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Swarm Robotics

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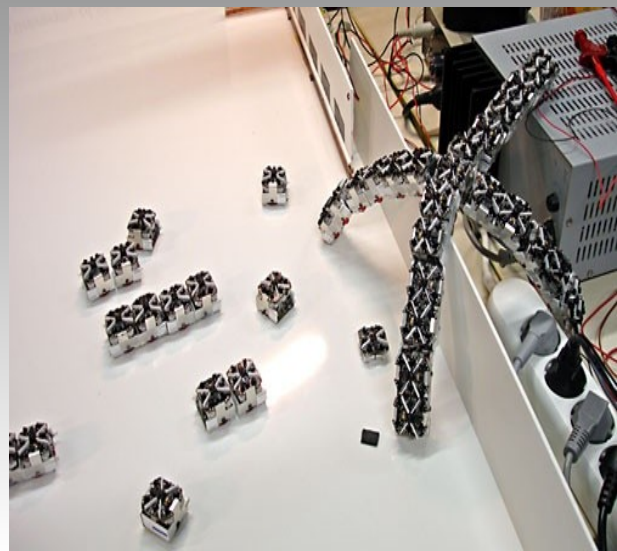
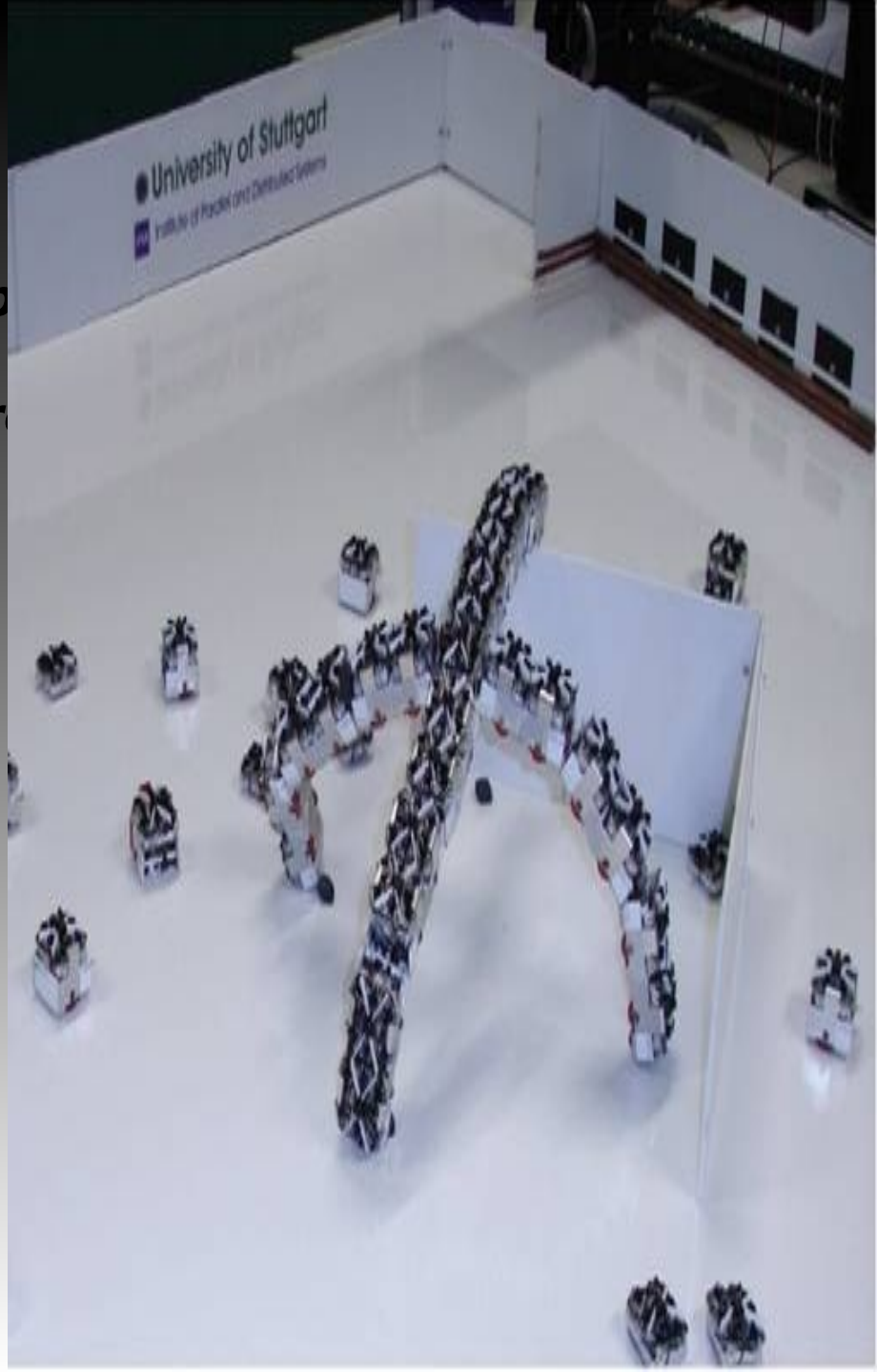


Contents



Introduction to swarm Robotics

Inspiration to Swarm Robots

Self-organizing natural systems

Social insect systems: ants, termites, wasps, bees, cockroaches, locusts…

Animals with social behaviors: Bees, Penguins, birds, fish, sheep…

***Definition*:**

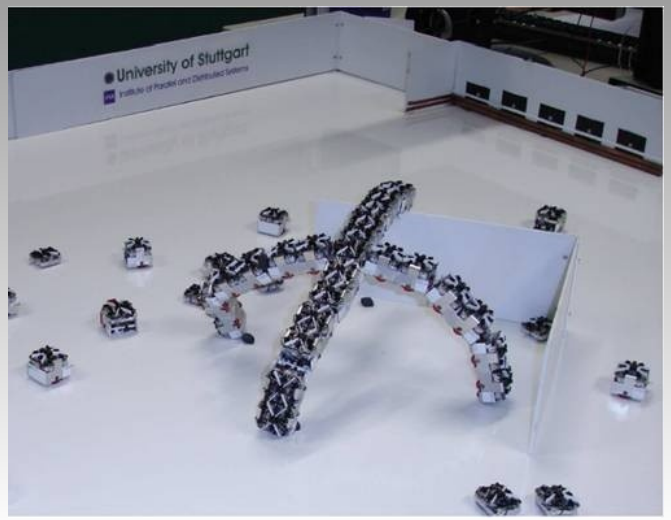
A Swarm consists of a large number of homogenous autonomous relatively incapable or inefficient robots with local sensing and communication capabilities.

In other words,

Swarm robotics is the study of how large number of relatively simple physically embodied agents can be designed such that a desired collective behavior emerges from the local interactions among agents and between the agents and the environment.

swarm Robots Vs Single Robots

- ***A larger range of task domain***
- ***Greater efficiency***
- ***Improved system performance***
- ***Fault tolerance***
- ***Robustness***
- ***Lower economic cost***



Swarm Robots Applications

Transportation

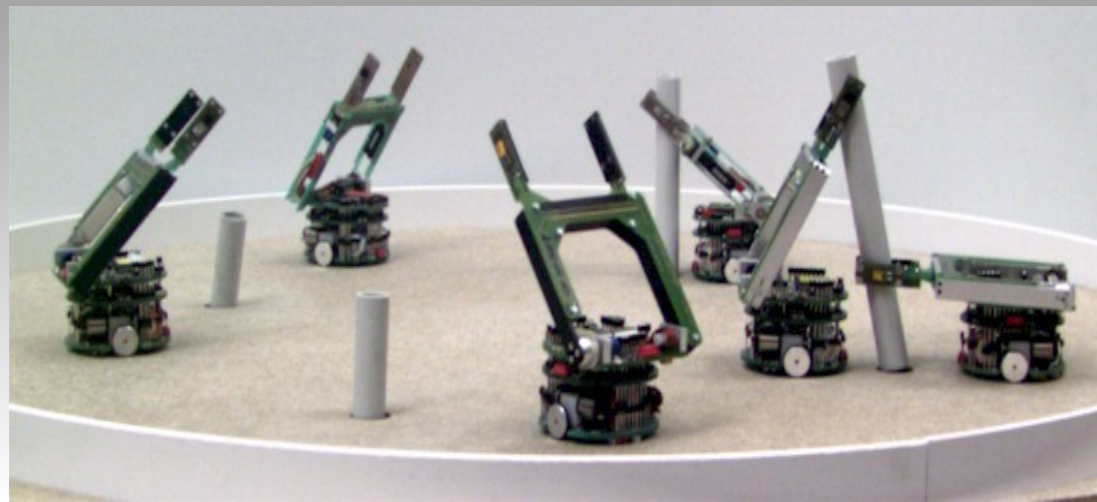
Search & Rescue

Mine Detection

Surveillance & Monitoring

Medical Service using small-size robots

Military . . .



Different Types of swarm robots

Types of Swarm Robots:

- ***Swarm Size***
- ***Limited Group multiple Robots***
- ***Infinite Group n>>1 Robots***

- ***Communication Range***
- ***None-Communicative Robots***
- ***Near-Communicative Robots***
- ***Infinite communicative Robots***

Swarm specifications

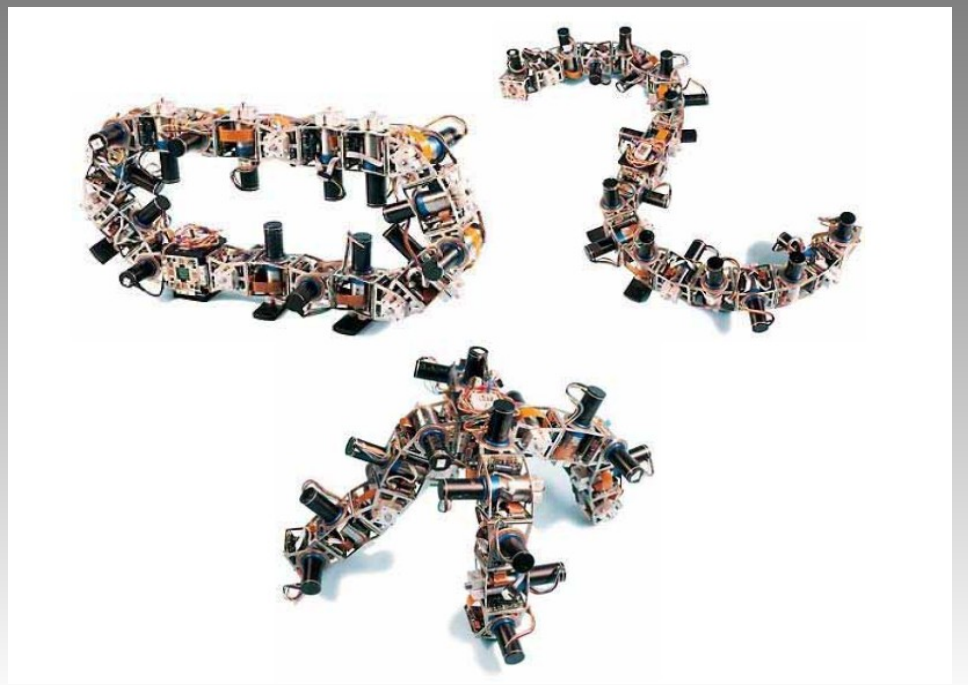
Re configurability

Scalability

Robustness

Reconfigurabili

- ***Reconfigurability is the rate at which the swarm can spatially reorganize itself.***
- ***Reconfigurability is equivalent to the rate at which members can move with respect to one another***.



Scalability

Ability to operate under a wide range of group sizes.

In other words, coordination mechanisms are rather independent of the number of individuals in the group.

Robustness

Swarm Robots can continue to operate despite large disturbances because of:

Redundancy

Simplicity of the individuals

Future challenges:

- Technical challenges to scalability

- Performing physical tasks in the real world

Examples

- Chain Formation
- Aggregation
- Obstacle Avoidance & Beacon Navigation
- Dispersing
- Self Assembly

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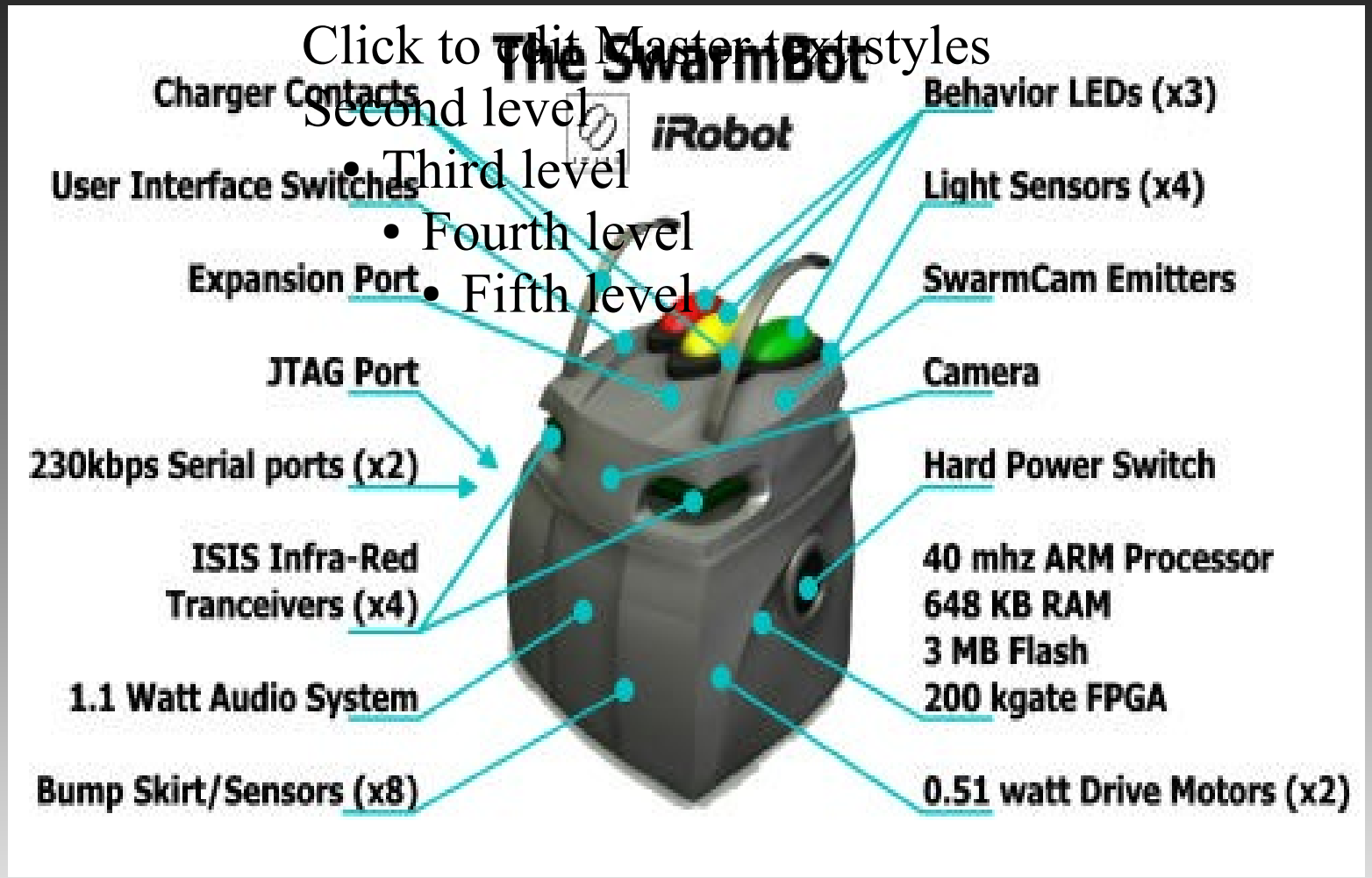
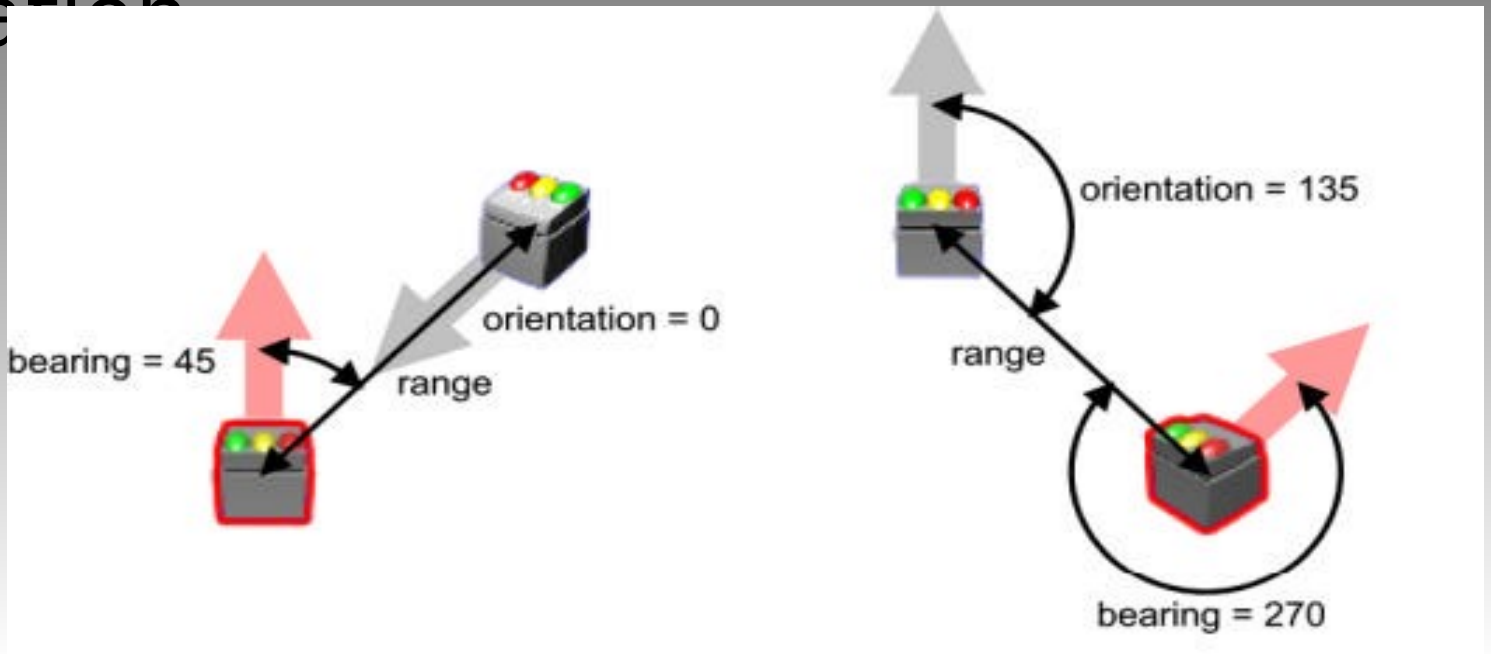
Second level

- Third level
- Fourth level
- Fifth level



Communication

The communication and robot location system Robot ISIS allow each robot to commute with its neighbors and determined their range, bearing, and orientation



TYPE of Behaviors

Primitive Behaviors

These low-level behaviors do not interact with other robots at all. They provide low-level motion control and obstacle avoidance for an individual robot.

EX: move or stop a robot

Pair Behaviors

Pair behaviors also direct the actions of a single active robot, but they use the position and current state of only one neighbor that is the reference robot.

EX: Orient to another robot, fellow a robot

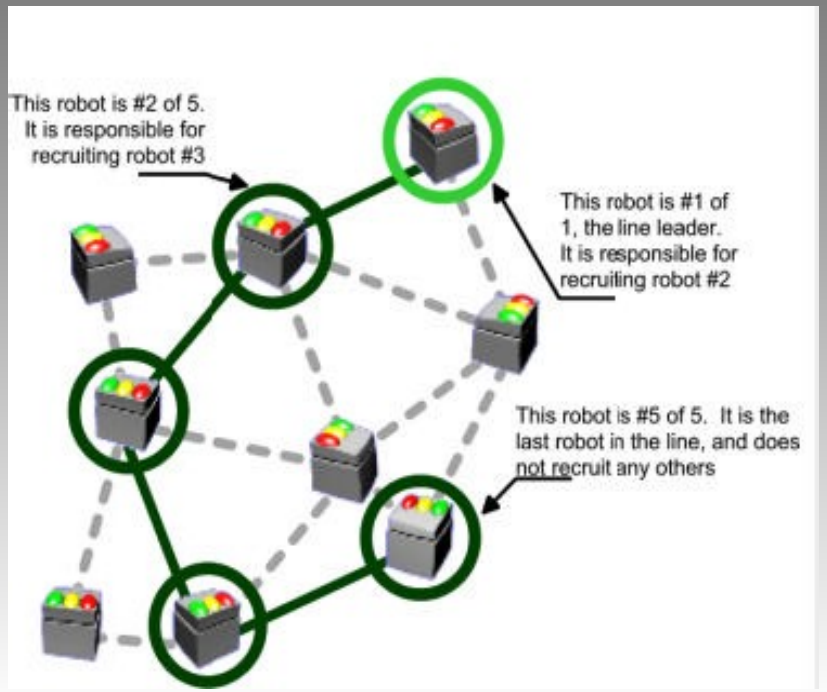
Group Behaviors

These behaviors form the bulk of the behavior library. They are responsible for guiding the actions of a single active robot based on the positions and current state of all of its neighbors. The entire set of neighbors are the reference robots.

EX: Follow a leader, clustering, grouping.

Chain formation

- In Chain Formation problem, the aim is to move the robots so that they form a chain pattern.
- The follow The Leader behavior dynamically constructs an ordered line of robots. This line is suitable for leading a group of robots into an area. Another behavior is required to control the leader.



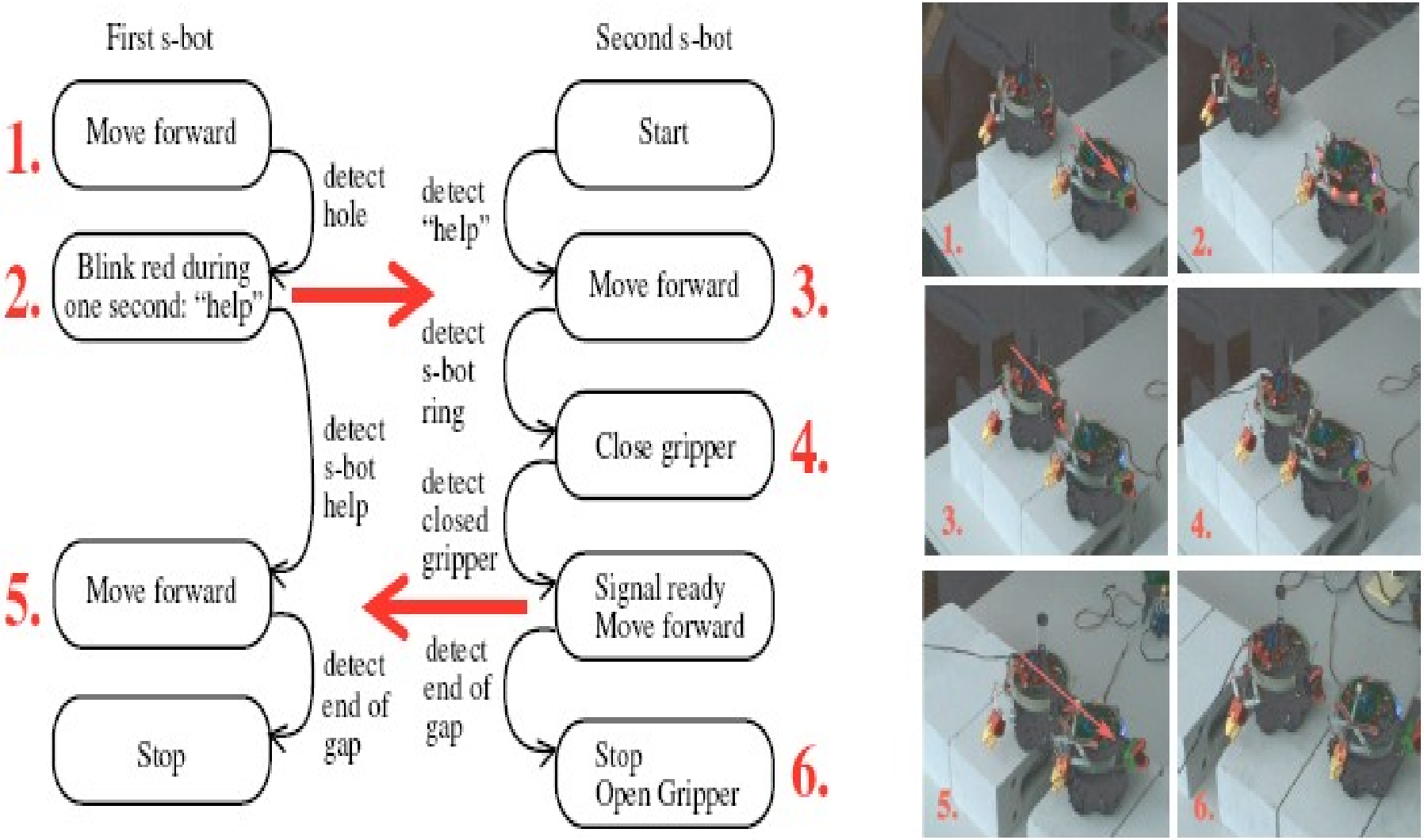


Figure 5: S-bot control for grasping and pass sequence.

Aggregation

+ The goal of the clustering behavior is to move the swarm to a centralized location
in as small an area as possible.

+ The clusterIntoGroups behavior implements a primitive form of division of labor. It
operates in two `steps; first, each robot selects a group to join, then the behavior moves
robots in the same groups together, while moving
each ot

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Obstacle avoidance & Beacon Navigation

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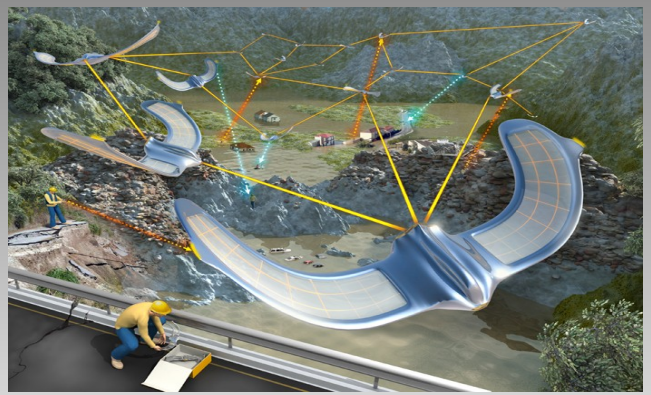
Swarm
-bots



MAV-
Swarm

Application of these behaviors

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What if we sent

2,000

robots to Mars?

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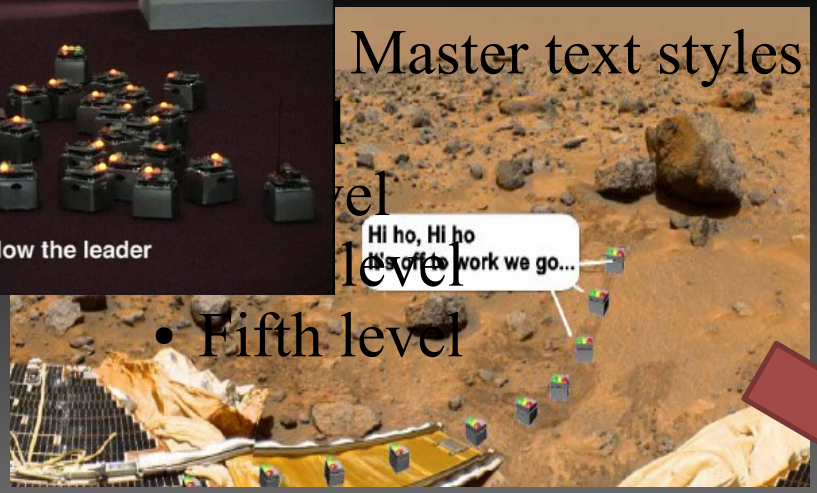
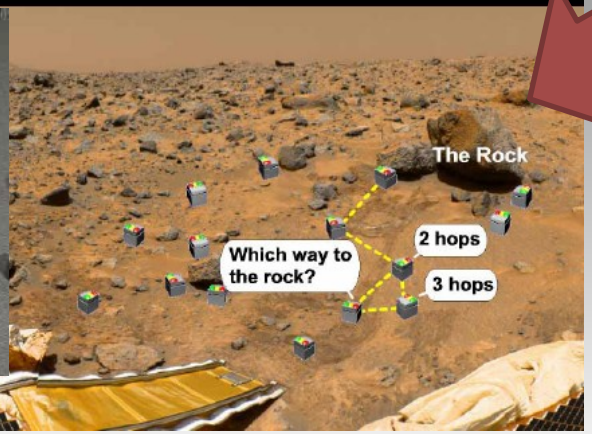


Exploration

Navigation



Project ANTS

Autonomous Nano Tech Swarm Architecture

Videos
&
Questions!

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References

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