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Cuckoo Search based Soft computing Approach for Quality Analysis of White Poppy Seeds

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***Abstract*:** Poppy seeds are found to be a strictly monitored crop which is because of its narcotic effects. However the use of poppy seeds in food, industrial and medical purpose opens the door for its survival. It generates a good amount of foreign currency for the producing country. Due to its high value its quality should also be assured. In this study nature is applied for benefit of nature, that is nature-inspired metaheuristic algorithms, that is Cuckoo Search (CS) and Particle Swarm Optimization (PSO) have been used to check and monitor the quality of the white poppy seeds. CS is used in the preprocessing stage of the approach, whereas PSO is used for segmentation and final outcome. Basically CS is used to enhance the image quality, which helps to further process the image in later stages. Combination of these two approaches is quite new, but the results are very good. Visual results imply that impurities in terms of black seeds within white seeds can be successfully recognized through computer vision analysis.

***Keywords*-** Poppy seeds, Computer vision, image enhancement, Cuckoo Search, L´evy flight, Particle Swarm Optimization, Segmentation, Histogram

I. INTRODUCTION

Scientifically known as Papaver somniferum or poppy as in general, is a widely used agricultural product. The cultivation of poppy is very restricted worldwide because of its narcotic effects. The countries such as India, China, Afghanistan, Turkey, some parts of Europe, Thailand are involved in cultivation of poppy. Though cultivated under strict observation poppy seeds have food, medicinal and industrial value. Due to strict monitoring the production of poppy is not sufficient to meet the demands and price issue of poppy is always high because of this. In India NDPS Act of 1985 was formed in accordance with United Nation drug conventions to empower the states to monitor narcotic abuse of the plant. As a food product poppy is used directly as a spice in many parts of South-East Asia [8], as in bakery foods it is used mainly in parts of Europe and United States of America. As because it belongs to oily seed group, edible oil is also a main derived product of poppy seed. Nutrition value of poppy contains oil, protein, fiber etc. Among the diversity of poppy seeds a study on the nutrition values of white poppy seeds shows that it contains as high as 27% protein [1], which is another factor why it has been used as a food product for a long time.

The presence of opiates alkaloids restricts the use of poppy seeds. [2]Various preprocessing treatments such as washing, drying or grinding reduces the negative effects up to 80%. In bakery foods, maintaining temperature around 200° C also helps in reducing the effects of morphine, narcotine etc. [3]Global production of poppy is around 1.0445 tons in average from 1961 to 2009 with a area of harvesting 140534 Ha worldwide. Poppy seeds also fetch a good exchange rate globally with an average of 1.08 USD/kg (upto 2009). As par import quantity it is around 1.062689 tons internationally. Sleep related health disorder is not new in medical science. A study [4] on human sleep related problem (insomnia) within the age group of 21 to 45 shows more than 60% improvement in such cases. Improvement in blood has been also noticed. For treatment of cancer poppy seeds are also found to be effective [5]. As poppy seeds are oil based seeds in which the amount of oil varies in each variety of it. [6]White poppy seeds produced in India tend to contain as high as 49% oil. The oil contains Linoleic acid which helps to prevent cardiovascular problems. It is evident that herbal medicinal benefits of poppy seeds cannot be ignored. To monitor harvesting of poppy a satellite data based approach has been taken [7].

This involves Landsat 7 and ASTER data. This can be seen as a step forward in the involvement of soft computing for this agricultural product. As a high value crop its quality should not be compromised. The involvement of industrial and agricultural image processing has been evolved a lot. Though certain agricultural product such a, poppy seeds has not been induced in it. Quality of which is an important parameter as various forms of it is been used widely as a food and medicinal product. In this study white poppy seeds have been considered to be evaluated based on Cuckoo search algorithm. The objective of this study is to show how softcomputing approach of computer vision in combination with nature inspired algorithm can be applied on this costly food product to ensure its quality for the end consumer. The experiment attempts to provide mainly visual analysis which is far more important when it comes to quality checking of a certain type of agricultural product. Quantitative analysis has been provided whenever found necessary.

METHODOLOGY

A. *Cuckoo search:*

The use of nature-inspired metaheuristic algorithms in computer vision is relatively new as compared with other methods and algorithms. After GA (Genetic Algorithm) and PSO along with their different improved versions the evolvement of this type of algorithm again came into existence after 2005[9], where a whole new variety being developed and proposed. [10] [11] [12] [13] Cuckoo Search

(CS) came into existence in the year of 2009. The algorithm was inspired by behavior of Cuckoos in addition with L´evy Flights, as a random work method. The algorithm depends upon three basic principles of cuckoos:

a) Based on a random choice cuckoo lays one egg at a time.
b) For upcoming productions a collection of best nests get identified with high quality of eggs
c) Host nest number is always fixed.

Based on the above three criterions, the proposed original algorithm was (as a pseudo code):

```
Begin
        Objective function f(x), x = (x1, ..., xd)T
        Generate initial population of
        n host nests xi (i = 1, 2, ..., n)
while (t <MaxGeneration) or (stop criterion)
        Get a cuckoo randomly by L´evy flights
        Evaluate its quality/fitness Fi
        Choose a nest among n (say, j) randomly
if (Fi > Fj),
        replace j by the new solution;
end
        A fraction (pa) of worse nests
        are abandoned and new ones are built;
        Keep the best solutions
        (or nests with quality solutions);
        Rank the solutions and find the current best
end while
        Postprocess results and visualization
end
```

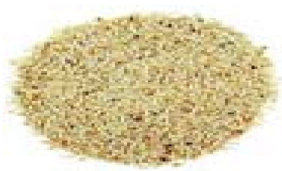

Figure.1

a. Histogram of the image:

Figure.2

B. Cuckoo Search based image enhancement:

To implement CS as an image enhancer three criterions discussed above was transformed according to the problem definition and then it was implemented through Matlab using the pseudo code as a reference.

(a). A random choice which depends upon L´evy Flights and is based upon the initial intensity values of the pixel range, where the pixel range defines the population.

(b). Based upon a threshold value (which depends upon the problem) intensity values were defined, which in turn decides the best intensity values.

(c). As range of intensity values depends upon threshold value, the total population depends upon the number of fixed found suitable within the range of provided pixels.

Objective function which was averagering values in this case, were proportional to the intensity values found suitable based on the three criterions. Fitness of a pixel was determined by the intensity values proportional to the highest current value.

In case of L´evy Flights which derives the random walk, the step size (α) was kept within the range of 0.398 to 0.684, which was best found during experiments, as it depends upon the current position of the previous walk position and also the distribution range of it, which remains within

$$L\acute{}evy \sim u = t^{-\lambda},\ (1 < \lambda \leq 3), \qquad (1)$$

It must be remembered that each nest can represent a set of solutions, which means the intensity values those are found to be suitable can be kept aside for every iteration applied.

Discovery rate of solutions (P_a) was within 0.01, 0.05, 0.1, and 0.15 for this problem found suitable.

The result of the enhancement (Fig.3) for a gray level image, with its histogram (Fig.4) as compared with its original input (Fig.1) with its histogram (Fig.2), found to be very encouraging.

a. Steps of the process:

a) Start with a random population of n host nests or pixels with the intensity of each pixel being its solution. Consider this to be the initial solution.
b) Get a random cuckoo solution denoted by (i) by Lévy flight technique.
c) Evaluate its quality or fitness value (Fi).

The function is evaluated as: xi(t+1) = wi xi(t) + α . Lévy (λ), where it indicates entry wise multiplication.

Note that the fitness value of every pixel is proportional to the intensity of the corresponding pixel.

d) Choose a nest with another solution among n randomly and say this solution is j.
e) Compare the two fitness values.
f) If the fitness value of the cuckoo egg is greater than that of the random nest, then replace the host egg (solution) with the cuckoo egg, otherwise do nothing.
g) Post each iteration, a fraction of the worst nests which do not contribute better solutions are abandoned and the ones yielding the best solutions are carried over to the next generation.
h) Processes 1-7 is repeated until the amount of iterations needed reaches the optimal maximum generation criteria.

b. Parameter Selection:

In the above procedure, the parameters were selected as follows:-

a) Maximum generation when fixed at 10 was found to give the best result. Thus, we fixed maxgen as 10.
b) The weight, w, is taken as inversely proportional to maxgen.
c) α1, α2 are of order 1 while the order of α3 € (0,1).

d) Beta is taken as 1.5 as it yielded the best results in accordance with [24]
e) Parameter Ÿ which is associated with stepsize in Lévy flight belongs to the range (0,1)

c. Livy flight:

a) ß = 1.5
b) σ = (gamma (1+ ß) * sin (π * ß /2) / (gamma ((1 + ß) / 2) * ß * 2^ (ß -1) / 2))) ^ (1/ ß) ;
c) s = input image
d) g = randn (size (s));
e) k = g* σ.
f) y = g.
g) Step = u ./ abs (y) .^ (1/ ß)
h) stepsize = Ÿ * step [here, Ÿ depends upon the typical length scale.]
i) actual step size = (stepsize .* g)

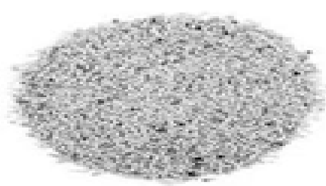

Figure.3

d. Histogram of the image:

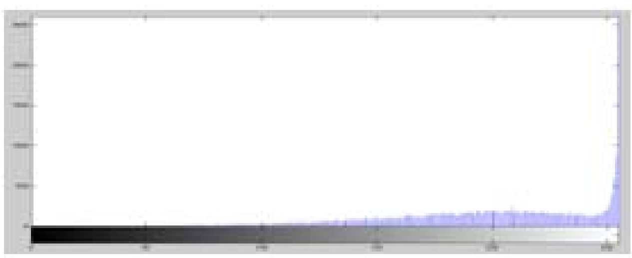

Figure.4

C. PSO based Segmentation:

Particle Swarm Optimization (PSO) was first established by Dr. Russell C. Eberhart and Dr.James Kennedy in the year of 1995[14] [15], with two primary operators are Velocity update and Position update. A new velocity value for each particle is calculated for individual iteration based on its current velocity, the distance from its previous best location, and the distance from the global best location. The new obtained velocity is used to determine the next location of the particle in the search space. For image segmentation purpose, this is nothing but a collection of a set of pixels, PSO can be effectively applied upon. Image characteristics varies from pixel to pixel, this makes the whole process of segmentation critical. Many modified versions of PSO are available nowadays among which MEEPSO (Multi-Elitist Exponential particle swarm optimization) was found to be less prone to failure [16]. However it was significantly slower as compared with original PSO, MEPSO (Multi-Elitist Swarm Optimization) [17] and EPSO (exponential particle swarm optimization). A PSO based segmentation approach for multi application smart cards [18] helps to overcome the problem of lossless compression. In case of medical image segmentation for abdominal CT scan images [19], PSO found to be effective showing good results. Though the use of PSO is many folds, here PSO based segmentation was used for poppy seeds segmentation, to analyze the quality of white poppy seeds. The initial setup of PSO:

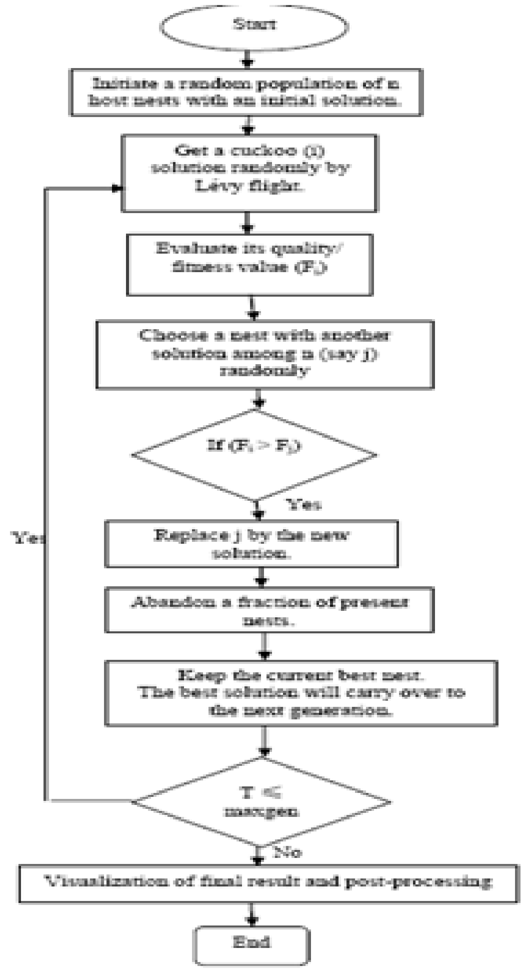

Figure: 5

Predefined PSO population (N) set to the total pixels.

a) Segmentation intensity set to 0.9.
b) Number of iterations set to 300.
c) Particle weight ~ 0.4.
d) Inertia (ω) = 1.(which controls momentum)
e) While not terminate
f) For each particle *i*:
g) Evaluate fitness *yi* at current position *xi*
h) If *yi* is better than *pbesti* then update *pbesti* and *pi*
i) If *yi* is better than *gbesti* then update *gbesti* and *gi*
j) For each particle i:
k) *xi* is a vector denoting its position and *yi* denotes its objective function value
l) *vi* is the vector denoting its velocity
m) *pi* is the best position that it has found so far and *pbesti* denotes its objective function score

The changes in velocity are updated using a linear proportional combination of the position and velocity matrix, where using constants (C), random value (rd) lies within [0 and 1], using a 3x3 window size and based on the values of gbest, region values are identified, which derives the integration point for similar particles within the range of given equations below.

Position update = $p_{i,j} + v_{i,j}$, (2)

Velocity update= $\omega * v_{ij} + C_1 * rd_1 \{P_{ij}-(p_{ij}+v_{ij})\} + C_2 * rd_2 [gbest_{ij} - \{(pij+v_{ij})\}]$, (3)

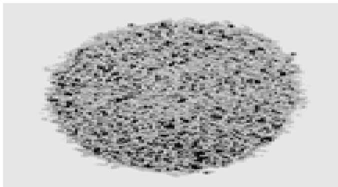

Figure. 6

a. *Histogram of the image:*

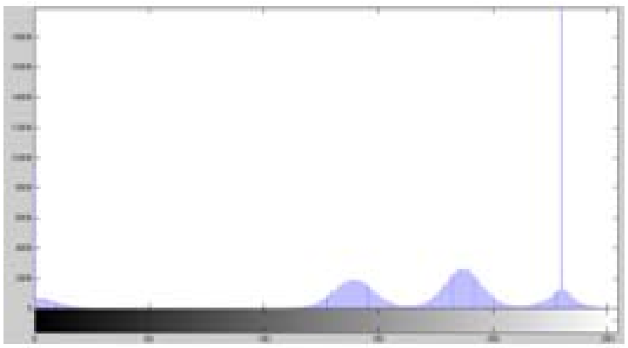

Figure.5

II. RESULTS

To attempt to make high value crop more purified in terms of its quality checking, it is found that, combination of CS and PSO is successful. CS able to provide an enhanced image as a preprocessing step, whereas PSO provided a clear segmented image, where black seeds of poppy within white seeds became visually clear. The results of CS (Fig.3) both in term of visually and quantitatively found suitable. This is also evident through the histogram (Fig.4). PSNR of image after applying CS calculated using, $20\log_{10}$ (255/RMSE), the value of which is 39.493, which is very good in terms of quantitatively. In case of PSO the same point is evident (Fig.5 and Fig.6). PSO successfully converged to its global best to achieve proper segmentation.

III. CONCLUSION

In conclusion it can be said that the objective of the experiment has been successfully achieved, which is nothing but the quality assurance of the agricultural food product. As discussed in case of both industrial and domestic use of the white poppy seeds its importance as a high value crop cannot be declined. This experiment is one of a kind in case of both technical and subject matter, i.e. poppy seeds. In future it can be expected that other high value crop quality monitoring can be taken as a problem at agricultural and industrial image processing levels.

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