Abstract

Noise removal is extreme demanded research area in digital image processing. Noise is undesirable information which degrades image quality. Impulse noise is commonly encountered noise in digital images. It arises from the process of image acquisition and transmission. Two types of impulsive noise encountered: Salt & Pepper noise also called Fixed Valued Impulse noise and have black/white dot appearance and Random Valued Impulse Noise (RVIN) which can have any intensity pixel value. To remove these noises, it is necessary that the acquired image must pass through an image preprocessing stage defined as a filter.

Filters are of two types: linear and nonlinear filters. In the linear filter, the value of output pixel is a linear combination of surrounding pixels results in blurriness in images. Generally, nonlinear image filters used in the removal of impulse noise because of better restoration and less blurriness. It performs in two phases, i.e. noise detection followed by filtering. Salt and Pepper noise have lowest and highest pixel intensity and its detection is easy as it is fixed in value. Removal of Salt and Pepper noise mainly focused on filtering operation and it is easier as compared to random value noise because of its characteristics. The performance of Random Valued Impulse filters is dependent on the performance of detection schemes.

Various nonlinear filters have been reported in the literature. But not a single study exhibits the performance of various filters for image enhancement analysis of image processing. This thesis will show an exhaustive study and comparative analysis of Simple, Adaptive, and Decision based (DBMF), Decision-based untrimmed (DBUTM), Edge preserving median filtering techniques. This study is based on finding the parameter i.e. Peak Signal to Noise Ratio, Mean Square Error, and Image Enhancement Factor, Computational time, fault detection and misses. The above study will consider both fixed and random valued impulse noise.

For the analysis, four set of standard images have been chosen. The size of images has been taken as 512×512. The simulations results have been calculated with different window size.
For fixed valued noise, DBUTM and edge preserving filters restoration results exceed over other techniques. The image restoration performance of Simple Adaptive median filter exceeds counterpart at high noise level. The DBMF is given optimized restoration in PSNR and computational time.

The later part of this thesis deals with random valued impulse noise removal scheme. The removal of RVIN dominates by impulse detection scheme. Convolution based and directional differences based impulse detector performance has been studied and tested with various parameters. It has been found that directional based impulse detector (DBID) perform better compared to convolution based impulse detector. DBID with edge preserving filter is reported in the literature. This technique has complex filtering scheme and high computational time. So new hybrid approach i.e. DBID with DBUTM and DBMF is proposed to overcome the disadvantage of existing technique. The DBID has been simulated extensively with edge preserving, DBMF, and DBUTM filters. The improvement in computational time has been reported with DBMF and DBUTM with same performance in terms of PSNR.

In the last part of this thesis, a hardware implementation of image filter has been done. For image filter, the traditional approach based on the comparator and single bit serial sorting approach is available. These techniques have their own limitations. To overcome these limitations, a new optimized approach of sorting i.e. dual bit serial sorting is proposed. The proposed dual bit serial bisection sorting has the advantage of minimizing the energy consumption and less clock pulse to find median value of nine input samples. This leads to a better energy efficient median filter for image processing applications. The total energy improvement of the sorting is about 20% over single bit serial sorting. It has wide applications in pre-processing steps of image processing like image enhancement which improves the result of later processing like edge detection etc. The Simulation results for Xilinx family of FPGA presented in this work and all other details may be very useful for readers working in this area. The algorithm has been implemented on FPGA Virtex-6 board to measure the performance with a random number of input samples.