ISSN: 2321-7782 (Online)
Volume 2, Issue 1, January 2014
International Journal of Advance Research in Computer Science and Management Studies
Research Article / Paper / Case Study
Available online at: www.ijarcsms.com

A Working Sense of Swarm Intelligence

Uttama Suryavanshi[1]
Information Technology Dept
KIT Raigarh
Raigarh - India

Rakesh Patel[2]
Information Technology Dept
KIT Raigarh
Raigarh - India

Abstract: ***Swarm Intelligence is the collective behavior of decentralized, self organized systems, natural or artificial. The concept is employed in work on Artificial Intelligence. Swarm Intelligence is a growing new discipline that deals with natural & artificial systems composed of many individuals that coordinate using decentralized control & self organization to represent an aggregation of the animals or insects which work collectively to accomplish their day to day task in an intelligent & efficient manner. Swarm is a fascinating, simplicity & robustness properties, make them an interesting model for solving problems in Computer Science. There are different areas including for studied by Swarm Intelligence are colonies of ants & termites, School of Fish, Flocks of birds, Herds of land animals, Particles in Cloud, Bacteria foraging, Honeybees, Spiders & Sharks.***

Keywords: Stigmergy; Pheromones; Swarmanoid; Marco Dorigo; Ant Colony.

I. INTRODUCTION

In 1989 Gerardo Beni & Jing Wang first introduced the term SWARM INTELLIGENCE in the context of cellular robotic systems, than after Bonabeau, Dorigo & Theraulaz defined Swarm Intelligence is "Any attempt to design algorithms or distributed problem solving devices inspired by the collective behavior of social insect colonies & other animal societies" So every time something is inspired by Swarm it is known as Swarm Intelligence. Swarm Intelligence refers to a kind of problem solving ability that emerges by the interaction of simple information processing units. The information processing units that compose a swarm can be Animate, Mechanical, Computational or Mathematical. Swarm Intelligence ability to solve various practical real world applications such as- Traffic routing, Networking, Games, Industry, Robotics & Controlling unmanned vehicles. Swarm Intelligence research is multidisciplinary systems are typically made up of a population of simple agents interacting locally with one another & with their environment.

II. A NATURAL BEHAVIOR OF SWARM

Swarm behavior or Swarming is a collective behavior exhibited by animals of similar size which aggregate together in same spot or perhaps moving en masse or migrating in some direction. The term flocking is usually used to refer specifically to swarm behavior in birds, Herding to refer to swarm behavior in quadrupeds, Shoaling or schooling to refer to swarm behavior in fish.

Swarm behavior was first simulated on a computer in 1986 with the simulation program boids. This program simulates simple agents that are allowed to move according to a set of basic rules. The model was originally designed to mimic the flocking behavior of birds, schooling fish & other swarming entities. [1]

Swarm behavior in nature is divided into two categories – A) Species B) Social insects

A. *In species -> whose individuals form a swarm because they benefit in some way.*

B. *Social insects -> which live in colonies whose members cannot survive on their own.*

The building & actions of the colony is the relative simplicity of an individual is a striking feature of social insects. Here termites build giant mounds with ventilation shafts & grow fungus for nourishment & ants manage to efficiently search on area for food whether it is evenly distributed or scattered in patches. In this paper we are describe swarm behavior of Artificial Intelligent Ant Swarm.

Fig 1 Natural behavior of ant

An Ant swarm use stigmergy for one to one communication .Stigmergy describes an indirect communication by leaving marks in the environment. These marks can be the structures that are built or markers meant especially for the purpose of communication. The marks left by the colony act as stimulate for the individual & can trigger certain actions. Ant use pheromones to find shortest path to food sources. They lay out pheromone trails behind them & prefer regions with higher pheromone concentration when deciding where to go. As ants taking the shorter path will reinforce the trail more often the pheromone concentration resist & the path will be preferred. This serf emergency effect leads to the development of a shortest path used by the individuals. [2]

III. Swarm Intelligence Principle in Artificial Intelligence Technique

Swarm Intelligence deals with natural & artificial systems. Composed of many individuals that coordinate using decentralized control & self organization. Swarm Intelligence research is the collective behavior that result from local interactions of individuals with each other & with their environment. [3]

The most application of the swarm Principle in technology is “Swarm Robotics”. The idea is a swarm of small cheap robots can cooperate to perform task more effectively & more expensive robot.

Fig 2 Swarm robotics

In the swarm there are 3 kinds of robot-

The name of each robot type is reminiscent of their principal respective robot functionality

A. Hand bots

Hand bots are robots that can manipulate objects & climb structures but cannot move on the ground they are transported by foot bots.

Fig 3 Hand bots

B. Foot bots

Foot bots are robots that can move on the ground & transported objects or other robots.

Fig 4 Foot bots

C. Eye bots

Eye bots are flying robots equipped with a camera & whose main functions are to search the environment & to guide Foot bots towards a goal location.

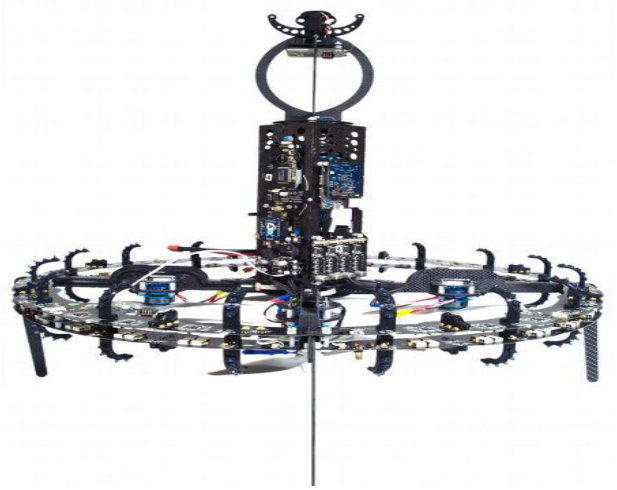

Fig 5 Eye bots

IV. How the work of Swarm intelligence or Swarm Robots

This type of swarm Intelligence Technique are used to search for & retrieve a book that was placed on a shelf at the end of a corridor in a standard office environment .To do so constituent robots of the swarmanoid had to cooperate both logically & physically .The eye bots main mission was to search for the book & once found to indicate to the foot bots the path to reach it. Foot bots were charged with transporting hand bots to the shelf .Once there hand bots climbed the self & grasped the book there were than carried together with the book to the start location. Here robots use light signals to convey information to their neighbors, a red light signal indicate that an object has been found for instance. This system is robust, flexible & scalable. The overall Artificial Intelligence technique can be seen in swarmanoid web site. [4,5]

Fig 6 Working of swarm robot

V. Ant Colony Algorithm

Here we describe a brilliant algorithm called Ant colony algorithm. Ant colony algorithm is popularly optimization algorithm based on swarm intelligence. It mimics the behavior of an ant colony foraging for food. This algorithm was first proposed by Marco Dorigo in 1992 as his PhD. Thesis. It is a part of the amazing world of swarm intelligence. Where in a swarm of low ability agents are used to solve complex problem. [6]

The operation of ant system can be illustrated by the classical Traveling salesman problem.(TSP). The TSP seeks for a round route covering all cities with minimal total distance.

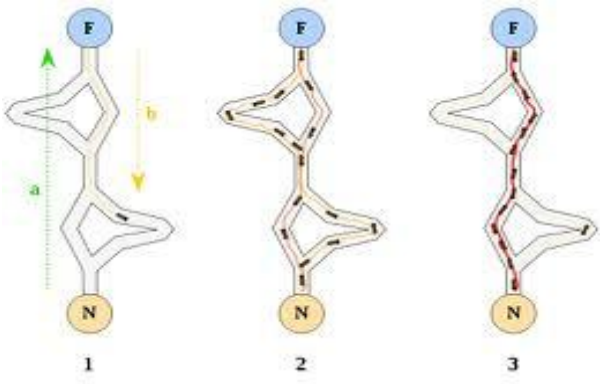

Fig 7 Working of ant colony to selecting shortest path

Suppose there are n cities & m ants. The algorithm starts with initial pheromone intensity set to so on all edges. Each ant begins its tour from a randomly selected starting city & is required to visit every city once & only once as follows-

- Randomly select the initial city for each ant.The initial pheromone between any two cities is set to be small positive constant . Set the cycle counter to be 0.
- Calculate the transition probability from city r to city s for the Kth ant as

$$P_k(r,s)=\begin{cases}\dfrac{[\tau(r,s)]\cdot[\eta(r,s)]^{\beta}}{\sum_{u\in J_k(r)}[\tau(r,u)]\cdot[\eta(r,u)]^{\beta}}, & \text{if } s\in J_k(r),\\ 0, & \text{otherwise,}\end{cases}$$

where r is the current city, s is the next city, τ (r, s) is the pheromone level between cities r and s, ( ) ( )1 , , η r s =δ r s − is the inverse of the distance δ (r, s) between cities r and s, J (r) k is the set of cities that remain to be visited by the k-th ant positioned on city r, and b is a parameter determining the relative importance of pheromone level versus distance. Select the next visited city s for the k-th ant with the probability P (r s) k , . Repeat Step (2) for each ant until the ants have toured all cities.

- Update the pheromone level between cities as-

$$\tau(r,s) \leftarrow (1-\alpha)\cdot\tau(r,s)+\sum_{k=1}^{m}\Delta\tau_k(r,s),$$

$$\Delta\tau_k(r,s)=\begin{cases}\dfrac{1}{L_k}, & \text{if } (r,s)\in \text{route done by ant } k,\\ 0, & \text{otherwise,}\end{cases}$$

Where Δ τk (r, s) Is the pheromone level laid down between cities r & s by the Kth ant Lk is the length of the route visited by the Kth ant ,m is the number of ants &

$0 < \alpha < 1$ is a pheromone decay parameter.

- Continue steps 2 to 4 until the behaviour stagnates or the maximum no. by cycles has reached. Stagnation is indicated when all ants take the same route.
- Updating the pheromone level for the shortest route only after completing the route for each ant as-

$$\tau(r,s) \leftarrow (1-\alpha)\cdot\tau(r,s)+\alpha\cdot\Delta\tau(r,s),$$

$$\Delta\tau(r,s)=\begin{cases}\dfrac{1}{L_{gb}}, & \text{if } (r,s)\in \text{global best route,}\\ 0, & \text{otherwise,}\end{cases}$$

Where Lgb is the length of the shortest route & α is a pheromone decay parameter. [7]

VI. Conclusion

Swarm Intelligence is a very active & exciting research field new approach & techniques are required for solving various optimization problems in areas like Computer Science, Robotics, MANATS etc. Nature inspired problem solving technique have been found to be an Intelligent & efficient way for this our technical systems become increasingly complex Swarm Intelligence algorithms which consist of many simple parts become more & more useful as a solution to difficult computational problems.

Swarm Intelligence is a computational Intelligence technique to solve complex real world problems. In this paper we present natural Swarm Intelligence power to implement in an Artificial Intelligence Technique.

Acknowledgement

We thanks to my colleagues who inspired me for selecting this topic.

References

1. En.wikipedia.org/wiki/swarm behavior.
2. Fundamentals of swarm intelligence.
3. Swarm intelligence research IRIDIA.
4. Mathware & soft computing magazine vol19 n2 marco dorigo.
5. www.projectswarm.net/part4.
6. Ameyajoshioos.wordpress.com/2012/ant colony algorithms.
7. Dorigo.m.ant system.optimization by a colony of cooperative system/overview of algo. For swarm intelligence.

AUTHOR(S) PROFILE

Uttama Suryavanshi, Complited degree Bachelor of Engg. In Information Technology in 2005 batch with first class HONS. From Kirodimal Institute of Technology Raigarh (India), & working as a lecturer in Kirodimal Institute of Technology Raigarh (India).

Rakesh Patel, Complited degree Bachelor of Engg. In Information Technology in 2005 batch with first class HONS. From Kirodimal Institute of Technology Raigarh (India), & working as a lecturer in Kirodimal Institute of Technology Raigarh (India).

