SWARM ROBOTICS

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Abstract: Swarm intelligence (SI) is an artificial intelligence technique based around the study of collective behavior in decentralized, self-organized systems. The concept of SWARM ROBOTICS is based on this basis of grouping of multiple robots or devices and perform the desired task. Swarm robotics is a new approach to the coordination of multi-robot systems which consist of large numbers of mostly simple physical robots. This approach emerged on the field of artificial swarm intelligence, as well as the biological studies of insects, ants and other fields in nature, where swarm behavior occurs.

The three major advantages of SI Robotic approach, since SI systems have the following properties:

1) Scalable: The control architecture of each robot is same, no matter the number of robots.

2) Flexible: The robots may be inserted or deleted to/from the environment, no requirement for any change in the task operation.

3) Robust: Not only due to unit redundancy but also through minimalist unit design.

Swarm Robotics have varied applications in all fields like communication, military services, civil engineering, building construction etc.

Keywords: Swarm Intelligence, Software from insects, working of swarm robotics

INTRODUCTION

Swarm robotics is the study of how large number of relatively simple physically embodied agents can be designed such that a desired collective behavior emerges from the local interactions among agents and between the agents and the environment. It is a novel approach to the coordination of large numbers of robots. It is inspired from the observation of social insect's ants, termites, wasps and bees which stand as fascinating examples of how a large number of simple individuals can interact to create collectively intelligent systems.

Social insects are known to coordinate their actions to accomplish tasks that are beyond the capabilities of a single individual: termites build large and complex mounds, army ants organize impressive foraging raids, and ants can collectively carry large preys. Such coordination capabilities are still beyond the reach of current multi-robot systems.

As robots become more and more useful, multiple robots working together on a single task will become common place. Many of the most useful applications of robots are particularly well suited to this "swarm" approach. Groups of robots can perform these tasks more efficiently, and can perform them in fundamentally difficult to program and co-ordinate.

Swarm robots are more than just networks of independent agents, they are potentially reconfigurable networks of communicating agents capable of coordinated sensing and interaction with the environment.

WORKING OF SWARM

Swarm Intelligence

Swarm intelligence describes the way that complex behaviors can arise from large numbers of individual agents each following very simple rules. For example, ants use the approach to find the most efficient route to the food source. Individual ants do nothing more than follow the strongest pheromone trail left by other ants. But, by repeated process of trial and error by many ants, the best route to the food is quickly revealed.

Software from insects

Local interactions between nearby robots are being used to produce large scale group behaviors from the entire swarm. Ants, bees and termites are beautifully engineered examples of this kind of software in use. These insects do not use centralized communication; there is no strict hierarchy, and no one in charge.

However, developing swarm software from the "top down", i.e., by starting with the group application and trying to determine the individual behaviors that it arises from, is very difficult. Instead a "group behavior building blocks" that can be combined to form larger, more complex applications are being developed. The robots use these behaviors to communicate, cooperate, and move relative to each other. Some behaviors are simple, like following, dispersing, and counting. Some are more complex, like dynamic task assignment, temporal synchronization, and gradient tree navigation. They are designed to produce predictable outcomes when used individually, are when combined with other library behaviors, allowing group applications to be constructed much more easily.

TYPES OF SWARM

1. Modular Robots

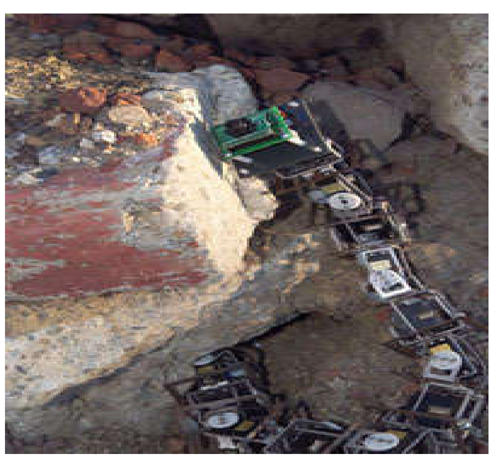
A module is essentially a small, relatively simple robot or piece of a robot. Modular robots are made of lots of these small, identical modules. A modular robot can consist of a few modules or many, depending on the robot's design and the task it needs to perform. Some modular robots currently exist only as computer simulations; others are still in the early stages of development.

But they all operate on the same basic principle- lots of little robots can combine to create one big one.

2. Chain robots

Chain robots are long chains that can connect to one another at specific points. Depending on the number of chains and where they connect, these robots can resemble snakes or spiders. They can also become rolling loops or bipedal, walking robots. A set of modular chains could navigate an obstacle course by crawling through a tunnel as a snake, crossing rocky terrain as a spider and riding a tricycle across a bridge as a biped. Examples of chain robots are Palo Alto Research Center's (PARC) Polybot and Polypod and NASA's snakebot. Most need a human or, in theory, another robot, to manually secure the connections with screws.

A Telecube G2 module fully contracted.



NASA's Snakebot

3. **Asteroid eaters: Robots to hunt space rocks, protect Earth.**

The best way to stop an asteroid from wiping out earth is to lob a few nuclear missiles at the rocky beast or blow it apart from the inside with megaton bombs. But the more efficient weapon can be a swarm of nuclear powered robots that could drill into asteroid and hurl chunks of it into space with enough force to gradually push it into non-Earth impacting course

4. **Madmen swarm**

Since each MADMEN robot could only give a small push to an asteroid over time, SEI researchers envision sending an entire fleet of them to a potential Earth impactor. The key, is said to have a lander on each face of an asteroid working together autonomously to push the space rock in one direction as it tumbles through space, each lander "firing" as it comes into position

5. **Nubot**

Nubot is an abbreviation for “Nucleic Acid Robots.” Nubots are synthetic robotics devices at the Nano scale. Representative nubots include several DNA walkers.

6. **The water skater**

The machine is over 7 centimeters long, and looks and moves very like a real insect. It has six legs: two front, two back and two out to the side, which row back and forth to propel it forward. Made of a light weight metal, the robot weighs only 0.6 grams. But the lightness alone is not what keeps it walking on water.

This robot has water-resistant legs to make Sure it floats in water

FEATURES AND APPLICATIONS

• The research of Swarm robotics is to study the design of robots, their physical body and their

Controlling behaviours.

• It is inspired but not limited by the emergent behaviour observed in social insects, called Swarm

Intelligence.

• Relatively simple individual rules can produce a large set of complex swarm behaviours.

• A key-component is the communication between the members of the group that build a system of constant feedback.

• The Swarm behaviour involves constant change of individuals in cooperation with others, as

Well as the behaviour of the whole group.

• Unlike distributed robotic systems in general, Swarm robotics emphasizes a large number of

Robots, and promotes scalability, for instance by using only local communication. That local

Communication for example can be achieved by wireless transmission systems, like radio frequency or infrared.

• Video tracking is an essential tool for systematically studying swarm-behaviour, even though

Other tracking methods are available.

• Recently Bristol robotics laboratory developed an ultrasonic position tracking system for

Swarm research purposes.

• Both miniaturization and cost are key-factors in swarm robotics. These are the constraints

In building large groups of robotics; therefore the simplicity of the individual team member

Should be emphasized. This should motivate a swarm-intelligent approach to achieve meaningful behaviour at swarm-level, instead of the individual level.

• Potential applications for swarm roboticsinclude tasks that demand for miniaturization (Nan robotics, microbotics), like distributed sensing tasks in micro-machinery or the human body.

• On the other hand swarm robotics can be suited to tasks that demand cheap designs, for instance mining tasks or agricultural foraging tasks.

• Also some artists use swarm robotic techniques to realize new forms of interactive art

CONCLUSION

This concept has various applications in huge industries like Automobile Industry and Warehousing. At present, while performing a particular task as one robot is performing its work the rest of the robots are idle waiting for the first robot to complete its work which results in slow processing of the assigned task. Using the concept of 'Swarm Robotics' less number of robots can complete the assigned task collectively in less amount of time which also in turn increases the efficiency and the output at same time reducing the cost.Robots are going to be an important part of the future. Once robots are useful, groups of robots are the next step, and will have tremendous potential to benefit mankind. Software designed to run on large groups of robots is the key needed to unlock this potential

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