

CoSTAR-bots: Collaborative SubTerranean Autonomous Resilient Robots to Explore Subterranean Environments

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CoSTAR-bots

Collaborative
SubT
Terranean
Autonomous
Resilient robots

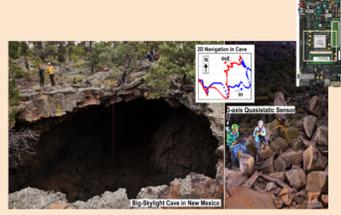
Mobility

Long-endurance all-terrain mobility platform.



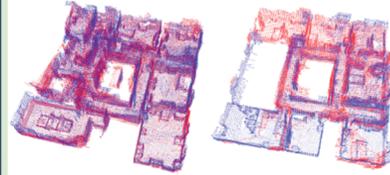
Localization

Magneto-quasi-static-based resilient localization system.



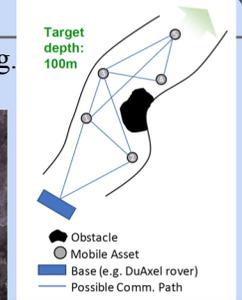
Distributed Perception

Robust distributed perception under uncertainty using DGPO.



Communication

Disruption-Tolerant Networking.



Autonomy

Risk-aware belief space autonomy using feedback-based information roadmaps.

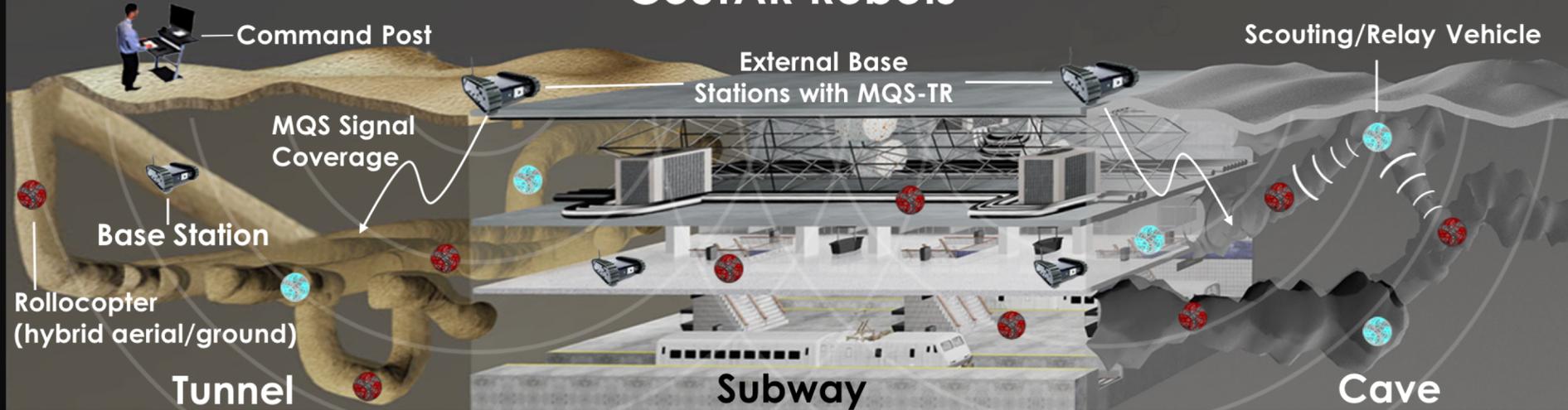


Mapping

High-resolution and consistent representation using Confidence-rich grid mapping.



CoSTAR Robots



Testing facility: Caltech's center for Autonomous Systems and Technologies (CAST), JPL's large Mars Yard, Mueller Tunnel, Bronson/Pisgah/Big-Skylight caves, Galvez tunnel, and potentially abandoned LA railway tunnels.

Challenges in Subterranean Environments

- Mobility

- Narrow passages
- Climbs and drops



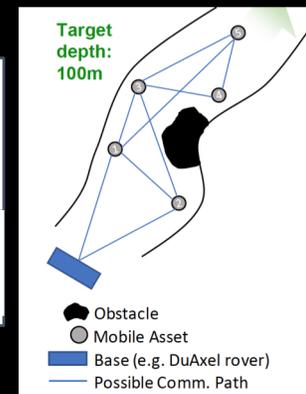
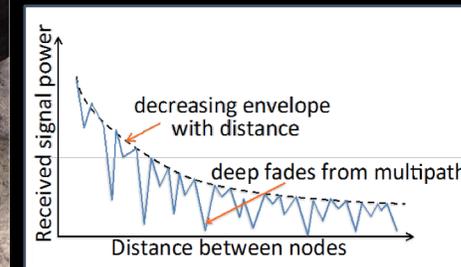
- Perception

- Bandwidth constraints
- Lightweight map representation
- Perceptual aliasing and high outlier rate



- Communication

- Latency constraints
- Requires daisy-chain operation
- Multipath environment can generate unpredictable link qualities
- Need to model, validate, and mitigate uncertainties in data links between nodes in SubT environment

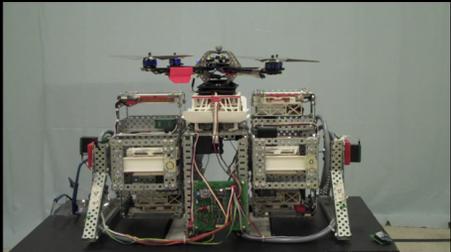
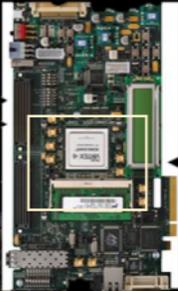


Challenges Specific to CoSTAR-bots

- Energy, endurance, and battery recharge/swap (complex/slow)
- Interaction with terrain and rolling/bouncing is complex
- MQS receiver can be carried by the ground robots – Not UAVs
- Flying mobility and payload on sensors



JPL MQS tests in Pisgah cave



Courtesy of ACL/MIT



Courtesy of Skysense

Open Questions for the Organizers

- When simulation testbed will be available?
- When the specific field is going to be revealed?
- How dark? Presence of water and reflective surfaces?
- How narrow? How wide?
- How long (space)?
- How long (time)?
- What part and how much of the environment will be dynamic?
- What are the metrics by which the map should be assessed? (geometry only? visual texture?)