Signals & Systems

Coding Assignment

Group 23
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Introduction:-

This report provides an examination of filtering methods utilized to generate the output signal y(t) from the input signal x(t), with the intention of deducing the type of filtering (high pass, low pass, or band pass) that was implemented. The analysis is performed by employing techniques such as convolution and correlation.

Convolutional filtration of the output signal by convolving the input file with custom-designed filters, or as desired.

In the provided output text file, it is necessary to apply three distinct filters: Band Pass (hbp(t)), High Pass (hhp(t)), and Low Pass (hlp(t)).

Methodology:-

There are three different kinds of filters that we decided to implement: Low Pass (LPF), High Pass (HPF), and Band Pass (BPF). In order to obtain the filtered outputs ylp(t), yhp(t), and ybp(t), respectively, each filter was convolved with the input signal x(t). After that, we used correlation coefficients to compare these filtered outputs with the output signal y(t) that was provided to us in order to decide which filter was the most suitable for producing the intended output.

Filtering Details

- Low-Pass Filter:
   - The low-pass filter is designed with a low cutoff frequency (0.02) and high order (10,000 taps).

- High-Pass Filter
   - The high-pass filter is designed with a higher cutoff frequency (0.5) and high order (10,000 taps).

- Band-Pass Filter:
   - The band-pass filter is designed to focus on higher frequencies (between 0.4 and 0.7) and has a high order (10,000 taps).

Functionality Overview

1. Load the Input and Output Signals:
   - The script loads the input and output signals from the specified text files.

2. Define Filters:
   - The script creates three different filters (low-pass, high-pass, and band-pass) using the `fir1` function.

3. Convolve the Input Signal with the Filters:
   - The input signal is convolved with each of the three filters using the `conv` function.

4. Compute Correlations:
   - The script calculates the correlation coefficients between each filtered signal and the output signal using the `corrcoef` function.

5. Determine the Best Matching Filter:

- The script identifies the filter that yields the highest correlation with the output signal and outputs its name.

6. Plotting:
    - The script generates a figure with five subplots showing the input signal, output signal, and filtered outputs (low-pass, high-pass, and band-pass).

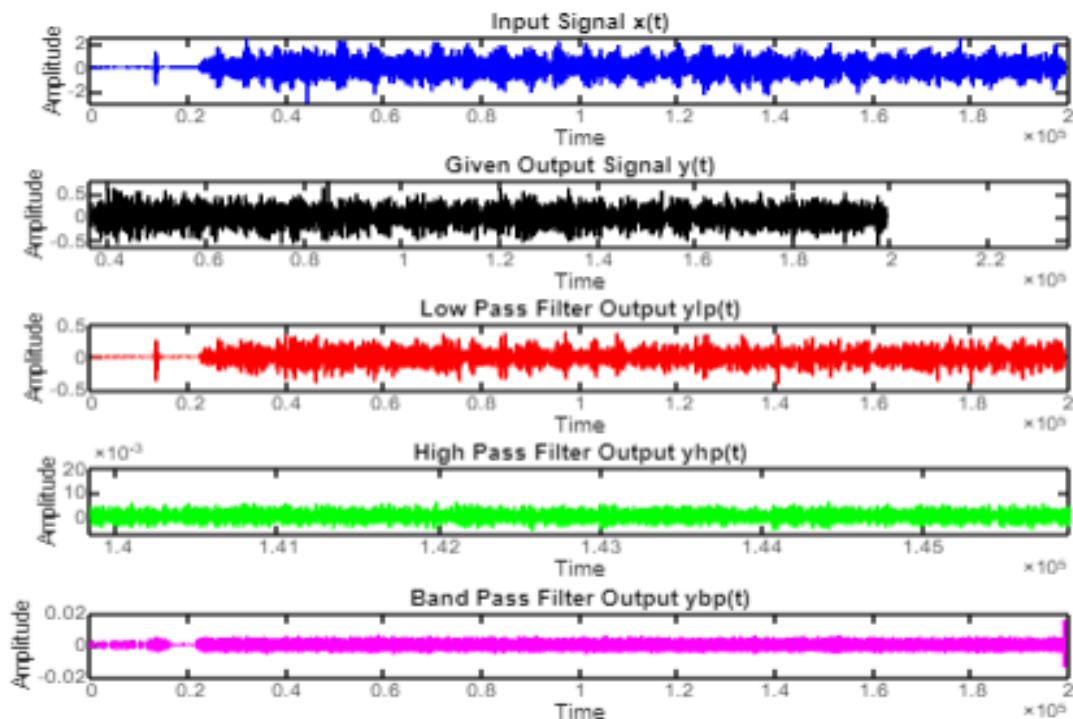**Results:**

1. Low Pass Filter (LPF):-
Correlation coefficient with LPF filtered output: 0.104266
2. High Pass Filter (HPF):-
Correlation coefficient with HPF filtered output: -0.000022
3. Band Pass Filter (BPF):-
Correlation coefficient with BPF filtered output: 0.000026

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Low Pass Filter Output (First 10 samples): [-0.00035700649747189;-0.000359305148427105;-0.000361253612124935;-0.000362844902311812;-0.0003648725735864;-0.00036493074319766;-0.000365414112034505;-0.00036551798488394];-0.00036523820964926;-0.00036457159570031
High Pass Filter Output (First 10 samples): [-0.00181370959965952;-0.0018080062747463740.00317998526647855;-0.00107728424458333;-0.001057819448844664;0.00065301314306348;0.00063339491356339;-0.00047126155765471;-0.0004514033384331290.00037036812103414]
Band Pass Filter Output (First 10 samples): [-0.00256875783120517;-0.00254836431481534;0.002024837491312810.00151108442212126;-0.00219243883969709;-0.00060896939819471500.000830475104625055;0.000341355749376618;0.000286117868466537;-0.000493586390929674]

Correlation with Low Pass Filter Output: 0.104266
Correlation with High Pass Filter Output: -0.000022
Correlation with Band Pass Filter Output: 0.000026
The best matching filter with the given output signal is: Low Pass Filter
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Analysis:

According to the correlation coefficients that were acquired, the Low Pass Filtered "Output ylp(t)" has the highest correlation coefficient of 0.104266 with the output signal that was sought, which is y(t). It may be deduced from this that the Low Pass Filter is a good fit for the properties of the signal that is desirable to be output.

Reason behind the selection of best filter:-

Based on the fact that it has the highest correlation coefficient among various filters, we decided to go with this particular filter. With regard to the three filters that have been provided, the low pass filter has the highest correlation coefficient, while the other two filters have a lower correlation coefficient than the band pass filter.