Development of a Human-Multi-AI Agent Experimental Framework

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Autonomous agents interact with the world through planning. For a human to team with an autonomous agent, the human will influence how that agent makes decisions, and vice versa.

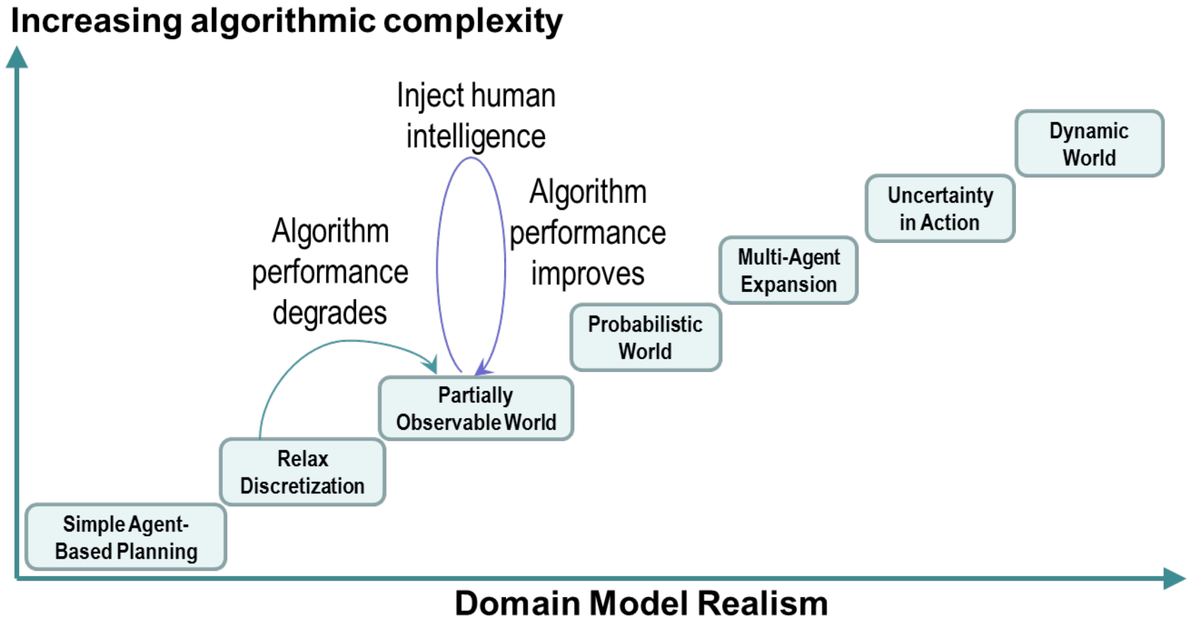
OBJECTIVES

Develop a collaborative human-autonomy teaming capability for the US Navy.

- Determine which Artificial Intelligence planning algorithms are most appropriate for naval-relevant scenarios
- Investigate how human operators can influence the planning of an autonomous swarm

RESEARCH APPROACH

- Analyze and evaluate state of the art planning algorithms, modeling methods
- Assess how algorithms perform in Navy-relevant scenario
- Remove an assumption and reevaluate algorithms



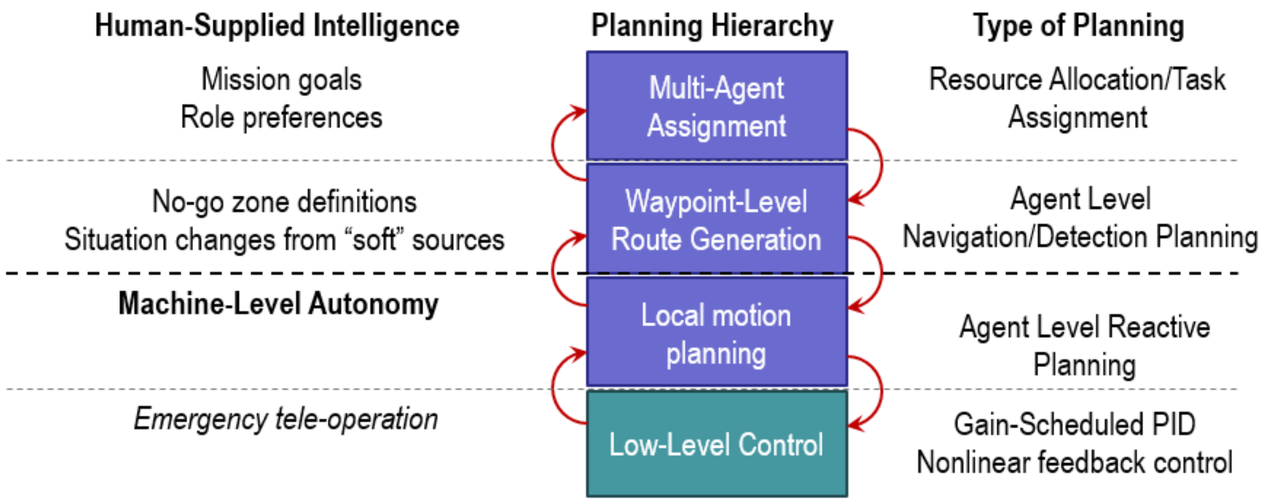
RESEARCH CONTRIBUTIONS

- Methods of feeding human decisions back into autonomous planning
- Empirical results on applicability of algorithms to naval-relevant scenarios
- Dynamic, adaptive planning under intermittent and denied communication

HUMAN-ASSISTED HIERARCHICAL PLANNING

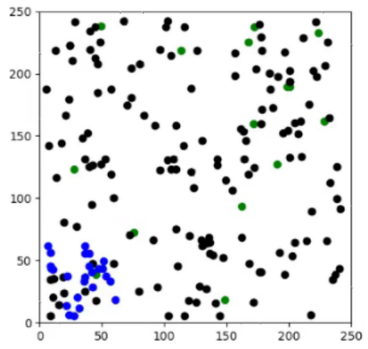
Monitoring several agents requires human-machine interactions at higher planning levels

- Humans set mission goals, no-go zones, and provide augmented situational awareness
- Agents plan their own motions without human help

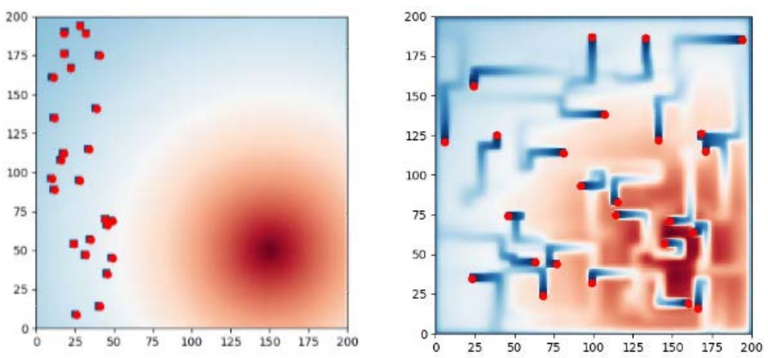


MULTI-AGENT PLANNING ALGORITHMS

- Each agent uses a Markov Decision Process (MDP) for navigation
- Agents are assigned search regions using Voronoi partitioning based on human-defined goals
- Replanning is triggered by human injection of new information such as revised goals and no-go zones, as well as when agents complete tasks and become available for new tasks



Agents replan at task completion

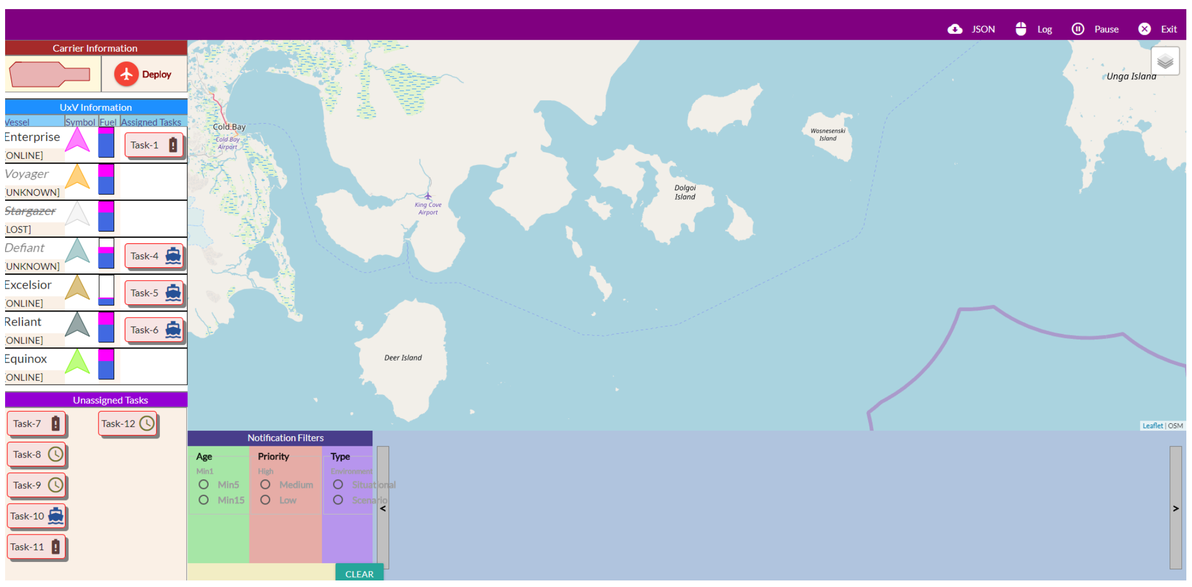


Persistent search by swarm: goal changes trigger replanning

HUMAN SUBJECT EXPERIMENT

A human commander and fleet of UxVs search for a moving target on the water surface

- UxV Fleet consists of the following machine agents
  - Unmanned surface vehicles (USVs) with MDP motion planning
  - Unmanned Air Vehicle (UAV) charging ship
  - UAVs with MDP motion planning and finite power
  - Virtual Tasking Assistant that uses Voronoi Partitioning
- Human interacts with agents using a GUI
  - Human sets search goals by clicking on map
  - Situational awareness for human commander provided in event timeline
  - Human can assign tasks to agents, and Tasking Agent will assign tasks to remaining agents
- Experiment Objectives
  - Quantify improvements in performance when humans team with agents
  - Determine effective mechanisms for translating human user intent and knowledge into forms planning agents understand
  - Gather information on human perceptions and interpretations of machine agent behavior
  - Collect human subject perceptions of difficulty of collaborating with AI agents



Screenshot of stand-alone human subject experiment Graphical User Interface