Hybrid Genetic Algorithm Based Image Enhancement Technology

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Abstract—**in image enhancement, Tubbs proposed a normalized incomplete Beta function to represent several kinds of commonly used non-linear transform functions to do the research on image enhancement. But how to define the coefficients of the Beta function is still a problem. We proposed a Hybrid Genetic Algorithm which combines the Differential Evolution to the Genetic Algorithm in the image enhancement process and utilize the quickly searching ability of the algorithm to carry out the adaptive mutation and searches. Finally we use the Simulation experiment to prove the effectiveness of the method.**

Keywords- Image enhancement; Hybrid Genetic Algorithm; adaptive enhancement

I. INTRODUCTION

In the image formation, transfer or conversion process, due to other objective factors such as system noise, inadequate or excessive exposure, relative motion and so the impact will get the image often a difference between the original image (referred to as degraded or degraded) Degraded image is usually blurred or after the extraction of information through the machine to reduce or even wrong, it must take some measures for its improvement.

Image enhancement technology is proposed in this sense, and the purpose is to improve the image quality. Fuzzy Image Enhancement situation according to the image using a variety of special technical highlights some of the information in the image, reduce or eliminate the irrelevant information, to emphasize the image of the whole or the purpose of local features. Image enhancement method is still no unified theory, image enhancement techniques can be divided into three categories: point operations, and spatial frequency enhancement methods Enhancement Act. This paper presents an automatic adjustment according to the image characteristics of adaptive image enhancement method that called hybrid genetic algorithm. It combines the differential evolution algorithm of adaptive search capabilities, automatically determines the transformation function of the parameter values in order to achieve adaptive image enhancement.

II. IMAGE ENHANCEMENT TECHNOLOGY

Image enhancement refers to some features of the image, such as contour, contrast, emphasis or highlight edges, etc., in order to facilitate detection or further analysis and processing. Enhancements will not increase the information in the image data, but will choose the appropriate features of the expansion of dynamic range, making these features more easily detected or identified, for the detection and treatment follow-up analysis and lay a good foundation.

Image enhancement method consists of point operations, spatial filtering, and frequency domain filtering categories. Point operations, including contrast stretching, histogram modeling, and limiting noise and image subtraction techniques. Spatial filter including low-pass filtering, median filtering, high pass filter (image sharpening). Frequency filter including homomorphism filtering, multi-scale multi-resolution image enhancement applied [1].

III. DIFFERENTIAL EVOLUTION ALGORITHM

Differential Evolution (DE) was first proposed by Price and Storn, and with other evolutionary algorithms are compared, DE algorithm has a strong spatial search capability, and easy to implement, easy to understand. DE algorithm is a novel search algorithm, it is first in the search space randomly generates the initial population and then calculate the difference between any two members of the vector, and the difference is added to the third member of the vector, by which Method to form a new individual. If you find that the fitness of new individual members better than the original, then replace the original with the formation of individual self.

The operation of DE is the same as genetic algorithm, and it conclude mutation, crossover and selection, but the methods are different. We suppose that the group size is P, the vector dimension is D, and we can express the object vector as (1):

$$xi=[x_{i1},\ x_{i2},\ \cdots,\ x_{iD}]\ (i=1,\ldots,P) \qquad (1)$$

And the mutation vector can be expressed as (2):

$$v_i = x_{r_1} + F \times (x_{r_2} - x_{r_3})\ i = 1,\ldots,P \qquad (2)$$

x_{r_1}, x_{r_2}, x_{r_3} are three randomly selected individuals from group, and $r_1 \neq r_2 \neq r_3 \neq i$. F is a range of [0, 2] between the actual type constant factor difference vector is used to control the influence, commonly referred to as scaling

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factor. Clearly the difference between the vector and the smaller the disturbance also smaller, which means that if groups close to the optimum value, the disturbance will be automatically reduced.

DE algorithm selection operation is a "greedy " selection mode, if and only if the new vector u_i the fitness of the individual than the target vector is better when the individual xi, u_i will be retained to the next group. Otherwise, the target vector xi individuals remain in the original group, once again as the next generation of the parent vector.

IV. HYBRID GA FOR IMAGE ENHANCEMENTImage

enhancement is the foundation to get the fast object detection, so it is necessary to find real-time and good performance algorithm. For the practical requirements of different systems, many algorithms need to determine the parameters and artificial thresholds. Can use a non-complete Beta function, it can completely cover the typical image enhancement transform type, but to determine the Beta function parameters are still many problems to be solved. This section presents a Beta function, since according to the applicable method for image enhancement, adaptive Hybrid genetic algorithm search capabilities, automatically determines the transformation function of the parameter values in order to achieve adaptive image enhancement.

The purpose of image enhancement is to improve image quality, which are more prominent features of the specified restore the degraded image details and so on. In the degraded image in a common feature is the contrast lower side usually presents bright, dim or gray concentrated. Low-contrast degraded image can be stretched to achieve a dynamic histogram enhancement, such as gray level change. We use I_{xy} to illustrate the gray level of point (x, y) which can be expressed by (3).

$$I_{xy}=f(x, y) \tag{3}$$

where: “f” is a linear or nonlinear function. In general, gray image have four nonlinear translations [6] [7] that can be shown as Figure 1. We use a normalized incomplete Beta function to automatically fit the 4 categories of image enhancement transformation curve. It defines in (4):

$$f(u) = B^{-1}(\alpha, \beta)\int_0^u t^{a-1}(1-t)^{\beta-1}dt \ (\alpha < 0, \beta < 10) \tag{4}$$

where:

$$B(\alpha, \beta) = \int_0^1 t^{a-1}(1-t)^{\beta-1}dt \tag{5}$$

For different value of α and β , we can get response curve from (4) and (5).

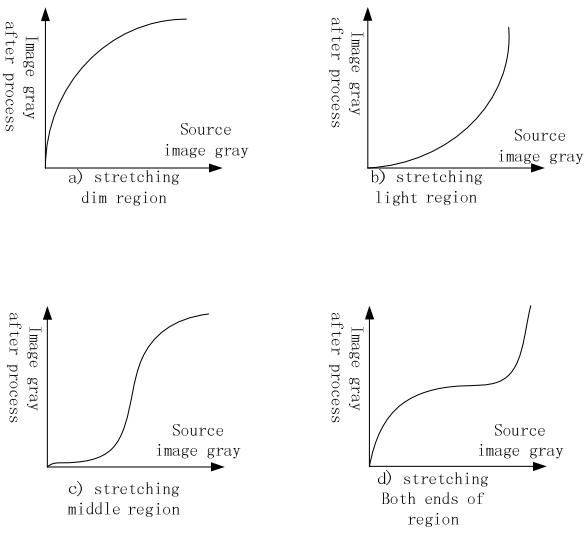

Figure 1. Four traditional translations

The hybrid GA can make use of the previous section adaptive differential evolution algorithm to search for the best function to determine a value of Beta, and then each pixel grayscale values into the Beta function, the corresponding transformation of Figure 1, resulting in ideal image enhancement. The detail description is follows:

Assuming the original image pixel (x, y) of the pixel gray level by the formula (4), denoted by $i_{xy}, (x, y) \in \Omega$, here Ω is the image domain. Enhanced image is denoted by I_{xy}. Firstly, the image gray value normalized into [0, 1] by (6).

$$g_{xy} = \frac{i_{xy} - i_{\min}}{i_{\max} - i_{\min}} \tag{6}$$

where: i_{max} and i_{min} express the maximum and minimum of image gray relatively.

Define the nonlinear transformation function f(u) ($0 \leqslant u \leqslant 1$) to transform source image to $G_{xy}=f(g_{xy})$, where the $0 \leq G_{xy} \leq 1$.

Finally, we use the hybrid genetic algorithm to determine the appropriate Beta function f (u) the optimal parameters α and β . Will enhance the image G_{xy} transformed anti-normalized.

V. EXPERIMENT AND ANALYSIS

In the simulation, we used two different types of gray-scale images degraded; the program performed 50 times, population sizes of 30, evolved 600 times. The results show that the proposed method can very effectively enhance the different types of degraded image.


a) Source image

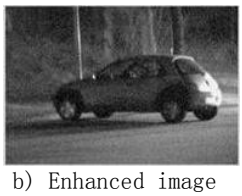
b) Enhanced image

Figure 2. The process of single object


a) Source image


b) Enhanced image

Figure 3. The process of moving objects

Figure 2, the size of the original image a 320 × 320, it's the contrast to low, and some details of the more obscure, in particular, scarves and other details of the texture is not obvious, visual effects, poor, using the method proposed in this section, to overcome the above some of the issues and get satisfactory image results, as shown in Figure 5 (b) shows, the visual effects have been well improved. From the histogram view, the scope of the distribution of image intensity is more uniform, and the distribution of light and dark gray area is more reasonable. Hybrid genetic algorithm to automatically identify the nonlinear transformation of the function curve, and the values obtained before 9.837,5.7912, from the curve can be drawn, it is consistent with Figure 3, c-class, that stretch across the middle region compression transform the region, which were consistent with the histogram, the overall original image low contrast, compression at both ends of the middle region stretching region is consistent with human visual sense, enhanced the effect of significantly improved.

Figure 3, the size of the original image a 320 × 256, the overall intensity is low, the use of the method proposed in this section are the images b, we can see the ground, chairs and clothes and other details of the resolution and contrast than the original image has Improved significantly, the original image gray distribution concentrated in the lower region, and the enhanced image of the gray uniform, gray before and after transformation and nonlinear transformation of basic graph 3 (a) the same class, namely, the image Dim region stretching, and the values were 5.9409,9.5704, nonlinear transformation of images degraded type inference is correct, the enhanced visual effect and good robustness enhancement.

Difficult to assess the quality of image enhancement, image is still no common evaluation criteria, common peak signal to noise ratio (PSNR) evaluation in terms of line, but the peak signal to noise ratio does not reflect the human visual system error. Therefore, we use marginal protection index and contrast increase index to evaluate the experimental results.

Edgel Protection Index (EPI) is defined as follows:

$$EPI = \frac{\sum\left(\left|I_D(i,j)-I_D(i+1,j)\right|+\left|I_D(i,j)-I_D(i,j+1)\right|\right)}{\sum\left(\left|I_O(i,j)-I_O(i+1,j)\right|+\left|I_O(i,j)-I_O(i,j+1)\right|\right)}, (i,j)\in Z \qquad (7)$$

Contrast Increase Index (CII) is defined as follows:

$$E = \frac{C_D}{C_O}, C = \frac{G_{\max} - G_{\min}}{G_{\max} + G_{\min}} \qquad (8)$$

In figure 4, we compared with the Wavelet Transform based algorithm and get the evaluate number in TABLE I.




a) Source image b) Enhanced image by Wavelet Transform c) Enhanced image by HGA

Figure 4. The Comparison of different processes

TABLE I. THE CONSTACT OF TWO METHODS

Methods	EPI	CII
Wavelet Transform	1.4567	0.7685
HGA	1.9876	3.9804

Figure 4 (a, c) show the original image and the differential evolution algorithm for enhanced results can be seen from the enhanced contrast markedly improved, clearer image details, edge feature more prominent. b, c shows the wavelet-based hybrid genetic algorithm-based Comparison of Image Enhancement: wavelet-based enhancement method to enhance image detail out some of the image visual effect is an improvement over the original image, but the enhancement is not obvious; and Hybrid genetic algorithm based on adaptive transform image enhancement effect is very good, image details, texture, clarity is enhanced compared with the results based on wavelet transform has greatly improved the image of the post-analytical processing helpful. Experimental enhancement experiment using wavelet transform "sym4" wavelet, enhanced differential evolution algorithm experiment, the parameters and the values were 5.9409,9.5704. For a 256 × 256 size image transform based on adaptive hybrid genetic algorithm in Matlab 7.0 image enhancement software, the computing time is about 2 seconds, operation is very fast. From TABLE I, objective evaluation criteria can be seen, both the edge of the protection index, or to enhance the contrast index, based on adaptive hybrid genetic algorithm compared to traditional methods based on wavelet transform has a larger increase, which is from This section describes the objective advantages of the method.

From above analysis, we can see that this method can be useful and effective.

VI. CONCLUSION

In this paper, to maintain the integrity of the perspective image information, the use of Hybrid genetic algorithm for image enhancement, can be seen from the experimental results, based on the Hybrid genetic algorithm for image enhancement method has obvious effect. Compared with other evolutionary algorithms, hybrid genetic algorithm outstanding performance of the algorithm, it is simple, robust and rapid convergence is

almost optimal solution can be found in each run, while the hybrid genetic algorithm is only a few parameters need to be set and the same set of parameters can be used in many different problems. Using the Hybrid genetic algorithm quick search capability for a given test image adaptive mutation, search, to finalize the transformation function from the best parameter values. And the exhaustive method compared to a significant reduction in the time to ask and solve the computing complexity. Therefore, the proposed image enhancement method has some practical value.

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