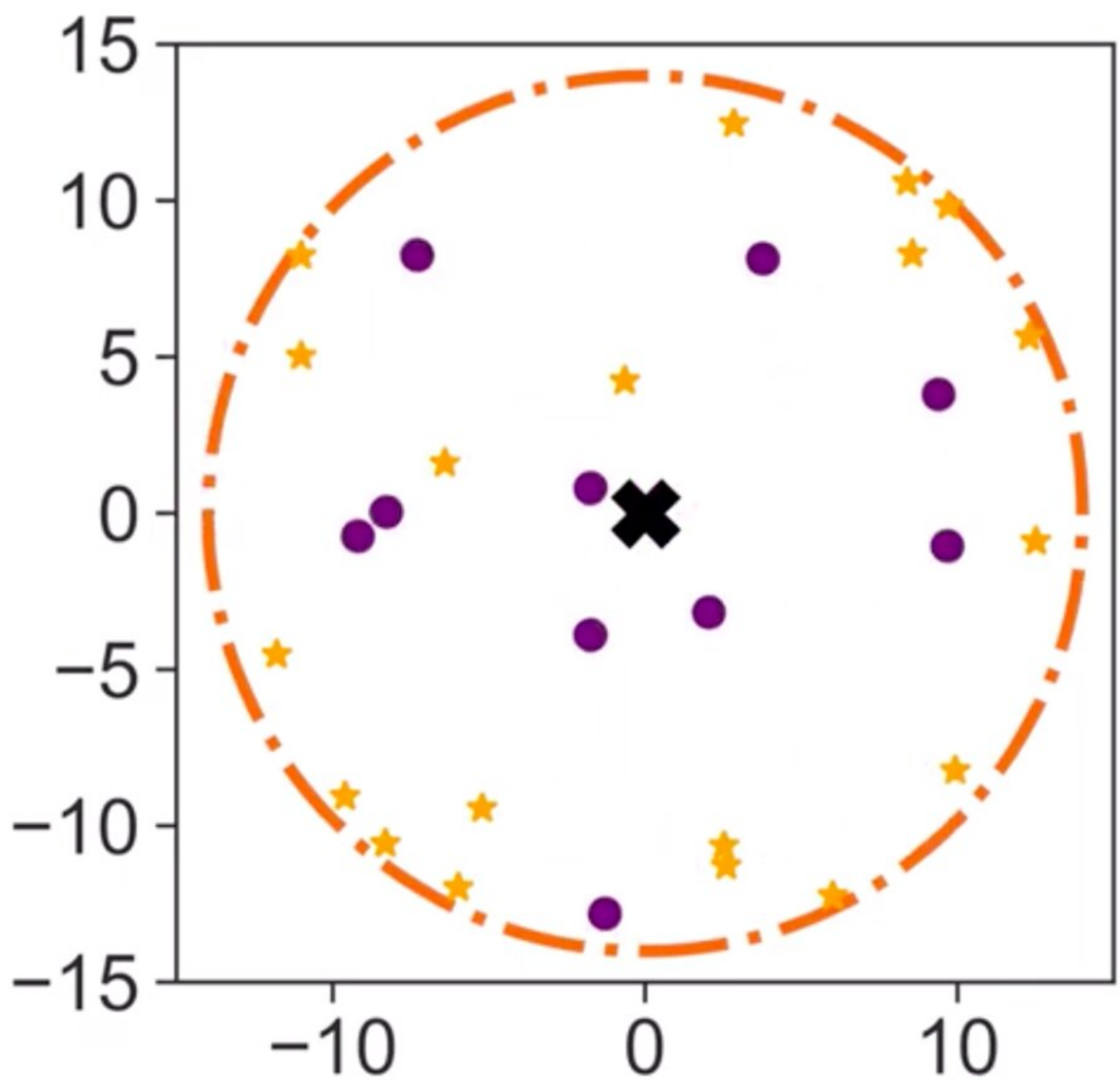
A swarm robotics approach inspired by behavior observed in microorganisms

July 9 2019, by Ingrid Fadelli



Credit: Obute, Dogar & Boyle.

Many animals and microorganisms are able to complete complex tasks, such as finding food or building nests, as a team, or "swarm." One of the most obvious examples of this is bees, as their survival as a group heavily depends upon cooperation with other members of their colony. Over the past few years, a growing number of researchers have tried to reproduce these fascinating group dynamics in robots, giving rise to an area of study called swarm robotics.

Researchers at the University of Leeds have recently presented a new swarm robotics approach called chemotaxis, inspired by a particular behavior observed in microorganisms,. Their study, pre-published on arXiv, stems from the authors' interest in the survival of simple invertebrate animals in dynamic real-world environments, and how these strategies can be applied in robots.

"During my Ph.D. and first postdoctoral fellowship, I studied the locomotion system of a small worm called *C. elegans* (a popular model organism), and successfully applied what I learned to control the locomotion of a snake-like robot," Jordan Boyle, one of the researchers who carried out the study, told TechXplore. "The current work is inspired by the same organism, but this time, looking at its higher level behavior—specifically the way it navigates toward food sources using its sense of smell."

In the absence of sensory inputs, *C. elegans* worms typically move forward, but make large turns at random time intervals. If they sense that a "positive" smell is getting stronger as they move in a particular direction, the frequency of their turns decreases. Inversely, when the "positive" or "desired" smell becomes weaker, there is a greater probability that they will turn. This behavior, known as chemotaxis, ultimately allows them to gravitate toward locations where a desired sensory stimulus is at its peak. In their study, Boyle, his colleague Mehmet Dogar and Ph.D. student Simon Obute set out to replicate this group strategy in robotic swarms and evaluate its usefulness.

"A key benefit of this strategy is that it only needs a single analogue sensor, because gradients are detected over time as the animal moves," Boyle explained. "In our work, we have replaced smell with sound, because it's much easier to create and sense with a robot, and also gets weaker as you get further from the source," Boyle explained. "The key advantages of this approach is that it allows a group of swarm robots to be confined to a specific area (i.e. around a sound source) without needing a physical boundary, mapping capability or complex sensory systems."

Using an algorithm that they developed, the researchers applied chemotaxis to a swarm of exploration robots, ultimately prompting them to return to a given work area around their nest situated within an unlimited environment. They tested their performance, and thus the effectiveness of their approach, in a series of simulation and hardware validation experiments. Although their results are primarily based on simulations and not real-world implementations, the researchers found that they succeeded in incorporating accurate models of sound propagation.

"Our hardware results are preliminary but promising at this point," Boyle said. "Ultimately, this work could be relevant to physical swarms consisting of very small, cheap robots with limited sensory and computational capabilities. While practical, real-world deployment of robot swarms is still some way off, they have potential in many applications."

In the future, experiments with real robots could help to ascertain the effectiveness of this new bio-inspired approach. If these tests yield positive results, the algorithm developed by Boyle and his colleagues could eventually be used to enhance the navigation and orientation strategies of robotic swarms, particularly when the environments they are navigating are not clearly mapped or defined.

Obute is now working on integrating chemotaxis into more complex swarm robotic systems, in simulations as well as in a few hardware experiments. His final Ph.D. project specifically investigates the possibility of using swarm robots for urban litter collection. Boyle, on the other hand, plans to continue exploring biological strategies that could prove particularly useful for robotics applications.

"Currently, I'm interested in applying similar techniques to a major project I'm involved in that aims to develop robot systems for monitoring the integrity of sewer and water distribution networks," Boyle said.

More information: Chemotaxis based virtual fence for swarm robots in unbounded environments. arXiv:1906.07492 [cs.RO]. arxiv.org/abs/1906.07492

Citation: A swarm robotics approach inspired by behavior observed in microorganisms (2019, July 9) retrieved 3 May 2024 from https://techxplore.com/news/2019-07-swarm-robotics-approach-behavior-microorganisms.html