Observations of robotic swarm behavior can help workers safely navigate disaster sites

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Using biologically inspired robotic swarms consisting of large groups of robots that have been programmed to operate cooperatively, much like individuals in an ant or bee colony, scientists from the University of Colorado demonstrate that the locally observed distribution of robots can be correlated to the location of environmental features, such as exits in office-like environments. The study's findings were published in *IEEE/CAA Journal of Automatica Sinica*.

According to Megan Emmons from Colorado State University, U.S., this is an important study to establish the feasibility of using local observations of a swarm's distribution—observing how individual robots in a swarm cluster together in certain areas—to infer global environmental features such as building exits. "There is a wide variety of potential real-world applications once the proposed approach is developed further but the focus of our work is to assist rescue workers in navigating disaster sites safely and robustly," said Emmons.

Individual robots within a swarm are programmed with simplistic individual behaviors, lack the ability to communicate, relying solely on random motion to explore their surroundings. But as they interact with the environment and other robots in the swarm, more complex swarm behaviors start to emerge—a phenomenon known as emergent swarm behaviors.

This "swarm" behavior can include traits such as group consensus, task allocation, and localization—the process of determining where a robot is located with respect to its environment, enabling it to make decisions regarding future actions—all of which have applications in environmental exploration. But for this study, the authors focused on the local distribution of the robots and show how these observations can be correlated to environmental features of the surroundings being explored. This in turn can help identify obstructions or openings in environments such as office buildings to help trapped office workers navigate their way out of a collapsed building, for example.

Currently, robotic exploration poses various challenges when used in disaster situations due to unreliable communication, limited sensing, and high failure rates of robots. The method used in this baseline feasibility study overcomes these limitations and confirms that a minimally equipped robotic swarm that lacks communication or sensors can still provide important information regarding environmental features in a simulated disaster scenario. One only needs to locally observe robot density in order to predict environmental features.

"Swarms offer an incredible increase in robustness," said Emmons. "From this work, we demonstrate that even in a worst-case scenario where you lose 9 out of 10 robots, have zero communication, and the robots are limited to purely random motion—an environment can still be classified with better-than-random accuracy."

"Future work will focus on extending this work more rigorously into domains where existing robotic solutions are known to fail," said Emmons.

More information: Classifying Environmental Features From Local Observations of Emergent Swarm Behavior, *IEEE/CAA Journal of Automatica Sinica*, www.ieee-jas.org/article/doi/1 … 109/JAS.2020.1003129

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