Autonomous Unmanned Systems Technologies to Support Subterranean Operations

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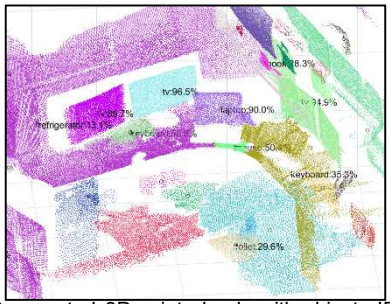
Rapid Abstraction in Confined Environments (RACE)

Challenge: Autonomous sit. awareness in denied interior environments
- Interior ops require high level of autonomy due to limited comms, high uncertainty
- State of art mapping algorithms return only geometric data; missions require semantic info

Goal: Geometrically & semantically map interior env. simultaneously – fast!

Three-pronged approach:
- *Classify rare / important objects:* Leverage pre-trained CNN's, but extend to classify targets with sparse or nonexistent training data
- *Active perception:* Close control loop around classification; autonomously move sensing agent(s) to reduce uncertainty
- *Multi-physics integration:* Framework to integrate RGB, depth data with other sensing physics (multispectral, magnetic, acoustic, spectroscopy,…) to support classification



Segmented 3D point clouds with objects ID'd

Perspective change, 3D & hyperspectral sensing distinguish people from decoys

Synergies: Classification & mapping / segmentation processes bootstrap each other
- Ongoing internally-funded R&D

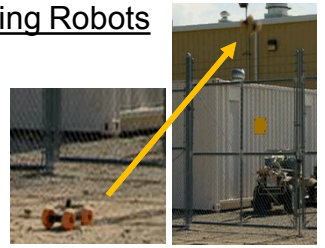
Relevant Mobility Exemplars

Gemini Scout Mine Rescue Robot

- Mature platform developed / hardened for mine rescue ops
- Multi-segment tracked body makes radical mobility over rubble, stairs, etc. easy

Small Hybrid Driving / Hopping Robots

- Specialized combustion process enables hops of >20x vehicle length
- Core tech from DARPA IMLM & Urban Hopper pgms



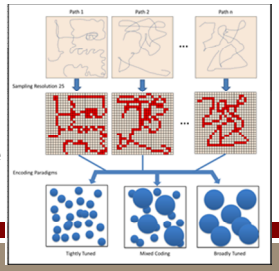
Versatile, Energy-Efficient Legged Robots

- Legged platforms handle terrain but use 10-100x energy of wheeled/tracked counterparts
- Novel silent drive systems & tailored passive mechanisms enable 10x increase in endurance
- DARPA M3 program

WANDERER: 91kg biped with 4 km range

Neural-Inspired Architectures for Efficient SLAM

- Brain-inspired SLAM algorithms leveraging deep learning processed sensor inputs, hippocampal algorithms and neuromorphic hardware
- Energy efficient implementations in emerging low-power neuromorphic computing hardware
- Adaptation via hippocampal-like functions



Brain-like navigation coding

Specialized Access

- Novel technologies enable compact, mobile, high-speed drilling
- Autonomous drilling through layered composite structures