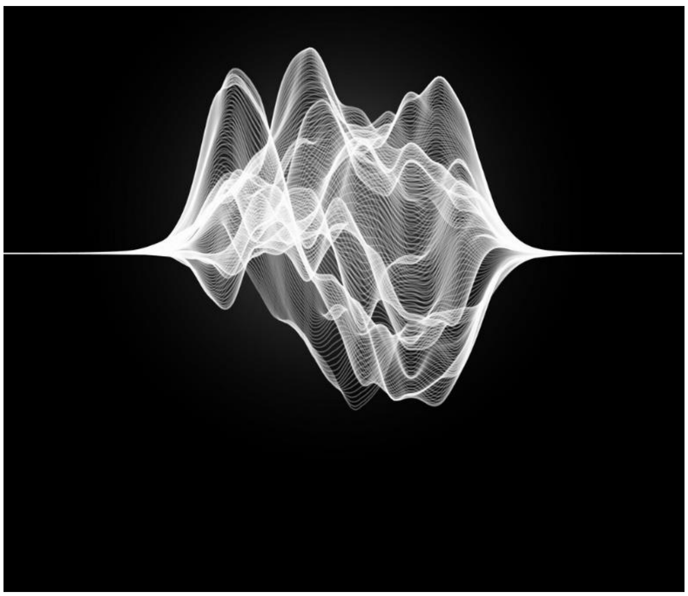
Addis Ababa Institute of Technology



Audio Read Impulse Noise Detection and Removal

ABSTRACT

Noise reduction, the recovery of the original signal from the noise-corrupted one, is a very common goal in the design of signal processing systems, especially filters.

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Digital Signal Processing

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Introduction

In signal processing, **noise** is a general term for unwanted (and, in general, unknown) modifications that a signal may suffer during capture, storage, transmission, processing, or conversion.

Sometimes the word is also used to mean signals that are random (unpredictable) and carry no useful information; even if they are not interfering with other signals or may have been introduced intentionally, as in comfort noise.

Noise reduction, the recovery of the original signal from the noise-corrupted one, is a very common goal in the design of signal processing systems, especially filters. The mathematical limits for noise removal are set by information theory. There are different types of noise like:

Continuous noise

Continuous noise is exactly what it says on the tin: it’s noise that is produced continuously, for example, by machinery that keeps running without interruption. This could come from factory equipment, engine noise, or heating and ventilation systems.

Intermittent noise

Intermittent noise is a noise level that increases and decreases rapidly. This might be caused by a train passing by, factory equipment that operates in cycles, or aircraft flying above your house.

Impulsive noise

Impulsive noise is most commonly associated with the construction and demolition industry. Impulsive noises are commonly created by explosions or construction equipment, such as pile drivers

Low-frequency noise

For low-frequency noise, you should be using a sound level meter with third octave band analysis, so you can analyse the low frequencies that make up the noise. You may also need to look at the C-weighted measurements and compare this to the A-weighted measurements, as this can show how much low-frequency noise is present.

Impulse Noise

Impulse noise describes random occurrences of energy spikes or irregular pulses of short duration, broad spectral density, and relatively high amplitude. These disturbances are usually distributed evenly over the useful passband of a transmission system.

Impulsive noise is most commonly associated with the construction and demolition industry. These sudden bursts of noise can startle you by their fast and surprising nature. Impulsive noises are commonly created by explosions or construction equipment, such as pile drivers, or your next-door neighbor doing some DIY on a Sunday morning.

To measure impulsive noise, you will need a sound level meter or a personal noise dosimeter that can calculate Peak values.

Don't forget that even in an environment that is usually quiet, a single very loud noise can cause hearing damage, which is why it's important to measure Peak levels alongside the average or Leq value. In most applications, Peak will be measured using the C-weighting, so you should make sure that your sound level meter provides this.

There are different types of impulse noise The one we have use for this project is salt and pepper noise

Salt and Pepper noise

Salt-and-pepper noise is a form of noise that is seen on images and audio signals. It is also known as impulse noise. This noise can be caused by sharp and sudden disturbances in the signal.

Matlab Code For creating Impulse noise

```
% Function To generate Impulse Noise


function spnoise = saltpeppernoise(sprate,t, Fs)
spnoise = zeros(size(t));%Initializing Our noise vector
```

```
 [~,indx] = sort(rand(size(t))); %getting sorted Indiceis from 
set of random number and keeping only the first set
 %of indiceis correspondig to our salt and pepper noise
 indx = indx(1:floor(sprate/Fs*length(t))) ;
 spnoise(indx) = randn(size(indx)); %define each value in SP 
noise to be randomly distributed number

 end
```

Signal may be corrupted by impulse noise due to noisy sensors or channel transmission errors. To improve the signal quality, it is important to remove these noises. Median or adaptive median filtering (AMF) is usually adopted to remove the impulse noise.

Median Filter

The **median filter** is a non-linear digital filtering technique, often used to remove noise from an image or signal. Such noise reduction is a typical pre-processing step to improve the results of later processing

Algorithm Description

The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For one-dimensional signals, the most obvious window is just the first few preceding and following entries, whereas for two-dimensional (or higher-dimensional) data the window must include all entries within a given radius or ellipsoidal region (i.e. the median filter is not a separable filter). We have used a window size of 5 for our project.

Algorithm Implementation

Typically, by far the majority of the computational effort and time is spent on calculating the median of each window. Because the filter must process every entry in the signal, for large signals such as images, the efficiency of this median calculation is a critical factor in determining how fast the algorithm can run. The naïve implementation described above sorts every entry in the window to find the median; however, since only the middle value in a list of numbers is required, selection algorithms can be much more efficient. Furthermore, some types of signals (very often the case for images) use whole number representations: in these cases, histogram medians can be far more efficient because it is simple to update the histogram from window to window, and finding the median of a histogram is not particularly onerous.

Matlab code for Median Filter

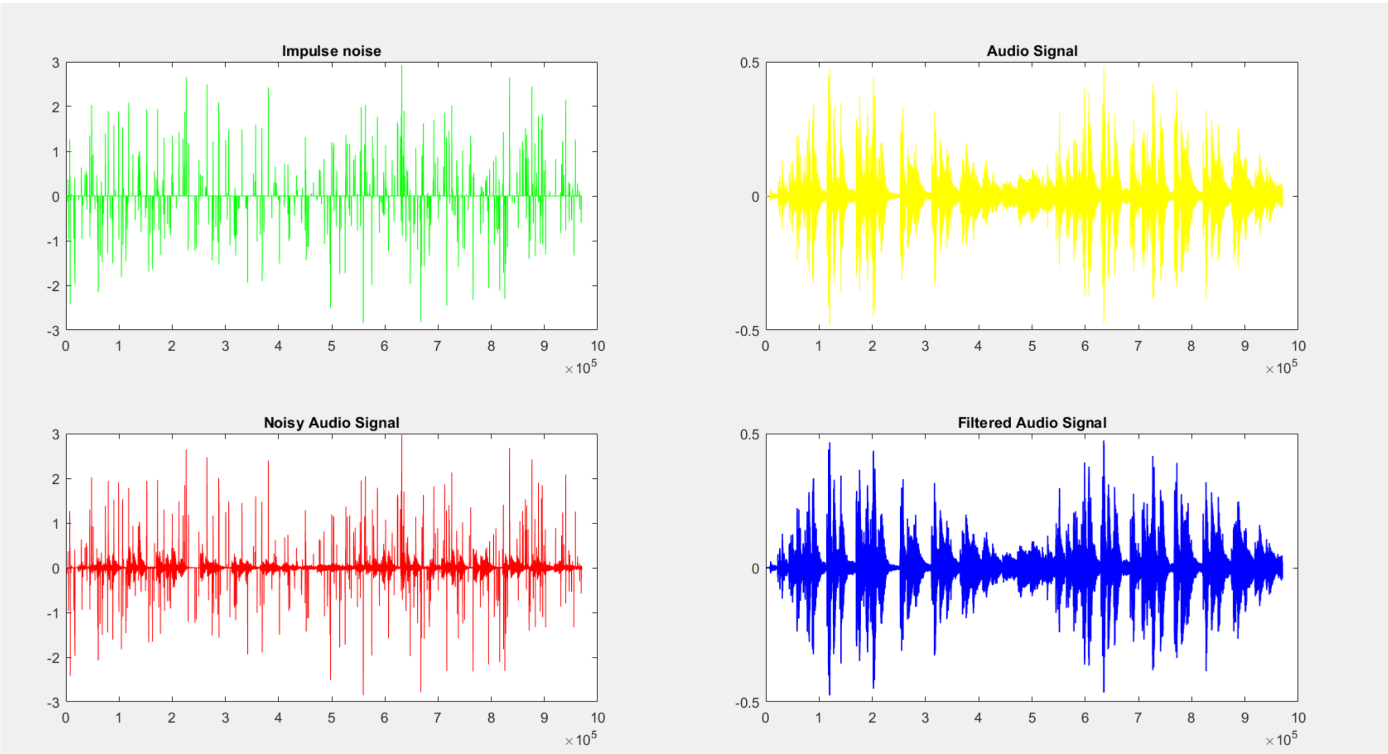
```
% Noise Detection and Removal of Impulse Noise
         %Using Meadian Filter


filtered = [];
filtered(1)    =    median([0    0    noisySound(1)    noisySound(2)
noisySound(3)]);
filtered(2) = median([0 noisySound(1) noisySound(2) noisySound(3)
noisySound(4)]);
```

Procedure

- ✓ Adding audio file to MATLAB.
- ✓ Generating the impulse noise
- ✓ Combining the two signals to form impulse noise disturbed audio signal.
- ✓ Then we used the above-mentioned Median filter to reduce and filter out the noise.
- ✓ After filtering and noise reduction we were able to recover our pure audio signal.

Matlab Plot of the signals before and after noise reduction



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Research Paper

- Impulse noise reduction in audio signal through multi-stage technique
  By Ali Awad
  Department of Engineering and Information Technology, Al-Azhar University, Gaza, Palestine