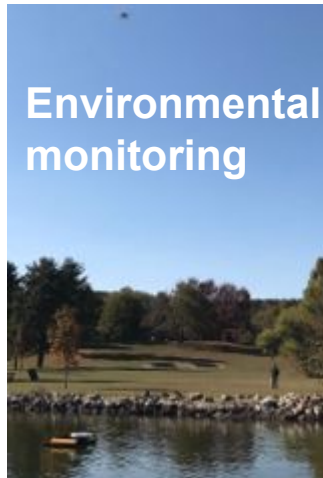


RAAS Lab Research

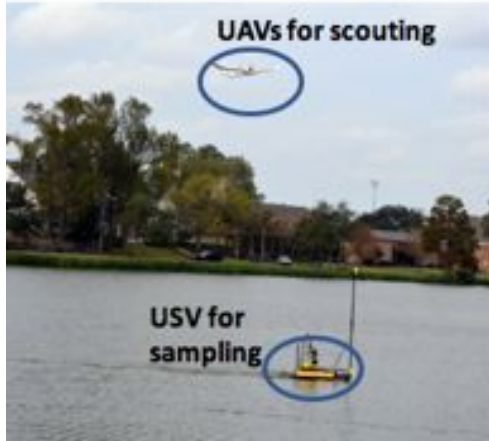
Algorithms

- ▶ Combinatorial optimization
- ▶ Computational geometry
- ▶ Markov Decision Processes
- ▶ Bayesian statistics

Systems & Applications



Track flows of pollutants





EDDIE ADDER

SOFTWARE ENGINEERING GRADUATE STUDENT, UNIVERSITY OF PENNSYLVANIA

Goals of this workshop

Share recent, late-breaking results

Identify pressing challenges

[if there is interest] Frontiers in Robotics and AI Special Issue
'Challenges in Deploying Robust Autonomy for Robotic Exploration'

<https://www.frontiersin.org/journals/robotics-and-ai>

Questions

1. What challenges exist at the frontiers of robotic exploration of unstructured and extreme environments?
2. How can we tie together the categories of systems, methods, and devices to address relevant scientific questions in such environments?
3. How can we deal with the algorithmic challenges from the perspective of planning, learning, and decision-making for long-term autonomy of robots in extreme environments?

09:00-10:10	Session 1 (1 hr 10 min) - Session Chair: João Sousa
09:00-09:10	Opening remarks
09:10-09:50	Geoff Hollinger - Marine Robotics: Planning, Decision Making, and Human-Robot Learning
09:50-10:10	<u>“Conducting robotics field trials: experiences, alternatives and best practices,”</u> Travis Manderson, Juan Camillo Gamboa Higuera, Sandeep Manjanna, and Gregory Dudek
10:10-10:50	COFFEE BREAK
10:50-12:10	Session 2 (1 hr 20 min) - Session Chair: Geoff Hollinger
10:50-11:30	João Sousa - Exploring the Pacific Subtropical Front: adventures in coordinated ship-robotic surveys
11:30-11:50	<u>“ORangE: Operational Range Estimation for Mobile Robot Exploration on a Single Discharge Cycle,”</u> Kshitij Tiwari , Xuesu Xiao, Ville Kyrki, and Nak Young Chong
11:50-12:10	<u>“Long-duration Autonomy for Open Ocean Exploration: Preliminary Results & Challenges,”</u> Alberto Dallolio , Laurent Bertino, Lukas Chrpa, Tor Arne Johansen, Martin Ludvigsen, Kjell Orvik, Lars Henrik Smedsrud, Joao Sousa k, Ingrid B. Utne, and Kanna Rajan

13:50-15:10

Session 3 (1 hr 40 min) - Session Chairs: Yoonchang Sung, Sarah Bearman

13:50-14:30

Robin Murphy - A User-Centric Perspective on Robust Autonomy in Unstructured Environments

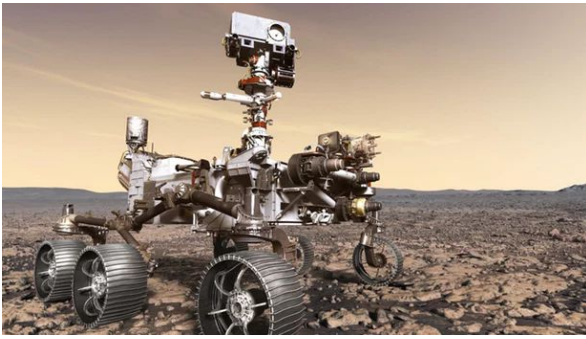
14:30-14:50

“Incorporating Human Input in Robotic Exploration,” **Katarina Popovic, Millicent Schlafly,** and Todd D. Murphey

14:50-15:10

“Towards Automated Monitoring of Animal Movement using Camera Networks and AI,” **Sarah Bearman,** Zhiang Chen, Harish Anand, Scott Sprague, Jeff Gagnon, and Jnaneshwar Das

Thank you!



A photo taken by one of the flight cameras shows, left to right: Andy Winhold, Justin Maki, Jim Bell and Alex Hayes. Bell is holding a mirror reflecting the faces of additional team members looking into the cleanroom window from the data analysis room outside.

Photo: Mastcam-Z Team/ASU, June 2019

