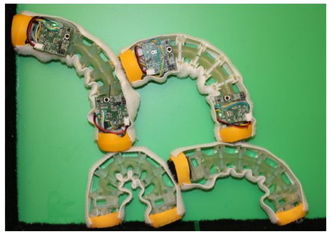
Influencing Emergent Structures in a Robotic Collective

Everardo Gonzalez[1], Lucie Houel[2], Radhika Nagpal[3], Melinda Malley[4]

Oregon State University[1], École polytechnique fédérale de Lausanne[2], Princeton University[3], Olin College of Engineering[4]

Robotic Self-Assembly

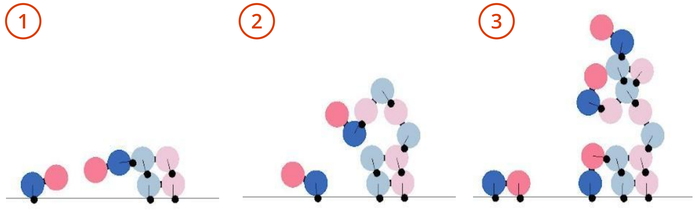
Self-assembly can allow robotic collectives to build structures to increase efficiency and to reach otherwise inaccessible areas. We take inspiration from natural swarms to form emergent structures through local interactions rather than meticulous planning.



Eciton Robotica self-assembles bridges in a similar manner to army ants.

Goal Driven Structure Formation

Local Rules: Set rules for local interactions.
Goal Location: Set a goal location for the collective to reach.
Speed Control: Slow robots as they approach the goal.
Parameter Tuning: Influence characteristics of the structure by tuning speed control parameters.



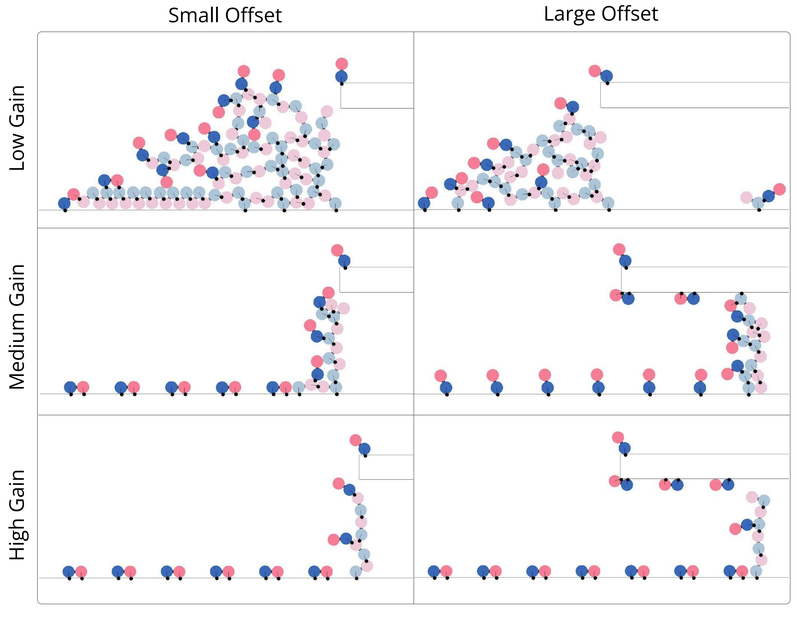
Flippybots use this method to build a structure and reach an arbitrary location.

Key Insight

We demonstrate that robotic collectives can form emergent structures based on simple rules and that we can induce the formation of a structure at a particular location by giving robot agents a goal location and dynamic speed control.

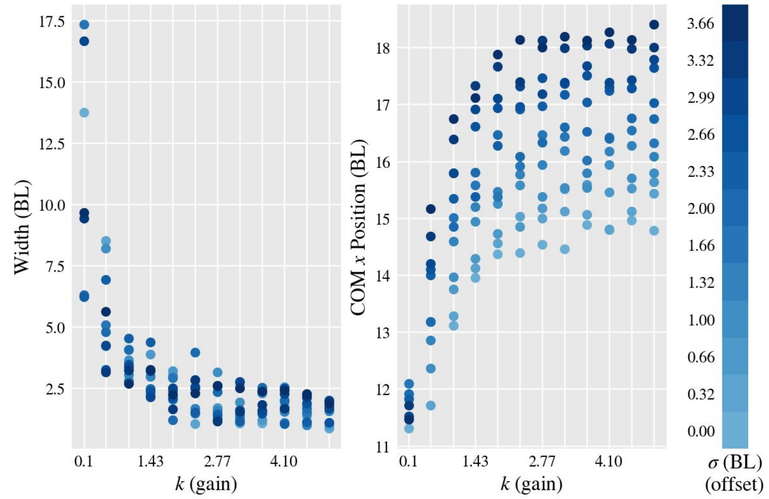
Experiments

2D simulated *Flippybots* flip forward to move across a terrain. A goal is set at the top of a floating island, robots change their speed as they approach the goal. We vary a *gain (k)* and *offset (σ)* in the robots' speed control function to demonstrate how these factors influence characteristics of the formed structure.



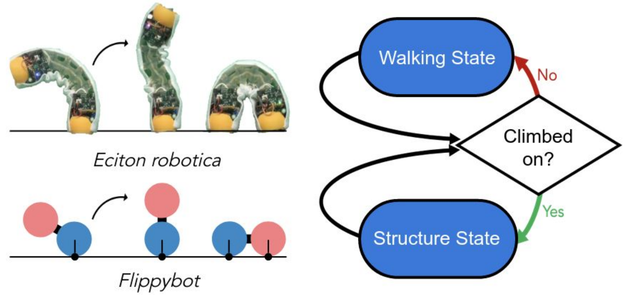
Varying gain and offset influences the size and position of the emergent structure

Structure Characteristics



The emergent structure's width and the x position of its center of mass (COM) are plotted in *flippybot* body-lengths (BL) as a function of *k* (gain) and *σ* (offset).

Agent Model



Flippybot and *Eciton Robotica* both move forward by flipping and use the same state machine to determine their local interactions. Robots flip forward unless they are contacted by another robot. Once "climbed on," they remain still and join the structure.