Bangladesh University of Business and Technology

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Project Report

on

Noise Removing from Continuous Signal Using FFT

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Dedicated to

Our Parents

and

Honorable Teacher

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Abstract

Noise reduction is the process of removing noise from a signal. Noise reduction techniques exist for audio and images. Noise reduction algorithms may distort the signal to some degree. Noise rejection is the ability of a circuit to isolate an undesired signal component from the desired signal component, as with common-mode rejection ratio.

All signal processing devices, both analog and digital, have traits that make them susceptible to noise. Noise can be random with an even frequency distribution (white noise), or frequency-dependent noise introduced by a device's mechanism or signal processing algorithms. In this project we have taken a continuous signal and then we have added noise with it and the we have removed that noise from that signal.

Chapter-01

Introduction

1.1 Description

In signal processing, the presence of unwanted disturbances, often referred to as "noise," can significantly impact the quality and accuracy of signals. Whether it's electrical interference, random fluctuations, or other undesired elements, effectively removing noise is crucial for enhancing signal clarity and reliability. MATLAB, a powerful numerical computing environment, offers a diverse set of tools and functions for tackling noise removal challenges in various applications.

Before delving into noise removal techniques, it's essential to understand the nature of the noise affecting a signal. Different types of noise, such as Gaussian noise, impulse noise, or random variations, require specific approaches for mitigation[1]. MATLAB provides an extensive range of functions for generating, visualizing, and analyzing noise characteristics, aiding in the identification of suitable noise removal methods. In this project we have taken a continuous signal and then we have added noise with it and the we have removed that noise from that signal.

1.2 Objectives

- To know about the MATLAB and how we can use it in any signal related work
- To know about the working procedure of MATLAB
- To know about the different kinds of command
- How we can generate any signal in MATLAB
- To know about how we can add noise and how we can remove the noise from the signal

Chapter-02
Code Explanation

```
clc
```
We use this to clear the command window

```
clear all
```
We use this to clear the workplace

```
close all
```
We have used it to close all window.

```
t=0:0.01:2*pi;
```
At first, we have taken a time sample with 0 to 2*pi and the increment is 0.01. Then we are taking very small incrementation because we are going to show the signal in continuous domain. In continuous domain the increment should be smaller and in discrete domain the increment will be 1.

```
x=sin(t)+sin(2*t);
```
Then we took a signal x signal consists of different frequency.

```
subplot(2,2,1);
plot(t,x);
```
Then we have plotted the signal and we have put the position of that signal by this using subplot command. Now it will show a pure continuous signal.

```
title('Original signal');
xlabel('Time');
ylabel('Amplitude');
```
Then we have given it a title “Original signal” and we have given it’s label of x-axis and y-axis. Now we will add noise in this signal. For addition of noise, two vectors must have to same length. So, we will create one noise vector which will consists of same length of time sample and the particular signal.

```
n=rand(1,length(t));
```
Then we have defined the noise sample as n and then we took the command “rand” which will generate random number and this will generate a gaussian distribution rate and basically in communication system, most of the time we take the noise as additive white gaussian noise, so, for exactly we can also use “rendom” but here I am using notion that will give same result and here we have to create the random number array of same length as my time(t). So, this will create my random number(n) which is a vector. So, we will be added with x to generate one distorted signal or noise corrupted signal.

```
x=x+n;
```

Here, we have added noise with the original signal.

```
subplot(2,2,2);
plot(t,x);
title('Noise corrupted signal');
xlabel('Time');
ylabel('Amplitude');
```

Here we have plotted that noise corrupted signal. Now we Have to eliminate this noise and this is an important part.

```
g=fft(x);
```

Here, we have denoted the corrupted signal by g and we have used "Fast Fourier Transformation" (FFT) command.

```
subplot(2,2,3);
plot(abs(g));
```

we took "abs" command because it is a complex signal, SO, we should take the magnitude and this will show us the magnitude response of the corrupted signal. We know the amplitude of the main signal is so higher than the noise signal. So, the components whose amplitude is below a particular threshold will be 0.

```
title('Magnitude part of fft');
xlabel('Time');
ylabel('Amplitude');
```

Then we have plotted it.

```
f=find(abs(g)<50);
```

So, here we are taking the threshold as "f". Here, we are finding the index positions using the find command and it will find those components whose value is lesser than 50 and we will make it all these 0.

```
g(f)=zeros(size(f));
```

And by the zero vector we are making all those noisy amplitudes 0.

```
w=ifft(g);
```

Now we will add the noise inverse Fourier transform because we have made the thresholding in the frequency domain. Now we have to get back our signal in time domain that's why we have used "ifft" (Inverse Fast Fourier Transform)
command and the have plotted it.

```
subplot(2,2,4);
plot(w);
title('Signal after noise removal');
xlabel('Time');
ylabel('Amplitude');
```

Then we have plotted it.

Chapter-03

Social Economy Impact

3.1 Application

The impact of noise removal from signals can have significant social and economic implications, influencing various industries and aspects of daily life. Here are some ways in which effective noise removal can contribute to the social and economic well-being:

Healthcare:

Diagnostic Accuracy: In healthcare, noise removal from medical signals (such as ECG or MRI) enhances diagnostic accuracy. Clearer signals enable healthcare professionals to detect abnormalities and make more accurate diagnoses, leading to better patient outcomes.

Communication and Telecommunications:

Improved Audio Quality: In telecommunications and audio communication systems, noise removal ensures clearer audio signals. This is crucial for phone conversations, video conferencing, and broadcasting, improving the overall communication experience.

Environmental Monitoring:

Data Accuracy: In environmental monitoring systems, noise removal from sensor signals enhances the accuracy of collected data. This is essential for studying climate patterns, pollution levels, and other environmental factors, contributing to informed decision-making and policy formulation[2].

Manufacturing and Quality Control:

Quality Improvement: In manufacturing processes, noise removal from sensor data ensures accurate quality control. This leads to improved product quality, reduced defects, and increased efficiency in production lines.

Automotive Industry:

Vehicle Safety: In automotive applications, noise removal from sensor signals (e.g., from radar or lidar systems) is critical for advanced driver-assistance systems (ADAS). This contributes to increased vehicle safety by providing clearer and more reliable data for collision avoidance.

Research and Development:

Scientific Discoveries: In scientific research, noise removal from signals allows researchers to extract meaningful information from experimental data. This contributes to advancements in various fields, from physics to biology, facilitating scientific discoveries and innovations.

Financial Markets:

In financial markets, noise removal from trading signals is essential for algorithmic trading strategies. Clearer signals contribute to better decision-making, reducing the likelihood of financial losses and optimizing trading outcomes.

Entertainment Industry:

Media Quality: In the entertainment industry, noise removal enhances the quality of audio and video signals. This leads to better user experiences in music, movies, and multimedia content, positively impacting consumer satisfaction[3].

Education and Research Institutions:

Signal Processing Education: Advances in noise removal techniques contribute to the curriculum in engineering and computer science programs. This ensures that students are equipped with the latest tools and methodologies in signal processing.

Smart Cities:

Efficient Infrastructure: In the development of smart cities, noise removal from signals collected by sensors (e.g., traffic sensors, energy consumption meters) contributes to efficient urban planning. This leads to improved resource allocation and infrastructure management.

Energy Sector:

Power Grid Monitoring: In the energy sector, noise removal from signals in power grid monitoring systems ensures the reliability of data. This is crucial for maintaining a stable energy supply and preventing potential failures[4].

Job Creation and Economic Growth:

Technology Development: The development and implementation of advanced noise removal technologies create opportunities for job growth in technology-related industries. This contributes to economic development and innovation.

3.2 Future plan

The future of noise removal from signals is likely to involve advancements in technology and the development of more sophisticated algorithms to address complex noise scenarios. Here are some potential future directions for noise removal in signal processing:

Machine Learning and Deep Learning:

Integration of machine learning (ML) and deep learning (DL) techniques for noise removal is a promising avenue. Neural networks, especially convolutional neural networks (CNNs) and recurrent neural networks (RNNs), can learn complex patterns in signals and effectively distinguish between signal and noise components. Training models on diverse datasets can enable the development of robust noise removal algorithms.

Adaptive and Self-Learning Systems:

Future systems may become more adaptive and capable of learning and adjusting to changing noise characteristics in real-time. Adaptive filtering algorithms could evolve to automatically detect and adapt to new noise patterns without manual intervention[5].

Advanced Wavelet Transform Techniques:

Research in advanced wavelet transform techniques may lead to more efficient and adaptive methods for noise removal. Tailoring wavelet transforms to specific signal characteristics and noise types could enhance the precision of denoising processes.

Real-time Noise Estimation and Removal:

Developing algorithms capable of real-time noise estimation and removal will be essential, especially in applications where immediate response is critical. This could be relevant in fields such as telecommunications, healthcare, and environmental monitoring.

Integration with Sensor Technologies:

As sensor technologies continue to evolve, future noise removal strategies may involve tighter integration with sensor hardware. This could include the development of sensors with built-in noise reduction capabilities or the optimization of noise removal algorithms based on specific sensor characteristics.

Multi-sensor Fusion for Noise Reduction:

Combining data from multiple sensors can provide a more comprehensive understanding of the signal and noise environment. Future approaches may focus on the fusion of information from various sensors, utilizing advanced fusion algorithms to enhance noise removal across different modalities.

Customizable and User-Friendly Tools:

There is likely to be a push toward developing more user-friendly tools and interfaces for noise removal. This could involve the creation of software with intuitive graphical user interfaces that allow users to easily apply, customize, and evaluate different noise removal techniques without extensive programming knowledge.

Quantum Signal Processing:

With the ongoing development of quantum computing, there is potential for quantum signal processing techniques that could revolutionize noise removal. Quantum algorithms may offer advantages in handling complex signal interactions and noise scenarios[6].

As technology progresses, the future of noise removal from signals will likely see a combination of these approaches, with an emphasis on adaptability, real-time processing, and integration with emerging technologies. Researchers and engineers will continue to explore innovative solutions to address the evolving challenges in signal processing and noise reduction.

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Conclusion

In conclusion, the process of noise removal from signals plays a pivotal role in various fields, offering substantial benefits in terms of data accuracy, decision-making, and overall system performance. Whether applied to medical diagnostics, communication systems, environmental monitoring, or manufacturing processes, the impact of effective noise removal is profound[7]. By employing advanced signal processing techniques, such as wavelet-based denoising, machine learning algorithms, and adaptive filtering, we can enhance the clarity and reliability of signals. This, in turn, leads to improved outcomes across different sectors, ranging from healthcare and telecommunications to research and development.

The social and economic implications of successful noise removal are far-reaching. In healthcare, it contributes to precise diagnoses and enhanced patient care. In telecommunications, it ensures clear communication, fostering connectivity and collaboration. Additionally, in manufacturing and quality control, noise removal leads to increased efficiency and reduced defects, positively impacting the bottom line. Furthermore, the continuous evolution of noise removal techniques, including the integration of artificial intelligence and deep learning, promises even more sophisticated approaches in the future. As technology advances, the societal and economic benefits of noise removal will likely expand, contributing to scientific discoveries, safer transportation, and the development of smart cities. In essence, noise removal from signals is not just a technical challenge but a transformative force that shapes the reliability of information, influences decision-making processes, and ultimately contributes to the overall well-being and progress of societies worldwide.

Chapter-05

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