NASA's Ant-Inspired Swarmie Robots

Prior Work:

- University of New Mexico's (UNM) iAnt project created a swarm of small, low-cost, autonomous robots.
- UNM added ant-inspired foraging behaviors to the iAnt robots.
  - The robots find and collect resources in an unknown environment and return them to a central site.
  - The robots have no prior knowledge of their environment.
  - The robots use trails as a simple indirect communication strategy.
- UNM created a genetic algorithm to evolve the most efficient behaviors for the iAnt system.

Swarmies:

- We designed and created an improved and more capable autonomous mobile robot platform, which we call a Swarmie, that is still small and is still low-cost.
- Swarmies are designed to be more easily accessible to researchers, scientists, and others.
- We added new in-situ resource utilization (ISRU) related parameters and behaviors to the Swarmies and also to the existing genetic algorithm to advance the system closer to a realistic future NASA mission.
  - Environmental obstacles of various distributions and numbers were added.
  - Robot battery discharging and battery charging scenarios were also added.
- The Swarmies are essentially a low-cost ground-based research platform that can be used to demonstrate ISRU mission techniques and technologies.

Results:

- We successfully demonstrated that in an obstacle laden environment, trails used as a simple indirect communication strategy can allow a swarm of small, low-cost robots to collect resources in an optimal manner when coupled with a genetic algorithm to evolve behaviors.
- We successfully demonstrated that an autonomous robot swarm can evolve battery charging behavior using a genetic algorithm to minimize or eliminate dead robots due to insufficient charge.
- We successfully elevated the idea of ISRU related swarming robotics behaviors coupled with genetic software algorithms from the conceptual and theoretical phase (NASA technical readiness level 2) to the experimental and proof of concept phase (NASA technical readiness level 3).

Conclusions:

- We have demonstrated that this system is error tolerant, adaptable to different robot types, and is scalable in both environment size and numbers of robots.
- This autonomous mobile robot system is a foundation for future research into the suitability of robot swarms and evolutionary algorithms for ISRU missions.
- All of these robot behaviors are performed in real-time with a small, low-cost onboard computer and small memory footprint. The Swarmie robot platform is constructed using commercial off-the-shelf parts and 3D printed parts with a total cost of less than $1,500 per robot.
- The low-cost of this type of system removes one of the barriers typically associated with swarm research and swarm operations.

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Meet the Swarmies!

Multi-Agent

Swarmies are small, simple and cheap rovers that are designed to work together to find and collect resources.

Genetic Algorithm

The University of New Mexico Biological Computation Lab has created a genetic algorithm that we are extending and testing on these Swarmie robots.

The genetic algorithm adapts to the environment and mimics the process of natural selection.

The goal is to optimize the behavior of the robots during their missions.

Biologically Inspired

The robot behavior and onboard software was designed by studying the foraging behavior of ants out in the wild.

Each ant is small and simple, but a colony of ants can find and collect a lot of food and do so efficiently.