Brainless bristlebots found to exhibit swarming behavior

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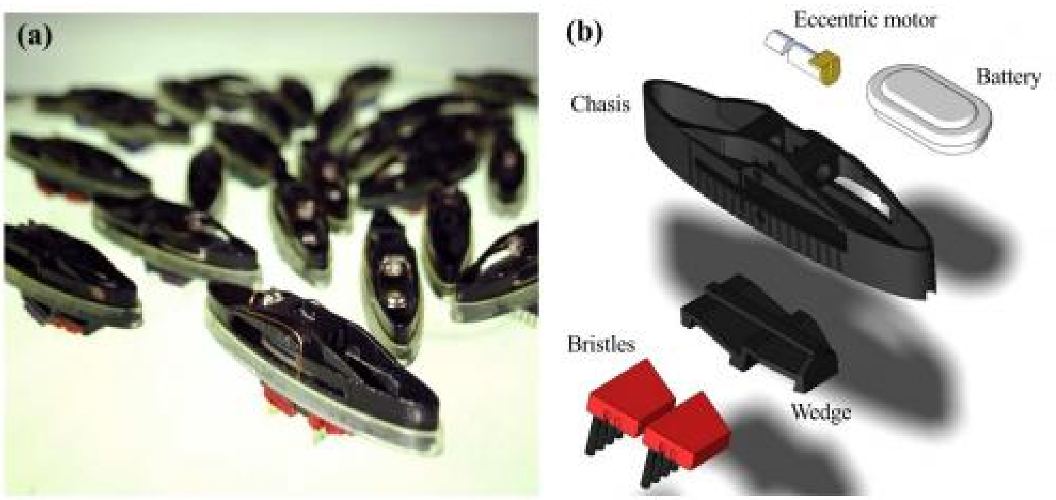

(a) A collection of the BBots used in the experiment. (b) Schematic of an individual BBot. A plastic chassis is connected to a pair of toothbrushes via a slanted wedge. An eccentric motor is positioned on the top side of the device and is powered by a VARTA rechargeable button-cell battery. Credit: L. Giomi et al, arXiv:1302.5952

(Phys.org) —A robot research team at Harvard University has found that tiny robots that move by vibrating bristle strands when grouped together, form spontaneously into groups—exhibiting, what the team describes as swarming behavior. In their paper the team has uploaded to the preprint server *arXiv*, the group describes how they built tiny robots out of tiny vibrating motors, a battery and bristles and then allowed them to roam randomly, and found that once a certain number were placed in a confined space, they grouped together forming what looked like a swarm.

Swarming in the natural world has been studied for years by scientists trying to understand how a school of fish can all turn as one, for example, or how seemingly simple-minded termites can build complex nests. In the lab, robot researchers have built tiny bots (with tiny processor brains) that are able to exhibit some of the same behaviors as the real life organisms they are meant to copy, but they have sensors onboard. Now, in this new effort, the team of researchers has found that some degree of swarming can occur without its members having any sort of sensing ability or intelligence at all.

They built little robots out of toothbrush bristles, a pager vibrator motor, a small frame and a battery—no sensors, processing chips or anything else that could be construed as providing intelligence or feedback sensing. When one of the robots is placed on a flat surface and turned on, it, it can move courtesy of the bristles, they are angled—when vibrating they push the bot forward. The team built two types of the bots, one kind simply moves around in a spinning motion, the other moves directly forward. When the bristlebots, as the team calls them, are placed together in a confined space, they run into each other and wind up moving around in chaotic fashion. But when more are added, they reach some tipping point and begin to bunch up, forming a crowd, or in this case, what the researchers call a swarm. Sometimes the swarm remains where it is, sometimes it moves, and sometimes those on the periphery leave and come back later to join the swarm again—all behavior that happens due to the properties of the bristle-bots themselves, working in apparent random fashion. Why they bunch, has yet to be explained.

More information: Swarming, swirling and stasis in sequestered bristle-bots, arXiv:1302.5952 [cond-mat.soft] arxiv.org/abs/1302.5952

Abstract
The collective ability of organisms to move coherently in space and time is ubiquitous in any group of autonomous agents that can move and sense each other and the environment. Here we investigate the origin of collective motion and its loss using macroscopic self-propelled Bristle-Bots, simple automata made from a toothbrush and powered by an onboard cell phone vibrator-motor, that can sense each other through shape-dependent local interactions, and can also sense the environment non-locally via the effects of confinement and substrate topography. We show that when Bristle-Bots are confined to a limited arena with a soft boundary, increasing the density drives a transition from a disordered and uncoordinated motion to organized collective motion either as a swirling cluster or a collective dynamical stasis. This transition is regulated by a single parameter, the relative magnitude of spinning and walking in a single automaton. We explain this using quantitative experiments and simulations that emphasize the role of the agent shape, environment, and confinement via boundaries. Our study shows how the behavioral repertoire of these physically interacting automatons controlled by one parameter translates into the mechanical intelligence of swarms.

via [IEEE]

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