

CS 758/858: Algorithms

<http://www.cs.unh.edu/~ruml/cs758>

Assembling a Swarm

Connectivity

Assembling a Swarm

- Challenges
- Not
- Making a Shape
- Assembly FSA
- Proofs

Connectivity

Assembling a Swarm of Robots

Challenges

Assembling a Swarm

■ Challenges

- Not
- Making a Shape
- Assembly FSA
- Proofs

Connectivity

decentralized, robust, local communication and sensing
cost, manufacturing, operations

- coordinated behavior
- goal-oriented behavior, planning

Not Swarm Robotics

Assembling a Swarm

■ Challenges

■ Not

■ Making a Shape

■ Assembly FSA

■ Proofs

Connectivity

Making a Shape

Assembling a Swarm

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Connectivity

<http://science.sciencemag.org/content/suppl/2014/08/13/3>
assumes: local comm, rough distance from sender, roughly
holonomic motion, given shape, 4 special seeds

1. place seed robots
2. compute gradient
3. edge following
(enter shape)
4. stop before exiting or when nestled at gradient

need: determine gradient, follow edge, localization

Assembly FSA

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Connectivity

idle

start-move: no nearby moving robots and I have smallest id of nearby idle robots

move-out

enter-shape: inside and boundary is no longer close

move-in: 2 possible successors

leave-shape: inside but boundary is at my radius

stop-out

or, gradient: about to edge-follow new robot with different gradient than previous

stop-in

Proofs

Assembling a Swarm

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- Assembly FSA
- **Proofs**

Connectivity

1. if there is a robot-sized place within shape that is reachable, a mobile robot will stop inside shape
2. robots will form 'ribbons' without gaps
3. when no robots can join, shape cannot fit more robots
4. with sufficient robots, shape will be filled

- Keeping Connected
- Algorithm
- EOLQs

A Mobile but Connected Swarm

Keeping Connected

Assembling a Swarm

Connectivity

■ Keeping
Connected

■ Algorithm

■ EOLQs

<https://www.youtube.com/watch?v=AJG4tYs2GU0>

Algorithm

Assembling a Swarm

Connectivity

■ Keeping
Connected

■ Algorithm

■ EOLQs

reach target locations while preserving connectivity
roles: root, worker, connector, spare
assumes can estimate relative position of sender

1. loop:
2. make tree from root to (or from) workers
3. workers try to grow toward targets
4. recruit spares as additional connectors
5. re-select root (improves efficiency)

Assembling a Swarm

Connectivity

■ Keeping
Connected

■ Algorithm

■ EOLQs

Nope!