NONLINEAR FILTERING FOR IMPULSIVE NOISE REDUCTION

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Abstract –

A factor which influences the performance of many signal processing applications is the contamination of the input signals by impulsive noise, causing accidental bursts or spikes in the normally distributed signals. As a result, their density functions decay in the tails less rapidly than the Gaussian density function. In this study, the performance of nonlinear filters in estimating signals in the presence of impulsive noise is investigated. The nonlinear filters chosen are the median family filters: median, weighted median and recursive weighted median filters. The input signals are contaminated by impulsive noise modeled as α-stable random process and investigations were carried out on 1-D and 2-D signals. At the end of this study, it is proven that median filters are best employed in signal and image processing applications as they are able to suppress impulsive noise effectively while preserving edge information.

Keywords – *Nonlinear filters, median filters, impulsive noise, α-stable random process, signal processing.*

INTRODUCTION

The main limiting factors in communication and measurement systems are noise and distortions. Hence, noise reduction and distortion removal are essential in the theory and practice of all signal processing applications. Many digital image processing and analysis problem can be solved using linear filtering techniques; however linear filters have serious limitations when dealing with signals contaminated by impulsive noise. Linear filters fail to remove the impulsive noise and tend to blur images. Therefore, there has been great interest to study and design nonlinear filters especially in digital image processing applications [1].

A number of models have been proposed for impulsive phenomena in communication systems, either by fitting experimental data or based on physical grounds. Recently, it has been suggested that the family of α-stable random variables provide useful models for impulsive phenomena. Stable distributions share defining characteristics with the Gaussian distribution, such as the stability property and Central Limit Theorems [11].

The interesting property of α-stable distributions is that after some generalization of Central Limit Theorem, the α-stable distribution replaces the Gaussian distribution [3]. Thus, this technique has become a popular research topic for modeling impulsive noise phenomena.

2. NONLINEAR FILTERING

There are many nonlinear methods for noise reduction such as the one using wavelet transform, using median filters, and using inhomogeneous diffusion filtering algorithm. Among those methods, the technique using median filter is chosen for this project because it can eliminate