Object Manipulation and Position Control Using a Swarm With Global Inputs

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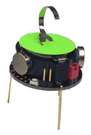

Actual Size

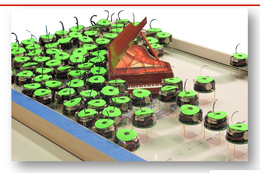
Website, C.V.

YouTube channel

Why a Swarm?

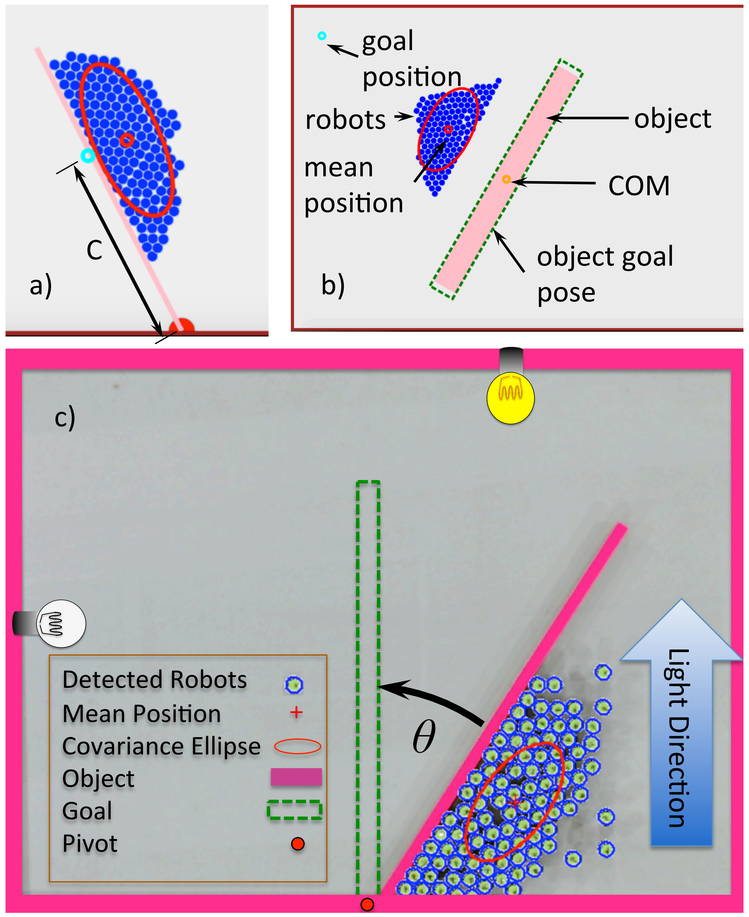
Swarm robots:

- Can pass through constrictions
- Can bend around obstacles
- Can be simple:
  - ✓ Easy to design, build, test
  - ✓ Disposable/ replaceable
  - ✓ Small, tiny, nano/micro robots



Swarm Piano Mover's video

Object Manipulation



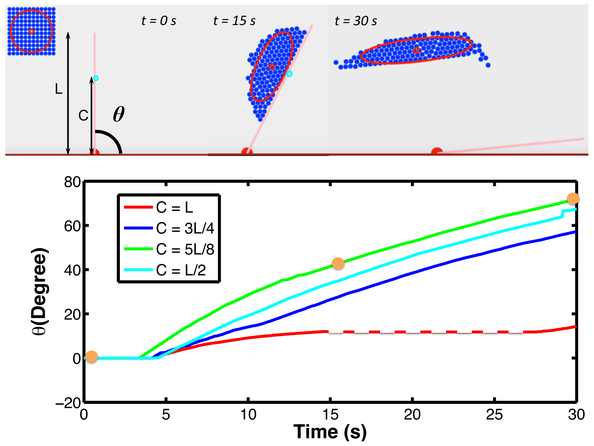
Rules: Inputs are simple & global. All robots receive exactly the same commands: move toward brightest light

Goal: Position and orientation (pose) control of the pink object using the swarm force and torque

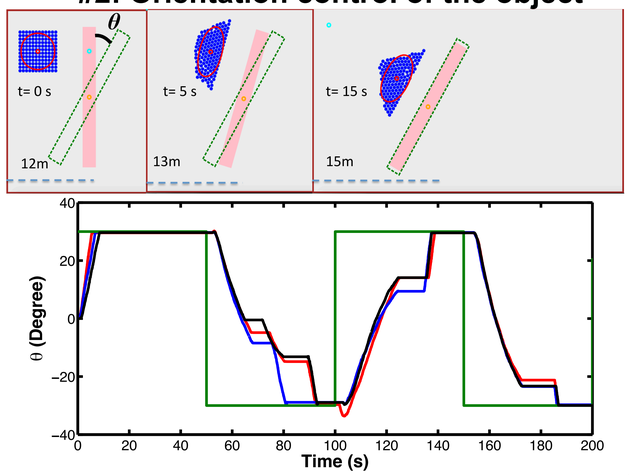
(a) Simulation of robots exerting torque on a hinged "door"
(b) Simulation of swarm orientation manipulation
(c) 97 hardware robots applying torque to an object

Four Challenges With Increasing Complexity

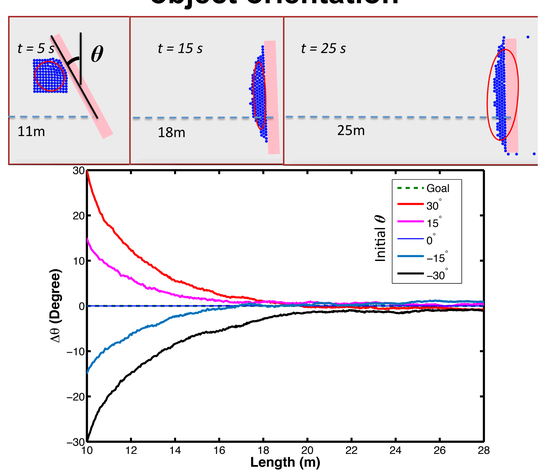
#1: Swarm torque control on pivoted object



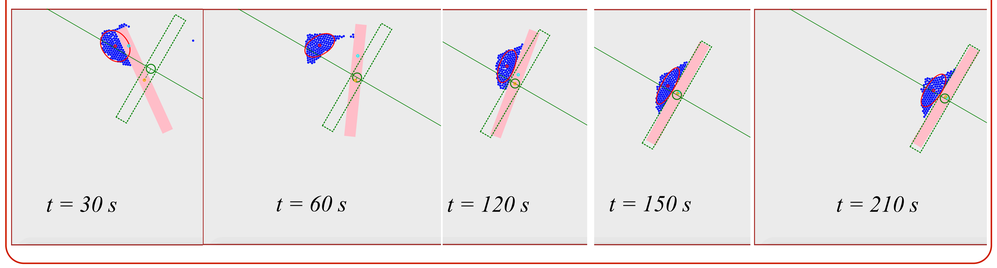
#2: Orientation control of the object



#3: Straight translation while regulating object orientation



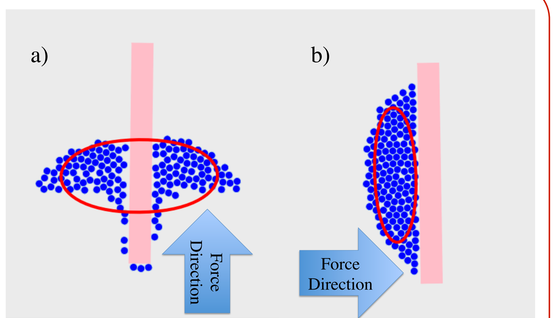
#4: Line following with perpendicular orientation

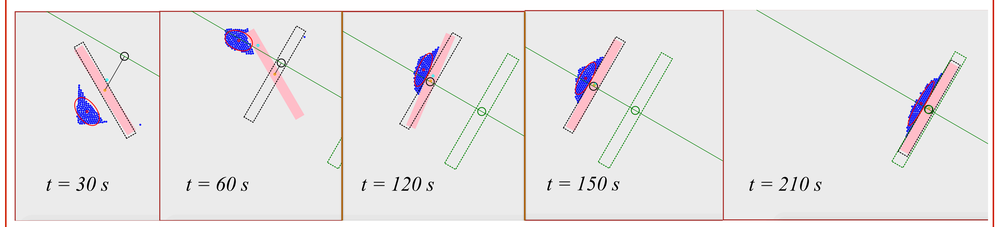


Grand Challenge: Pose Control

a) Pushing an object perpendicular to its minor axis, the swarm spreads around the object

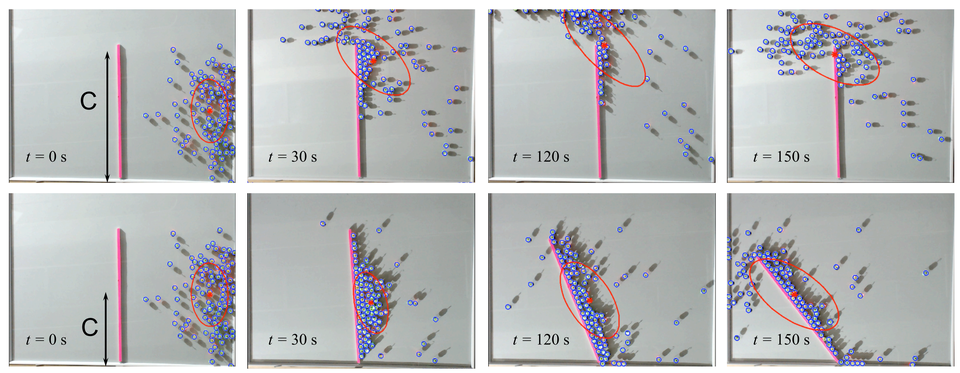
b) Applying force perpendicular to the object's long axis reduces the probability of splitting the swarm





Manipulating the object to the desired pose(orientation and position)

Experiment With Hardware Robots



Pure torque control experiments with kilobots
Kilobots are programmed to go toward the brightest light in the room as their global input