Ant Colony Optimization :
A Technique used for Image Processing

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Abstract

Ant colony optimization (ACO) is a technique which can be used for various applications. Ant colony Optimization is an optimization technique that is based on the foraging behaviour of real ant colonies. Ant colony optimization is applied for the image processing which are on the basis continuous optimization. This paper proposes an ant colony optimization (ACO) based algorithm for continuous optimization problems on images like image edge detection, image compression, image segmentation, structural damage monitoring etc in image processing .This paper represents that how ACO is applied for various applications in image processing. The algorithm can find the optimal solution for problem. The results show feasibility of the algorithm in terms of accuracy and continuous optimization.

Keywords

ACO (Ant Colony Optimization), CACO (Continuous ant Colony optimization), Image compression.

I. Introduction

Ant Colony Optimization: The ant colony optimization algorithm (ACO) is a probabilistic technique for solving many problems which can be reduced to finding good paths through graphs. Although real ants are blind, they are capable of finding shortest path from food source to their nest by exploiting a liquid substance, called pheromone, which they release on the transit route [1]. This algorithm is a member of ant colony algorithms family, in swarm intelligence methods, and it constitutes some met heuristic optimizations. Ant Colony Optimization (ACO) is a population-based, general search technique for the solution of complex continuous problems which is inspired by the pheromone track laying behaviour of real ant colonies. The behaviour of ant is intimidated in artificial ant colonies for the search of estimated solutions to discrete optimization problems, to continuous optimization problems, and to important problems in telecommunications, such as routing and load balancing. Initially proposed by Marco Dorigo in 1992 in his PhD thesis, the first algorithm was aiming to search for an optimal path in a graph, based on the behaviour of ants looking for a path between their colony and a source of food. The ant colony optimization (ACO) meta-heuristic a colony of artificial ants assists in finding good solutions to difficult discrete optimization problems [2]. The choice is to allocate the computational resources to a set of relatively simple agents (artificial ants) that communicate indirectly by stigmergy. Good solutions are an emergent property of the agents' cooperative interaction. The original idea has since diversified to solve a wider class of numerical problems, and as a result, several problems have emerged, drawing on various aspects of the behaviour of ants. The main underlying idea, loosely inspired by the behaviour of real ants, is that of a parallel search over several constructive computational threads based on local problem data and on a dynamic memory structure containing information on the quality of previously obtained result. The collective behaviour emerging from the interaction of the different search threads has proved effective in solving combinatorial optimization (CO) problems. The developed AS strategy attempts to simulate behaviour of real ants with the addition of several artificial characteristics: visibility, memory, and discrete time to resolve many complex problems successfully such as the travelling salesman problem (TSP) ,vehicle routing problem (VRP), and best path planning, Even though many changes have been applied to the ACO algorithms during the past years, their fundamental ant behavioural mechanism that is positive feedback process demonstrated by a colony of ants is still the same. Ant's algorithm has also plenty of networking applications such as in communication networks and electrical distribution networks.

II. Ant Colony System Algorithm

Different steps of a simple ant colony system algorithm are as follows.

A. Problem Graph Representation

Artificial ants move between discrete states in discrete environments. Since the Continuous problems solved by Ant Colony System algorithm are often discrete, they can be represented by a graph with N nodes and R routes.

B. Ants allocation Initializing

A number of ants are placed on the origin nodes. The number of ants is often defined based on trial and error and number of nodes in the region.

C. Ants possibility Distribution Rule

Ant's probabilistic transition between nodes can also be specified as node transition rule as node transition rule.

D. Update Global Trail

When every ant has assembled a solution, at the end of each cycle, the intensity of pheromone is updated by a pheromone trail updating rule.

E. Stopping Procedure

This procedure is completed by arriving to a predefined number of cycles or the maximum number of cycles between two improvements of the global best solutions.

Ant System's algorithm is important be a resident of mainly in being the prototype of a number of ant algorithms which have found many interesting and successful applications. In ant-cycle ants deposit pheromone after they have built a complete tour.

III. Pheromone

In Ant Colony System once all ants have computed their path. Ant system updates the pheromone track using all the solutions produced by the ant colony [1]. Each edge belonging to one of the computed solutions is modified an amount of pheromone proportional to its solution value. At the end of this phase the pheromone of the entire system evaporates and the process of construction and update is iterated.

Ant Colony System is more successful since it avoids long convergence time by directly focus the search in a neighbourhood of the best tour found up to the current iteration of the algorithm. Ant system has two mechanisms:

i. Attractiveness
ii. Trail update

IV. Ant Colony Optimization for Continuous Problems

ACO met heuristic to explore continuous spaces. This extension can be done by the suitable discretization of a search space or by probabilistic sampling [3]. Continuous problems are the problems in which next value is obtained from previous one and present one. e.g. TSP, Edge detection. Continuous ACO algorithm was a first attempt on the field of continuous optimization. It is suggested for a local search in the neighborhood of the place called nest. The CACO authors suppose to find this place by a global optimization method, for example Genetic Algorithm. The neighborhood is then searched by using v vectors leading from the nest. Initially, they are uniformly distributed inside a global search radius and have small amount of a pheromone attached.
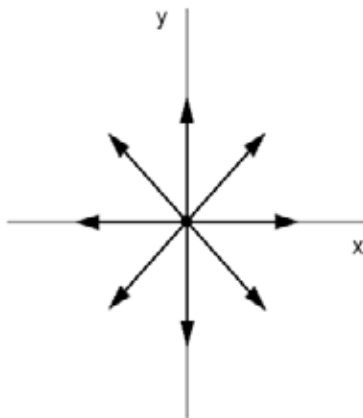

Fig.1: Initial State Of ant Colony Optimization
At initial state ant can move in any direction towards nest to food. The search evaluation is shown in fig2.
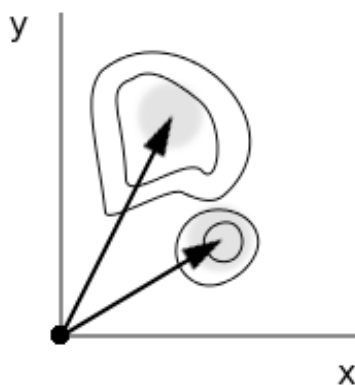

Fig. 2: Continuous ACO
The implementation of ACO for continuous problems is discussed as the following sample of lines of codes:-

```
clear all
clc
global N
Nvar=4;
for ii=1:Nvar
Up(ii)=5.12; Lo(ii)=-5.12;
end
```

```
maxit=10;Q=10;ee=0.001;
N=120;
dettt=ceil(N/4);Nants=500; aa=1;
tt(N+1,Nvar)=0.01;pp=0.99
```
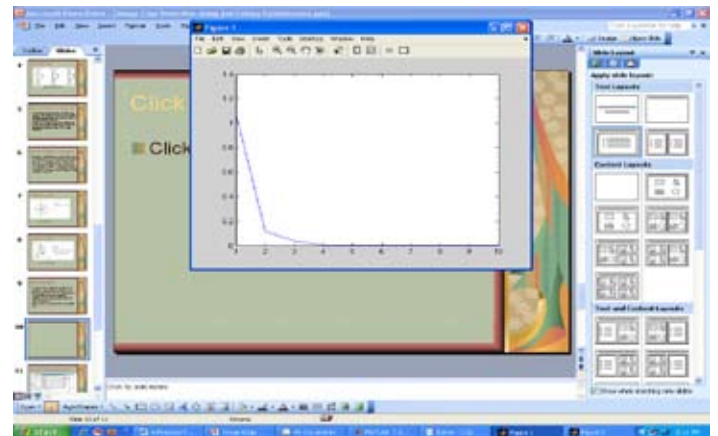
etc. The results are as shown in Fig. 3 and Fig. 4.
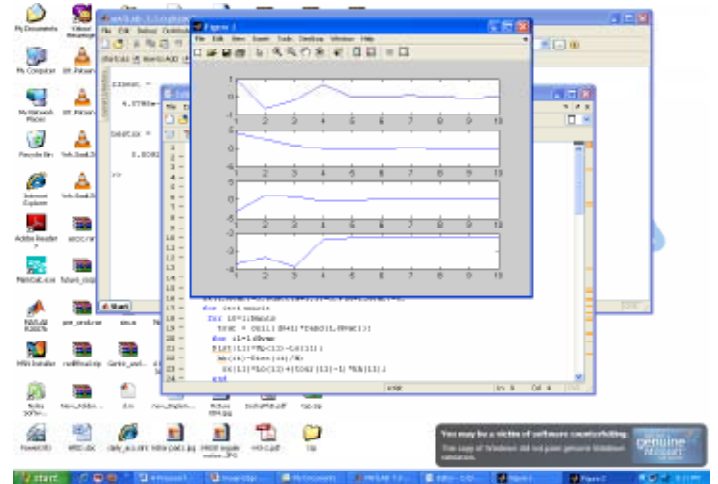

Fig. 3: Continuous Ant Colony Problem

Fig. 4: Optimal Solutions of CACO

V. Ant Colony Optimization for edge detection

Edges are points where there is a boundary between two image regions [4]. An edge can be of almost illogical shape, and may include junctions. In practice, edges are usually defined as sets of points in the image which have a strong gradient magnitude [6]. The algorithms usually used some constraints on the properties of an edge, such as shape, smoothness, and gradient value. Edge detection is a technique for marking sharp intensity changes, and is important in further analyzing image content data. Variables involved in the selection of an edge detection operator include:

Edge orientation: The geometry of the operator determines a characteristic direction in which it is most sensitive to edges. Operators can be optimized to look for horizontal, vertical, or diagonal edges. Noise environment: Edge detection is difficult in noisy images, since both the noise and the edges contain high-frequency content. Attempts to reduce the noise result in blurred and distorted edges [7]. Operators used on noisy images are typically larger in scope, so they can average enough data to discount localized noisy pixels. This results in less accurate localization of the detected edges.

Edge structure: Not all edges involve a step change in intensity. Effects such as refraction or poor focus can result in objects with

boundaries defined by a gradual change in intensity. The operator needs to be chosen to be responsive to such a gradual change in those cases. Newer wavelet-based techniques actually characterize the nature of the transition for each edge in order to distinguish, for example, edges associated with hair from edges associated with a face.

VI. Conclusions

Ant Colony optimization is a technique which is used for image processing such as edge detection, image compression, image segmentation, image enhancement etc. [5]. As ACO is used for optimization of continuous problems, so it is used for various applications of image processing which shows continuous behaviour. The Ant Colony optimization gives the optimal solutions which are further processed to find the actual results. It gives many outputs on different threshold values. The shortest path of ants has more pheromone than longest paths. So the pheromone updating information is necessary in ACO.

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