Demo 8 Exercises: The Circular Buffer

DSP Lab (ECE 4163 / ECE 6183)

2023

Demo files

```
echo_via_append.py
echo_via_circular_buffer.py
myfunctions.py
author.wav
```

Exercises

For the following exercises, modify the demo program `echo_via_circular_buffer.py`

1. For the filter implemented in the demo program, what is the difference equation, transfer function, and impulse response? Submit a diagram of the impulse response and write the impulse response as a mathematical expression. Use Matlab to plot the pole-zero diagram of the filter.   SUBMIT

2. Experiment with different delay and gain parameters. How do short delays (e.g., less than 50 milliseconds) and long delays (e.g., longer than 0.2 seconds) sound different?

3. Modify the demo program so it produces a stereo output, with a different delay in right and left channels.

4. Note that the provided demo program truncates the output audio before it is finished (the end of the delayed signal is truncated). It is not noticeable for short delays or for wav files ending with a sufficiently long period of silence, but in other cases it may be noticeable. Modify the demo program so the output signal is not truncated at the end (i.e., so that the trailing end of the final echo is played.)

5. Modify the demo program so the input audio is from the microphone.

6. Modify the demo program so the input audio is from the microphone, and the output signal is saved to a wave file. Create a wave file of applying the filter to yourself saying your name; and submit your wave file as part of your work.

7. In the demo program `echo_via_circular_buffer.py`, change the line   SUBMIT

   ```
   buffer[k] = x0
   ```

   to

```
    buffer[k] = y0
```

and comment on how this affects the sound of the output. With this change, what is the difference equation and transfer function? Find a formula for the impulse response of the system, and the poles/zeros of the system.

Modify the demo Python program `echo_via_circular_buffer.py` so that it saves the output signal as a wave file (and plays the output signal on the audio device). Create a wave file of yourself saying your own name, and use it as the input to your Python program. Submit your Python program, your input wave file, and your output wave file.

What happens when the gain for the delayed value is greater than 1?