BAIN MUSC 336
Introduction to Music Technology

Assignment #2
DSP with MSP

Due Date:

Friday, Feb. 29
Be prepared to demonstrate your work in class.

Reading:

This document assumes that you have read the following sections in the *MSP Tutorials and Topics* documentation:[1] 1. "How Digital Audio Works," and 2. Tutorials 1-5. In Exercise 12, you will also be asked to read MSP Tutorial 7.

All output should be directed to the Digi 002R unless otherwise specified.

Part 1: MSP Programming

Instructions:

Create the following digital signal processsing (DSP) networks. Store each program in a separate .pat file. Files should be named after the respective exercises as follows: MSP1.pat, MSP2.pat, MSP3.pat,…, MSP7.pat. Use Max's Comment object to document your work.

Using MSP Tutorial 1 as your starting point:

1. Create a *digital signal processing network* (heretofore called a program) that uses a **cycle~** and **dac~** object to produce a cosine wave with frequency 440 Hz., and absolute amplitude 0.5.

2. Replace the **dac~** in the previous patch with an **ezdac~** human interface object. Change the frequency of **cycle~** to 60 Hz.

Using MSP Tutorial 2 as your starting point:

3. Change the fade in/out time of the 1000 Hz. tone to two seconds.

4. Create a glissando from 55 Hz. to 1760 Hz. The glissando should begin when you click a **bang** object. Use a **line~** object (see Tutorial 4 if necessary) to create the glissando control signal.

5. A *chirp* is a pure tone frequency sweep from 0 to 10,000 Hz., and back again, that is commonly used to test audio equipment. Create a chirp program.

   There are many ways to approach this exercise. One way is to use Max's **toggle**, **metro**, and **counter** objects to produce the sweeping frequency value in a number box. Be sure to keep the absolute amplitude of the pure tone below 0.5 so that it doesn't get too loud in the upper end of the audio range.

Using MSP Tutorial 3 as your starting point:

6. Create a program that plays white noise with the following ADSR amplitude envelope:

   0, 1. 1000 0.8 1000 0.8 8000 0. 2000

   Delete all unneeded objects.

7. Create a program that converts *absolute amplitude* values (0-1) to *relative amplitude* vaules (*dB*) values. Perform the necessary conversion in a subpatch using an **expr** object. Name the subpatch AtodB. Display the absolute amplitude and db vlues in two float number boxes.
   HINT: See the sub-patch AtodB in Tutorial 4.

[1] Available on the course Web site, or in the MaxMSP application directory in the Documentation folder.

Part 2: Digital Audio Concepts

Guidelines:

Use MaxMSP Tutorials 2-7 (as described below) to investigate the following digital audio concepts. E-mail the answers to your instructor, being sure to include the original question with your answer.

8. Using the chirp you created in Ex. 5:
How does the perceived loudness of a pure tone change as its frequency changes?

9. Use MSP Tutorial 4 to investigate the principles of *beats* and *roughness*:

    9.1 What are *beats*?
    9.2 What is the *beat theorem*?
    9.3 What are *binaural beats*?
    9.4 Begin with two 440 Hz. tones in unison. Slowly change FreqB in the upward direction.
        9.4.1 Approximately where does your perception of *beats* end and *roughness* begin?
        9.4.2 Where do you begin to hear two distinct tones?

10. Use MSP Tutorial 5 to study the following classic waveshapes:

    a. *sine*
    b. *sawtooth*
    c. *square* (a pulse wave with a duty cycle of 1:2)
    d. *triangle*

    10.1 What is the spectrum of each waveshape?
    Be sure to describe the relative amplitude each partial in terms of harmonic numbers (*n*) and the fundamental's amplitude *A*?
    10.2 Why do the sawtooth, square, and triangle waves in MSP Tutorial 5 sound "distorted"?

11. Use MSP Tutorial 5 to generate a sawtooth wave with frequency components that exceed the *Nyquist frequency*.

    11.1 What is the Nyquist frequency (in Hz.) in this case?
    11.2 What happens to frequency components of the sawtooth wave that exceed this frequency?

Part 3: Additive Synthesis

12. Read MSP Tutorial 7 *Additive Synthesis*.

    Modify the MSP Tutorial 7 patch to accommodate 8 partials (it currently accommodates 6 partials) and same it in a file called MSP12.pat. Now create *band-limited* versions of the four classic waveshapes in Ex. 10. Use Max's **preset** object (be sure to read the Help file) to save the four classic waveshapes as presets 1-4. Now use MaxMSP's graphical **function** object to create individual amplitude trajectories for all 8 partials. Create four "cool sounds" and save them as presets 5-8. Be sure to describe your cool sounds using the comment object. You will be asked to demonstrate your cool sounds in class.

Be sure to comment your work!

Reminders

Use MaxMSP's interactive Object Help feature as you work. Thoroughly document your programs and strive for visually well-organized signal networks by using Max's Align, Fix Width, and Segmented Patch Cords options.

Grading

Store all of your work in a sub-folder called **MSP**. Followed instructions. 60%; Code well organized/easy to follow - 20%; Presented work in class - 20%.

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Updated: 2/13/2008