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Optimum green plane masking for the contrast enhancement of retinal images using enhanced genetic algorithm

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ABSTRACT

Masking based techniques are well known and effective for contrast enhancement applications. The conventional unsharp masking in which fixed scale value is using irrespective of the types of test images. In this paper we propose an optimum green plane masking (OGPM) using enhanced genetic algorithm (EGA) for the contrast enhancement of retinal images. The green plane has more details of retinal images than the other two planes. The EGA can adaptively perform the selection, crossover and mutation of chromosomes. First, the proposed approach is evaluated using the standard test images and real time images for different contrast enhancement techniques and optimization techniques. Finally the proposed approach is used for the enhancement of retinal images. Results are analyzed using various performance measures and our OGPM shows better enhancement than other reported literature.

1. Introduction

The contrast enhancement techniques have vital role in the field of retinal image enhancement. Because of the low light intensity of human eyes enhancement is used as a preprocessing step in retinopathy. These are used for the biometric applications [1] and diagnosis purposes. Glaucoma [2] and diabetes [3] are the main causes of blindness. Early identification of these diseases will prevent from the blindness. For the identification of retinal features [4] enhancement plays an important role in retinopathy [5]. Contrast enhancement have also vital role in the field of other medical imaging. Examples like computer tomography [6], ultrasound image [7] and X-ray images [8]. Thavavel proposed a novel intelligent noise filtration technique in wavelet domain. In the proposed technique genetic algorithm based optimization is using for the optimal threshold selection, in which MR and Ultra sound images are used for the performance measures [9]. Disease identification is the key factor in the medical imaging. It is used for efficient computer based disease identification. Pereira proposed a method for segmentation and identification of breast cancer using wavelet transform and genetic algorithm [10].

Generally the image enhancement is divided into different classes such as histogram based, transform based and masking based approach. Histogram based enhancement techniques are classical contrast enhancement approach. In last few decades huge advancements are performed in the field of histogram equalization such as bi histogram, adaptive histogram, automatic histogram, weighted histogram and selective dynamic histogram, etc. [11–17]. Masking based approach is the derived field of contrast enhancement in which formulated mask is added to the original image for sharpen the base image. Recently some modification approaches performed in masking for contrast enhancement [18–20].

Genetic algorithm (GA) is a biologically inspired optimization technique, proposed by John Holland in the year 1978. It deals with the classical biological (evolution) terms such as initial population, selection, fitness function, chromosomes, crossover, and mutation [21,22]. Originally developed genetic algorithm is known as simple genetic algorithm (SGA). In recent years these optimization techniques have rapid advancement in image processing applications. The advancement of genetic algorithm includes hybridization with other optimization techniques and transforms. Zhang proposed a wavelet domain cloud image enhancement technique for the contrast enhancement, in which performed better enhancement in wavelet domain [23]. Hoseini proposed a hybrid approach using ant colony optimization, genetic algorithm, and simulated annealing for the contrast enhancement of various standard test images [24]. Multi objective genetic algorithm is an advancement of conventional technique. For example, Wang proposed a multi objective water marking algorithm based on genetic algorithm for standard test images and the real time images [25]. Multi-level thresholding is used for image segmentation applications [26]. Limitations of

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0030-4026/

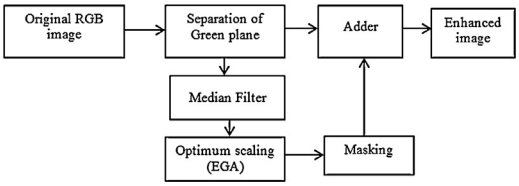

Fig. 1. Block diagram of proposed enhancement technique.

SGA can be overcome with the enhanced technique in genetic algorithm [27]. The adaptive genetic algorithm [AGA] can dynamically fix the crossover ratio and mutation ratio. The automatic selection based GA performs better results than the conventional techniques [28].

2. Proposed green plane masking

Our proposed technique is the modification of conventional unsharp masking. First it makes the mask of image and added with the original image. Unsharp masking is a classical approach for sharpness enhancement of image. It enhances the contrast and smoothen the edges of the image Original image is blurred with the filtering and scaling techniques. The blurred image is subtracted from the original image. This mask is added to the original image, which is the enhanced image which having sharpened edges [29,30]. In this approach colour (RGB) images are taken as input images. Green plane is separating from the original image. This has more information as compared with the red and blue plane. The separated green plane image is filtered using median filter. Conventional technique is using the static scaling selection for the masking formulation. But it may be under or over sharpened. In our approach enhanced genetic algorithm based scale selection is using. It can be dynamically select the scale value for green plane mask. In our enhancement technique masked image is adding to the input image (Fig. 1).

3. Enhanced genetic algorithm

In this section we are proposing an adaptive genetic algorithm for scale optimization in the application of contrast enhancement. In our adaptive approach genetic algorithm can dynamically perform the enhancement. The various steps of genetic algorithm are described below.

3.1. Initial population generation

In this approach the members (scale values (k)) of initial populations are randomly generated. The size of the population is 50. The range of the value is less than one ($K < 1$).

3.2. Fitness function

In our approach we propose fitness function based on the quality of enhancement. We are calculating the fitness of all the samples in the population.

$$F(x) = \mathrm{PSNR}_{\mathrm{image}} + \mathrm{PSNR}_{\mathrm{edge}} \tag{1}$$

It is a maximization function; we calculate the quality of the enhancement using the PSNR values of image and edges of the image [17]. In our approach Sobel filter is using for calculating the edges of the image

$$\mathrm{PSNR} = 20\log_{10}\frac{255}{\mathrm{RMSE}} \tag{2}$$

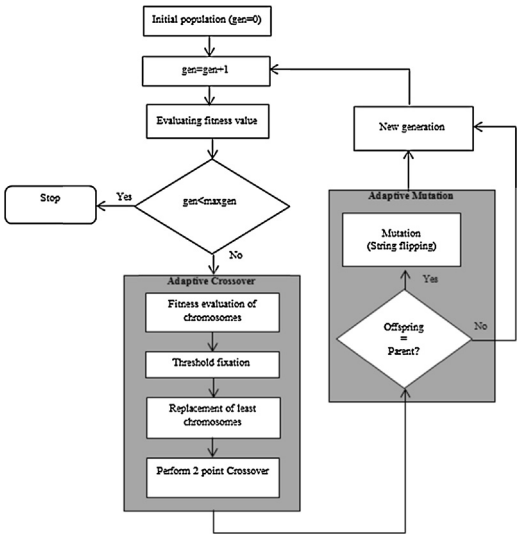

Fig. 2. Flow chart of enhanced genetic algorithm.

where RMSE is the root mean square error, which is defined as

$$\mathrm{RMSE} = \left(\frac{1}{MN} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} \left| \hat{I}_{xy} - I_{xy} \right|^2 \right)^{1/2} \tag{3}$$

3.3. Adaptive crossover operation

In this section we have described about the selection, discarding, insertion and crossover operation of chromosomes. Here we are considering the fixed length binary chromosome of size 8 bits. In which each 2 bits are combined to make a string. In first evaluate the fitness values of each chromosomes are calculated and a threshold value is found. In our approach average decimal value is considering as the threshold. Then we replace all the chromosomes having lesser fitness than the average value by the higher chromosomes in sequential order. In this approach the cross over ratio is automatically changed. The limitation of static crossover ratio can overcome by this adaptive selection and insertion of chromosomes.

3.4. Adaptive mutation operation

In adaptive mutation single string of the chromosome is flipped. The flipped chromosomes form new generation. In our adaptive mutation operation the generated offspring is compared with the parent chromosome. Through this way we can avoid the parental repetition after crossover operation. In our method mutation ratio is changing dynamically (Fig. 2).

4. Experimental results

In this section we are analyzing the performance of the adaptive genetic algorithm with various contrast enhancement techniques and optimization techniques. This section is focused on quantitative analysis of the techniques. The steps involved are:

1. Quantitative and qualitative evaluation of enhancement results using standard test images.
2. Quantitative and qualitative evaluation of enhancement results using real word images.
3. Quantitative and qualitative evaluation of our method for colour fundus images.