Chapter 10
Image Enhancement Techniques Using Particle Swarm Optimization Technique

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ABSTRACT

The image quality enhancement process is considered as one of the basic requirement for high-level image processing techniques that demand good quality in images. High-level image processing techniques include feature extraction, morphological processing, pattern recognition, automation engineering, and many more. Many classical enhancement methods are available for enhancing the quality of images and they can be carried out either in spatial domain or in frequency domain. But in real time applications, the quality enhancement process carried out by classical approaches may not serve the purpose. It is required to combine the concept of computational intelligence with the classical approaches to meet the requirements of real-time applications. In recent days, Particle Swarm Optimization (PSO) technique is considered one of the new approaches in optimization techniques and it is used extensively in image processing and pattern recognition applications. In this chapter, image enhancement is considered an optimization problem, and different methods to solve it through PSO are discussed in detail.

INTRODUCTION

In real life scenario, huge amount of data available in the form of images and its quality need to be enhanced for making it ready to apply high level image processing techniques like pattern recognition, feature extraction, analysis and any other automation engineering applications. In general, process of improving the quality of images is called image enhancement and it is considered as one of the important preprocessing techniques for high level processing of images. The enhancement can be performed by hardware devices through software algorithms but this chapter deals with various software techniques

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in particular. Gorai and Ghosh (2009) outlined in their work, that in image enhancement process images are transferred from one level to another level through the process of intensity transformation or filtering approaches to improve the perception of information for human viewers, or to provide better input for other automated engineering applications.

In general image enhancement processes include histogram equalization, intensity transformation, smoothing, sharpening, contrast adjustment, frequency domain filtering and pseudo coloring as explained by Gonzales and Woods (1987). Majority of the image enhancement work usually manipulates the image histogram by some transformation function to obtain the required contrast enhancement. Consequently, this operation also delivers the maximum information contained in the image. In detail, the histogram transformation is considered as one of the fundamental processes for contrast enhancement of gray level images, which facilitates the subsequent higher level operations such as detection and identification. Histogram processing could be carried out either by local processing or by global processing. In linear contrast stretching, the gray value of input image is mapped to the complete range of gray values in the output image. Similarly in Pseudo coloring gray values are mapped to color values artificially to highlight and enhance the important regions in images. Generalizing gray scale image enhancement to color image enhancement is not a trivial task. Several factors, such as selection of a color model, characteristics of the human visual system, and color contrast sensitivity, must be considered for color image enhancement. Color images could be separated into the chromaticity and intensity components. The intensity components are also called luminance components. The quality of color images could be increased by applying any of the image enhancement techniques on luminance part of color images.

Some of the image/signal processing applications include iris recognition, fruit quality grading, face detection, object recognition, image segmentation, synthetic aperture radar image processing, image classification, image fusion and many more. Recently various areas of automation engineering find its use and contribution of image processing techniques and it includes medical imaging, people identification proposed by Xiaodong and Zhong (2006), indoor security surveillance elaborated by Xiang and Yan (2007) and crowd monitoring in outdoor environments proposed by Dorigo and Stützle (2004) etc. Many classical enhancement methods exist but it does meet the requirements of automation engineering.

In recent years, it has been proved that it is possible to identify and exploit the underlying principles of computational intelligence for solving scientific, engineering and industrial problems. Thus it is required to incorporate the computational intelligence as a part of it. Evolutionary algorithms have been previously used to perform image enhancement. Gorai and Ghosh (2009)'s have stated that the enhancement process could have been be carried out through genetic programming (GA) by adapting various techniques so as to fit the demands of the human interpreter. But based on literature review, among many optimization techniques, particle swarm optimization (PSO) proposed by Eberhard et al. (2001) and ant colony optimization techniques proposed by Dorigo and Stützle (2004) are considered as two important techniques. Both methods have found a strongly increasing number of applications in diverse fields, including image and signal processing research fields. In this chapter, image enhancement process through PSO technique is focused. In comparison to GA, PSO does not require selection, crossover and mutation operations. Moreover PSO takes less time to converge to better optima. The resulted gray-level enhanced images by PSO are found to be better compared with other automatic image contrast enhancement techniques. Both objective and subjective evaluations are performed on the resulted image which says about the goodness of PSO as stated in Gorai and Ghosh (2009)'s work.

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