Probabilistic Ant Colony Optimization for Contour Detection of Psoriasis

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Abstract. Psoriasis is characterized by hyperkeratosis and thickening of the epidermal layer followed by an increase in vascularity and infiltration of inflammatory cells to the dermis, as a result of this process the scales appear, erythema and induration. In the field of health, identification and image analysis can be used as a conclusion to support expert decisions such as identification of tumors, cancers or other diseases including Psoriasis. Ant Colony Optimization (ACO) algorithms are the most successful and widely recognized algorithmic techniques based on ant behaviours. These algorithms have been applied to numerous problems; moreover, for many problems ACO algorithms are among the current high performing algorithms. The goal of this research is to develop a detection emphasize on the contour detection of Psoriasis using ACO. By using the parameters of the Pheromone intensity control values (α), the visibility (β), Evaporation coefficient of pheromone intensity (ρ) and the constant Q the results show that this method is can detect the contour an image of psoriasis.

Keywords: ACO, contour, image, parameter, psoriasis

INTRODUCTION

Psoriasis is a chronic, multisystem inflammatory disease with predominantly skin and joint involvement. Beyond the physical dimensions of disease, psoriasis has an extensive emotional and psychosocial effect on patients, affecting social functioning and interpersonal relationships. As a disease of systemic inflammation, psoriasis is associated with multiple comorbidities, including cardiovascular disease and malignancy (Kim et al., 2017)

The Swarm Intelligence (SI) algorithm is inspired by the social intelligence of insects. The simple concept of the SI system is referring to interactions between individuals while intelligence lies in the network of interactions between individuals. and between individuals and the environment (Dorigo et al., 2004). ACO was inspired by the actual behavior of ants who sought the shortest path from their colonies to food sources (Dorigo et al., 1999). Prospective solutions to the problem are represented as ants in the population. The communication mechanism is that these ants store pheromones on the ground to mark the path through which they can be used as paths that can be used by other ants in the colony. The most pheromone intensity is used as one of the solutions of the many paths made by ants. This mechanism allows the algorithm to explicitly use elements from the previous solution, which are characteristic of the ACO algorithm. Dorigo and Stützle (2004) Ant Colony Optimization (ACO) algorithms are the most successful and widely recognized algorithmic techniques based on ant behaviours. These algorithms have been applied to

numerous problems; moreover, for many problems ACO algorithms are among the current high performing algorithms called the ant system. An ant colony is highly organized, in which one ant interacts with others through pheromones in perfect harmony. Optimization problems can be solved through simulating ants' behaviours. Since the first ant system algorithm was proposed, there has been a lot of development in ACO.

Real ant colonies make probabilistic movement based on the intensity of pheromone to find the shortest paths between their nest and the food source. ACO algorithms use similar agents called artificial ants. Artificial ants have the properties of the real ants. The differing characteristics of the artificial ants from the real ants were explained in. In foraging for food, the real ants will directly evaluate the intensity of pheromone during their way from the nest to the food. While artificial ants will evaluate a solution with respect to some quality measure, which is used to determine the intensity of pheromone during their return trip to the nest. The real ants might not take the same path on their way to the food sources and return trip to their nest. Meanwhile, each of the artificial ants moves from the nest the food sources and follows the same path to return.

Some of the combinatorial optimization problems are difficult to solve optimally in polynomial computational time. Metaheuristic is an alternative to solve this kind of problems by using approximate methods that try to improve a candidate solution with problem-specific heuristic. Metaheuristics give a reasonably good solution in a short time, although they do not guarantee an optimal solution is ever found. Many metaheuristics implement some stochastic optimization. For example, greedy heuristic can be used to build the solution, which is constructed by taking the best action that improves the partial solution under construction. However, these heuristic methods produce a very limited variety of solutions, and they can easily get trapped in local optima. There are metaheuristic methods proposed to solve these problems; e.g. simulate annealing that guides local search heuristic to escape local optima (Dorigo and Stützle 2004).

A metaheuristic is a general framework that guides a problem specific heuristic. In the Ant Colony Optimization, ants use heuristic information, which is available in many problems, and pheromone that they deposit along paths which guides them towards the most promising solutions. The most important feature of the ACO metaheuristic is that the ants search experience can be used by the colony as the collective experience in the form of pheromone trails on the paths, and a better solution will emerge as a result of cooperation.

MATERIALS AND METHODS

In this experiment used the digital image with 100x100 pixels and the format image is *jpg. Image have different characteristics. In this Experiment used different parameters α , β , ρ , Q. The process of detecting contours by inserting a pre-processed RGB image and the modified image into a binary image. The binary image is processed using ant colony, then the image with the contour of the detection result is obtained. The process of finding the next node/pixel is by calculating the highest value of the neighboring pixels. Figure 1 shows the process of detecting images with ACO



Figure 1. Image detection process.

The procedure in the ant algorithm is as follows 1. Initialize

Set the parameters and assigning the initial $\alpha,\,\beta,\,\rho,\,Q$ value

- 2. Schedule Activities
- a. Construct Ant Solutions

$$p_{ij}^{k}(t) = \begin{cases} \frac{\left[\tau_{ij}(t)\right]^{\alpha} \cdot \left[\eta_{ij}\right]^{\beta}}{\sum_{k \in allowed_{k}} \left[\tau_{ij}(t)\right]^{\alpha} \cdot \left[\eta_{ij}\right]^{\beta}} & \text{if } k \in allowed_{k} \\ 0 & \text{otherwise} \end{cases}$$
(1)

- Here, τ_{ij}(t) represents quality of pheromone on the edge.
- η_{ij} represents the heuristic information.

b. Actions:

- Performed by multiple ants to improve the solution or search process.
- c. Update Pheromones:

The goal of the pheromone update is to increase the pheromone values associated with good solutions and decrease those associated with bad ones. Update is done by:

$$\tau_{ij}(t+n) = p \times \tau_{ij}(t) + \Delta \tau_{i,}$$
(2)

With p, is pheromone evaporation rate and $\Delta \tau_{ij}$ is the quantity of pheromone laid on edge.

RESULTS AND DISCUSSION

Designing contour detection system

Images data have different characteristics (Supriyanti et al., 2017). It is used to test the extent to which this system can work. To facilitate the use of algorithms that we developed, we developed a Graphical User Interface (GUI) based on the programming language Matlab. The solution is obtained by using a program that applies the probabilistic ant colony optimization algorithm that is applied to the programming language. From the experimental results carried out by changing the intensity of the pheromone value, a comparison of parameters was performed.

Following are the results of the calculation of the total distance of all routes obtained for each problem with different parameters, namely based on alpha, betha, rho and Q constants (Rasyid, 2013). The ACO algorithm is modified to include the probability process of finding a path in the respective area of the pixel value and local search before the pheromone update process.

1. Initialization

Determine the number of vehicles or ants (K), number of customers or cities (N), maximum vehicle distance (E), maximum vehicle capacity (W), ant trail intensity controller, visibility control distance pixels i to pixel j, controller constant ant trail evaporation speed (ρ), constant Q, initial pheromone (τ earning) and total iteration (T) (Rasyid, 2013). Destination point selection mechanism. The point of destination is done by removing the probability from the starting point with its neighbor point, the highest probability value is used as the next destination point. By using formula (1)

2. Local search process Swap the position of the starting point with a new

point, then calculate the total of all points.

3. Pheromone update

Feromone update is done after the local search process aims to reduce the evaporation of the intensity value.

Data Input

Input data is data that is entered into the system and then processed by the program to produce a contour of the image with an image size of 100x100 pixels (Nugroho, 2018). The image in the experiment used is the image of the legs taken at Dr. Hospital. Margono Soekardjo, Banyumas, Central Java.

Table 1. Detection results with comparative alpha, beta, rho, Q.



Figure 2. Leg image with psoriasis.

Schema

The initial node of the ant is randomly placed then the ant will directly evaluate the intensity of the pheromone. The intensity of the pheromone value in each ant is used as a reference for the other ants. More pheromone intensity is considered as the best path, and the ant is considered capable of detecting pixel values in the image. Detection results are obtained from ant pheromone intensity of ants

The determination of the starting point of the ant is carried out randomly until a pixel is found in the input image. From the images in the figures obtained the results of the contour details in Table 1.

No -	Parameter					Size of image	Imaga Nama	Descrift
	α	β	ρ	Q	Ant	Size of Image	image Name	Kesun
1	2	1	0.01	100	100	100X100	Image 1	
2	5	5	0.05	100	100	100X100	Image 2	
3	10	10	0.08	100	100	100X100	Image 3	
4	12	20	0.10	100	100	100X100	Image 4	
5	20	20	0.12	100	100	100X100	Image 5	

From the four pictures of the test results above in Table 1, the processing time of each image is presented in Table 2.

Table 2. Time Process and Accuracy.

Time process(s)/Accuracy									
Image 1	Image 2	Image 3	Image 4	Image 5					
154.34/75	155.12/69	157.56/73	150.67/63	152.21/64					
%	%	%	%	%					

The result from the contour detection construction using by the distribution probabilities from pheromone intensity, From the results of experiments conducted using one psoriasis skin image obtained results of image 1 in table 1 shows the best results compared to other images. The image generated from the acquisition is not optimal so that the ant has not been able to optimally detect the contour of the input image. By providing ant colony parameters, ants can detect the contours of the inputted image.

CONCLUSIONS

By using the parameters of the Pheromone intensity control values (α), the visibility (β), Evaporation coefficient of pheromone intensity (ρ) and the constant Q the results show that this method is can detect the contour an image of psoriasis.

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