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Design and Development of Pest Image Segmentation Technique Using Soft computing Algorithm

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***Abstract*-Image segmentation is a major step for automated object recognition systems. In many cases, image processing is affected by illumination conditions, random noise and environmental disturbances due to atmospheric pressure or temperature fluctuation. The quality of pest images is directly affected by atmosphere medium, pressure and temperature. This emphasizes the necessity of image segmentation, which divides an image into parts that have strong correlations with objects to reflect the actual information collected from the real world. Image segmentation is the most practical approach among virtually all automated image recognition systems. The performance of an image segmentation algorithm depends on its simplification of image. The different segmentation algorithms namely, fixed threshold, Experience threshold, Iteration method, OTSU method and fuzzy c-means segmentation [5] are implemented for pest images and they are compared using nonlinear assessment or the quantitative measures like gray level energy, entropy, and normalized mutual information. Out of the above methods the experimental results show that fuzzy c means clustering algorithm performs better than other methods in processing pest images. FCM based simulated annealing algorithm [2] provides better results than other intelligent techniques .**

Keywords-segmentation, energy, entropy, Mutual information, simulated-annealing algorithm, fcm clustering

I.INTRODUCTION

The automatic detection for the pest is a critical field in agriculture engineering. Each year, the loss of agriculture caused by pest is very serious.Develop effective, convenient, no pollution detection system is necessary and imperious. The pattern recognition based on pest image procession is proposed. The image procession technology is important for this kind of system. The CCD camera is used to get the pest images which are sent to the computer to detect the kind and number of the pests. Pest image segmentation is a key step in this procedure.

II.BASICS OF SEGMENTATION

Image segmentation is to divide the image point set into different sub regions. And these regions must satisfied five conditions as follow:

1) $R = \bigcup_{i=1}^{N} Ri$;
2) For all I and j,i $\neq$ j , $Ri \bigcap Rj = \phi$;
3) If i=1,2,…N,then $P(Ri) = True$;
4) If $i \neq j$,then $P(Ri \bigcup Rj) = False$;
5) For i=1,2,3…,N are connected components.

Condition (1) means the union of sub-regions should contains all points of original image; condition (2) means the sub-regions are not overlapped; condition (3) means the points in a same sub-region should have some same characteristics; condition (4) means different sub-regions have different characteristics; condition (5) means the each sub-region is connected.

III.CLASSICAL IMAGESEGMENTATION ALGORITHMS

A. *Fixed Threshold Method*

In this method threshold value is given manually and value is fixed one.

$$g(x,y) = \begin{cases} 255, f(x,y) \geq T \\ 0, f(x,y) < T \end{cases} \quad or$$

$$g(x,y) = \begin{cases} 0, f(x,y) \geq T \\ 255, f(x,y) < t \end{cases}$$

Where,

f(x,y) is source image.
g(x,y) is segmented image.

B. *Experience Threshold Method*

Experience threshold method is same as fix threshold; the only difference is that the user should try several times with different threshold T.

C. *Iteration Threshold Method*

In this method threshold value for segmentation is calculated using iterative method: The main steps of iteration threshold method are as follow:

1. Initial threshold is calculated using following formula

$$T^0 = T^k | k = 0$$

$$T_0 = \frac{Z_{\min} + Z_{\max}}{2}$$

$Z_{\min}$ =minimum gray value of the image

$Z_{\max}$ =maximum gray value of the image

2. By using the above threshold the input image is divided into two segment. The segmented image is represented in R_1, R_2

$$R_1 = \{f(x,y) | f(x,y) < T^k\}$$

$$R_2 = \{f(x,y) | 0 < f(x,y) < T^k\}$$

3. Compute the average gray value of segmented image R_1, R_2.Using following formula

$$Z_1 = \frac{\sum_{f(i,k)<T^k} f(i,j) \times N(i,j)}{\sum_{f(i,j)<T^k} N(i,j)}$$

$$Z_2 = \frac{\sum_{f(i,k)>T^k} f(i,j) \times N(i,j)}{\sum_{f(i,j)>T^k} N(i,j)}$$

4. Updating the threshold value by average gray value which is calculated above.For updating threshold the following formula is used

$$T^{K+1} = \frac{Z_1 + Z_2}{2}$$

5. Now check the iteration count value $T^k = T^{k+1}$ stop the algorithm, weather the value is less means $K = K + 1$ goto step 2.

d. Otsu Method

Otsu's thresholding method involves iterating through all the possible threshold values and calculating a measure of spread for the pixel levels each side of the threshold, i.e. the pixels that either fall in foreground or background. The aim is to find the threshold value where the sum of foreground and background spreads is at its minimum.

With Class Variance $\sigma_W^2 = W_b \sigma_b^2 + W_f \sigma_f^2$

Between Class variance $\sigma_B^2 = \sigma^2 - \sigma_W^2$

$$\sigma_B^2 = W_b(\mu_b - \mu)^2 + W_f(\mu_f - \mu)^2$$
$$\sigma_B^2 = W_b W_f (\mu_b - \mu_f)^2$$

Above formulas are used for calculating threshold to separate foreground and background.

E. *Fcm Clustering Algorithm*:

Fuzzy C-means [5] is an algorithm based on one of the segmentation methods which allows data to have membership of multiple clusters, each to varying degrees. This method, used in pattern recognition, was developed in 1973 by Dunn and improved by Bezdek in 1981. The algorithm is based on minimization of the following function:

$$J_m = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^m \left\| x_i - c_j \right\|^2$$

$$1 \le m < \alpha$$

Where:
m is any real number greater than 1, **uij** is the degree of membership of xi in the cluster **j**,
xi is the i-th of d-dimensional measured data,
cj is the d-dimension center of the cluster,
||*|| is any norm expressing the similarity between any measured data and the center.

This algorithm (Bezdek, J. C. 1981) realizes an iterative optimization of the Jm function, updating membership uij and the cluster centers cj using the following formulas:

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{\|x_i - c_j\|}{\|x_i - c_k\|} \right)^{\frac{2}{m-1}}}$$

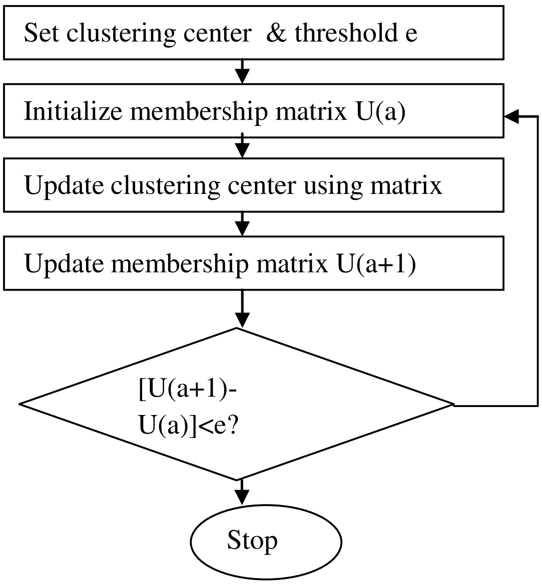
$$c_j \frac{\sum_{j=1}^{N} u_{ij}^{m} . x_i}{\sum_{j=1}^{N} u_{ij}^{m}}$$

The minimization of Jm is achieved only when the uij function saturates, that is, the stop criterion is given by the equation:

$$\max_{ij} \left\{ \left| u_{ij}^{k+1} - u_{ij}^{(k)} \right| \right\} < \varepsilon$$

Where ε is a number between 0 and 1, and k is is the iteration step.

FLOW DIAGRAM OF FCM :



Figure(1) flow diagram of FCM algorithm

IV. NON LINEAR OBJECTIVE ASSESSMENTS

A . *Energy*

The gray level energy [9] indicates how the gray levels are distributed. It is formulated as

$$E(x) = \sum_{i=1}^{x} p(x)$$

Where E(x) represents the gray level energy with 256 bins and p(i) represents the probability distribution functions.

The larger energy value corresponds to the lower number of gray levels, which means simple. The smaller energy corresponds to the higher number of gray levels which means complex.

B. *Entropy*

The entropy [9] is the measure of image information content, which is interpreted as the average uncertainty of information source. It is calculated as the summation of the products of the probability of outcome multiplied by the log of the inverse of the outcome probability. It is formulated as

$$H(x) = -\sum_{i=1}^{x} p(i) \log_2 p(i)$$

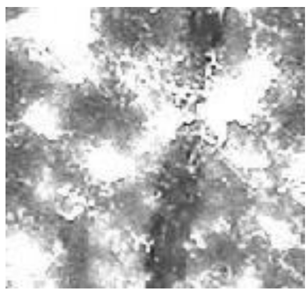
P(i)-probability distribution function.

B. *Normalized Mutual Information*

It is the measure of covering contents from both discrete entropies and mutual information [9]

$$NMI = \frac{I(x;y)}{\sqrt{H(X),H(Y)}}$$

H(X),H(Y)-discrete entropies



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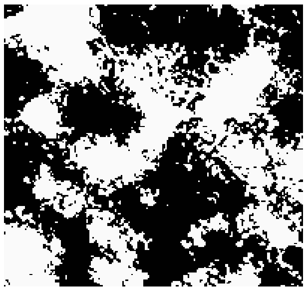
Fig(1) Original Image

TABLE 1
NONLINEAR ASSESSMENT COMPARISION

Parameters/image segmentation methods	Fixed threshold method	Experience threshold method	Iteration threshold method	OTSU method	FCM
Energy	0.16	0.17	0.3	0.35	0.63
Entropy	0.7	0.75	0.95	0.96	0.09
Normalized Mutual information	0.32	0.35	0.36	0.38	0.035

As shown in the table(1) parameter considered for comparison gives good result for Fuzzy C Means algorithm.So its concluded that FCM is suitable for pest image segmentation .

Fig(2) Edge detection



Fig(3) FCM Segmented image

V.IMPROVED FCM BASED ON SIMULATED ANNEALING

Simulated Annealing (SA) [2] is an intelligence searching algorithm proposed by Kirkpatrick, It is proofed that this algorithm is convergence to global optimization in probability one. It adopts Metropolis acceptance criteria and a serial of parameters called cooling schedule to control the process of simulate annealing to get an approximate global optimization within a polynomial time.

A .simulated annealing Algorithm:

```
s ← s0; e ← E(s) // Initial state, energy.
sbest ← s; ebest ← e // Initial "best" solution
k ← 0 // Energy evaluation count.
while k < kmax and e > emax // While time left & not good enough:
snew ← neighbour(s) // Pick some neighbour.
enew ← E(snew) // Compute its energy.
if enew < ebest then // Is this a new best?
sbest ← snew; ebest ← enew // Save 'new neighbour' to 'best found'.
if P(e, enew, temp(k/kmax)) > random() then // Should we move to it?
s ← snew; e ← enew // Yes, change state.
k ← k + 1 // One more evaluation done
return sbest // Return the best solution found.
```

FLOW DIAGRAM OF SIMULATED ANNEALING ALGORITHM :

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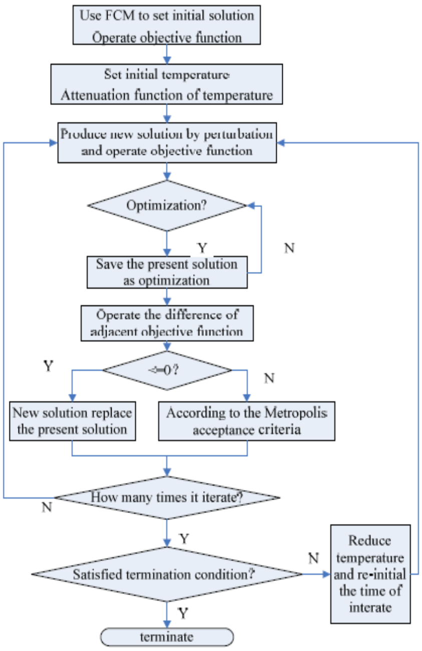
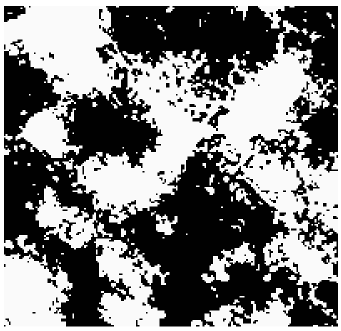


Figure(2) flow diagram of SA algorithm



Fig(4) SA Segmented image

VI.CONCLUSION

Image segmentation is the most practical approach among virtually all automated image recognition systems. The performance of an image segmentation algorithm depends on its simplification of image. The different segmentation algorithms namely, fixed threshold, Experience threshold, Iteration method, OTSU method and fuzzy c-means segmentation are implemented for pest images and they are compared using nonlinear assessment or the quantitative measures like gray level energy, entropy, and normalized mutual information. The non-linear objective assessment used to evaluate the different segmentation techniques. After evaluation it is concluded that fuzzy c means cluster which gives less value of Normalized Mutual Information (NMI) and Entropy which is most suited for pest image segmentation. At the same time gray level energy gives better performance related to Entropy and Normalized Mutual Information.

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