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Texture Enhancement of Plants IR Images Using Genetic Algorithm

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Abstract- Image enhancement technique means to process a given image so that the resultant image is more suitable than the original image. It sharpens image features such as edges, boundaries, or contrast to be more helpful for display and analysis. Approaches to texture enhancement are usually categorized as structural, statistical, model-based and transform methods based. Genetic Algorithm (GA) is the most powerful unbiased optimization technique for sampling a large solution space. The GA may be adopted to achieve better results and faster processing time in some specialized applications. In this paper, the effect of GA on the enhancement of the texture of plants infrared (IR) images has been investigated. The investigations showed that the image texture stabilizes after 50 iterations and there is hardly any change in the brightness of the image.

Index Terms- Digital image processing, IR images, Genetic algorithm, Mutation, Texture enhancement, Contrast enhancement.

I. Introduction

In digital image processing image enhancement plays an important role. Genetic algorithm (GA) is one of the most accepted, quick and easy techniques for image enhancement of digital images [1]. Image Enhancement technique means to process a given image so that the resultant image is more suitable than the original image. The input image can be from any image capturing device. There are various methods which can enhance the original image without losing its inherent properties. Digital image enhancement techniques provide large number of choices for improving the visual quality of images [2]. It sharpens image features such as edges, boundaries, or contrast to be more helpful for display and analysis. The main purpose of image enhancement is to modify various image attributes to make the original image more suitable for any given task and for a specific observer. Fig. 1 shows basic structure of image enhancement strategy [3].

Texture has great significance in digital image processing. Textures are a pattern of non-uniform spatial distribution of differing image intensities, which focus mainly on the individual pixels that make up an image. Texture can be defined as the spatial or visual patterns formed by the surface characteristics of an object that manifests itself as color or grayscale variations in the image [4, 7]. Each surface has its own texture, some objects can be said to have unique textures (e.g. skin or sand). Analysis and matching of texture can be carried out in spatial or the frequency domain. Commonly used texture features are gray-level co-occurrence matrices, local binary patterns (LBP), Markov random fields, and Gabor wavelets [5, 6, 8]. Fig. 2 shows the different textures of plants.

Fig. 1 Image enhancement

Fig. 2 Different textures of plants

Approaches to texture analysis giving useful information for enhancement are usually categorized as structural, statistical, model-based, and transform methods based. Structural approaches represent texture by well-defined primitives (micro texture) and a hierarchy of spatial arrangements (macro texture) of those primitives. The advantage of the structural approach is that it provides a good symbolic description of the image; however, this feature is more useful for synthesis than analysis tasks. In contrast to structural methods, statistical approaches do not attempt to understand explicitly the hierarchical structure of the texture. Statistical approaches compute different properties and are suitable if texture primitive sizes are comparable with the pixel sizes. Model based texture analysis using fractal and stochastic models, attempt to interpret an image texture by use of, respectively, generative image model and stochastic model. Transform methods of texture analysis, such as Fourier and wavelet transforms represent an image in a space whose co-ordinate system has an interpretation that is closely related to the characteristics of a texture (such as frequency or size) [9].

In many applications images are distorted due to the atmospheric aberration mainly because of atmospheric variations and aerosol turbulence [10, 11]. New algorithmic strategies have been investigated to enhance the visual quality of IR images. The idea has been to model the infrared (IR) image pixels as an input-output system with IR image as the input and a similar IR image as the output [12].

In this paper, the effect of GA on the enhancement of the texture of plants IR images has been investigated. The details of GA have been presented in the next section. The methodology adopted for the investigations is discussed in Section III. The results and discussions are presented in Section IV followed by conclusion in Section V.

II. GENETIC ALGORITHM

GA [13] is a relatively a new standard for search, based on principles of natural selection. For the first time these algorithms had been introduced by John Holland in 1960s [14, 15]. The simplest form of GA involves three types of operators: selection, crossover (single point), and mutation.

Selection This operator selects chromosomes in the population for reproduction. The fitter the chromosome, the more times it is likely to be selected to reproduce.

Crossover This operator randomly chooses a locus and exchanges the subsequences before and after that locus between two chromosomes to create two offspring. For example, the strings 10000100 and 11111111 could be crossed over after the third locus in each to produce the two offspring 10011111 and 11100100. The crossover operator roughly mimics biological recombination between two single-chromosome (haploid) organisms.

Mutation This operator randomly flips some of the bits in a chromosome. For example, the string 00000100 might be mutated in its second position to yield 01000100. Mutation can occur at each bit position in a string with some probability, usually very small (e.g., 0.001) [14].

They employ natural selection of fittest individuals as optimization problem solver. Optimization is performed through natural exchange of genetic material between parents. Offspring's are formed from parent genes. Fitness of offspring's is evaluated. The fittest individuals are allowed to breed only. In computer world, genetic material is replaced by strings of bits and natural selection replaced by fitness function. Matting of parents is represented by cross-over and mutation operations.

A simple GA consists of following steps steps:

Step 1. Determine the number of chromosomes, generation, and mutation rate and crossover rate value

Step 2. Generate chromosome-chromosome number of the population, and the initialization value of the Genes chromosome-chromosome with a random value

Step 3. Process steps 4-7 until the number of generations is met

Step 4. Evaluation of fitness value of chromosomes by calculating objective function

Step 5. Chromosomes selection and crossover.

Step 6. Mutation

Step 7. New Chromosomes (Offspring)

Step 8. Solution (Best Chromosomes) [17].

Each iteration of this process is called a generation. A GA is typically iterated for anywhere from 50 to 500 or more generations. The entire set of generations is called a run. At the end of a run there are often one or more highly fit chromosomes in the population. Since randomness plays a large role in each run, two runs with different random-number seeds will generally produce different detailed behaviors. GA researchers often report statistics (such as the best fitness found in a run and the generation at which the individual with that best fitness was discovered) averaged over many different runs of the GA on the same problem.

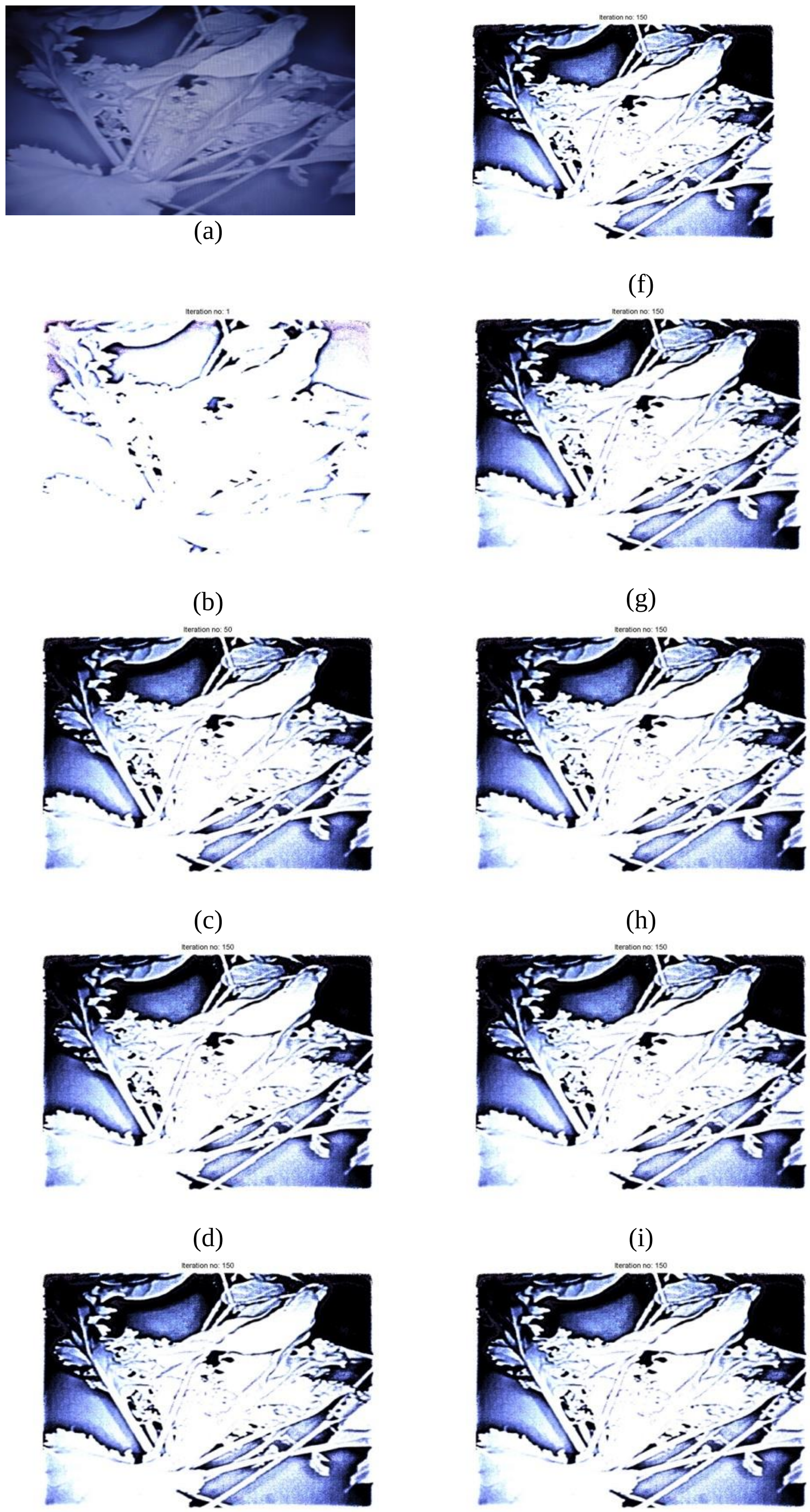
III. METHODOLOGY

The plant images were digitally recorded in both normal and IR light conditions. Five types of plants having different textures were selected. The IR images were taken using IR camera with VGA resolution. The images were taken at different orientations of the plants. While taking the IR images, the visible lights were totally switched off. For each plant nine IR images were taken using by fixing the camera at a distance of three feet from the plants. Different textures of plants were taken. The enhancement of images was carried out using GA. The genes of the algorithm were composed of four intensity ranges and two modification factors leading to a total of 10 genes per DNA. A total of 10 DNA were initially taken. The initial values of the genes were randomly initialed. The investigations were carried out by varying the number of iterations.

IV. RESULTS AND DISCUSSIONS

The experiment was conducted on infrared image. The investigations were carried out for iteration numbers 1to 1000 for the input images. Fig. 3 shows the unprocessed input images and the corresponding processed enhanced images at different values of iteration numbers 1, 50,100, 150, 200, 300, 500, 700, and 1000 respectively. From Fig. 3 and Fig. 4, it can be observed that the enhancement in the texture of the image increases with the successive iterations up to 50th iterations. The image texture becomes to stabilize or after 50 iterations and there is hardly any change in the brightness of the image. Therefore, 50 iterations are chosen as the stopping criterion for the proposed algorithm.

It may be observed from the images that after enhancement more details of the texture structure is prominently highlighted by the GA which may be further used for automatic identification of plants and quality assessment in agriculture.



(a) (f) (b) (g) (c) (h) (d) (i) (e) (j)

Fig. 3. Original and processed images. (a) unprocessed IR, (b) iteration no. 50, (c) iteration no. 100, (d) iteration no. 150, (e) iteration no. 200, (f) iteration no. 300, (g) iteration no. 400, (h) iteration no. 500, (i) iteration no. 700, (j) iteration no. 1000.

V. CONCLUSION

Investigations were carried out to enhance the texture plants using IR images with genetic algorithm. It was observed that GA can be used as a very prominent unbiased optimization method for texture enhancement of plant images. The method may be made automatic and robust for plant identification and quality assessment in agriculture industry.

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