Noise Reduction Via Genetic Algorithm (GA)

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Abstract

This paper describes an effective method for performance both image de noising and brightness to images corrupted with wide category of noise. The method employs a Real-coded Genetic Algorithm (GA) with ***subjective fitness and crossover operator*** called (Uniform Crossover).

The filters are used noise smoothing and adaptive to local changes in image statistics algorithm [1]. Two methods are used for this purpose, one is the classical and other is the Genetic Algorithm.

This paper describes effective Genetic Algorithm (GA) methods for performing together noise reduction for image and brightness using GA, by employing a computational model capable of deriving the filter to the human interpreters demands.

Keyword

Noise **R**eduction, **G**enetic **A**lgorithm, **A**daptive filter, **S**moothing

Introduction

Image Processing is becoming a widely acknowledged and very extensive field. You don't have to be a scientist or an engineer to come into contact with image processing. It's applications range from space exploration and remote sensing to document processing and desktop publishing. Even eyeglasses can be considered as a form of image processing. With digital images, we have more options available to us than ever before [2].

On the fundamental image-processing techniques, spatial filtering is widely used to extract detail and control noise [3]. Spatial filtering modifies a pixel according to the appearance of its neighbors.

The system uses Genetic Algorithms (GA) is implemented to generate optimal different filter that is required to reduce the noise from the original image. Also classical methods are implemented to compare it with the new one.

1. Adaptive Smoothing Filters

Most of the well known adaptive filters (that are on image model and local image statistics) is used to smooth sensed spackle images i.e. they consider the speckle noise as to be multiplicative. To avoid blurring effects and retaining faint lines and structures, the adaptive filters can be efficiently used to smooth speckle image [4]. Will be dealt with only two of these filters. The performance of the adaptive noise-smoothing filter depends heavily on the method used to calculate the local statistics. There are two types of filters are used (***Lee Filters and Kuan Filters)***

Lee suggested the use of local statistics to restore images corrupted by both additive and multiplicative noise. He exploits the local statistics with in image region to reduce both additive and multiplicative noise in different images [4,14]. Lee filters can be grouped into two-type [4] **(additive noise *and multiplicative* noise).**

Kuan suggest It is most frequently used as a speckle filter and considered to be an adaptive in the sense that the filtering operation depends on estimations of local statistics calculated on a neighborhood of the considered pixel [4]. Kuan filters can be grouped into two types also (additive noise *and multiplicative* noise).

Lee Additive Noise introduced adaptive digital smoothing filter to remove additive noise. The problem associated with the implementation of this smoothing filter is how to estimate the noise within a desired region of an image [4].

If it is assumed that the ensemble statistics can be replaced by local spatial statistics that are estimated from the degraded image.

Lee Multiplicative Noise (In this section, the explicit structure is driven from the adaptive noise-smoothing filter for multiplicative noise) ; but the Kuan Multiplicative Noise (Generally, images contain multiplicative noise have the following characteristics, the brighter area is the nosier mathematically. For multiplicative noise), the adaptive noise-smoothing filter is a systemic derivation of Lee’s algorithm with some extensions that allow different estimators for local image variance. In Lee’s local statistics algorithm linear approximation is made for multiplicative noise [4].

2. Genetic Algorithm

Genetic algorithms are heuristic search procedure based on the mechanics of natural selection. The search space of the problem is represented as a collection of individuals (population), which are encoded by character strings. An objective function measures the quality of the individuals and the genetic algorithm tries to find the individual, which optimizes that objective function [5,7]. In this paper we use subjective function.

3. Design and implementation of noise reduction system

Figure (1) represents a block diagram of the system design and its implementation, which includes the main two methods. The classical methods using smoothing reduction noise from image), or genetic algorithm (GA). Here used the GA as subjective rather than objective.

Each block represents one of the implemented filters in the classical methods, which can be compared with the GA in image enhancements. The types of noises used were (Gaussian, Uniform noises) which are added to the image through the applications of (Adobe-PhotoShop). The experimental results could be seen through any of the following:

- Quantitative caliber (SNR, signal to noise ratio), and
- Human vision

4.1 Adaptive Smoothing Filters

Most of the well known adaptive filters (that are based on image model) and local image statistics are used to smooth sensed spackle images (i.e. they consider the speckle noise to be multiplicative). To avoid blurring effects and retaining faint lines and structures, the adaptive filters can be efficiently used to smooth speckle image.

Two types of the adaptive filters above (additive Lee & Kuan Filters) and (Multiplicative Filters).

The Life Cycle Algorithm of GAs

To appreciate the principles of operation of a basic genetic algorithm, it is perhaps best to outline an example problem and the application of the evolutionary process to its solution.

1.Chromosome**:** Genetic algorithms modeled their elements (**genes**) of **chromosomes,** as real code. The length of chromosome is L= 9 genes corresponding to a 3 x 3 sliding window.

2.Fitness**:**.In a genetic algorithm pairs of individuals were selected from a population to breed using a **measure of fitness**. **Individuals with a higher fitness** were allowed to produce **offspring**, which would contain copies of the parent chromosomes that may have crossed over in the breeding process.

3.The population is composed of chromosomes representing the string of GOSF coefficients a j.

The **General Order Statistics Filter (GOSF)**, can be defined as follows [6]:

$$y_j = \frac{\sum_{j=1}^{n} a_j x_j}{\sum_{j=1}^{n} a_j} \qquad \text{(eq. 1)}$$

♦ Where xj are the inputs arranged in increasing order of magnitude. In image processing applications, the inputs are the ordered pixel intensity values in a sliding window centered on the pixel for which the output is calculated. Here the GOSF are based on robust statistics principles to fill the gap left by not having a direct method to find the filter’s coefficients (mask) giving any corrupted image (Roulette wheel principles) by applying equation (2) below:

$$f_{(x,y)} = \frac{|x|}{4} + \frac{|y|}{4}$$

where x,y = -1… 1 (eq. 2)

♦ $\mathbf{a_j}$ are the filter coefficients starting with a bit mask of length L [6]:

mask = { mask (i)} $_{i=1...L}$ with:}

mask (i) ≅ {1 if $r_i \leq 0 : 0.4$

0 otherwise} (eq. 3)

With ri a sample from a uniform distributed random variable R ≈U(0, 1), and using a traditional crossover, the good results are obtained when the range of crossover rate (Rc) is between (0.06-0.6).

These equations are used to ordere the coefficients which adaptive make filters has building, where the corners values is the highest values, the middle values are smaller than corners and the minimum value is in the central position.

♦ $\mathbf{y_j}$ is the filters outputs.

4. Mutation that chooses randomly an allele from the allowed allele domain has been employed. The **m**utation **r**ate (**R_m**) is between (0.0011- 0.0033).

5. Fitness function: The fitness functions, which are a subjective fitness rather than an objective ones are shown below [7] :

$$f_{(x)} = x^2 \qquad \text{(eq. 4)}$$

The fitness function are used to weaken the smallest values and strength length the largest values.

6. Maximum generation: For stopping criteria the maximum generation is used.

Can see the table (1) which include the general configration of test images that's used in the our implamantation.

4.3 Experimental Results

- ♦ The score represents the fitness of the chromosome, which is a subjective fitness rather than an objective one.
- ♦ The user has a better control on the process of enhancement. His particular demands regarding performance, visual quality of the output image, as well as several other subjective factors of image interpretation can be embedded in the GOSF involved in a direct and quite transparent fashion.
- ♦ GA results in the removal of any types of noises that are dealt with in this work, especially speckle noise, where the traditional methods can't effect efficiency unless an adaptive filters is used.
- ♦ **S**ignal to **N**oise **R**atio (**SNR**) is used to measure the quantitative calibration as these equations below show, to achieve the probability of each image results.

$$SNR = \frac{M}{\sigma} \qquad \text{(eq. 5)}$$

where M : Mean

σ : Standard deviations

- ♦ The effectiveness of applying the GA to image enhancement was tested experimentally. The results obtained in this work cover two aspects: **GA and classical methods of image enhancement**. The Figure (2) represesent the baby image using genetic algorithm including (Population size 20, Max generation 57,the Crossover probability 50 and the mutation probablilty 0.01).
- ♦ When we implemented the Lee and Kuan adaptive filters for the same baby image the noise is sitell and the baby image is not enhansed for the best . The Figure (3) can see the implamantation of the baby image using Lee and Kuan

adaptive filters to gather, But the Figures (4) and (5) represent the implemantations of the Lee and Kuan adaptive filters respactivley.

5. Conclusions

From the analysis of the results demonstrated the following conclusions may be extracted:

1. In GA the masks are generated according to the details of image (dynamic) where static filters are used in classical methods.
2. Many processes are needed in classical method to find the best enhancement, but GA gives the same results with fewer processes.

GA proves to be very good in removing most of noises, while classical methods usually deal with one type of noise, for example adaptive filters (Lee &Kuan) can remove speckle noise only.

Operators	Value
Initial pool entered	Randomly
Population size	20 - 30 Individuals
Chromosome length	9
Selection operator	Roulette wheel
Crossover operators	CX (single-point)
Mutation operator	Randomly
Crossover rate rang	0.60 – 0.060
Mutation rate range	0.0011- 0.0033
Maximum generations range	50 - 60
GA mask	(R ≅ U(0-1)

Table (1), The GA configuration of test images

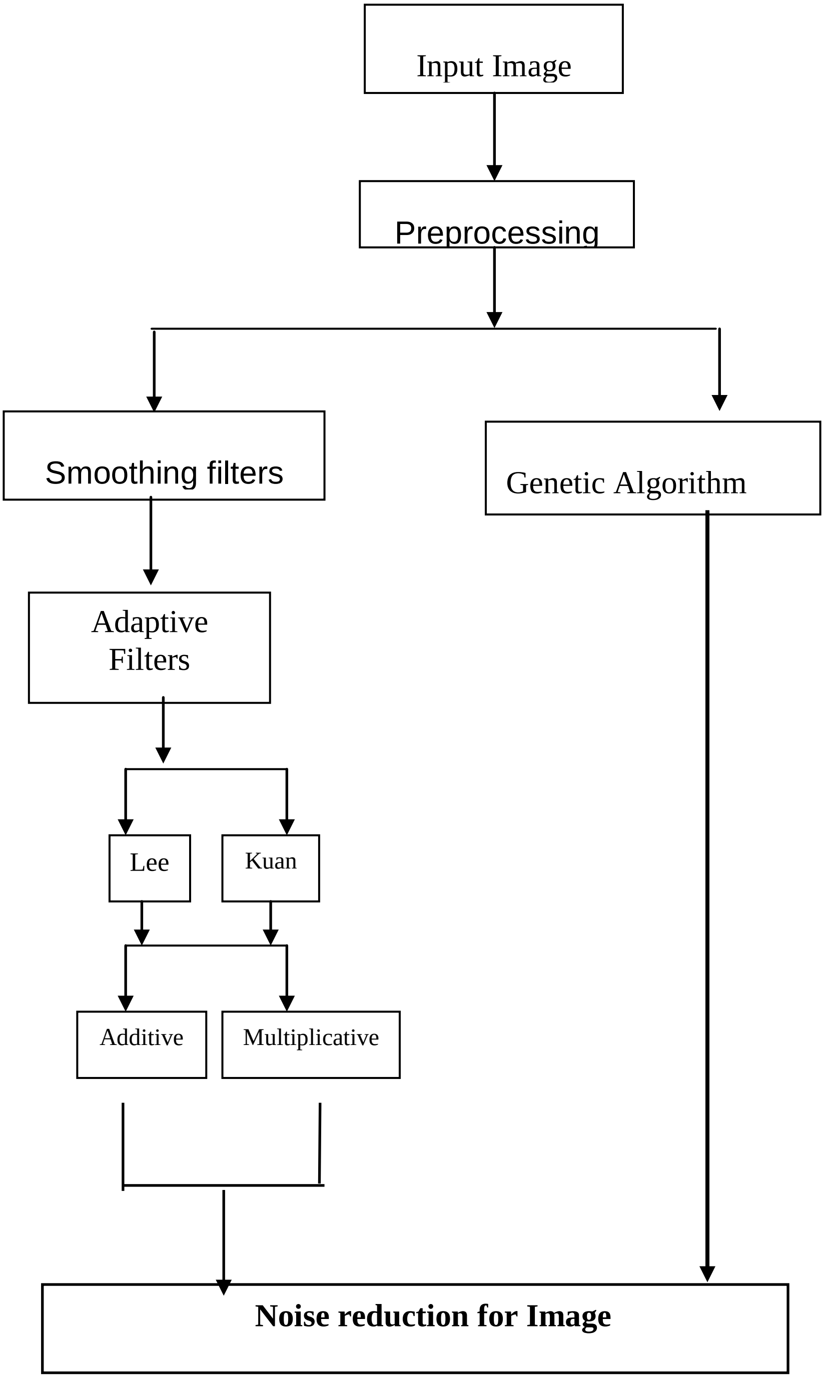

Figure (1): Block Digram for System Design of Genetic Alogrith

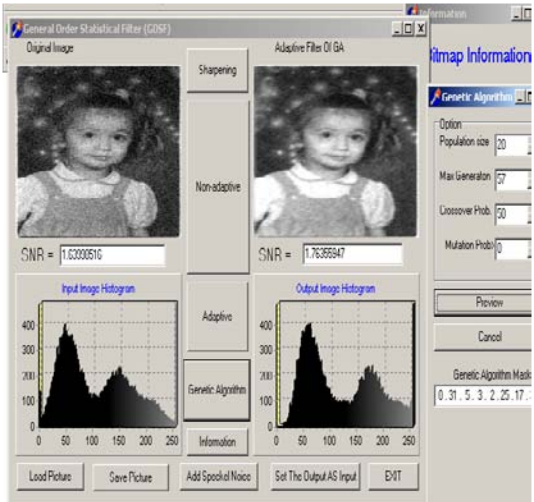

Figure (2) : Using Genatic Algorithm

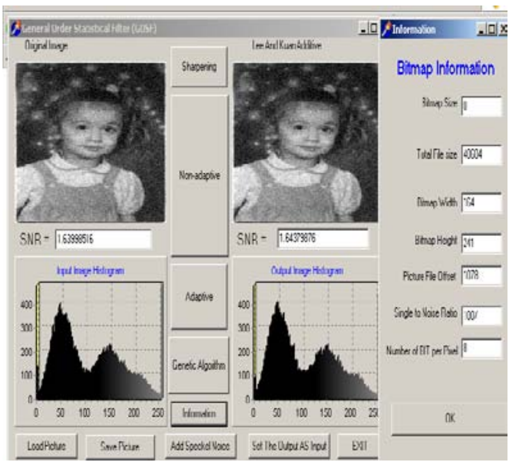

Figure (3): Using Lee and Kuan adaptive filter

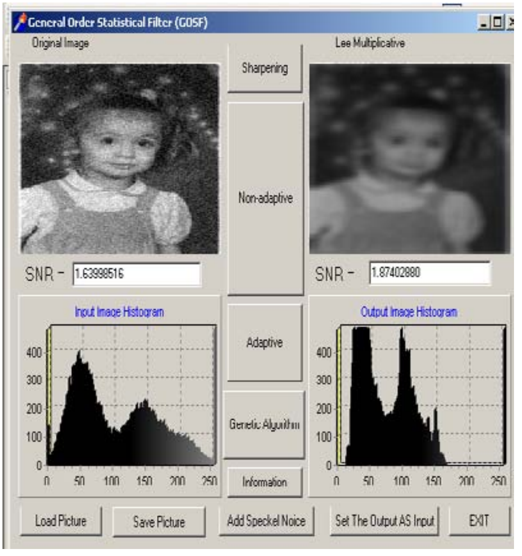

Figure (4) : Using Lee adaptive filter

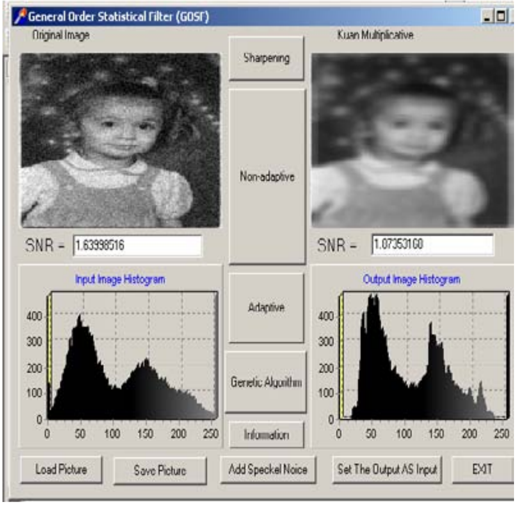

Figure (5) :Using Kuan adaptive filter

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