

Smarmanoid: a novel concept for the study of heterogeneous robotic swarms

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Presented by:

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Swarm Robotics

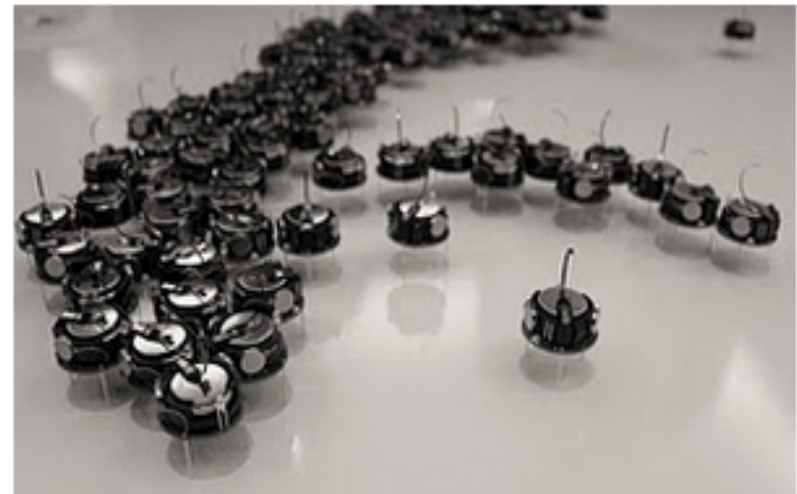
- No centralized control
- Limited communication between robots
- Use of local information
- Emergence of global behavior
- **Homogeneous system components**



Jason Loyd, Amanda Minnich, and Karl Stolleis

Pros of Homogeneous Swarms

- Interchangeable parts/ robots
- Robust to failure and external disturbances



Courtesy of Kilobot Project, Harvard

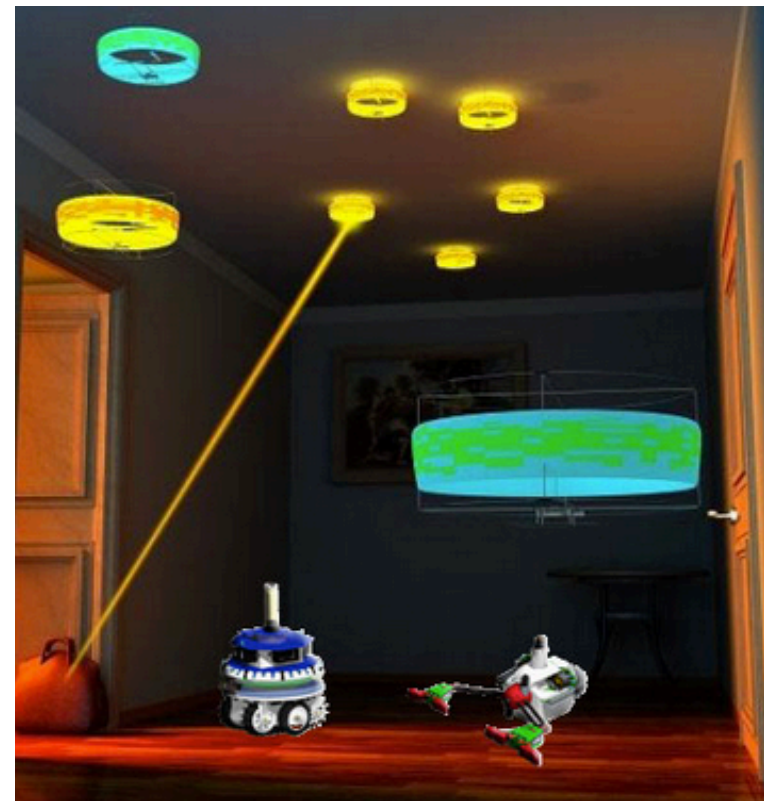
Pros of Heterogeneous Swarms

- Combines different sensing and analyzing modalities
- Individuals can form more complex integrated structures
- Swarms can carry out more complex tasks



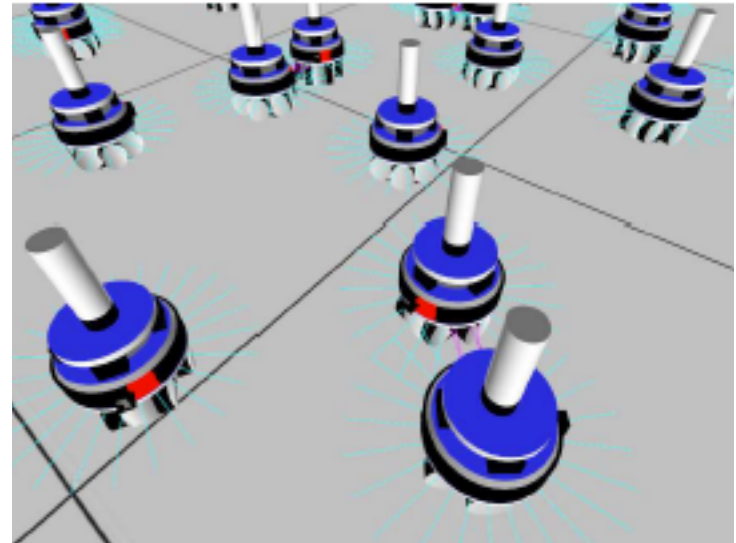
Challenges of Heterogeneity

- Individual behavior rules must lead to inter-group cooperative behavior
- Differing robot hardware must be physically compatible
- Balance robot-type hardware design with inter-type communication



Challenges of Heterogeneity, cont.

- Robots must communicate disparate sensory input in common framework.
- Simulation software must handle multiple robot types with different behavior rules



Common Technologies

- Uniform hardware architecture
- ASEBA: A modular architecture for event-based control of complex robots
- Scalable
- Communication between different robotic platforms
- Range and bearing communication system

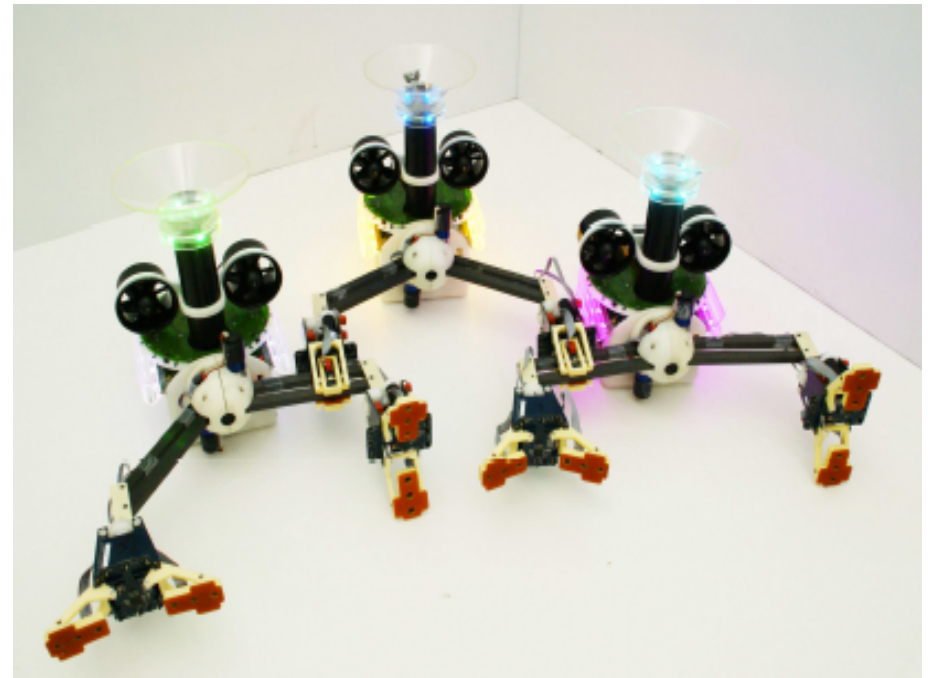
Foot-bot

- Autonomous
- All-terrain capabilities
- Capable of self-assembly
- Can transport other robots
- Base, Gripper, Upper Modules



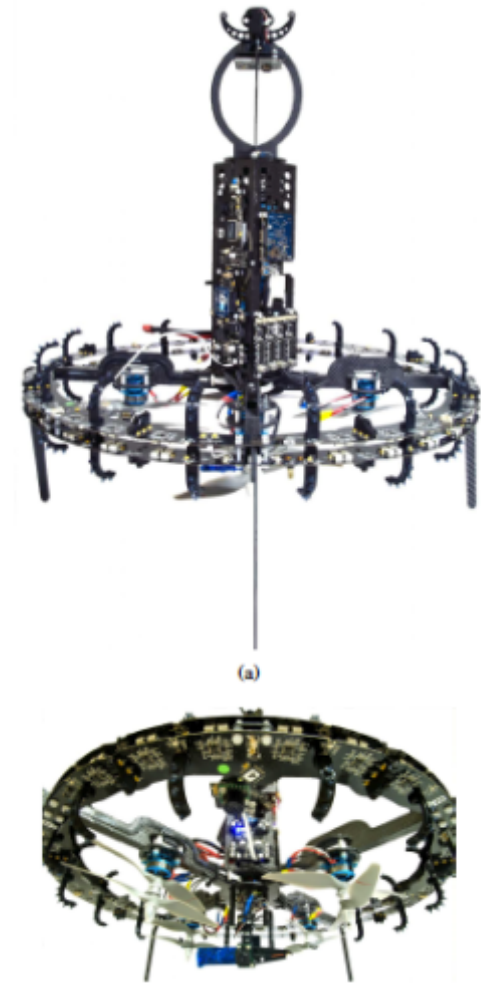
Hand-bot

- No autonomous mobility
- Specialized for climbing vertical surfaces and manipulating small objects
- Gripper
- Roper launcher
- Magnetic system modules



Eye-bot

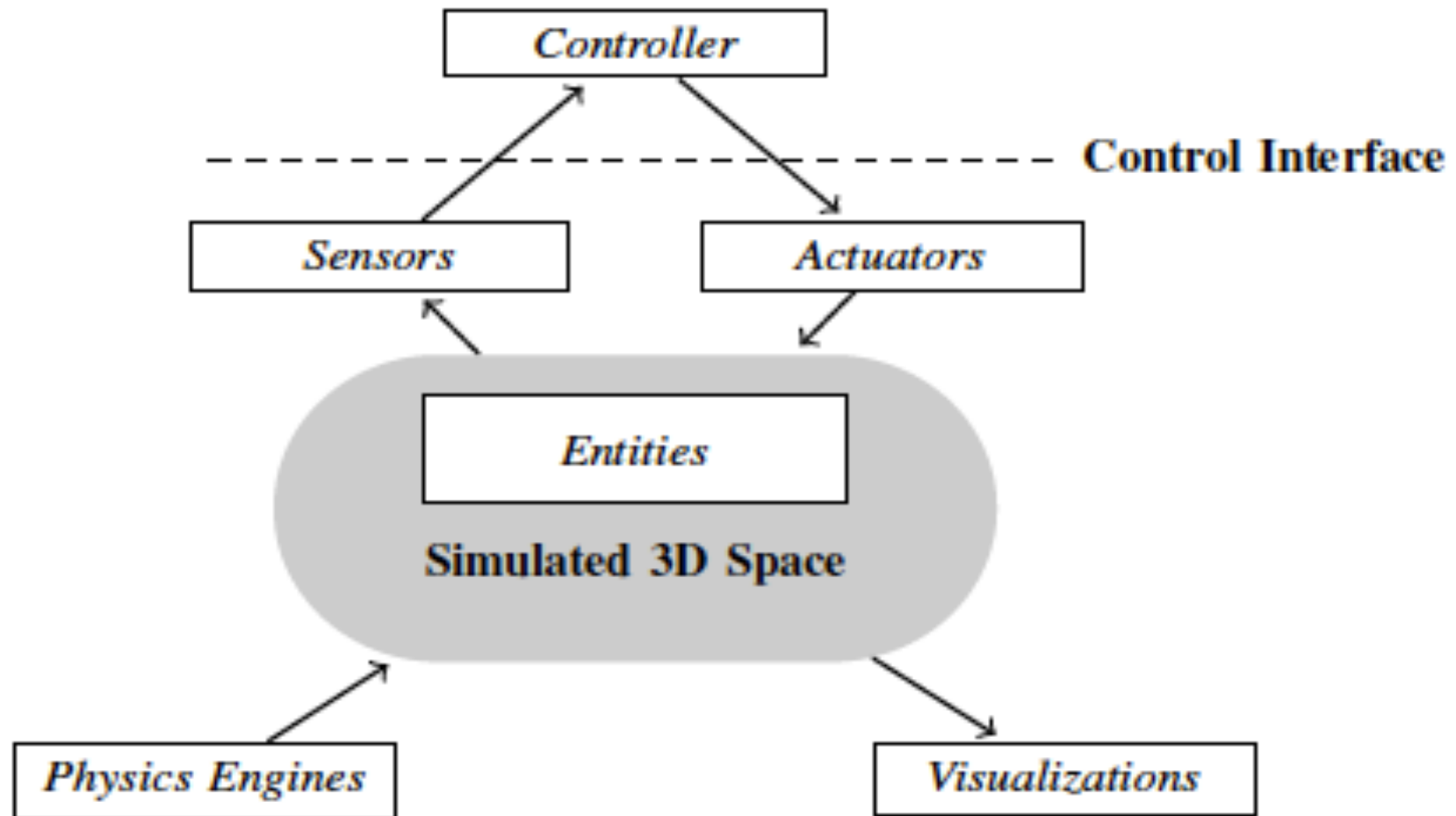
- autonomous
- Specialized for flying
- Analyze environment and communicate information to hand- and foot-bots
- Ceiling attachment system
- infrared 3D motion tracking cameras
- Provide aerial view for object detection
- Propulsion system



Movie Clip describing different robots



ARGoS Simulator

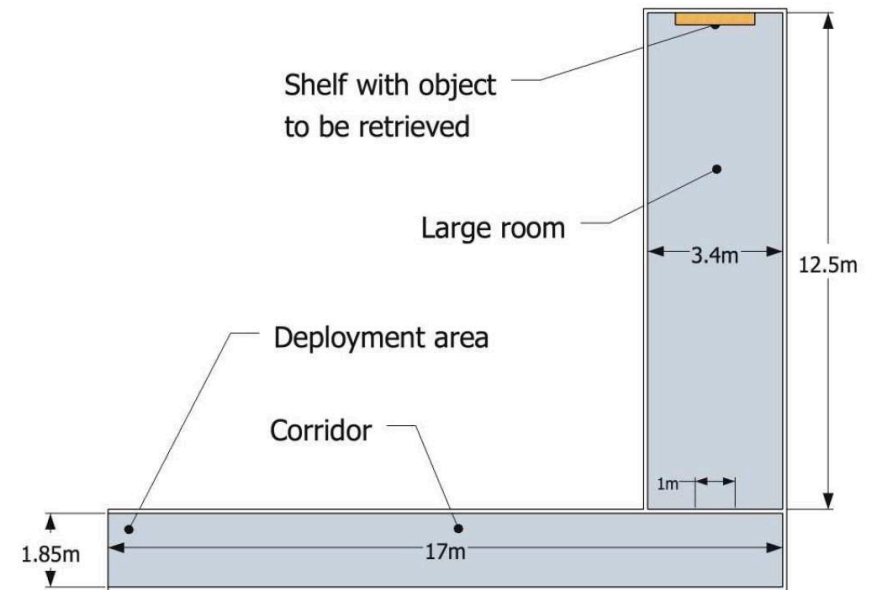


ARGoS Simulator

- Scalable and flexible
- Positional entities
- Composable entities
- Sensors and actuators
- Available visualizations
- Can't simulate noise
- Results: ARGoS can simulate 10,000 simple robots 40% faster than real time

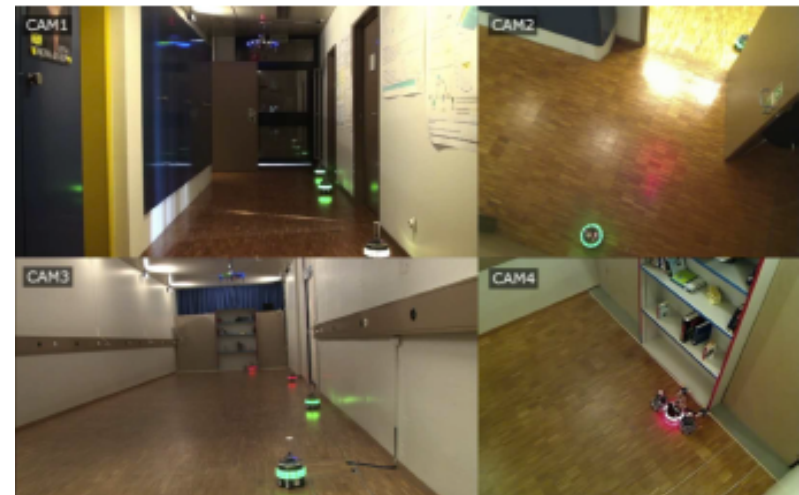
Real-World Trial

- Human habitable, 3D environment suitable where humanoid robots are used
- Foot-bots explore environment seeking target objects and maintain network connectivity
- Eye-bots move to edge of established network but do not break connection
- Hand-bots brought in once target object has been found



How bots work together

- Foot-bots establish search area, com network and carry hand-bot to task area
- Eye-bots are scarce but increase search capacity through speed
- Eye and foot-bots exchange distance and heading information
- Hand-bots provide climbing and grasping



Discussion

- Is the network connectivity a constriction to the swarm's versatility?
- Is there any emergent behavior? This is more difficult because there are different types.
- Is there a single-point of failure present in the swarm, as described?
- What are the real advantages of having a heterogeneous swarm?

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