

Performance Evaluation of Optimal Parameters for Pest Image Segmentation using FCM and ACO

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Abstract

In gift agricultural subject, pest identity causes enormous discount in both fine and quantity of crop cultivation. If you want to growth the production price of crop, the presence of tiny pests such as aphids, whiteflies, and spider mites which purpose leaf deformation is the main hassle. Consequently early pest detection is a primary project in agricultural field. This research specializes in photograph processing, sensible set of rules and computer technology to expand a new pest detection device that's vital and imperious to crop cultivation. In existing system, the pest detection using fuzzy c-manner clustering address the problem of overlapping of gadgets can purpose for hiding the pest. As cluster length will increase the rims are brittle and compactness of the clusters gets altered. Therefore the prevailing FCM segmentation now not able to cope with the constituent parts of the picture implicitly. The proposed technique known as ant colony optimization method resolves this hassle, and offers the implicit pest segmentation. The segmentation approach uses the swarm intelligence approach based totally at the behavior of the ant colonies. Ant colony optimization became used to extract the area of the insect pest and also to attain the most suitable constant parameters of recognized insect pest. In the beginning the captured pix are processed for pre-processing. Then photo segmentation is done based totally on ACO to get pest target location. Later constant parameters are measured for pest image segmentation the use of ACO which include structural content, top signal to noise ratio, normalized correlation coefficient, and average difference and normalized absolute mistakes. The matlab simulation experiments demonstrate that this proposed ACO technique is extra powerful than fuzzy c-way clustering consequently it can phase the pest photograph higher.

Keywords: Ant Colony Optimization, Consistency Measures, Early Pest detection, Fuzzy C-means

1. Introduction

India is the "land of agriculture" which has many conventional and even a massive variety of cultures. Approximately 75% of the Indian populace is connected with agriculture. New contemporary agricultural technique is hooked up to be able to the amount and best of the yield. However the production is decreased in recent times because of reduction in landscape and also increasing of different types of pest, there is no viable way to increase the landscape however there may be a possibility

to lessen the consequences of pest. In maximum of the cases, pests or sicknesses are seen on the leaves or stems of the flora like tomato plant, cotton, sugarcane and crop yielding are also decreased due to mealy bug. Image processing has been proved to be effective tool for evaluation in diverse fields and packages. Agriculture zone in which the parameter like cover, yield, exceptional of product were the critical measures from the farmer's point of view. In¹ authors intends to focus at the survey of software of image processing in agriculture field along with imaging strategies, weed detection and fruit grading. The analysis

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of the parameters has proved to be accurate and much less time consuming compared to standard techniques. In² author recognized the price of browning inside braeburn apples and created a picture recognition system to stumble on pest harm with the usage of a wavelet based image processing method and a neural network. In³ work shows entropy based thresholding in which the maximum records content material is used to decide the segmentation rule established upon a shade area choice. His counseled segmentation set of rules is applied for snap shots of pest infected leaves and their consequences are in comparison with the results of fuzzy c-means approach⁴. A spread of strategies had been evolved for fixing image segmentation problems. In those processes, exceptional strategies have defined various price capabilities for the undertaking of photo segmentation. ACO is first introduced by way of m. Dorigo⁵. One fundamental idea of the aco technique is to use the counterpart of the pheromone trail used by real ants as a medium for verbal exchange and as an oblique shape of memory of previously observed solutions. The ants construct solutions constructively guided by means of heuristic facts and the pheromone trails left via ants in preceding iterations. In⁶ they recommend a framework for ACO based totally image processing methods and create the flexibility of defining exceptional mechanisms for an ant's behavior consistent with numerous problems, which grew to become out aggressive and quite promising, with great effectiveness and practicability specifically for snap shots with complex neighborhood texture situations. The application of different photograph segmentation and clustering set of rules addresses to remedy the trouble of checking the consistency of different algorithms primarily based on a few small quantity of photos or pix from one particular area^{7,8} bear in mind accepted segmentation of the clinical pix which is completed for exceptional types of clinical photos and compared using fine measures. From this literature assessment we conclude that early pest detection is a primary mission in crop cultivation. Pest detection become investigated in various papers the usage of photograph processing strategies. Image segmentation the usage of clustering method carries many clustered items, overlapping of items can cause hiding the shape. For this reason it becomes now not suitable to discover consistent parameters for high-quality of photo. Our research objectives are to endorse a new pest detection gadget the usage of ant colony optimization technique to find the pest location and also to locate most useful consistency values.

2. Need for Pest Image Segmentation

According to the united countries' food and Agriculture Corporation, India topped the list of maximum crop cultivation countries, but there may be the great financial loss for farmers due to plant sicknesses and insect pests every year. Greenhouse plants want to be covered from a diffusion of various pests, organisms that gift a chance to the crop. Tiny pests together with aphids, whiteflies, and spider mites are much more likely to infest greenhouse vegetation than beetles or caterpillars consequently, it's miles of outstanding each theoretical and realistic importance to expand the automated identity and diagnose system of whiteflies insect about 1.5 mm long; located at the side of tiny yellow crawlers or green, oval often gift on leaves. It snacks on foliage, coating the leaves with a sticky white residue that shrivels them and attracts black mold to the fruit. Using the whiteflies because the studies difficulty, performance comparison of pest picture segmentation based totally on fuzzy c means clustering and ant colony optimization method changed into proposed and also describes the numerous consistency parameters are measured for the fine of pest segmented photograph.

3. Overall Scheme of a System

We've got taken captured pest photograph from the rural subject and loading them because the filter creation photo; following acquisition the shade transformation shape for the rgb plant pest images was created. A device-unbiased, $L^*a^*b^*$ (abbreviation for the cie 1976 (L^* , a^* , b^*) (or $cielab$), which includes luminosity L^* , chromaticity layer a^* and chromaticity layer b^* , which homes all of the colour (red-green and blue data) color space transformation shape was implemented⁹. Photo segmentation is an essential step for an automated item recognition machine. The aim of segmentation is to simplify and alternate the illustration of an photograph into some thing this is more meaningful and less complicated to research. Pest photograph segmentation is a key step on this procedure¹⁰.

4. Clustering Techniques

The goal of clustering analysis is to divide a given set of items right into a cluster, which represents subsets or a group. The partition ought to have houses: Homogeneity

inner clusters: The item belongs to 1 cluster, ought to be as comparable as possible and heterogeneity between the clusters: the object belongs to special clusters, have to be as unique as possible¹¹. Maximum commonly used clustering algorithms are okay-approach algorithm and fuzzy c-way algorithm. The first-class of the final end result of the clustering technique depends especially on the initial set of clusters.

4.1 FCM Clustering Algorithm

Fuzzy c-approach is a set of rules based on one of the segmentation strategies which lets in information to have membership of multiple clusters, each to varying ranges. This technique, used in sample reputation, was evolved in 1973 by using Dunn and advanced through Bezdek in 1981. The set of rules is primarily based on minimization of the following function.

$$J_m = \sum_{a=1}^N \sum_{b=1}^C u_{ab}^m \|x_a - c_b\|^2, 1 \leq m < \infty \quad (1)$$

Where:

- m is any real number greater than 1.
- u_{ab} is the degree of membership of in the x_a cluster j.
- x_a is the d-dimensional measured data.
- c_b is the d-dimension center of the cluster.
- $\|x_a - c_b\|$ is any norm expressing the similarity between any measured data and the centre.

This algorithm realizes an iterative optimization J_m of the function, updating membership u_{ab} and the cluster centers c_b using the following formulas:

$$c_b = \frac{\sum_{a=1}^N u_{ab}^m \cdot x_a}{\sum_{a=1}^N u_{ab}^m} \quad (2)$$

$$u_{ab} = \frac{1}{\sum_{k=1}^C \left(\frac{\|x_a - c_b\|}{\|x_a - c_k\|} \right)^{\frac{2}{m-1}}} \quad (3)$$

The minimization of J_m is achieved when u_{ab} function are saturates that is, the stop criterion is given by the equation

$$\max_{ab} \{|u_{ab}^{k+1} - u_{ab}^{(k)}|\} < \varepsilon \quad (4)$$

Compare $u_{ab}^{(k)}$ and u_{ab}^{k+1} in a convenient matrix norm; if $\max_{ab} \{|u_{ab}^{k+1} - u_{ab}^{(k)}|\} < \varepsilon$, stop; otherwise, set $K = K + 1$, and go to step third step by updating the cluster

centre iteratively and also the membership grades for data point¹².

5. ACO Model for Image Segmentation

For picture segmentation into multiple regions purposes each ant is assigned to a one-of-a-kind colony. Ants from distinct colonies can crossover with the equal opportunity as with ants from the equal colony. New ant colony is chosen from the encompassing ants and determine ant colonies through a roulette-properly method. The ants speak using a chemical substance referred to as pheromone. As an ant travels, it deposits a consistent amount of pheromone that different ants can follow. Whilst searching out meals, ants tend to follow trails of pheromones whose concentration is higher¹⁹. There are two main operators in ACO algorithms. These are:

5.1 Route Construction

Initially, the moving ants construct a route randomly on their way to food. However, the subsequent ants follow a probability-based route construction scheme²⁰.

5.2 Pheromone Update

This step includes two important pheromones. First of all, a special chemical “pheromone” is deposited at the course traversed by means of the individual ants. Secondly, this deposited pheromone is problem to evaporation. The amount of pheromone up to date on an person path is a cumulative impact of these pheromones.

6. Acceptable Parameters of ACO

Ants are purported to be shifting over the grayscale photo. Doing so, each ant can occupy best one cellular, moreover handiest one ant may be in a single cellular. Every ant has certain associated with it opportunity to transport to unoccupied area and to go away a pheromone trace²⁰.

Population Size ($\mathcal{S}$): Preliminary population length is one of the most important elements that decide time of new release. The greater ants have populations the longer it takes to compute final result.

Ant's Attraction (β): Increase of attraction parameter causes ants to attract everywhere on image and population size remains very high for a long time.

Ant's Trail (ρ): With high values of ants' electricity coefficient α ants can travel longer distance previous demise at the identical time through duplicate growing the total number of ants. Ants of the same colony tend to occupy more than one pests. With low α values, ants die speedy and segmentation of image does now not occur.

Pheromone Information (α): With lower values of ants just circulate according to gradient, opposition decreases and protein spots are not absolutely included with the aid of pheromone.

Pheromone Evaporation (κ): High evaporation of pheromone K ends in lower pheromone level and one colony can without difficulty take over few pests.

7. Consistency Measures

An excellent goal best degree ought to replicate the distortion at the photo, as an example, blurring, noise, compression, and sensor inadequacy. Such measures can be instrumental in predicting the performance of vision-based algorithms inclusive of characteristic extraction, image-primarily based measurements, detection, monitoring, and segmentation²².

Approaches to analysis the overall performance:

- Pixel distinction-based measures: (e.g., The imply square error and most difference).
- Correlation-based measures: A version of correlation based totally measures may be obtained with the aid of thinking about absolutely the mean and variance information (e.g., Structural content material, normalized pass correlation).

The proposed algorithms were applied the usage of matlab. The performance of image segmentation techniques are analyzed and discussed. 1. Structural Content (SC). 2. Peak Signal to Noise Ratio (PSNR). 3. Normalized Correlation coefficient (NK). 4. Normalized Absolute Blunders (NAE). 5. Common variations is considered for take a look at in this work on the authentic image $x(i,j)$ and on the segmented picture $y(i,j)$.

7.1 Structural Content (SC)

Correlation, a familiar idea in image processing, estimates the similarity of the structure of two alerts. This degree effectively compares the total weight of a unique signal to that of a coded or given. It's far consequently a international metric; localized distortions are overlooked. The

structural content is given with the aid of Equation (1) and if it's miles unfold at 1, then the decompressed photograph is of higher first-rate and huge cost of sc way that the image is of terrible first-class.

$$SC = \frac{\sum_{i=1}^M \sum_{j=1}^M x(i,j)^2}{\sum_{i=1}^M \sum_{j=1}^M y(i,j)^2} \quad (1)$$

7.2 Peak Signal to Noise Ratio (PSNR)

Larger SNR and PSNR imply a smaller distinction among the unique (without noise) and reconstructed photograph. The main benefit of this measure is ease of computation however it does now not reflect perceptual quality. An vital belongings of PSNR is that a moderate spatial shift of an image can cause a big numerical distortion however no visual distortion and conversely a small average distortion can result in a harmful visible artifact, if all the error is focused in a small essential vicinity. These metric neglects international and composite errors PSNR is calculated the use of equation

$$PSNR = 10 \cdot \log_{10} \left[\frac{\max(x(i,j))^2}{\frac{1}{n_i \times n_j} \left[\sum_{i=0}^{n_i-1} \sum_{j=0}^{n_j-1} (x(i,j) - y(i,j))^2 \right]} \right] \quad (2)$$

7.3 Normalized Correlation Coefficient (NK)

The closeness among virtual pics also can be quantified in terms of correlation feature. It measures the similarity among snap shots like an unique colour area in the picture different one transformed coloration area photo, consequently on this sense they may be complementary to the difference based measures. All of the correlation primarily based measures have a tendency to one, as the difference among images has a tendency to zero. As difference degree and correlation measures complement each different, minimizing distance measures are maximizing correlation degree and normalized correlation is calculated using Equation (3).

$$NK = \frac{\sum_{i=1}^M \sum_{j=1}^N [x(i,j) \times y(i,j)]}{\sum_{i=1}^M \sum_{j=1}^M x(i,j)^2} \quad (3)$$

7.4 Normalized Absolute Error (NAE)

Normalized absolute mistakes computed by Equation (4) is a degree of the way a ways is the conversion photograph from the authentic image with the value of zero being the

right suit. Huge price of NAE indicates terrible first-rate of the photograph.

$$NAE = \frac{\sum_{i=1}^M \sum_{j=1}^N |x(i, j) - y(i, j)|}{\sum_{i=1}^M \sum_{j=1}^N |x(i, j)|} \quad (4)$$

7.5 Average Difference (AD)

A decrease fee of Average Difference (AD) offers a “cleanser” image as extra noise is reduced and it is computed the usage of equation

$$AD = \frac{1}{MN} \sum_{i=1}^M \sum_{j=1}^N [x(i, j) - y(i, j)] \quad (5)$$

8. Simulation Result and Analysis

On this segment photograph segmentation methods are carried out to pest photograph and the various parameter values are calculated. Ant colony optimization strategies are simulated for pest photo segmentation. Utility of ACO for picture segmentation depends on ideal parameter values. Let us carry out search for suited values of ACO parameters based totally on artificial pix. Initial parameters of aco are selected in keeping with^{21,23}: $\alpha = 0.025$; $\beta = 3.5$; $\delta = 0.2$; $\eta = 0.07$; $p = 1.5$; $K = 0.01$; $\mu = 0.1$ and Population size S is 30% of the total image size. Simulation is performed in MATLAB environment. The comparison results of image segmentation algorithms are presented in Table 1.

The average results of various parameter are shown in desk ii. The standard PSNR price of image will be within the variety of 25 to 40 db, the small fee of PSNR means the photograph is of terrible great, sc with price unfold at 1, suggests a higher high-quality photo.

Table 1. Input image and processed output image

Original pest image	FCM processed image	ACO processed image
		

Table 2. Quality measures of pest segmented image

Methods	Consistency Measures				
	PSNR	SC	NK	NAE	AD
FCM	37.249	1.001	0.91	0.045	0.154
ACO	39.231	1.015	0.99	0.021	0.129

Large value of NAE, NK and AD indicates poor quality of the image. Structural content is a global measure, which compares the total weight of the segmented image and input image, is 1.001 for FCM, 1.015 for ACO. The structural content with value spread at 1 indicates a better quality image and it is very close to 1 for ACO output. Normalized correlation gives closeness between the input and segmented image and is obtained as 0.91 for FCM and 0.99 for ACO respectively. This value tends to 1 if the difference between the images is zero and from the computed values, it is observed that for the ACO segmented images obtained highly correlated to the original images. NAE which is a measure to study the quality of approximation of the images is 0.045, 0.021 for FCM and ACO respectively. The simulated value of Average difference for FCM is 0.154 and ACO is 0.129, the observed results shows that the proposed ACO provides good quality of segmented image when compared to the FCM algorithm. The stimulation result of PSNR shows that the segmented image for FCM is the lowest value of PSNR 37.24 dB and for ACO segmented image as 39.231 dB. Practically it is in the range of 25 to 40 dB hence ACO shows highest value than FCM. From the simulation results it's observed that our proposed ACO technique for pest image segmentation shows optimal consistent performance measures when compared to FCM clustering segmentation algorithm.

9. Conclusion and Future work

This research proposed the solution for best regular values of pest photograph segmentation the use of Ant Colony Optimization technique. The performance of ACO segmentation is measured for various parameters such as Peak Sign to Noise Ratio (PSNR), Structural Content (SC), Normalized Correlation (NK), Normalized Absolute Error (NAE) and Common Distinction (AD). The excellent measures are more suitable for the segmented pictures thru the ant colony optimization method than the bushy

c-approach clustering algorithms. The destiny studies is in direction of contrast of ACO techniques with neural network optimization fashions

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