Best Viewpoints for External Robots or Sensors Assisting Other Robots

(DOE NRI: Collaborative Visual Assistant for Robot Operations in Unstructured or Confined Environments)

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http://faculty.cs.tamu.edu/murphy/visualAssistant.html

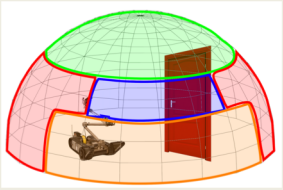
Challenge

Current practice: **2 robots** and **2-4 operators** to perform **one task** because the operator needs external view.

Issues: Increased **cognitive workload** and humans pick **suboptimal viewpoints**.

Goal: **2 robots- a UAV tethered to a UGV-** and **1 operator** where the assisting **robot autonomously and safely positions itself** in the provably **best viewpoint**.

Research Questions



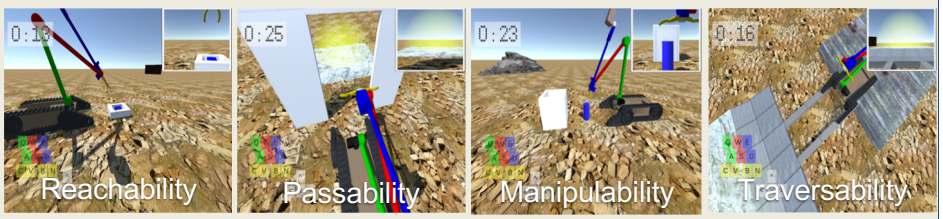
1. **What is perceptually the best viewpoint? Can we learn the best viewpoint?** A **fundamental model** for **utility** of different external **viewpoints** providing principled understanding of viewpoint value based on **psychomotor** behavior of human operators.

2. **What viewpoint is the safest to reach or be at? How can path risk be represented? Can we balance good enough viewpoint with safest path?** A **risk-aware reward-maximizing** motion planning algorithm to **autonomously** provide best viewpoint while reducing motion risk using a **formal risk reasoning framework**.

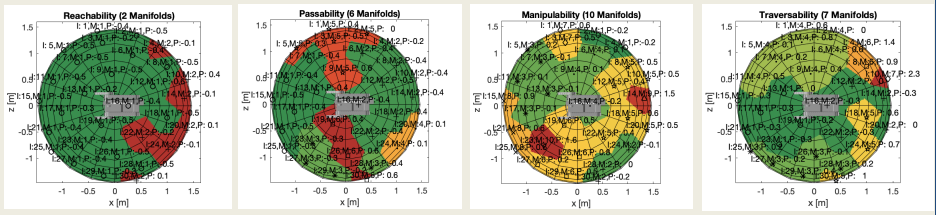
Method and Results

Optimal Viewpoint Impacts Performance, Errors for 4 Different Tasks

- **Decreases time to perform a task 18%-52%**
- **Eliminates or reduces errors by 87%**



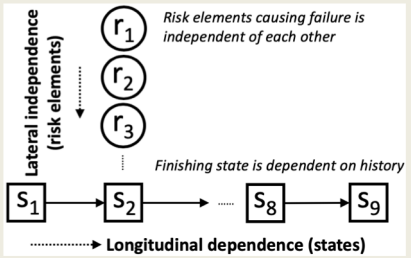
Manifolds of viewpoints with equivalent value learned (hierarchical clustering) through simulation with 30 bomb squad robot operators



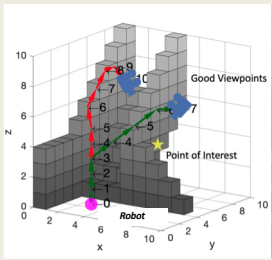
Other Results

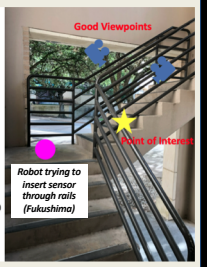
New, Comprehensive Method of Projecting Risk

Formal reasoning framework based on propositional logic, probability theory incorporating risk elements due to locale as well as the actions and traverse dependencies



Formal Reasoning Framework





Broader Impacts

- Speed up of time critical, life-saving co-bot applications such as disasters, SWAT, and hazardous materials handling
- Increased productivity and reduction of costly errors for DOE, NASA, homeland security and assistant co-bots applications
- Open source perceptual simulator for Talon, Packbot
- Trained four grad students, including 1 African-American woman

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