Swarm Robotics using the Wolf Pack Algorithm

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1 Introduction

The Wolf Pack Algorithm is an optimization algorithm inspired by the behavior of wolf packs. It has been applied to swarm robotics, where a group of robots collaboratively solve complex tasks. This report explores the application of the Wolf Pack Algorithm in swarm robotics and its impact on the behavior and performance of the swarm.

2 Wolf Pack Behavior

In a wolf pack, the lead wolf serves as the decision maker, commanding other wolves. The lead wolf determines the overall strategy and guides the pack towards the task at hand. The other wolves have specialized roles, such as the scout wolf and the ferocious wolf.

2.1 Scout Wolf

Scout wolves are elite members of the pack who are responsible for scouting the environment and searching for prey. If the scout wolf finds prey, it howls to communicate the discovery to the lead wolf. This communication is crucial for coordinating the pack's hunting behavior.

2.2 Ferocious Wolf

Ferocious wolves play a critical role in the pack's hunting behavior. Once the prey is located, the ferocious wolves join the hunt and work together to capture the prey. They rely on their instinct and aggression to pursue and subdue the target.

3 Sense and Communication

Wolves have a keen sense of smell, which they use to detect the presence of prey. In swarm robotics, robots can be equipped with similar sensing capabilities, allowing them to detect specific signals or environmental cues. For example, robots can sense the proximity of the prey based on the strength of a particular scent. Once a robot detects the prey, it sends a signal to the lead robot, who then issues commands to the rest of the swarm.

4 Algorithm Steps

The Wolf Pack Algorithm consists of several steps to optimize the behavior and performance of the swarm. Here is a simplified overview:

1. Initialize parameters: This includes setting the initial positions of the artificial wolves, the number of wolves in the swarm, the maximum number of iterations, and the maximum number of repetitions in scouting behavior.

2. Scout Behavior: The n-1 wolves, excluding the lead wolf, act as artificial scout wolves. They engage in scouting behavior until a condition is met, such as the scent detected by the scout wolf (yi) being greater than the scent detected by the lead wolf (ylead) or reaching the maximum number of repetitions. This scouting behavior allows the wolves to search for prey or relevant targets.

3. Prey Found: If the prey is found, the n-1 wolves act as artificial wolves and gather towards the lead wolf. This grouping behavior is crucial for coordinated hunting and capturing of the prey.

4. Position Update: The positions of the artificial wolves, who take on besieging behavior, are updated based on the specific algorithm rules and objectives.

5. Leader Position Update: The position of the lead wolf is updated using the winner-takes-all generating rule, where the best solution or position is selected. Additionally, the wolf pack is updated using the population renewing rule, allowing for exploration and adaptation.

6. Termination: The algorithm iterates through steps 2-5 until either the maximum number of iterations is reached or a desired level of precision or optimal solution is achieved.

5 Conclusion

The Wolf Pack Algorithm offers a valuable approach to swarm robotics, leveraging the behavior and communication patterns observed in wolf packs. By incorporating concepts such as the lead wolf, scout wolves, ferocious wolves, sensing, and a structured algorithmic approach, the Wolf Pack Algorithm enables efficient task allocation, coordination, and collaboration within the swarm. The algorithm's principles and mechanisms provide a framework for improving the behavior and performance of swarm robotics systems, leading to advancements in various fields such as exploration, navigation, and collective decision-making.