# FACE RECOGNITION BASED ON CUCKOO SEARCH ALGORITHM

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**ABSTRACT:-**

**Feature Selection is a optimization technique used in face recognition technology. Feature selection removes the irrelevant, noisy and redundant data thus leading to the more accurate recognition of face from the database.Cuckko Algorithm is one of the recent optimization algorithm in the league of nature based algorithm. Its optimization results are better than the PSO and ACO optimization algorithms. The proposal of applying the Cuckoo algorithm for feature selection in the process of face recognition is presented in this paper.**

## 1. Introduction:-

1.1***Face Recognition***:

Face recognition, and computer vision research in general, has witnessed a growing interest in techniques that capitalize on this observation, and apply algebraic and statistical tools for ex-traction and analysis of the underlying manifold [1][2][3].This process includes the extraction of features of the query image and selecting the most approximate (matched) image from the database of the images of faces of persons. The features of each image in the database are already extracted and these features are used for recognizing an unknown face.

*1.1.1Feature Extraction*:-

To classify an object in an image, we must first extract some features out of the image. These features of human faces are either geometrical or statistical based. Feature extraction for a face extracts best discriminate features which are not sensitive to arbitrary environmental variations such as variations in pose, scale, illumination, and facial expressions[4][5].
Here we use the DCT Transformation of the image for the purpose of Feature selection.

i*)Discrete Cosine Transformation*

The discrete cosine transform (DCT) represents an image as a sum of sinusoids of varying magnitudes and frequencies. The dct2 function computes the two-dimensional discrete cosine transform (DCT) of an image[6]. The DCT has the property that, for a typical image, most of the visually significant information about the image is concentrated in just a few coefficients of the DCT. For this reason, DCT is used for feature extraction of an image[7][8][9].

The two dimensional DCT of an NxM matrix Apq of an image is defined as follows:

$$F(p,q) = \alpha(p)\alpha(q)\sum_{m=0}^{M-1}\cos\left[\frac{\pi(2m+1)p}{2M}\right]\sum_{n=0}^{N-1}\cos\left[\frac{\pi(2n+1)q}{2N}\right]Apq,$$

$0 \le p \le M-1$, $0 \le q \le N-1$

where : $\alpha(p) = \begin{cases} 1/\sqrt{M} & p = 0 \\ 2/\sqrt{M} & 1 \le p \le M-1 \end{cases}$

$$\alpha(q) = \begin{cases} 1/\sqrt{N} & q = 0 \\ 2/\sqrt{N} & 1 \le q \le N-1 \end{cases}$$

----Eq.(1)

1.1.2)*FeatureSelection*:-

Feature selection is the process which selects the optimal *d* feature out of total features *t* [10][11]. The extracted features are reduced further by Feature selection to remove redundancy and irrelevant features. The resulting feature subset (obtained by Optimization) is the most representative subset and is used to recognize the face from face gallery. The idea of applying the cuckoo algorithm for the feature selection is presented here.

**2. Cuckoo Algorithm:-**

Cuckoo search (CS) is an optimization algorithm developed Xin-she Yang and Suash Deb in 2009[12].Each egg in a nest represents a solution, and a cuckoo egg represents a new solution. The aim is to use the new and potentially better solutions (cuckoos) to replace a not-so-good solution in the nests [13].

The three basic principles are:

1] Each cuckoo lays one egg at a time, and dumps its egg in a randomly chosen nest.

2] The best nests with high quality of eggs will carry over to the next generation.

3] The number of available host nests is fixed and the host bird finds the egg laid by the cuckoo having fixed probability.

The random walks and the *L vy* flights are applied in the calculation of the new solutions of the generic equation.

Here, the random walks are linked with the similarity between a cuckoo's egg and the host's egg. An important issue is the applications of *Levy* flights and random walks in the generic equation for generating new solutions. The step size S determines how far a random walker can go for a fixed number of iterations. If s is too large, then the new solution generated will be too far away from the old solution (or even jump out side of the bounds). Then, such a move is unlikely to be accepted. If s is too small, the change is too small to be significant, and consequently such search is not efficient. So a proper step size is important to maintain the search as efficient as possible.

This constraint is met by applying the *L vy* flight as the step size. For the calculation of this step size Mantegna's algorithm is used [14].

$$S = \frac{\tau r2}{td} \qquad \text{-----Eq.2}$$

S: *L vy* step-size in the dimension space d and $\tau$ is the time taken to cover the average distance of r in dimension space d.

**3.Analogy To Feature Selection:-**

Here, the analogy between the feature selection in the face recognition and the cuckoo search are as follows:

i) The host nest actually represents the features extracted by the DCT of an image.

ii) Each cuckoo's egg is the new solution which represents the feature subset. This is further used for face recognition from the gallery.

iii) For each host nest (feature subset), quality of eggs is either 1 or 0, which represent whether it will carry on to the generation or not .i.e. whether the feature subset is selected or not for the face recognition.

iv) Probability that the egg laid by a cuckoo is discovered by the host bird is Pa. It represents discarding the feature subsets which are least significant (worst feature subset) and these features are dumped from further calculation. This probability is assumed to be fixed.

**4]Cuckoo Algorithm Based Feature Selection:**

***4.1Pseudo-Code***

1] Feature Extraction:-Apply DCT to an image and obtain the DCT array.

2] Select the most significant features of size nxn in the upper-left corner of the DCT array.

3] Feature selection: Assigning the parameters

N: dimension of search space/no. of host nest.

G: maximum generation.

C: total number of cuckoos.

4] Generation step: t

5] while (t< G)

{

For (i=0, i<=C, i++)

{

- Move cuckoo to the new nest with step size S
- Calculate fitness given by function Fi

If ( Fi >Fj)

{

Fj=Fi;

}

End for

- A fraction Pa of the worst solution is abandoned and new ones are built.
- Rank the solutions as per the fitness.
- Find the current best solution (nest).
- Pass the current best solutions to the next generation.

End while.

6] Pick up the solution (nest) with the maximum egg i.e. maximum fitness.

7] This solution is the output of the feature selection procedure.

8] Classifier:-

Euclidean distance is defined as the straight-line distance between two points.

$$D = \sqrt{\sum_{i=1}^{N} (Pi - Qi)^2}$$

Pi, Qi: co-ordinates of points in dimension i.

Euclidean distance is employed to measure the similarity between the feature subset of query image and the reference feature subsets in the image gallery. The image which has the smallest distance with the image under test is considered to be the required image.

Thus, we finally gets the target image from the gallery database and face recognition is achieved.

***4.2Fitness Function**:*

Let *u1,u2..., uL*denote the classes

*K1, K2... KL* denote the number of images within each class

Let *E1, E2,….. EL and E0* be the means of corresponding classes and the grand mean in the feature space

Ei can be calculated as follows:

$$Ei = \frac{1}{Ki}\sum_{j=1}^{Ki} Uij \quad \text{i=1,2,…L} \qquad \text{-------Eq.(3)}$$

Uij: represents the sample image from class ui

$$Eo = \frac{1}{K}\sum_{i=1}^{L} KiEi \qquad \text{------Eq.(4)}$$

L: Total no. of class K: Total no. of images

The class scatters fitness function F is computed as:

$$F = \sqrt{\sum_{i=1}^{L} (Ei - Eo)(Ei - Eo)^t} \quad [15] \qquad \text{-------Eq.(5)}$$

**5.Experimental Setup:-**

The above algorithm for feature selection can be implemented in MATLAB. Each of 2- dimensional subset DCT array should be converted to a 1-dimensional array using raster scan. This can achieved by processing the image row by row concatenating the consecutive rows into a column vector. This column vector will be the input to the cuckoo feature selection algorithm. The DCT array can be taken of size 30x30,40x40 etc.

For the MATLAB implementation X.-S. Yang and S. Deb have given the formula for the step size S as:

S=rand*(nest(randperm(n),:)- nest(randperm(n),:));-----Eq.(6)

new_nest=nest+stepsize.*K; ------Eq.(7)

where K=rand(size(nest))>pa and pa is the discovery rate.

The above step size based upon the biased random walk [12].

## 6.Conclusion:

In this paper, a proposal of Cuckoo-algorithm based feature selection algorithm for Face Recognition is presented. The algorithm is applied to array of feature vectors extracted by 2-D Discrete Cosine Transform of an image. The algorithm is utilized to search thefeature space for the optimal feature subset. Then, the classifier finds the most matching image from the database using Euclidean Distance. Cuckoo algorithm give better optimization results than PSO and thus face recognition based on cuckoo algorithm will be more efficient.

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