Software for a better world

Framework for Human Robot Cognition Interaction

Tim McCarthy, John McDonald, Conor Ryan, Michael Whitford, Yao Yao

1 INTRODUCTION:

- As wireless data transfer abilities continue to improve, multi-robot systems have become the preference over single-robot systems for an increasing number of tasks.
- This type of system can be further leveraged by combining the advantages of multiple vehicle types like unmanned ground vehicles (UGVs) and unmanned aerial vehicles (UAV's).
- Combined with assistance from humans, when necessary, multi-robot systems excel at completing mission-critical tasks like Emergency Response and surveys of dangerous areas.

Research Aim and Objective

- Highlight the key components of an end-to-end air-ground collaborative robotic system.
- Analyze how knowledge graphs can be implemented for planning and advanced environment interaction.
- Develop a framework for human-robot interaction.

Research Questions

1. How to address cognitive complexity, communication, shared autonomy, and performance for human-robot interaction?
2. How can the knowledge graph improve human-robot interaction?
3. How can this concept be tested, measured, and evaluated?

2 REAL-WORLD EXEMPLAR 'COLLABORATIVE ROBOTICS':

- Modern Collaborative Robotic Systems must provide solutions to a set of real-time issues like mapping, localizing, and navigating an environment.
- The multi-robot team must communicate data efficiently so processing can be done online.

Multi-View SLAM

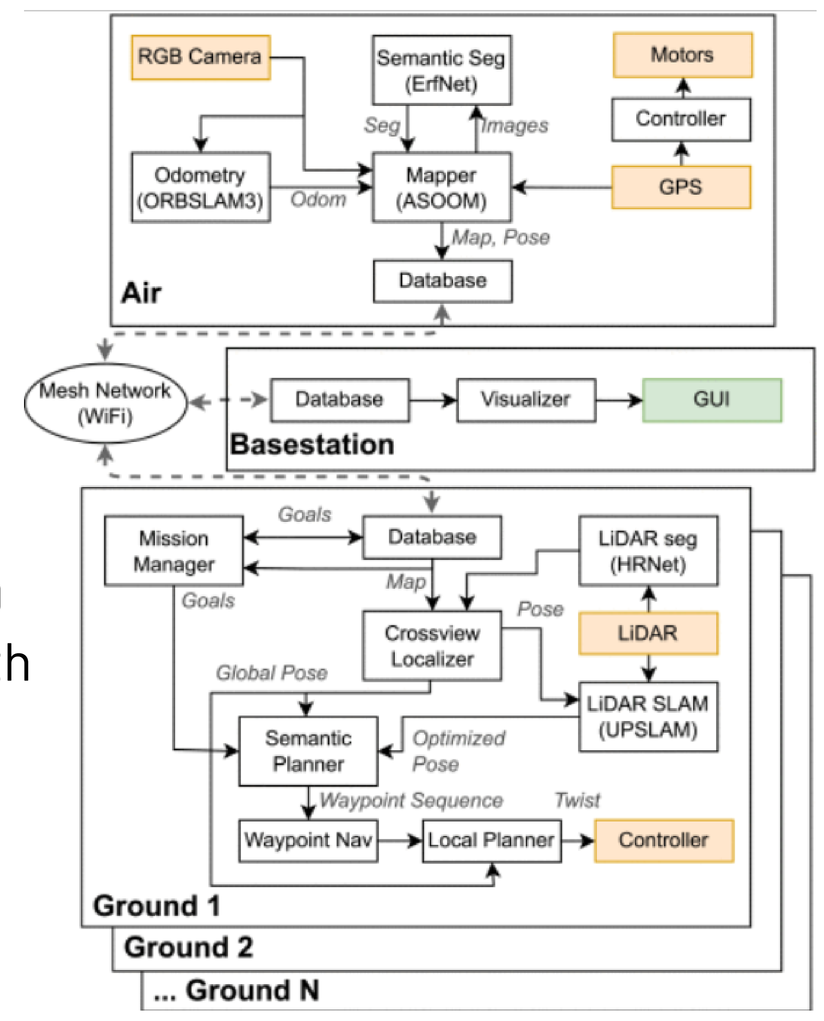
- Use speed and PoV advantage of UAV to quickly map environment and localize.
- Map shared with ground team and used by UGV's to perform cross-view localization against.

Planning and Navigation

- Different approaches consider 3D vs 2D planning and navigation, with a tradeoff between accuracy (3D) and efficiency (2D).

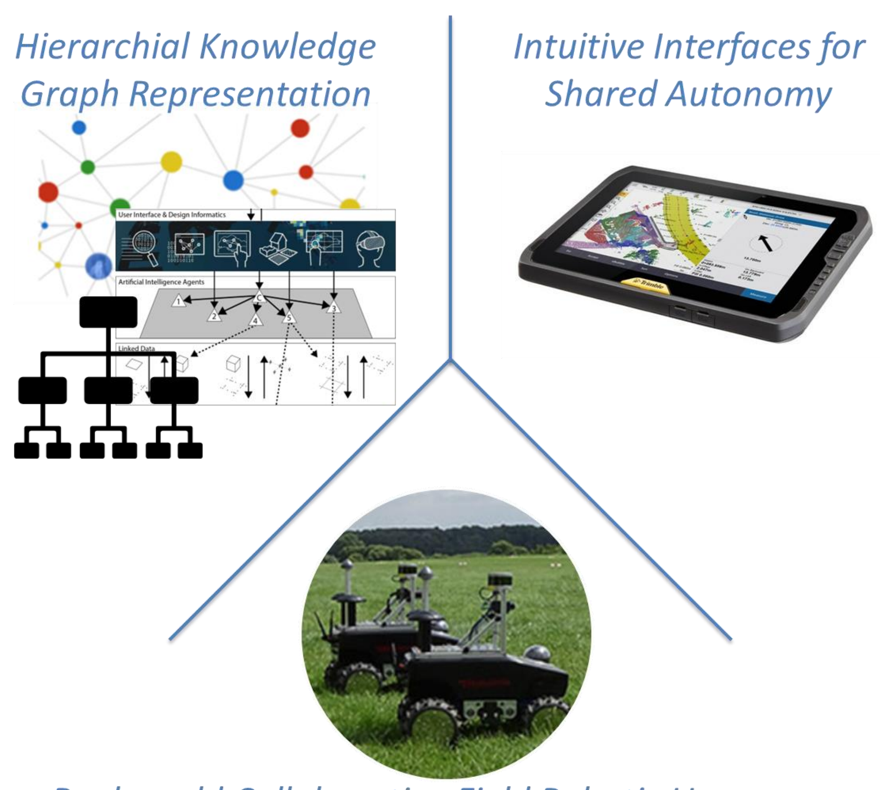
Communication

- A distributed communication system is used for robot and human communication.



3 OVERVIEW OF HRI FRAMEWORK:

- We use interdisciplinary methods to address the challenge as shown below:
  A. Knowledge integration framework
  B. Collaborative Field Robotic Systems
  C. Interactive user interfaces based on semantic models



Real-world Collaborative Field Robotic Use-case

- The relevant scenarios will be implemented in Hardware-in-the-loop (HIP) simulation tests and real-world experiments.
- The evaluation of the result will focus on performance, safety, ethical issues as well as associated standards and protocols.

4 CONCLUSIONS AND FUTURE WORK:

Through an overarching HRI framework, our research aims to provide a novel and efficient approach to improving human-robot interaction under various task contexts. We will implement our goal from multiple aspects such as Collaboration, Shared Autonomy, Effective coordination & Planning, and Intuitive Interfaces.
It is intended to use this collaborative project as a basis to spearhead joint Lero proposal preparation for new (€80B) Horizon Europe programme and (€8.2B) Digital Europe in Robotics and AI.

Resources

I. D. Miller, F. Cladera, T. Smith, C. J. Taylor and V. Kumar, "Stronger Together: Air-Ground Robotic Collaboration Using Semantics," in *IEEE Robotics and Automation Letters*, vol. 7, no. 4, pp. 9643-9650, Oct. 2022, doi: 10.1109/LRA.2022.3191165.

I. D. Miller *et al.*, "Any Way You Look at It: Semantic Crossview Localization and Mapping With LiDAR," in *IEEE Robotics and Automation Letters*, vol. 6, no. 2, pp. 2397-2404, April 2021, doi: 10.1109/LRA.2021.3061332.

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