Human-autonomous teamwork of ground and air vehicles

Team Members:
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Client: Thomas Eskridge – FIT Faculty
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Goal and motivation:
The overall goal of the group is to create a team of agents capable of working with humans to effectively complete tasks. We would like for our demonstration to include autonomous ground and air vehicles working together for the purpose of a search-and-rescue-esque mission; this would involve the multiple agents in pursuit of a single agent. The team task would be to successfully corner/capture the evading agent by leveraging one another's strengths and weaknesses, as one does on a team.

Approach:
- **Continuous compositional control**
  - The purpose of this feature is to provide the user with the ability to be in multiple places simultaneously. The user will have the ability to jump between different agents to assist / keep the agents on task. This will be helpful because users may be able to speed up the process of task completion by communicating what they can see to the neighboring agents.
- **Interface with natural language processing**
  - This functionality will allow agents to receive information from other agents and translate it into a manner that is meaningful to them. Each agent has its own meaning of movements. The goal is for the agents to process what is being sent by the others and interpret how that scales to their abilities.
- **Multi-agent teamwork with Predator-Prey Dynamics**
  - This functionality will add purpose to the autonomy. There will be an agent whose purpose is to evade the pursuing-agents. This predator-prey dynamic gives the robots, in pursuit, a better task orientation by working together to find the best way to corner the target.
  - This translates to the robots being able to work together and find the best or most efficient way to complete a task as a member of a team.

Novel features/functionalities:
- **Multi-Agent Coordination**
  - It is important for the agents to understand their capabilities and have knowledge of their neighbors'. The efficiency and speed of a task's completion can be hindered if an agent spends too much time trying to accomplish something without realizing it is not feasible for it to attempt. We are going to mediate this

by creating a way for each member of the team to know what it is capable of doing, as well as what its teammates have the ability to do. **A bidomain pursuit**.

- **Dynamic Role Assignment**
    - Once the agents have identified their strengths and weaknesses as a team, they can then start assigning roles based on known capabilities. This role assignment can change depending on proximity, known information, or an agent's reliability from a performance perspective. Initially, the human operator will assign roles. Eventually, the agents will self-organize as part of the team.
- **Distributed Situational Awareness**
    - This functionality is novel because it will allow multiple agents to input their perspectives for the purpose of creating a larger picture of what the environment is like. The senses each of the robots are able to provide, will be shared amongst the others; this gives a general idea of what the environment is like to each of them so the others can get an idea of what they could encounter.
    - We will create a GUI frontend to display this data.

Algorithms and tools:

- Python
    - ROS2
    - OpenCV
    - PyTorch
    - Pandas & numpy
- Rust
    - ROS2
    - Backend processes
- JavaScript & HTML
    - Frontend GUI
- Github
    - Collaboration and version control
- LLMs
    - Powerful research tool
    - Useful for NLP
    - Assistance for boilerplate code generation

Technical Challenges:

- Generalization of the ROS2 protocol
    - ROS2 standardized the channels with which you can communicate with various robots but does not create conventions for commands such as "move forward". Part of our product will be creating an abstraction layer to lay a stable foundation for the control and operation of various types of robots.
- Compositional control of predator & prey simulation
    - Creating an algorithm for a robot to run away and another to search is relatively simple, but to allow seamless human-robot cooperation is significantly harder.

Milestone 1 (Sep 29):

- Direct control of robots
    - Simple movement commands and camera output
    - Basic frontend interface
- Isolate factors that are relevant to our final demonstration and find methods to implement them with the minimal work.
- Using prebuilt blocks, implement a basic search algorithm for the robot to find a stationary target
- Enable human-robot cooperation to locate the stationary target
- Demonstration of USAR (Urban Search and Rescue) with independent team members

Milestone 2 (Oct 27):

- Randomly moving target
- Test the robots autonomous method for locating a moving target
- Allow for information about the target to pass between the robots
- Adjust performance measures, and define expectations to build on natural language processing (Each robot will have its own understanding)
- Demonstration of USAR (Urban Search and Rescue) with coordinated and collaborative team members

Milestone 3 (Nov 24):

- Implement prey algorithm
- Force robots to collaborate to pin the prey
- Further adjust performance measures
- Full demonstration of predator & prey algorithm

Task matrix for Milestone 1:

Task	**Yav**	**Young**	**Pop**
Direct control of robots	Interface	ROS2 commands	Bridge
Isolate factors that are relevant to our final demonstration and find methods to implement them with the minimal work.	Interface styling/design/ layout toolkits	Search Algorithms/ Techniques	Robot Visualization
Using prebuilt blocks, implement a basic search algorithm for the robot to find a stationary target	Connect the interface	Apply search algorithm	Implement the visualization

Enabled human-robot cooperation to locate the stationary target	50%	25%	25%
Abstract Wrapper Layer	33%	33%	33%
Compare and select Collaboration Tools	Programs	Documents/presentations	Communication, task calendar
Requirement Document	50%	25%	25%
Design Document	25%	25%	50%
Test Plan	25%	50%	25%

Approval from Faculty Advisor
"I have discussed with the team and approve this project plan. I will evaluate the progress and assign a grade for each of the three milestones."
Signature: _____Thomas C Eskridge_____ Date: _9/3/2025_____