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Nature Inspired Optimization Algorithms: An Insight to Image Processing Applications

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Abstract:

Image processing is the technique of converting an image into its digital format and performing manipulations on it to enhance its quality or to extract some valuable information from it. Nature inspired optimization algorithms are the algorithms which adopts processes running in the nature. These algorithms follow the principle of Charles Darwin of "Survival of Fittest". This paper reveals the detailed explanation of various applications of image processing and how the optimization algorithms work in particular application.

Keywords: Image processing; Evolutionary algorithms; Swarm intelligence; Optimization algorithms

I. INTRODUCTION

Images are the best way of transmitting any kind of information. Digital Images can be seen as a collection of pixels and each pixel having some value to represent color, brightness, hue etc. Critical information can also be encrypted in digital images and transmitted from one person to another. During this transmission process images sometimes gets corrupted or distorted. Humans on seeing these images can only get approx 75% of information because human mind can only analyze and process the visual aspect of the image but it can't analyze the other information hidden in it in digital format. Thus we need a system which can accept the raw image data which can be corrupted also and give us some quantitative information hidden in it. Seeing this problem the field of image processing emerged. Image processing in general sense means processing / manipulating/ transforming an image. Image processing is the way of transforming or manipulating an image in such a manner so that quality of image can be enhanced or some kind of valuable information can be extracted. Image processing includes basic three steps:

1. Capturing the scene and transferring image from optical device to computer.
2. Treating this image as input in image processing system and analyzing it to identify hidden information which can't be seen by human brain.
3. Analysis report of image is generated.

Many different techniques were introduced to perform different tasks on the image. Recently many new approaches are introduced which are inspired from nature. They follow the principle of Charles Darwin of "Survival of Fittest". The solutions which are best among vast pool of solutions are only forwarded to next generation or next iteration step and rest are discarded. These algorithms are broadly classified into two categories namely Evolutionary Algorithms and Swarm Intelligence.

The discussion in this paper is about detailed explanation of various applications of image processing and how these new algorithms find their way in the field of image processing. This paper is divided into four sections. Section II & III gives brief overview on evolutionary algorithms and swarm intelligence respectively, Section IV reveals about various applications of image processing, their detailed explanation and how these new optimization algorithms work in this particular application. Section V concludes this paper.

II. EVOLUTIONARY ALGORITHMS

Evolutionary algorithm comes under the category of evolution computation. Evolution computation [1][2] has its foundation in natural evolution or we can say biological evolution. It follows the phenomenon how the members of nature evolve i.e. change themselves according to the changing environment.

The steps which are being followed in evolutionary algorithms are as follows [1][3][4]:

1. The population of individuals is created and each individual is assigned a fitness value.
2. The best individuals which are having highest fitness value are chosen using the process of natural selection.
3. The selected individuals are parents and new individuals are generated using the recombination process and mutation.
4. Now the newly generated individuals are assigned some fitness value, combined with the population and again selection procedure is applied.
5. This process goes on until solution is found.

Evolutionary Algorithms can be classified as:

- Genetic Algorithms
- Genetic Programming
- Evolutionary Strategies

A.) Genetic Algorithms

Genetic Algorithms was proposed by J. Holland, K. DeJong, D. Goldberg in 1970's [5][6]. These algorithms follow the idea of natural evolution. These algorithms are metaheuristic in nature i.e. generates optimal solution from vast search space. GAs are inspired from crossover, mutation and inheritance.

B.) Genetic Programming

Genetic Programming was proposed by John Koza in 1992 [7]. Genetic programming is an enhanced version of genetic algorithms. Genetic programming uses the same process of natural evolution to evaluate computer programs to perform user defined task [8]. The population of computer programs is used to find optimal solution to a high level complex problem statement [9].

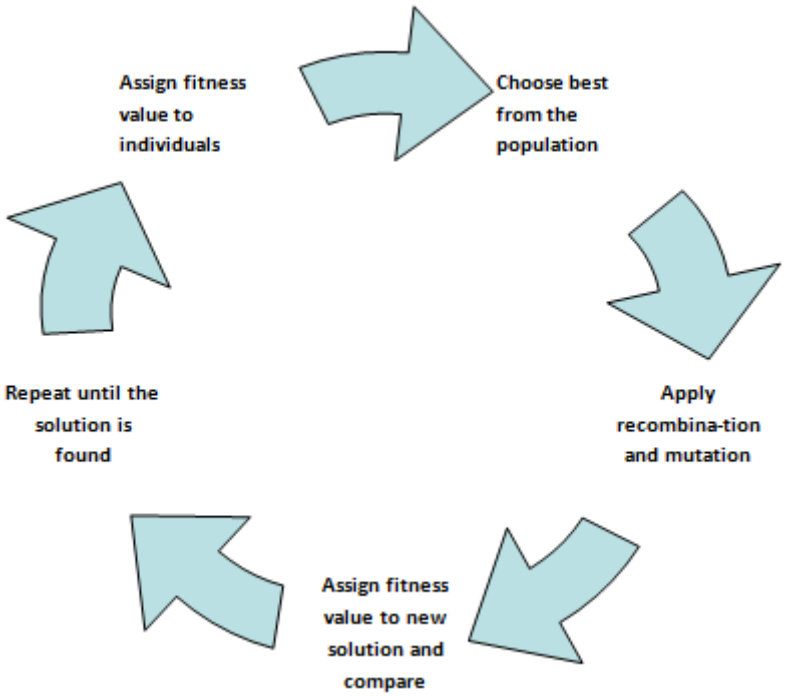
C.) Evolutionary Strategies

Evolutionary Strategies was proposed by three students, Rechenberg, Schwefel and Bienert of Berlin University [10][11]. This algorithm also follows the same process of natural evolution and the process of selection and generation goes on until solution is found. There are three strategies followed:

(1+1)-ES: Independent solution is selected and mutated and further compared with the previous solution and the best between the two is chosen for next generation.

(μ+λ)-ES: μ parents are chosen from population and recombined to generate λ offsprings. These offsprings are combined with the previous solutions and best μ solutions are chosen from the set for next generation.

(μ,λ)-ES: μ parents are chosen from population and λ offsprings are generated (λ≥μ). From λ offsprings best μ are chosen to serve as parents in next generation.



Flow Cycle of steps of evolutionary algorithms:

III. SWARM INTELLIGENCE

The term "SWARM INTELLIGENCE" was introduced by Gerardo Beni and Jing Wang in 1989 in the context of cellular robotic systems. Bonabeau et al, 1999[16] describes swarm intelligence as the process of inter-working and inter-communication among groups of social agents to find their food. Swarm intelligence is an extension to evolutionary computation. Evolutionary computation is based on genetics whereas swarm intelligence is based on behavior of social agents like ants, bees, insects etc. The swarms work in decentralized and self organization manner. A single member of a swarm may not work properly but the group works very well.

The swarm intelligence based systems have following properties:

1. There are many individuals which are homogeneous in nature.
2. The individuals interact with each other using simple behavioral rules.
3. The overall working of the system is affected by the interactions between individuals and interactions between individuals and environment.

The three main algorithms which come under the category of swarm intelligence are:

- Particle Swarm Optimization
- Ant Colony Optimization
- Artificial Bee Colony Optimization

A.) Particle Swarm Optimization

This algorithm was proposed by Kennedy and Eberhart in 1995 [15]. This algorithm is mainly inspired from behavior of bird flocking searching for food. Each particle in the pool represents a solution. These particles are mass less / volume less or of small mass / volume. Each particle has its position and velocity in the pool. This position and velocity is updated relative to other particle's position and velocity and its own previous position and velocity.

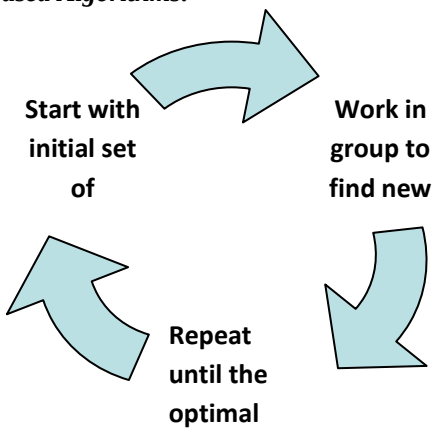
B.) Ant Colony Optimization

Ant Colony Optimization algorithm was proposed by Dorigo & Di Caro in 1999 [17]. As the name says this algorithm is inspired from the colony of ants that how they find the optimal path for their food source. Ants leave pheromone trails on the path during their searching of food. Several ants follow the same path thus leaving pheromone on the way. The concentration of pheromone on the way tells the quality of food source at the end of the path. The algorithm initiates by setting up of ACO parameters and construction of ant solutions i.e. creating artificial ants. These ant solutions find new solutions. The pheromone values are updated; they are increased for good solutions and decreased for bad solutions.

C.) Artificial Bee Colony Optimization

Artificial Bee Colony Optimization algorithm was proposed by Karaboga in 2005 [18][19]. This algorithm takes idea from the bee colony as to how they search food. There is an interesting way in which bees find their good quality nectar source. The bees are sent in different direction. When they return, they perform a waggle dance to communicate about the location of the food source. Other bees on their wish choose any bee to follow. The bee which gets more followers is the bee which has found the best nectar source. In the same way, algorithm approaches to the best solution. Employed bees are the ones sent to search for food source. Onlooker bees follow the best employed bee and scout bees are sent again to search for better food source.

Flow Cycle of Swarm Intelligence Based Algorithms:



IV. APPLICATIONS OF IMAGE PROCESSING

In the vast domain of image processing, there are several applications on which researches are currently being done. An overview to these applications will be given below.

A.) Image Segmentation Using Edge Detection

Image Segmentation is partitioning of an image into homogeneous regions. Edge detection is a process in image processing for detecting object boundaries in the image. It is done by detecting sharp brightness discontinuities in an image. Edge detection is mainly used for the purpose of image segmentation. The basic four steps involved in edge detection are:

1. Image Smoothing or Filtering: It is used to reduce or remove the unwanted disruption i.e. noise from the image.
2. Image Enhancement: It is used to enhance or sharpen the intensity of the pixels of an image to improve its quality.
3. Detection: There are many pixels in the image which are to be discarded as noise and retained as edge pixels. So some method needs to be followed for this purpose.
4. Localization: It is used for determining exact location of the edge in the image.

The techniques used for edge detection are [21]:

1. The Roberts Detection: The Roberts edge detection method was given by Lawrence Roberts in 1965. It performs a easy, fast to evaluate, 2-D spatial gradient measurement on an image. This method focuses on the regions of high spatial frequency which often correspond to edges.

+1	0
0	-1

Gx

0	+1
-1	0

Gy

Roberts Mask

2. The Sobel Detection: The Sobel edge detection method was given by Sobel in 1970 (Rafael C.Gonzalez (2004)). It precedes the edges at those points where the gradient is highest. The Sobel detection technique performs a 2-D spatial gradient quantity on an image and so highlights regions of high spatial frequency that correspond to edges. In general, it is used to find the approximated absolute gradient magnitude at each point in m input grayscale images. It is very much same as Roberts's technique.

-1	0	+1
-2	0	+2
-1	0	+1

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

Sobel Mask

3. The Prewitt Detection: The Prewitt edge detection was given by Prewitt in 1970 (Rafael C.Gonzalez). In this technique, horizontal and vertical filter is applied in sequence and the result of the two is combined to achieve the final result. The operator finds gradient of image intensity at each point. The prewitt operator finds edge's magnitude and orientation in the image.

-1	+1	+1
-1	-2	+1
-1	+1	+1

0°

+1	+1	+1
-1	-2	+1
-1	-1	+1

45°

Prewitts Mask

4. The LoG Detection: The Laplacian of Gaussian (LoG) was proposed by Marr(1982). In this laplacian and Gaussian filtering is combined. The result after operation is a double edge image.

0	-1	0
-1	4	-1
0	-1	0

G_x

-1	-1	-1
-1	8	-1
-1	-1	-1

G_y

LoG Mask

5. The Canny Detection: The Canny Edge Detection technique was given by John F. Canny in 1986. Firstly the image is smoothened i.e. noise is removed. It then finds the image gradient to emphasize regions with high spatial derivatives. The pixel not at the maximum is suppressed. The gradient array is now further reduced by hysteresis. Hysteresis is used to suppress remaining pixels which have not been tracked. Hysteresis uses two thresholds and if the magnitude is below the first threshold, it is set to zero, i.e. it is made a non-edge and if the magnitude is above the second threshold, it is made an edge. And if the magnitude is between the two thresholds, then it is set to zero unless there is a path from this pixel to a pixel with a gradient above the second threshold. The mask used is of Sobel operator.

(a)

(b)

(c)

(d)

(e) (f)

The Comparison of Edge Detection Techniques
(a) Original Image (b) Using Roberts Operator
(c) Using Sobel Operator (d) Using Prewitt Operator
(e) Using LoG Operator (f) Using Canny Operator

Using Nature Inspired Optimization Algorithms:

I. Genetic Algorithm Based Approach

The primary why image segmentation incorporated the use of genetic algorithms is that GA can work with large and complex search spaces in those cases where knowledge is minimum about objective function. Genetic algorithm can be used in two major ways i.e. Parameter selection, where GAs are used to select parameters of an image among various parameters available and modify them to generate enhanced output. Secondly, Pixel level segmentation where GAs are used for region labeling [22]. The most comprehensible work on GAs with image segmentation is given by Bhanu and Lee [23]. They used genetic algorithms for the selection of parameters according to changing environmental conditions. The experiments have been done on both indoor and outdoor color images.

II. Swarm Intelligence Based Approach

Most of the work in edge detection is done using ant colony optimization algorithm [24-28]. The main concept using ACO based approach is to use n number of ants to track 2-D image matrix (gray level) and create a pheromone matrix, each entry has the information about the edge at each pixel location. The ants tracking direction is based on the local intensity (discontinuities or sharp changes) values of the image pixel.

B.) Content Based Image Retrieval

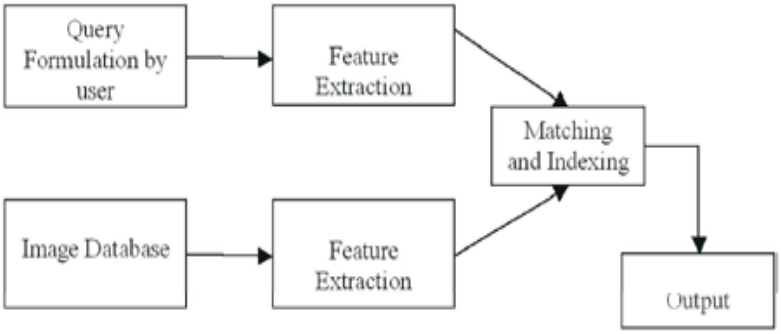
Content based image retrieval or CBIR is a technique of accessing or organizing digital images from a large set of image database according to the image features. The research in CBIR is mainly focused on reducing the semantic gap between low level visual features and high level image semantics. The images are retrieved using visual features like color, texture, shape, faces etc. The term content based image retrieval was first used by T. Kato in 1992, to describe his experiments on automatic retrieval of images from the database based on shapes, colors etc

The basic steps involved in image retrieval are:

1. The user gives an input image as a query to the CBIR system.
2. CBIR system evaluates a feature metrics for the query image and for the images that are stored in database.
3. Next step is to perform similarity between feature matrices.
4. According to the result of evaluation, the similar images are displayed.

Retrieval can be performed in three ways[29][30]:

I. Color Based Retrieval: The color is the most important feature of any image. To retrieve an image based on color, color histogram method is used. A color histogram is the graph showing the distribution of colors in the image. To obtain images based on



CBIR System

this technique, histogram of the query image is evaluated and histograms of all the images in the database is also evaluated. The difference between query image histogram and each stored image histogram is calculated, threshold is set. The difference values which satisfy the threshold criteria are given as output to the user.

II. Texture Based Retrieval: Texture in image can be explained as some structures or patterns which are repeated in image all over. The images can be retrieved based on textures also. Tamura features come under the category of textures. The six tamura features are coarseness, contrast, directionality, line-likeness, regularity and roughness. Another method is to use gray level co-occurrence matrix which can derive contrast, entropy, correlation and energy homogeneity.

III. Shape Based Retrieval: Shapes are objects in an image. Shapes can be represented in an image either by using boundary based method which deals with the outer boundary of the shape or region based method which deals with the whole region of the shape. Fourier descriptors are used for boundary based method. In this, Fourier transform of the boundaries is taken, which is the mapping of every boundary pixel to the complex number $x + iy$. For region based methods, moment invariants are used. Moment invariant is some kind of weighted average of intensity of image pixels. The three popular methods for calculating moments are invariant moments, Zernike moments and Legendre moments.

Using Nature Inspired Optimization Algorithms:

I. Genetic Algorithm Based Approach

Interactive genetic algorithm comes under the category of evolutionary computation. CBIR using IGA is a new technique. In this user interacts with the system for producing new generation from existing population, based on the user query input and instructions given for reproduction of new generation, IGA generates new system. Chin-Chin Lai et.al [31], proposed a CBIR system using interactive genetic algorithm which reduced the gap between retrieved results and user's expectations.

II. Swarm Intelligence Based Approach

The main problem in image retrieval is how to choose features which can give best results in less time. Ant colony optimization algorithm is applied on feature selection. Here artificial ants selects subset of features from original given feature set, based on this pheromone trails are updated. In repeated iterations, best subsets are chosen from previous subset. In this way we get to the best optimal feature set [33].

Comparison of Image Retrieval Techniques

(a) Original Image

(b) Color Based Retrieval

(c) Contrast Based Retrieval (Texture)

(d) Entropy Based Retrieval (Texture)

C.) Fingerprint Recognition System

Fingerprint is a mark or an impression on a person's finger tip which uniquely identifies him/her. Using this concept a recognition system was made based on fingerprints so that an authorized person can only enter the system.

Fingerprints can be classified into three classes:

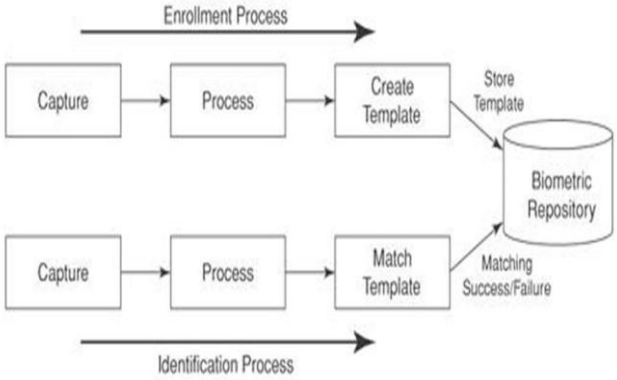
1. Arches: The ridges in the fingerprint start from one end and leave out on other end.

2. Whorl: The ridges form a circular pattern around a central point in the fingerprint.

3. Loop: The ridges in the fingerprint from one end, goes inside and returns to the point from where it started.

Fingerprint Recognition System:
Fingerprint recognition system works in two ways either in verifying mode or in identifying mode. In verification mode, the person first enters or enrolls his fingerprint in the system and then when he access the system, the system verifies it from the existing database and takes further action. In identification mode, the person does not enrolls his fingerprint in the system, and when he access the system, the system checks from the database and takes further action whether to allow that person to enter to the system or reject him[37][38].

Fingerprint recognition System



Fingerprint Matching Techniques [34][39][40]:

1. Minutiae Extraction Technique: Minutiae extraction technique is based on extraction of local features of fingerprint like termination and bifurcation. The features are extracted from fingerprints which are to be matched and stored in the database. Then minutiae matching process is initiated which includes alignment stage and match stage. In alignment stage, any minutia from each image is taken and similarity between two ridges is found out which is associated with minutia pair. In match stage, the elastic algorithm is used to count the similar minutia pairs to deduct that fingerprints are same.
2. Pattern Matching or Ridge Feature: In this technique, fingerprint patterns like arches, loops and whorls are matched for finding the matching fingerprints. For doing this the fingerprint images are to be aligned so that similarity between ridges can be found out.
3. Correlation Based Technique: In this technique, the images which are to be matched are aligned and correlation between corresponding pixels is calculated. Cross correlation is the widely used method.
4. Image Based Technique: In this technique, matching is done based on the global features of a fingerprint image. It is a new emerging technique.

Using Nature Inspired Optimization Algorithms:
I. Genetic Algorithm Based Approach
Genetic Algorithm is used in verification stage of the system, in which it is used to detect and compare minutiae from two fingerprint images. A gene is coded in such a manner that if there is a relation between minutiae between two images it is coded as 1 otherwise 0. The selection is performed using roulette wheel selection. The crossover and mutation operator is used for exploration of whole search space [41].

II. Swarm Intelligence Based Approach
Ant colony optimization algorithm is used here for segmenting the fingerprint image so rather than analyzing the whole image blocks of image are analyzed. Using this method, fingerprints can be verified at remote systems also[42].

D.) Image Restoration
Digital images can be prone to any kind of degradation. This degradation can be noise (noise is the result of errors in the image acquisition process that result in pixel values that do not reflect the true intensities of the real scene) or blurring (any kind of distortion in the image mainly due to rapid motion of camera lens or object). Image restoration is the technique which removes these types of degradations from the image.

Image Restoration Process

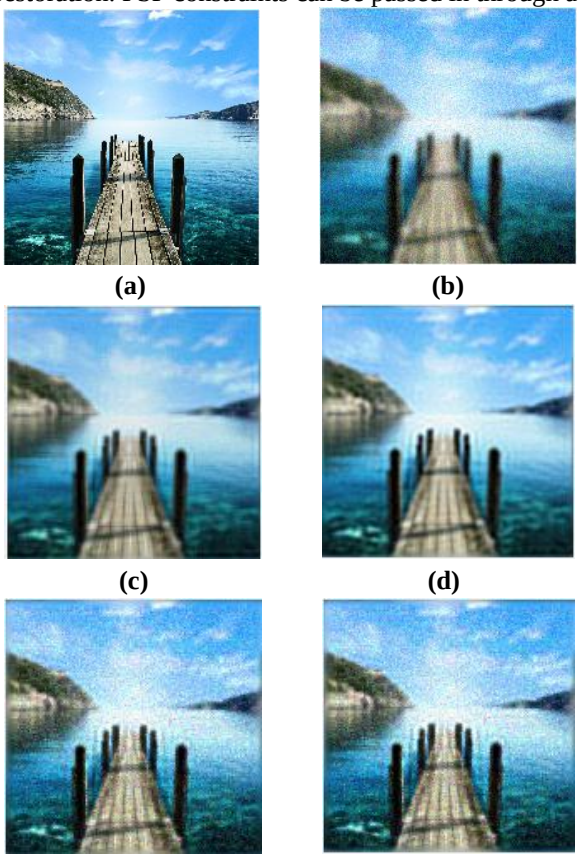
Image Restoration Techniques [43][44]:

1. Wiener Filter: The Wiener filter was proposed by Norbert Wiener in 1940. It mainly deals with the reduction of amount of noise in the image. This is done by comparing the received signal with the estimation of a desired noiseless signal. Wiener deconvolution can be useful when the point-spread function and noise level are known or can be estimated.

2. Regularized Filter: Regularized deconvolution can be used effectively when constraints are applied on the recovered image (e.g., smoothness) and limited information is known about the additive noise. The degraded image is restored by a constrained least square restoration algorithm that uses a regularized filter.

3. Lucy-Richardson Filter: The Lucy-Richardson algorithm can be used effectively when the point-spread function PSF (blurring operator) is known, but less or no information is known for the noise. The degraded image is restored by the iterative, accelerated, damped Lucy-Richardson algorithm.

4. Blind Deconvolution Filter: The Blind Deconvolution Algorithm can be used effectively when no information about the distortion (blurring and noise) is known. The algorithm restores the image and the point-spread function (PSF) simultaneously. Additional optical system (e.g. camera) characteristics can be used as input parameters that could help to improve the quality of the image restoration. PSF constraints can be passed in through a user-specified function.



(a) **(b)**

(c) **(d)**

(e) **(f)**

The Comparison of De-blurring Techniques
(a) Original image (b) Degraded image (c) Using Wiener Filter
(d) Using Regularized Filter (e) Using Lucy-Richardson Filter
(f) Using Blind Deconvolution Filter

Using Nature Inspired Optimization Algorithms:

I. Genetic Algorithm Based Approach

In genetic algorithm based approach, population of a number of estimated original images and then each estimated image is degraded. Now the fitness function is evaluated by comparing each degraded estimate image with the degraded image of the original image entered in the system. The cost function is calculated for each estimate using this equation

$$E = \|g - \hat{f} * h\|^2$$

Where f^ is the estimate of original image f. The lower the cost function, the higher the fitness function. The optimal solution is obtained by minimizing the cost function[45].

II. Swarm Intelligence Based Approach

Whenever an image is restored, it has ringing effect near the sharp edges. This ringing effect occurs due to the loss of high frequency information from the image. So to detect this ringing effect ant colony optimization technique is used. When an image is restored, ant colony optimization algorithm is used to find all the edges and to detect ringing effect across the edges in the image then edge taper function is used to remove the ringing effect[46][47].

E.) Face Expression Detection

Facial expression shows the inner emotions of any human being. So the facial expression detection system recognizes emotions on accepting an image. The first task of the system is to identify the human figure on the given input image.
The three main tasks of face expression detection system are:

1. Face Detection: Face detection is the process of identifying human faces in the image. It is not necessary that the input image contains only human face; it can also have various objects of environment. So to detect expression it is firstly needed to identify human face in the image. The most popular method for this purpose was given by C. Tomasi and T. Kanade. This method was called Kanade- Lucas-Tomasi tracker[48].

2. Feature Extraction: After the face detection, it is necessary to understand the features of the image. For this purpose, a database of various emotions is needed for comparison. Tian et al[49] developed an automated face analysis system to analyze facial expressions based on both permanent and transient features. Various models were developed to show the state of lips, eyebrows, cheeks, eye-lids etc. and for wrinkles edge detector was used.

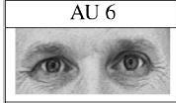
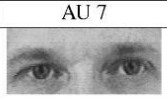
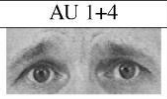
The features extracted for expression detection can be classified as:

a.) Geometric Features: These features are always present on the face but are deformed due to any kind of expression appearing on the face. For example, while smiling, our lips stretch and furrows appear under cheeks and our eyes also get little stretched. This deformation of facial muscles comes under this category.

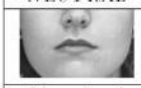
b.) Appearance Features: In this category those features are considered which occur temporarily due to any kind of expression like wrinkles, bulges, forefront etc. To extract this kind of feature vector Gabor Wavelet is used and applied either on whole face or on particular region of the face.

3. Expression Classification: After the above two steps are completed, the last step is to classify the expressions. So for this a good expression classifier is required. To achieve this challenge, Cohen et al[50] proposed facial expression recognition system based on bayesian classifiers and Hidden Markov Model based classifiers.

The most commonly used face expression classification system is Facial Action Coding system proposed by Paul Ekman and Wallace Friesen in 1976. This system is based on the concept of analyzing the relationship between muscle contraction and the changes that appear in facial expressions. In this system face is divided into two action unit upper face and lower face. Action units are the changes that occur due to a single muscle contraction or combination of multiple muscle contractions. Using FACS the facial expressions are classified into action units. There are 46 action units that represent changes in facial expressions and 12 action units that are associated with eye gaze and head orientation [51].

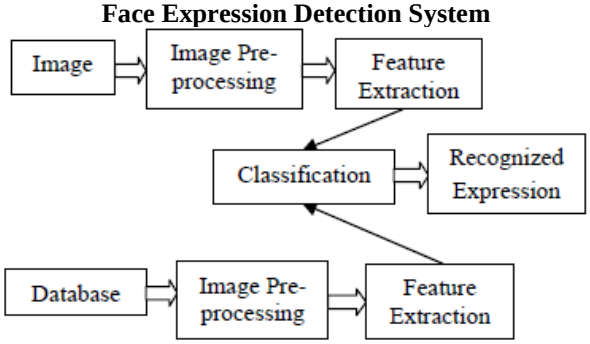
NEUTRAL	AU 1	AU 2	AU 4	AU 5
				
Eyes, brow, and cheek are relaxed.	Inner portion of the brows is raised.	Outer portion of the brows is raised.	Brows lowered and drawn together	Upper eyelids are raised.
AU 6	AU 7	AU 1+2	AU 1+4	AU 4+5
				
Cheeks are raised.	Lower eyelids are raised.	Inner and outer portions of the brows are raised.	Medial portion of the brows is raised and pulled together.	Brows lowered and drawn together and upper eyelids are raised.
AU 1+2+4	AU 1+2+5	AU 1+6	AU 6+7	AU 1+2+5+6+7
				
Brows are pulled together and upward.	Brows and upper eyelids are raised.	Inner portion of brows and cheeks are raised.	Lower eyelids cheeks are raised.	Brows, eyelids, and cheeks are raised.

Upper Face Action Units

NEUTRAL	AU 9	AU 10	AU 12	AU 20
				
Lips relaxed and closed.	The infraorbital triangle and center of the upper lip are pulled upwards. Nasal root wrinkling is present.	The infraorbital triangle is pushed upwards. Upper lip is raised. Causes angular bend in shape of upper lip. Nasal root wrinkle is absent.	Lip corners are pulled obliquely.	The lips and the lower portion of the nasolabial furrow are pulled pulled back laterally. The mouth is elongated.
AU15	AU 17	AU 25	AU 26	AU 27
				
The corners of the lips are pulled down.	The chin boss is pushed upwards.	Lips are relaxed and parted.	Lips are relaxed and parted; mandible is lowered.	Mouth stretched open and the mandible pulled downwards.
AU 23+24	AU 9+17	AU9+25	AU9+17+23+24	AU10+17
				
Lips tightened, narrowed, and pressed together.				
AU 10+25	AU 10+15+17	AU 12+25	AU12+26	AU 15+17
				
AU 17+23+24	AU 20+25			
				

Lower Face Action Units

Face Expression Detection System



Using Nature Inspired Optimization Algorithms:

I. Genetic Algorithm Based Approach

Genetic algorithm can be used for optimizing facial feature for classification or it can be used to select features for enhancing the performance of the system.

Expressions are mainly built due to contraction of eye and lips muscles, so genetic algorithm can be used to extract eye and lip region from the image [52].

II. Swarm Intelligence Based Approach

Particle Swarm optimization algorithm is commonly used for expression detection. A new proposed algorithm Guided Particle Swarm Optimization Algorithm [53] is used for emotion detection which works on the concept of action units given by Ekman and Friesen [51]. A swarm of particles is defined so that each particle consists of components from the neighborhood of AU. By using this algorithm swarm of particles converge on the path to action unit. The approach is working very well and made the swarm to converge very quickly to identify the emotion being expressed.

V. CONCLUSION

The sole purpose of this paper is to give a brief overview of image processing applications and to show how traditional methods and nature inspired optimizations algorithms works in this area. In some or the other aspect these optimization algorithms have enhanced the performance of each image processing application which are discussed here and further more in the vast domain. These optimization algorithms are gaining more interest day by day due to their effective performance in every research domain.

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