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Swarm Optimization with Slave Distribution

Rajashree Kumkar
Fr.C.R.Institute of Technology,Vashi,Navi Mumbai, India

Vinit Rodrigues
Don Bosco Institute of Technology, Ghatkopar, Mumbai, India

Aishwarya Patil
Fr.C.R.Institute of Technology,Vashi,Navi Mumbai, India

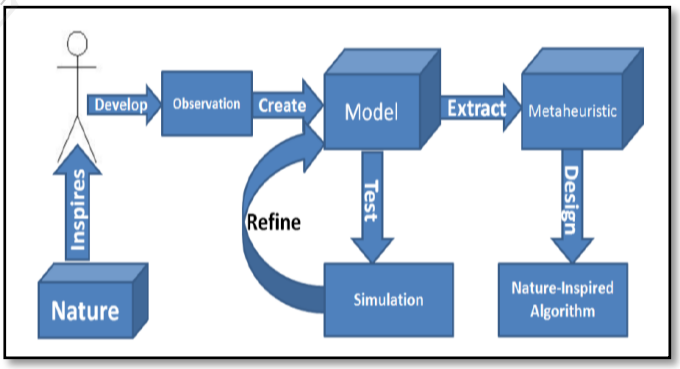
Trupti Lotlikar
Fr.C.R.Institute of Technology,Vashi,Navi Mumbai, India

Abstract-Swarm Robotics is a new approach to the co-ordination of multi-robot system which takes inspiration from social insects . It is about the internal and external structure of a Robot and its behaviour under certain conditions. It has three desired characteristics for multi-Robot system: *Robustness, Flexibility, scalability*. In this paper we are proposing a new mechanism which describes how the slave robots will be divided into small clusters by themselves. Then one master will be assigned to each cluster according to the priority assigned to them. We will be presenting a mechanism in which cluster will co-ordinate among themselves and complete the task efficiently. For controlling the action of each master, there will be one permanent master. Permanent master will give instructions to other masters by passing signals. Each cluster will have tasks assigned to them. If any cluster completes its task early then they spread out and joins other cluster to complete their assigned task. So that the total work completion rate will increase.

***Keywords*-Master, Slave , Permanent master, Flexibility, Signal passing.**

I. INTRODUCTION

Cooperative control of multi-robotic systems has been studied extensively in recent years especially for some tasks that cannot be handled by one single robot. It can improve skills of robots and enlarge application fields of robots. These robots can sense its surrounding environment through different typesof sensors mounted on-board within the robot platform. Theapplicability of the robotic swarm will increase as theadvancement of the sensor technologies.The work aims at minimizing the human intervention for taskaccomplishment. Human can monitor the overall progress ofthe work from a computer screen or others means of datalogging.Now what is swarm Robotics ?-Swarm robotics is the study of how a large number of relatively simple physically embodied agents can be designed such that a desired collective behaviour emerge
from the local interactions among the agents and between the agents and the environment." Thebasic idea of swarm robotics is to divide a complex taskand distribute them effectively among the members. It is basically inspired
from observation of insects – ants, termites, wasps, bees.
To achieve such coordination capabilities swarm robotics has many underlying issues that need to be addressedin order to create a viable system. Communication, pathplanning, tracking, workload distribution, choice of sensors,system reliability, and scalability are just some of the mostbasic issues that need to be addressed. This work addressesan effective use of a radio frequency communication system among a swarm of mobile robots and navigating to the pointof interest effectively.Swarm intelligence(SI) as defined by
Bonabeau, Dorigo and Theraulaz is "any attempt to design algorithms or distributed problem-solving devices inspired by the collective behaviour of social insect colonies
and other animal societies".



general framework used to move from a natural phenomenon to a nature-inspired algorithm.

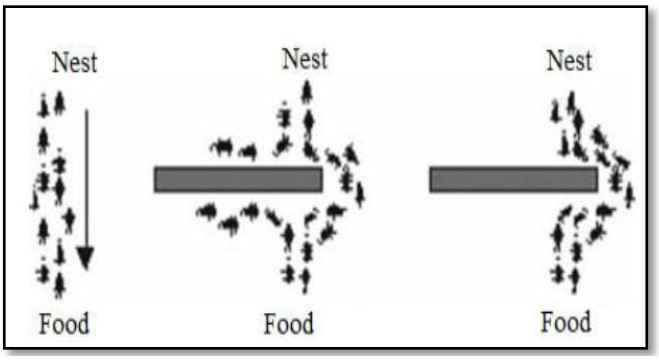
II. AVAILABLE ALGORITHMS:

2.1 Particle swarm optimization:

Particle swarm optimization is an algorithm modelled on swarm intelligence that finds a solution to anoptimization problem in a searchspace, or model and predict social behaviour in the presence of objectives.7

2.2 Ant colony optimization:

The ant colony optimization algorithm is a probabilistic technique for solving computational problems which can be reduced to finding good paths through graphs.



Ants‘ stigmergic behavior in finding the shortest route between food and nest

2.3Artificial bee colony algorithm:
The artificial bee colony algorithm is an optimization algorithm based on the intelligent foraging behavior of honey bee swarm

2.4 The Bees Algorithm:
The Bees Algorithm is a population-based search algorithm which was developed in 2005. It mimics the food foraging behavior of honey bee colonies.

2.5 Artificial immune systems:
Artificial immune systems are a class of computationally intelligent systems inspired by the principles and processes of the vertebrate immune system

2.6 Grey wolf optimizer:
The GWO algorithm mimics the leadership hierarchy and hunting mechanism of grey wolves in nature.

2.7 Bat algorithm:
The Bat algorithm is based on the echolocation behavior of micro-bats with varying pulse rates of emission and loudness

2.8 Gravitational search algorithm:
GSA is an optimization algorithm based on the law of gravity and mass interactions.This algorithm is based on the Newtonian gravity: "Every particle in the universe attracts every other particle with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them".

2.9 Altruism algorithm:
This algorithm shows how altruism in a swarm of entities can, over time, evolve and result in more effective swarm behavior.

2.10 Intelligent water drops:
IWD algorithm is a nature-inspired swarm-based optimization algorithm which attempts to mimic the behavior of natural water drops in rivers.

III. PROPOSED SYSTEM:

Swarm Robotics which has developed and been practiced today.Though it is a smart solution for many complicated task and very high accuracy can be achieved. But still there is major problem in dividing a slave into a appropriate number of clusters for accurate working and assign one master to each cluster. This problem can be solved by algorithm we are providing here.

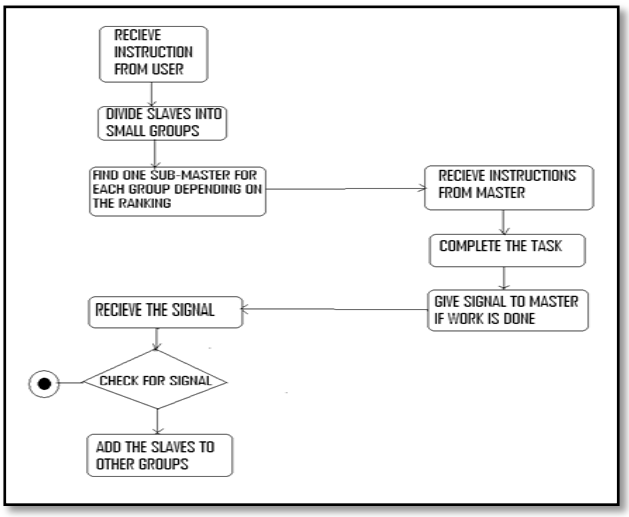
3.1 DISTRIBUTION OF SLAVES AMONG MASTERS:

Algorithm:
1.Consider there are ‘n’ number of slaves and ‘m’ number of clusters required.
2. Calculate a= n / m and b= n % m
3. Give ‘a’ number of slaves to each group
4. Assign master to each group which will be done by permanent master.
5. Now distribute ‘b’ number of slaves according to rank provided to its master.
6. If ‘p’ number of slaves get added to a group then master will check the amount of work done by each cluster and then distribute the slaves as given below:
a’=(n+p)/m and b’=(n + p)%m Here b’ number of slaves will get added according to the priority given by permanent master.

3.2 WORKING OF A MASTERS:

As we know the entire group of robots is divided into clusters and the algorithm for this process is as given above.
The sub-masters of each group are under control of one permanent master. The user will give instructions to the permanent master. According to the instructions he will distribute work among the masters of each group. The sub-master will receive instructions and ask slaves tocomplete the work. As soon as slaves complete their tasks they report their master. If all the work assigned to a master of a particular cluster is completed then he will send a signal to the permanent master.

MASTER SUB-MASTER



WORKING OF A MASTER

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The tasks assigned to all clusters can be different. In that case one cluster may complete its task earlier than other cluster. The master of that cluster will send a signal to the permanent master. Permanent master will check for work done by a other

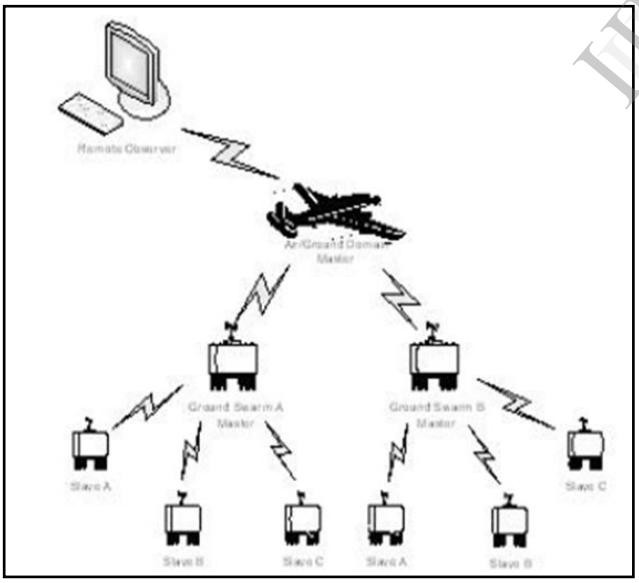
clusters. If other cluster's work is still incomplete then the permanent master will request to the master of that cluster to divide his slaves and make them work under some other master to complete their tasks

IV. COMMUNICATION LINK:

Communication works different in most robotics swarms depending mostly on factors like the environment the size of the robots the budget of the project and on the limitations set by creators or other instances. The larger the robots are, the more possibilities are there for building up a properly working communication between the robots. Some ways of communication are Bluetooth, wireless LAN, communication via the environment or via infrared LED's.

4.1 IMPORTANT FACTORS OF COMMUNICATION:

4.1.1 Communication Range:
Communication range should be appropriate enough, i.e. it should not be too short or big. If range is too short then robots can't communicate or only if they are nearby. If the robot has to listen to every message that was sent.
4.1.2 Communication area:
In ideal case the robot covers an area of 360º.
4.1.3 Length of message:
Short message produce a large overhead due to the header information normally sent with every message. Large message tend to fail more often than short once.
4.1.4 Propagation time:
The time it takes to send a message through the network.



Master-submaster-slave communication

V. APPLICATION:

The properties of swarm robotics systems make them appealing in several potential application domains. For example:the use of robot for tackling dangerous tasks like search and rescue, cleaning up toxic spills.
Another application domain for swarm robotics aretasks that have to be accomplished in large or unstructured environment that can be used to control the robot. Eg.: no available communication network or global localization system. Swarm robots are employed for such a applications because they are able to act autonomously without the need of any infrastructure or external co-ordination.
Swarm robotics has been used to investigate via controlled experiments, the conditions under which some complex social behaviours might result out of an evolutionary process. For example: swarm robots have been used to study the evolution of communication and collective decision making.

VI. ADVANTAGES:

6.1 Robustness: Robust to environmental disturbances and individual swarm member's faults.
6.2 Flexibility:Can coordinate their actions to achievesomething
6.3 Scalability: SI systems are highly scalable; their impressive abilities are generally maintained when using groups ranging from just sufficiently few individuals up to millions of individuals. In other words, the control mechanisms used in SI systems are not too dependent on swarm size, as long as it is not too small.
6.4 Adaptability:
SI Systems respond well to rapidly changing environments, making use of their inherit auto-configuration and self-organization capabilities. This allows them to autonomously adapt their individuals' behavior to the external environment dynamically on the run-time, with substantial flexibility.
6.5 Fast execution: Since masters can share the slaves the total work completion rate will increase.
6.6 Individual Simplicity: SI systems consist of a number of simple individuals with fairly limited capabilities on their own, yet the simple behavioural rules at the individual level are practically sufficient to cooperatively emerge a sophisticated group behaviour .

VII. CONCLUSION:

Swarm intelligence is a growing field with potential to provide accurate and efficient solutions. It is sustainable and affordable for many engineering challenges. More research and development into same will provide great future to human being.

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