Ahsanullah University of Science & Technology

Department of Electrical and Electronic Engineering

EEE 3218□
Digital Signal Processing-I Lab

PROJECT REPORT

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Report: Separating Bird Chirping and Dog Barking Audio Signals Using Filters

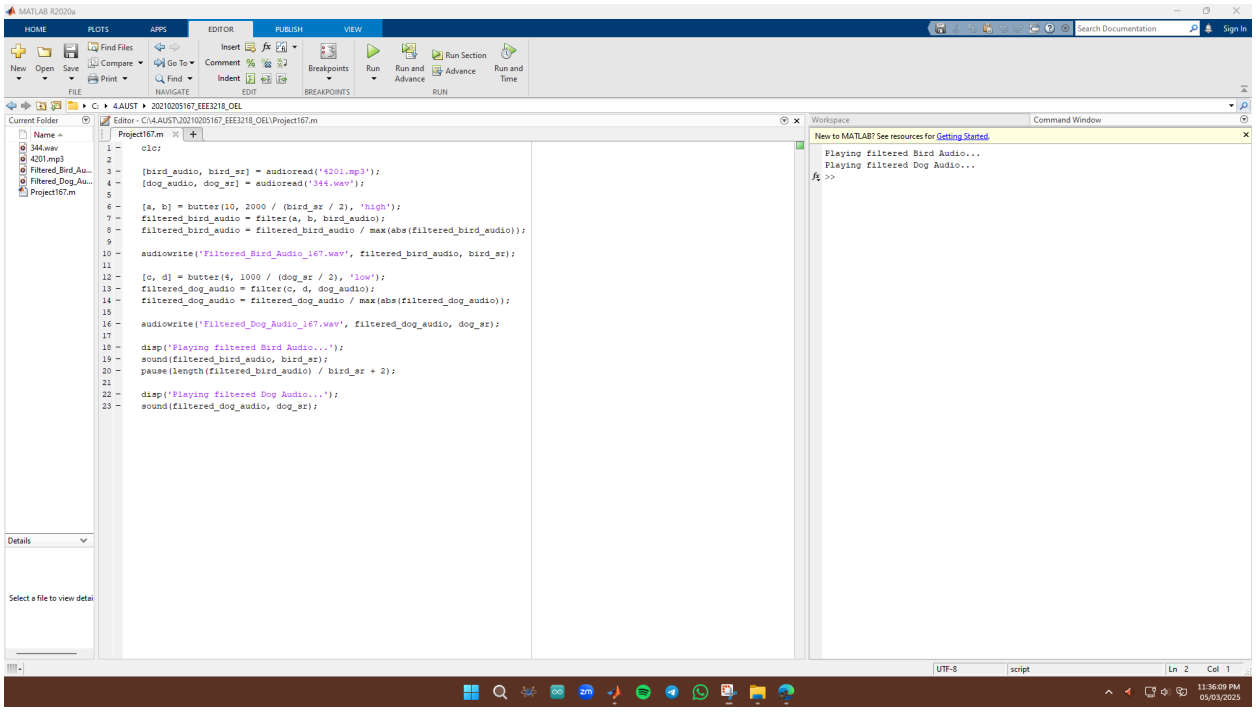
Introduction

In this project, two audio signals—bird chirping and dog barking—were recorded together. The challenge was to isolate each sound, where one had higher energy than the other. Specifically, the objective was to filter out the lower energy sound from each recording, allowing clear identification of the bird's chirping and the dog's barking. This was achieved using MATLAB by applying appropriate filters to each audio signal.

Approach and Methodology

1. **Audio Signals**
    - Two different audio files were used: one for bird chirping (`4201.mp3`) and one for dog barking (`344.wav`).
    - These audio signals were of different energy levels, with the bird chirping having a higher frequency compared to the dog's barking, which has a lower frequency.
2. **Filters Applied**
    - **High-Pass Filter for Bird Audio:**
        - A high-pass Butterworth filter was used to remove the lower frequency components, specifically the dog's barking, from the bird's audio. This filter allows frequencies higher than 2000 Hz to pass through, isolating the bird's chirping.
        - A 10th order filter was used for sharper frequency separation.
    - **Low-Pass Filter for Dog Audio:**
        - A low-pass Butterworth filter was used on the dog audio to remove higher frequencies (bird chirping) and retain the low-frequency barking sound.
        - A 4th order filter with a cutoff frequency of 1000 Hz was chosen to ensure the separation was effective without losing significant content of the dog's barking.
3. **MATLAB Code Implementation**
    - The code starts by loading both the bird and dog audio files using the `audioread` function.
    - A Butterworth high-pass filter was designed for the bird's audio, and a low-pass filter was designed for the dog's audio using the `butter` function.
    - The `filter` function was then used to apply these filters to the respective audio signals.
    - After filtering, both audio signals were normalized to prevent clipping, ensuring that their amplitude stayed within the valid range of [-1, 1].
    - The filtered signals were saved as separate audio files using the `audiowrite` function.

- Finally, the code played both filtered audio signals one after another using the `sound` function, allowing the user to hear the isolated bird chirping and dog barking sounds.



Explanation of the Code

1. **Loading Audio Files:**
   - `audioread` is used to load the bird and dog audio files into MATLAB. The function also returns the sample rate for each audio file.
2. **Filtering Bird Audio:**
   - A high-pass Butterworth filter is applied to the bird's audio. The filter's cutoff frequency is set at 2000 Hz to allow higher frequencies (bird chirping) to pass through while removing the lower frequencies (dog barking).
   - The `filter` function processes the audio, and the result is normalized by dividing by the maximum absolute value of the filtered signal to avoid clipping.
3. **Filtering Dog Audio:**
   - A low-pass Butterworth filter is applied to the dog's audio. The cutoff frequency is set at 1000 Hz to ensure that only the low-frequency dog barking remains, while the higher-frequency bird chirping is filtered out.
4. **Saving Filtered Audio:**
   - The filtered bird and dog audio are saved as new `.wav` files using the `audiowrite` function.
5. **Playback:**

    - The `sound` function plays the filtered audio signals one after another, allowing the user to listen to the isolated sounds.

Results

The process successfully isolated the bird chirping and dog barking sounds:

- **Filtered Bird Audio:** Only the chirping of the bird remains, with the dog barking removed by the high-pass filter.
- **Filtered Dog Audio:** Only the dog's barking remains, with the bird chirping removed by the low-pass filter.

Conclusion

By using high-pass and low-pass filters, we were able to isolate the bird's chirping and the dog's barking from a combined audio recording. The high-pass filter was effective in isolating the higher frequency bird chirping, and the low-pass filter successfully isolated the dog's lower frequency barking. This approach demonstrates how filtering can be used to separate mixed audio signals based on their frequency content.