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A Self-Assembly Strategy for Swarm Robots

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In nature it is not uncommon for insects, such as ants, to come together to cross an obstacle without prior knowledge of the structure. A number of approaches have been reported where swarm robots are assembled into structures to cross a gap, avoid holes, or climb obstacles by applying a range of self-assembly techniques [1], [2], [3]. In this work we consider a number of related challenges:

- Developing an effective, reliable, algorithm that will allow a swarm of small mobile robots to autonomously construct a structure to cross a gap, without any a-priori knowledge.
- Developing a practical swarm robot that incorporates a low cost coupling mechanism, capable of autonomous construction using the developed algorithm.

In the poster we will present the following scenario, a small number of homogenous swarm robots are required to locate a target by traversing a gap that separates two halves of an arena. They have no a-priori knowledge of the gap's location or width. In addition any member of the swarm can autonomously act as the lead robot for the structure's construction.

In the developed algorithm, once any mobile robot detects the gap (this robot is now termed the *seed robot*), it broadcasts a *gap found* signal to all other members of the swarm, who immediately stop moving. Then the closest robot moves forward to the rear of seed robot and rigidly couples to form a simple line structure. As the number of robots in the structure passes a preset parameter, the structure moves towards across the gap, with the other robots joining the structure to maintain structural stability. When the structure has crossed the gap and the number of robots at the opposite side is sufficient to maintain stability, the front robot uncouples from the structure. The process continues with additional mobile robots joining the structure, with and the structure continually moving forwards, Figure 1. The process continues until there is no more mobile robot available to join the structure. The structure will continue to advance at which point all the mobile robots have crossed the gap.

In the event of the structure not satisfying the stability criteria or not having enough swarm member to cross the gap, the structure will retreat to prevent the loss or damage to the robots. This will give the opportunity for a shorter crossing to be located.

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The simulations have clearly demonstrated the robustness of this approach, with swarms of various sizes crossing a range of gap widths. As the model currently does not include a physics engine, the simulation assumes the robots are of minimal weight and the coupling is infinitely stiff. To allow the practical realization of this challenge we are developing a lightweight, compact, locking mechanism that will allow any number of small swarm robots to autonomously form a rigid structure. The mechanism will be able to accommodate the positional and orientation errors that can be presented with low cost differentially steered mobile platform.

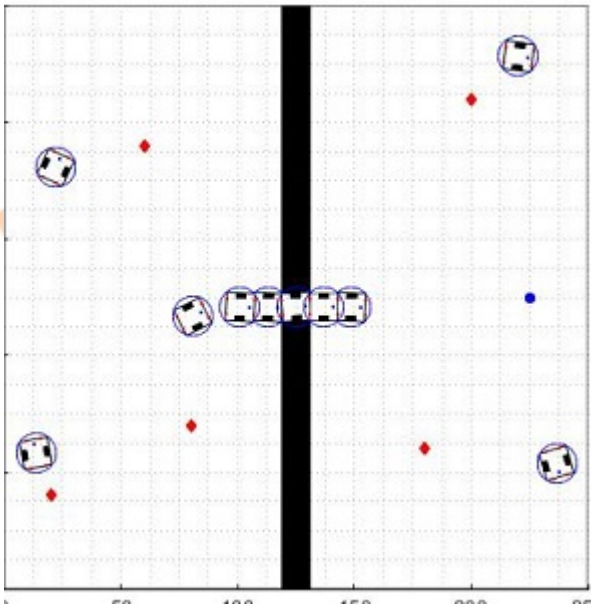

Fig. 1. A swarm of ten robots are moving from the left of the arena to the right, across the gap. Two robots have successfully traversed the gap and have decoupled, meanwhile the process of self-assembly to form a structure still continues, where a robot is moving towards the structure to join, allowing the structure to advance.

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