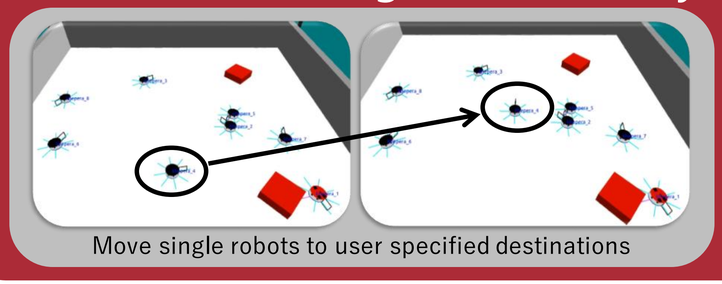
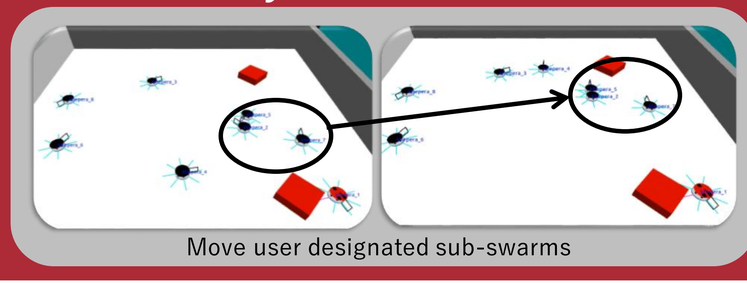
Augmented Reality Human-Swarm Interaction

Authors: Eric Arthur, Danny Sullivan, Przemek Gardias
Advisors: Prof. Carlo Pinciroli, Jayam Patel

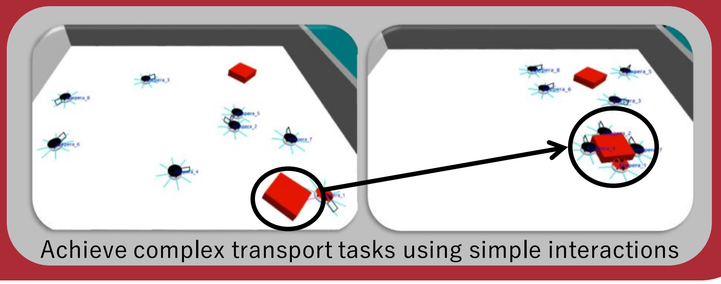
Augmented Reality Improves Efficiency and Immersiveness of Human-Swarm Interaction



Move single robots to user specified destinations



Move user designated sub-swarms

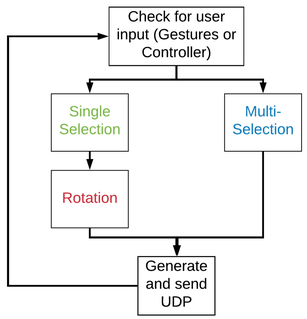


Achieve complex transport tasks using simple interactions

Why an Augmented Reality Headset?

- Graphical overlays on the real world provide feedback to prevent user frustration
- Intuitively combined with gestures and feedback methods to provide seamless and responsive modes of interaction
- Reduces operator fatigue, a limitation of tablet-based task durations

System Architecture

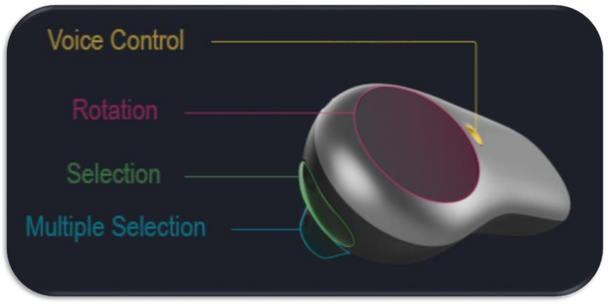


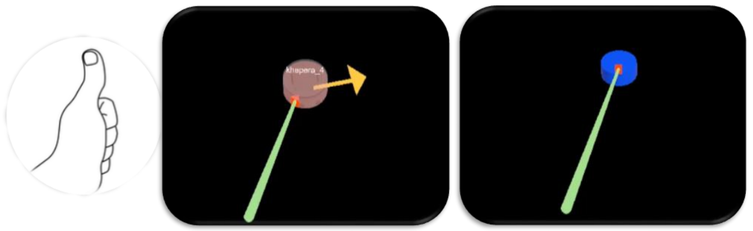
Left: System architecture information flow diagram. **Right:** Logical flow of the Magic Leap loop.

Lessons Learned

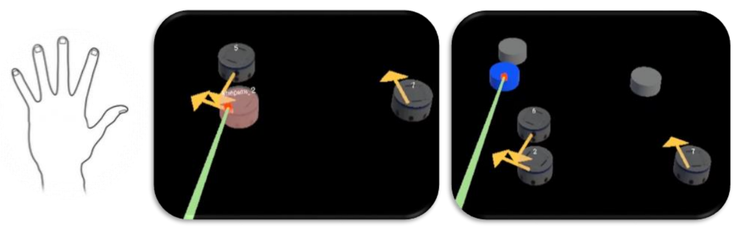
- Magic Leap One is not mature enough to support all native methods of human control (i.e. voice and indication by hand)
- Augmented reality currently suffers from limited field of view and hardware restrictions although shows a promising future for human-swarm interaction due to multiple input modalities

Interaction Design

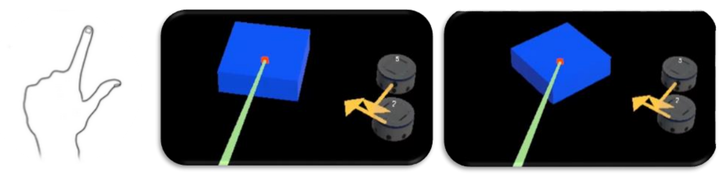




Thumbs Up Gesture or **Bumper:** Select single object

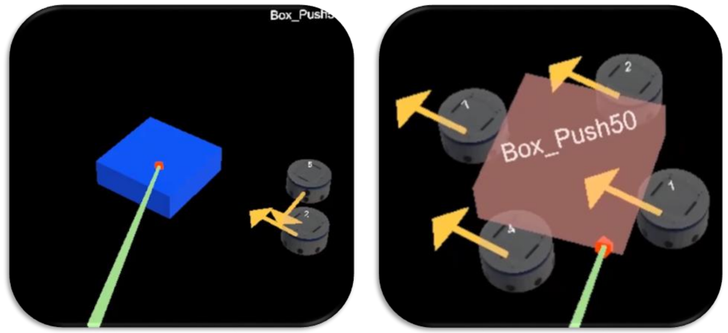


Back of Hand Gesture or **Trigger:** Select multiple virtual robots



"L" Gesture or **Touchpad:** Rotate objects

Example: Collective Transport



Left: Selecting a destination for box. **Right:** Khepera robots moving box to indicated destination.

Future Work

- Full implementation of voice commands
  - Using local audio transcription or through API
- Recognize pointing gesture with ray casting from fingertip to replace controller
- Add unit tests so newer features can be developed without need to test whole application
- User study to test our gesture-based AR headset against existing tablet-based AR system

References

[1] Patel, Jayam, Yicong Xu, and Carlo Pinciroli. "Mixed-Granularity Human-Swarm Interaction." *ICRA 2019.*

[2] Patel, Jayam, and Carlo Pinciroli. "Improving Human Performance Using Mixed Granularity of Control in Multi-Human Multi-Robot Interaction." *arXiv preprint arXiv:1909.07487* (2019).

[3] Pinciroli, Carlo, et al. "ARGoS: a Modular, Parallel, Multi-Engine Simulator for Multi-Robot Systems." *Swarm Intelligence, volume 6, number 4, pages 271-295.* Springer.