ABSTRACT

Nowadays devices are able to capture and process images from complex surveillance monitoring systems or from simple mobile phones. The visual quality of the most recorded or captured images are inevitably degraded during the image acquisition process because of inadequate lighting and incorrect setting of the aperture or the shutter speed or both. Deficiencies in the image acquisition process often result in low contrast images which normally contain noisy backgrounds. In addition, there are several reasons for an image/video to have poor contrast: the poor quality of the used imaging device, lack of expertise of the operator, and the adverse external conditions at the time of acquisition. These effects result in under-utilization of the offered dynamic range. As a result, such images and videos may not reveal all the details in the captured scene, and may have a washed-out and unnatural look.

Contrast enhancement targets to eliminate these problems, thereby to obtain a more visually-pleasing or informative image or both. This thesis focuses to solve the above mentioned problems, and proposes three methodologies for fast image contrast enhancement methods. The proposed methods are based on Histogram Equalization (HE) for handling gray-level and color images. Histogram equalization is one of the most popular techniques used for image contrast enhancement, since HE is computationally fast and simple to implement. HE performs its operation by remapping the

gray levels of the image based on the probability distribution of the input gray levels. However, HE is rarely employed in consumer electronic applications such as video surveillance, digital camera, and television, since HE tends to introduce some annoying artifacts and unnatural enhancement, including intensity saturation effect. One of the reasons for this problem is that HE normally changes the brightness of the image significantly and thus makes the output image become saturated with very bright or dark intensity values. This is not desirable in the case of image contrast enhancement for consumer electronics products, where preserving the input brightness of the image is required to avoid the generation of non-existing artifacts in the output image. To overcome this drawback, Bi-histogram equalization methods for both preserving the brightness and contrast enhancement have been proposed. Although these methods preserve the input brightness on the output image with a significant contrast enhancement, they may produce images which do not look as natural as the ones which have been given as input image.

In order to overcome this drawback, Fuzzy logic-based Histogram Equalization (FHE) is proposed for image contrast enhancement. The FHE consists of two stages. First, fuzzy histogram is computed based on fuzzy set theory to handle the inexactness of gray level values in a better way compared to classical crisp histograms. In the second stage, the fuzzy histogram is divided into two sub-histograms based on the median value of the original image and then equalizes them independently to preserve image brightness. The qualitative and quantitative analyses of proposed algorithm are evaluated

using two well-known parameters namely Average Information Contents (AIC) and Natural Image Quality Evaluator (NIQE) Index for various images. From the qualitative and quantitative measures, it is interesting to see that this proposed method provides optimum results by giving better contrast enhancement and preserving the local information of the original image. Experimental result shows that the proposed method can effectively and significantly eliminate washed-out appearance and adverse artifacts induced by several existing methods. The proposed method has been tested using several images and gives better visual quality as compared to the conventional methods.

In order to enhance contrast, preserve brightness and produce natural looking images, the Brightness Preserving Bi-level Fuzzy Histogram Equalization (BPBFHE) is proposed for both gray scale and color images. First, fuzzy histogram is computed based on fuzzy set theory. Then, the technique involves decomposing the fuzzy histogram of an image into two sub-histograms based on the mean intensities of the multi-peaks in the original image as a threshold. Finally, each sub-histogram is equalized independently to preserve image brightness. The quantitative and subjective enhancement of proposed BPBFHE algorithm is evaluated using two well known parameters namely Entropy or Average Information Contents (AIC) and Feature Similarity Index Matrix (FSIM) for different images. The experimental results show that the proposed method can prevent excessive enhancement in contrast and preserves naturalness of an image than conventional methods. Moreover, Structural Similarity Index Matrix (SSIM)

and Natural Image Quality Evaluator (NIQE) Index are used to evaluate image quality.

To overcome the ringing artifacts (contrast), noise and unnatural enhancement, the Fuzzy logic based Weighted Thresholded Histogram Equalization (FWTHE) is proposed for both gray scale and color images. The proposed method consists of three stages. First, gray level intensities are transformed to fuzzy plane whose value ranges between 0 and 1. In the second stage, the Probability Distribution Function (PDF) of the image is computed by weighting and thresholding before the histogram equalization is performed and then, the HE procedure is applied to the fuzzy plane of the image based on weighted and thresholded PDF value to preserve the image brightness. Finally, it maps the fuzzy plane back to image gray level intensities. The quantitative and subjective enhancement of proposed method is evaluated using three well known parameters like Entropy or Average Information Contents (AIC), Feature Similarity Index Matrix (FSIM) and Contrast Improvement Index (CII) for different gray scale and color images. The proposed algorithm controls perceived sharpness, ringing artifacts (contrast) and noise, resulting in a good balance between visibility of details and non-disturbance of artifacts. This method is simple, and more suitable for consumer electronic products.