EE 367 Lab 5

Reverb Effect in Audio

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1 Finding IIR difference equations

In part 1 we will be finding difference equations from block diagrams.

1. For the comb filter of Figure 1, find a difference equation an expression for w[n] in terms of x[] and w[]?

   The output in terms of x[] is:

   $$w[n] = x[n-\tau] + gx[n-2\tau]$$

   in terms of w[n] is:

   $$w[n] = w[n]$$

2. For the all-pass filter of Figure 2, find a difference equation for w[n] in terms of x[] and w[]?

   w[n] in terms of x[n] is:

   $$w[n] = x[n-\tau] + gx[n-2\tau]$$

   w[n] in terms of w[] is

   $$w[n] = w[n]$$

3. For the all-pass, find a difference equation for y[n] in terms of w[n] and x[n]?

   y[n] in terms of x[n] is:

   $$y[n] = -gx[n] + x[n-\tau] + gx[n-2\tau] - g^2x[n-\tau] - g^3x[n-2\tau]$$

   y[n] in terms of w[n] is:

   $$y[n] = -gx[n] + w[n] - g^2w[n]$$

2 Reverb Implementation

In part 2 of this lab we will be implementing a reverb from a complicated block diagram provided below

1. Paste the sections of your Python code that implement the six digital filters, using your FIFO?

Listing 1: Reverb FIFO Setup

```
##########################################################################
# students - allocate your fifo, with an appropriate length (M)

# Creating a 0.125 second echo

M1 = int(0.030 * 16000) - 1

M2 = int(0.035 * 16000) - 1

M3 = int(0.040 * 16000) - 1
```

```

    M4 = int(0.045 * 16000) - 1

    fifo_array_1o = [my_fifo(M1 + 1), my_fifo(M2 + 1), my_fifo(M3 + 1), my_fifo(M4 + 1)]
    input = my_fifo(M4 + 1)

    M5 = int(0.005 * 16000) - 1

    M6 = int(0.0017 * 16000) - 1

    f5i = my_fifo(M5 + 1)
    f6i = my_fifo(M6 + 1)
    final = my_fifo(M6 + 1)

    stageGain = 0.7
    finalGain = 0.8
    # students - well done!
    ################################################################
```

Listing 2: Reverb Filter Code

```
        ################################################################
        # students - there is work to be done here!

        runningSum = 0

        input.update(xin)
        w1 = input.get(M1) + (stageGain * fifo_array_1o[0].get(M1))
        w2 = input.get(M2) + (stageGain * fifo_array_1o[1].get(M2))
        w3 = input.get(M3) + (stageGain * fifo_array_1o[2].get(M3))
        w4 = input.get(M4) + (stageGain * fifo_array_1o[3].get(M4))

        fifo_array_1o[0].update(w1)
        fifo_array_1o[1].update(w2)
        fifo_array_1o[2].update(w3)
        fifo_array_1o[3].update(w4)

        k = w1 + w2 + w3 + w4

        f5i.update(k)

        allin = -stageGain * k + 0.49 * f5i.get(M5) + (0.357 * f5i.get(M5))

        f6i.update(allin)

        out = (-0.7 * allin) + (0.49 * f6i.get(M6)) + (0.357 * final.get(M6))
        final.update(out)

        # Update history with most recent input
        yout_right = int(0.5 * (finalGain * out + xin))
        yout_left = int(0.5 * (finalGain * out + xin))

        # students - well done!
        ################################################################
```

2. Upload your output WAV file with the reverb effect.

   WAV file uploaded.

3 Testing and Verification via Impulse Response

In part 3 of this lab we will be testing that our reverb works using an impulse response.

1. Documentation: Paste a copy of your (scaled and delayed) impulse response into your report.

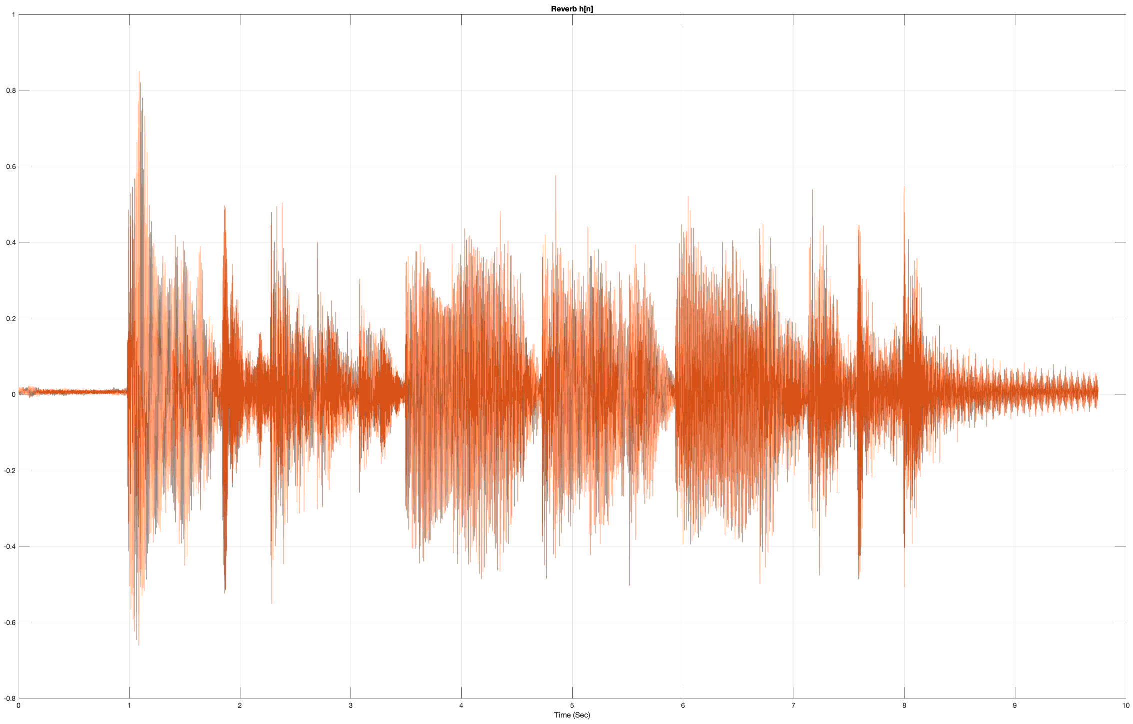

Figure 1: Reverb Impulse Response