ABSTRACT

During acquisition, digitization and transmission of images captured in outdoor surveillance environment such as rain, fog and mist will cause severe degradations of scene information. Especially there is a wide interest in handling the outdoor surveillance images in remote surveillance, automatic incident detection, traffic monitoring and law enforcement services. In each case, there is an underlying object or scene which is wished to be captured, processed, analyzed and interpreted. Hence this implies that, these applications have more significance in visual quality improvement of outdoor surveillance images for efficient interpretation of scene details. But there are a lot of climatic factors which affects the quality of the outdoor surveillance images. During image acquisition, the visual quality of the scene details is degraded by bad weather conditions such as rain, fog, mist and uneven illumination. Some variations in the pixel level may occur during live recording and transmission of surveillance images which will be visible as grains and missing blocks. Thus the need of the hour is to improve the visual quality of the outdoor surveillance images for efficient analysis and recognition.

The above mentioned factors necessitate the visual quality improvement of scene details of outdoor surveillance images which has a

number of potential applications with inherent complexity. Therefore, the focus is to develop an improved visual quality system in order to replace the traditional passive systems. This research work addresses a few critical issues of visual quality improvement of images captured in outdoor surveillance environments. This work primarily focuses on noise reduction, missing block recovery, rain streaks removal, contrast improvement for weather degraded images of fog, mist and simple Very Large Scale Integrated (VLSI) models for uneven illumination and low contrast image correction. Noise reduction for gray scale images is achieved by sparse representation with proposed dictionary pruning algorithm. The dictionary pruning is achieved by K-Means clustering algorithm which classifies all of the dictionary atoms into two clusters. The two clusters are based on the maximum and minimum mean of its patches and the cluster with the maximum mean is identified as optimized dictionary. This optimized dictionary reduces the number of iterations by discovering an optimum number of dictionary elements in the learned dictionary. Besides the decomposition algorithm, the optimized dictionary design provides better denoising and convergence speed for images and image sequences.

The recovery of missing blocks in gray scale images is achieved by fast inpainting and sparse representation in order to restore small target region. Fast inpainting algorithm adapts a diffusion process involving repeated convolution with small isotropic smoothing kernel. But it blurs the image details for high missing blocks and this blurring is restored by sparse representation approach. This approach provides an improved visual quality inside the difficult textured area and also recovers the boundary part well.

The rain streaks removal for gray scale images is considered as an inverse problem and is solved using sparse coding. The dictionary partition algorithm is formulated by K-Means clustering algorithm. This algorithm classifies all of the dictionary atoms into two clusters based on the maximum and minimum mean of its patches. To identify the optimized dictionary the variance of the gradient direction of each atom in the clusters and the mean of each clusters are calculated. Based on the edge coherence of the rain streak, the cluster with larger mean of the variance of gradient direction is identified as optimized dictionary. In addition to rain removal, the fog and mist are removed by non-model based technique. This technique limits the enhancement of the noise and it enhances the details of the images. To achieve better visual enhancement in image sequences, the foreground and background pixels are processed separately by the Contrast Limited Adaptive Histogram Equalization technique (CLAHE). This will provide an excellent color fidelity and visibility enhancement to the weather degraded images.

Finally, the last proposed fragment in this thesis is the hardware implementation of windowing models for uneven illumination and low contrast correction in gray scale images using a Spartan-3E Field

Programmable Gate Arrays (FPGA) board. The necessary hardware based model is built and programmed into the FPGA board. This offers fast and parallel computing by a model based design available in Xilinx System Generator (XSG). This windowing based hardware model outperforms other existing hardware algorithms.

The models of visual improvement system developed for this thesis are validated by simulating algorithms on several natural/synthetic images collected from internet or extracted from existing movie files and also data taken from the local environments. These simulations show that the proposed techniques such as K-Means dictionary pruning algorithm for sparse denoising, missing block recovery based on fast inpainting and sparse representation, dictionary partitioning algorithm for rain streaks removal, a non-model based approach for fog, mist removal and windowing models for uneven illumination and low contrast correction, provide better improvement in visual quality of outdoor surveillance images for efficient interpretation and analysis of scene details.