www.ijecs.in
International Journal Of Engineering And Computer Science ISSN:2319-7242
Volume 3 Issue 12 December 2014, Page No. 9660-9666

Development of Cognitive Architecture using Ambient and Swarm Intelligence for the Agents

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***Abstract*— This paper demonstrates on how to design an ambient environment for a group of agents called Swarm exhibiting the Swarm Intelligence. Ambient and Swarm Intelligence areemerging technologies in the field of Artificial Intelligence. The Proposed Ambient Environment aim is to ensure that bad agent should be avoided from collecting the resources. Swarm is a group of homogenous individuals, which interact locally among themselves and their surrounding environment, with no centralized control and from which interesting global behavior emerges. The proposed Swarm is group of agents had to collectively collect the resources from the environment and together has to construct the bridge. The main aim of this research is to check the two parameters- Coordination and Performance. How much coordination to be given so that maximum performance is achieved. Thus concluded that coordination is directly proportional to the performance.**

***Index Terms*—Agents, Ambient Intelligence, BDI, Cognitive Architecture, Swarm Intelligence.**

I. INTRODUCTION

Swarm is a collection of similar agents which communicates among themselves and with their surroundings.In Swarm the interactions are of two types: Direct interaction through audio and visual contact. Indirect interaction is through environment which is called Stigmergy.Some of the examples of swarm intelligence in nature are colonies of ants foraging for food, birds flocking, bees foraging for food.

A. Ants

Ants Colony Optimization:

The ants are considered to be one of the best natural example of the swarm .The first ant algorithm was been developed by Dr. Dorgio in 2003. The ants travel from source to destination in search of food. They find the shortest way from source to the food through the chemicalsubstance called pheromone as shown in the figure. Initially they travel in therandom manner while travelling they leave chemical substance and other ants follow the path in which the deposition of the pheromone is more in this way they find the shortest path[1].

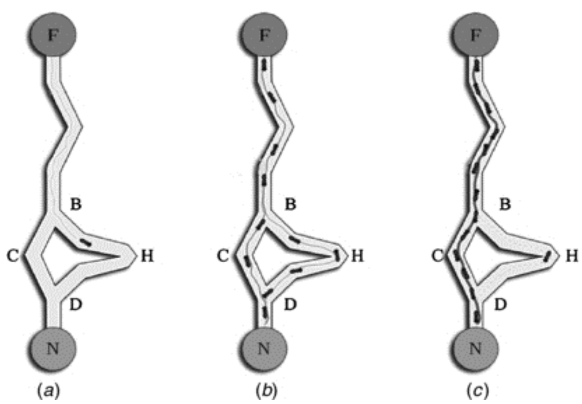

Figure 1: Ants select the shortest path.

B. OBSTACLE AVOIDANCE TECHNIQUE IN ANTS

Ants can often deal with the obstacles. They detect obstacle by seeing them. The obstacle becomes less attractive than the destination path as the pheromone gets evaporated by the time it reaches the destination. And hence the ants follow the path in which the pheromone deposition is more. There are different obstacle avoidance techniques that are followed based on the availability of the sensors and the other resources. The ant follows the Reflexive and Edge Detection methods. In Reflexive method [2] the ants does not have knowledge of the obstacles. When it hits the obstacles it identifies that it has hit the obstacle it comes backward and tries in the other directions randomly. Based on the goal location it decides whether to movie left front or at the right front. By going in the opposite way it avoids the obstacle.And in the Edge Detection method,[2] method the algorithm tries to determine the position of vertical edges of the obstacles and tries to overcome the obstacle. The line that connects the two edges is considered as the boundary of the obstacle. One of the disadvantage of this method is it should stop the robot in a while when the obstacle is in the front.

C. ALGORITHM:

Ant Colony Optimization is an algorithm that was proposed by Colorni ,Dorigo,and Maniezzo . The ACO was proposed based on the behavior of the ants. The main idea that included here based on the ants was the parallel search over the computational threads based to the local environment problem. Later the Extended version of the ACO emerged that was the Ant Algorithm.

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ANTS Algorithm

1. compute a (linear) lower bound LB to the problem, L is the lower bound on the Optimal Path solcution .

initialize $\tau\iota\psi$ ($\forall\iota,\psi$) with primal variable values.

2. for k=1,m(m= no of ants) here the variale K denotes the no of solcuctios do repeat compute $\eta\iota\psi$ $\forall(\iota\psi)$

choose in probability the state to move into

.append the choosen move to the k-th ant's tabu list

until ant k has completed its solution

carry the solcution to its local optimum

end for

3. for each ant move (($\iota\psi$),

compute $\Delta\tau\iota\psi$ and update trails by means of (5.6)

4. If not(end_test) goto step 2 [6].

LB is the Lower oud of the optimal solcution cost. the dyamic scalig allows to cocentrate not only on the good achievement on the last search but also on the small achievements.

each ad every time of the iteration when the ants complete they update the trials in $\tau\iota\psi$. there are ants denoted by m each solcutions is denoted by k. and later these solcutions are tabulated. $\Delta\tau\iota\psi$ deotes the sum of the contribuction of all ants if it is not ended the loop continous.

D. BOIDS

Boids was developed by Craig Reynolds in 1986. Boids is an artificial life program which simulates the flocking behavior of birds. The name "boid" means "bird-oid" object which refers to "bird-like" object.[3]

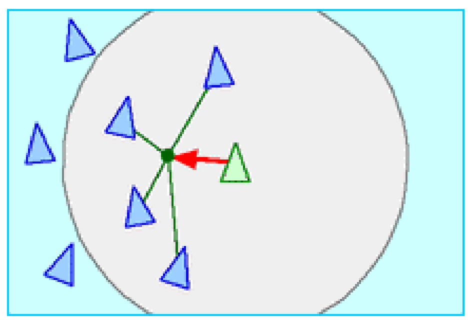
BEHAVIOR:

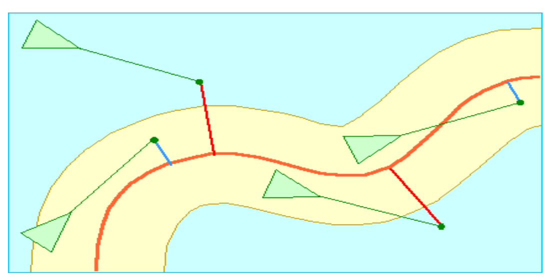
Boids is an example of emergent behavior; that is, the complexity of Boids arises from the interaction of individual agents adhering to a set of simple rules. The rules applied in the simplest Boids world are as follows:[4]

- **separation**: steer to avoid crowding local flock mates
- **alignment**: steer towards the average heading of local flock mates
- **cohesion**: steer to move towards the average position

The movement of Boids can be in order or disorder. Disorder means splitting groups and wild behavior. Splitting flocks and reuniting after avoiding obstacles are few unexpected behaviors and these can be considered as newly formed or newly independent. Boids simulation specifies each individual bird behavior.

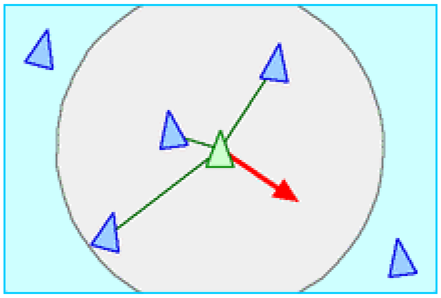
OBSTACLE AVOIDANCE IN BOIDS:





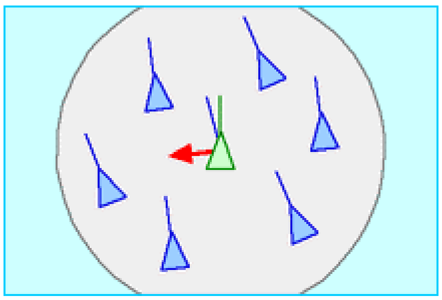
The Boids program consists of a group of objects (birds) that each has their own position, velocity, and orientation. There are only 3 rules which specify the behavior of each bird.

Separation:



Each bird maintains a distance between itself and birds which are nearby to it to avoid collision.

Alignment:



Birds try to change their position so that it corresponds with the average alignment of other nearby birds.

Cohesion:

Every bird attempts to move towards the average position of other nearby birds.

E. BOIDS ALGORITHM:

The structure of the boids programs: [5]

```
Initialize_positions( )
Loop
Draw_boids( )
Move_all_boids_to_new_positions( )
End loop
```

Initialize_positions( ) procedure initializes all the boids at a starting position. To start with, they all are initialized at random locations. When the simulation starts, they all fly in towards the middle of the screen.

Draw_boids( ) procedure draws one 'frame' of animation with all the boids in their current positions.

Move_all_boids_to_new_positions( ) procedure contains the actual boids algorithm. It involves simple vector operations on the positions of the boids. Each of the boids rules work independently for each boid. We calculate how much it will get moved by each of the three rules, giving the three velocity vectors. Then add those three vectors to the boids current velocity to work out its new velocity. Interpreting the velocity as how far the boid moves per time step we simply add it to the current position.

Move_all_boids_to_new_positions( )

Vector v1, v2, v3

Boid b

For each boid b

V1=rule1(b)

V2=rule2(b)

V3=rule3(b)

b.velocity=b.velocity+v1+v2+v3

b.position=b.position+b.velocity

end.

THE BOIDS RULES:[6]

Rule 1: boids try to fly towards the center of mass of neighboring boids

The 'center of mass' is the average position of all the boids. Assume we have n boids called b1, b2…..bn. position of boid b is denoted as b.position. Then 'center of mass' c of all n boids is given by

C=(b1.position+b2.position+…….+bn.position)/n

To move a boid towards its 'perceived center' that is the center of all the other bods we have

For boidj(1<=j<=n), the perceived center pcj is given by

Pcj=(b1.position+b2.position+….+bj-1.position+bj+1.positio+…..+bn.position/(n-1)

After calculating the perceived centre we need to more the boid towards it. To move it 1% of the way towards the center we consider

Pcj-bj.position/100

Procedure rule1(boid bj)

Vector pcj

For each boid b

If b!=bj then

```
Pcj=pcj+b.position

End if

End

Pcj=pcj/n-1

Return (pcj-bj.position)/100

End procedure
```

Thus we have calculated the first vector offset,v1, for the boid.

Rule 2: boids try to keep a small distance away from other objects. This is done by subtracting from a vector c the displacement of each boid which is near by. We initialize c to zero as we want this rule to give us a vector which when added to the current position moves a boid away from those near it.

```
Procedure rule2(boid bj)

Vector c=0;

For each boid b

If b!=bj then

If |b.position-bj.position|<100 then

C=c-(b.position-bj.position)

End if

End if

End

Return c

End procedure
```

Rule 3: boids try to match velocity with near boids

```
Procedure rule3(boid bj)

Vector pvj

For each boid b

If b!=bj then

Pvj=pvj+b.velocity

End if

End

Pvj=pvj/n-1

Return (pvj-bj.velocity)/8

End procedure.
```

F. HONEY BEE SWARMS:

Honey Bees one of the examples of Swarm, has been used in nature as an efficient and intelligent distributed system. Honey bee swarms are dynamic and intelligent they are capable of dividing various tasks among the other bees. The various tasks involved are foraging, storing, retrieving and distributing honey, collecting pollen, communication, and adapting themselves to the changes in the environment in a collective manner without any central control.

G. BEHAVIOR OF BEES

Bees organize the colonies well so that there is no need of hibernation for it. Bees produces honey and store it in there honey combs , bees produces honey by collecting the nectar and pollen from the flower, these are the two main things required for making the honey, and bees are always social and live together in colonies. They are divided among themselves like there is a queen, worker bees and the scout bees. These workers are responsible for making their nests from secreting from there abdominal glands. The young workers take pollen and nectar as their food for developing larvae. There are two types of worker bees named as scouts and foragers. At first the scout bees are sent out in search for food source. These bees move randomly from one flower to another and keep exploring other flowers in order to find the best food until they are tired. And after they have found a flower they deposit their nectar or pollen and then they move to the dance floor and perform a dance to communicate about the flower or food to the other bees. From these the bees can be sent to the flower, the Bees have knowledge about the environment outside is because of their waggle dance. Because of this dance they can find the flowers of good quality and quantity. All the workers will be sent to the best patches; because of these they can collect the food faster and in an efficient manner. And they will be monitoring there food levels in order to decide on the next food source and the waggle dance. The nature of the dance performed by a scout bee represents the quality and the food source. This waggle dance which conveys direction of the flower, distance of the flower from the hive and the quality. After getting this information forager bees are sent to the various patches by the colony. Higher the quality of the food source more will be the number of foragers sent to it. With this strategy the bee colony is able to gather good quality food quickly and efficiently. [7]

H. OBSTACLE AVOIDANCE IN BEES

Bees use path integration and memories of visual landmarks to navigate through familiar path or terrain. Principles of visual guidance determine the perception of the world in three dimensions, obstacle avoidance, control of flight speed, and smooth landings. For navigation over long distances, bees use information from the celestial compass to determine their flight bearing, and information from the movement of the environment in their eyes to gauge how far they have flown. From these studies are now being used to design biologically inspired algorithms for the guidance of aerial vehicles without human intervention.

Optic flow in bumble bees: Bumble bees use optic flow to avoid crashing to the objects surrounding. Optic flow is the sensation when the surrounding objects move past the bumblebee flies. If the bee comes closer to an object, the object appears to be moving faster, then the optic flow becomes greater in one of the eye than the other this is when the bumblebee will take opposite direction with respect to its eyes, they should have constant balance of optic flow in its two eyes.

Inspired by the bee's compound eyes that can see more than 300-degrees, the Laser Range Finder (LRF) detects obstacles in a 180-degree radius in front of it up to two meters away. The BR23C calculates the distance to the obstacle(s), then immediately sends a signal to a microprocessor, which translates this information and moves or repositions the vehicle accordingly to avoid a collision. [8]

I. BEES ALGORITHM

The Bees Algorithm is an optimization algorithm, which is inspired by the foraging behavior of bees. This algorithm is used to find the optimal solution.

The number of parameters to be set is:

number of scout bees (*n*), number of sites selected out of n visited sites (*m*), number of best sites out of m selected sites (*e*), number of bees recruited for best e sites (*nep*), number of bees recruited for the other

(*m-e*) selected sites (*nsp*), initial size of patches (*ngh*) which includes site and its neighborhood and stopping criterion.

ALGORITHM

1. Initialise population with random solutions.
2. Evaluate fitness of the population.
3. While (stopping criterion not met)

//Forming new population.

4. Select sites for neighbourhood search.
5. Recruit bees for selected sites (more bees for best e sites) and evaluate fitnesses.
6. Select the fittest bee from each patch.
7. Assign remaining bees to search randomly and evaluate their fitnesses.
8. End While.

This algorithm starts with the n scout bees being placed in random in the search space, in the step 1.

In step 2, the finesses of the sites visited by the scout bees are Evaluated.

In step 4, bees which have the highest finesses are chosen and are selected and the sites visited by them are chosen for neighbourhood search. Then, in steps 5 and 6, the algorithm conducts searches in the neighborhood of selected sites; it assigns more bees to search near the best e sites. The bees can be chosen directly according to the finesses associated with the sites they are visiting. Alternatively, the fitness values are used to determine the probability of the bees being selected.

Searches in the neighborhood of the best e sites give more promising solutions. Together with scouting, differential recruitment is a key operation of the Bees Algorithm.

In step 6, for each patch only the bee with the highest fitness will be selected to form the next bee population. In nature, there is no such a restriction. This restriction is introduced here to reduce the number of points to be explored. In step 7, the remaining bees in the population are assigned randomly around the search space scouting for new optimal solutions. [9]

J. PROPOSED SYSTEM

By considering all the above system, we are proposing a new swarm for a agents who are working together to achieve a given task. In the simulated environment the group of agents collectively enters the environment, get authorized by the environment and collectively collect the objects. Once the objects are collected they move together towards the destination for the goal. In the proposed environment the agents detect the obstacle either by the edge detection method [2] or by the image processing algorithm.

AGENTS:

1. There are 5 authenticated agents, which are of green in color. And there is one bad agent of red color.

   SWARM:

   1. Entering the environment.
   2. Going together for constructing the bridge.
   3. Swarm is observed during the construction.

      ALGORITHIM:

      Step 1: Start

      Step 2: Initialize authenticated agents i.e., ag1, ag2, ag3, ag4 & ag5;

      Initialize Bad agents bg , bricks b1, b2 ,b3, b4, b5, b6, b7, b8, b9, b10, b11, b12, b13, b14, b15;

      Initialize destination point;

      Step 3: 5 agents enter together in the environment in vertical direction. With initial information "go near the bricks".

      For I=0 to 3

Step 4: If authenticated agents then information should be sent to agents to "collect the bricks" (blink). Go to step 6.

Step 5: else if not an authenticated agents then "bricks not available " is sent to the bad agent.

End if
End if

Step 6: All authenticated agents (green) will collect the bricks.

K. AMBIENT INTELLIGENCE

The word ambient means immediate surroundings of something. Surrounding area is an ambient. Ambient intelligence is an emerging discipline that brings intelligence to our everyday environments and makes those environments sensitive to us. (DianeJ.Cook,JuanC.Augusto 2009).

Ambient Intelligent is an intelligent interface which enables the people and devices to interact with each other and with the environment. Here Technology operates at the background and all the computing capabilities are connected and are available everywhere. This environment is aware of specific characteristics of human presence and preferences it take care of the needs and even capable to respond intelligently to the desire. AmI is all about 'human centred computing', user-friendliness, user empowerment and the support of human interaction (ISTAG, 2001; HARWIG & SCHUURMANS,2001).

Ambient intelligence is been implemented in most of the fields like Education, Transport, Hospital, Smart Home. The one of the field that is discussed in this paper is Smart Home. Ambient Environment is very expensive to setup because of its hardware requirements. In this paper we demonstrate on how to design the Ambient Environment for the group of agents. This contains the several of tools and technologies involved like wireless sensors, Pressure Sensors, Image processing algorithms to identify the facial expressions,radiometers - they are in charge of measuring the surrounding area at a certain distance. They can be fixed to typical home appliances that act on the environment for changing its properties. In the These tools are used to identify the Pressure of the surrounding, how caution the person is, how the person is presented himself, his Linger around their target, how desperate they are, walks awkwardly. These are the some of the basic inputs needed to the system to identify the bad agent.

L. Research Implementation Plan

The output is demonstrated using SWI Prolog Using Simulation. There are 2 types of Agents in the environment. Authenticated Agent and a Predictor Agent. Aim of each Agent is: Authenticated Agent has to collect the objects from the treasure box and move towards the goal. Predictor Agent acts as a thief whose job is to steal the objects from the box. Resources in the test bedare:Objects of 3 different sizes of same shapes (Large rectangle, Medium Rectangle, Smaller Rectangle). These objects are placed in the box (Ambient Environment).

Second resources are Food, in the shape of the circle. Based on the metabolism rate of the agent, the agent will consume the food.The Research is about using the Ambient and Swarm Intelligence.

Here the Ambient is the TestbedWhere the Treasure Box is placed which contains the objects which are collected by the agents. Treasure Box is called Ambient because Ambient is nothing but immediate surroundings of the Agent.Treasure Box is placed in the testbed, so it is surrounding for the agent.Intelligence is given to the Treasure Box such that only authenticated agents should collect the objects from the box. Intelligence should also ensure that Predictor Agent should not be allowed to collect the objects from the Box.Intelligence should also ensure that when the authenticated agent and the predicator agent come infront of the treasure box the door should not open. When this situation arises all other agents should come together and attack the predictor.

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