Sound Synthesis - Coursework 2
Physical Modelling Synthesiser

April 5, 2012

1 Overview

Using Max/MSP, create an synthesiser using physical modelling techniques (i.e. based on digital waveguides or modal synthesis). The technical specifications of the patch are contained in Table 1. In addition to the Max/MSP patch, a README file documenting your patch, at least recordings of the instruments you are emulating (very brief, consisting of a single note for each instrument) and an audio recording demonstrating a creative use of the patch should also be submitted.

2 Demo recording

The recording should meet the following criteria:

- The submitted file should be a 2-channel stereo, 16-bit, 44.1kHz sampling rate wav file (uncompressed PCM). Submitting the recording in any other format will be penalised.
- The submitted file should have the name "demo_cw2.wav".
- The recording should not be longer than 30 seconds.

The purpose of this task is to demonstrate how the Max/MSP patch can be used creatively, and hence the content of the recording is not prescriptive. Some examples of what your recording may contain are:

- A simple solo recording of the patch.
- A more complex recording where several voices are synthesised using the patch (e.g. a Bach fugue).
- A recording combining the use of the Max/MSP patch developed for the coursework with other instruments (which may themselves be natural or synthetic).

The demo recordings will be played back during a lecture where they will be discussed by the class. The discussion will centre on how many of the capabilities of the patch have been explored (e.g. emulating different types of instruments, use of dynamics, vibrato, pitch bending and portamento) and how successful the patch is at emulating real instruments.

3 The README file

The README file documenting you patch should contain the following:

- The user instructions for the Max/MSP patch.
- Any implementation and/or development details of the patch which require discussion. Note that if this is covered by the comments inside the patch then this section may be unnecessary.
- Brief details of how the patch was used in the creation of the submitted recording (e.g. how a particular sound was achieved).
- Details of the song and original artist if the submitted demonstration recording is a cover version.

None of these sections need be very long; bullet points will suffice. The format of the README file can be a Microsoft Word document file (".doc"), an ".rtf", ".txt" or pdf file. The README file must have the correct file extension.

4 Submission of the coursework

A zip file containing any Max/MSP files necessary for your patch, any picture files used in your patch, the README document and the wav files should be emailed to ***martin.dewhirst@surrey.ac.uk*** by ***4pm on the Tuesday in week 12***. The zip file should include:

- The Max/MSP patch and any subpatches needed.
- The samples of the instruments you are trying to emulate (as wav files).
- The README document.
- Any picture files needed by your patch.
- A wav file of your demo.
- Any other files used in the construction of your patch (e.g. output files from the SNDAN program).

It is recommended that you keep a backup copy of your coursework on e.g. a memory stick as well: problems with emails are not unknown.

Technical specification		Notes
MIDI support	Note on /off data	Configured so that it works with the Oxygen 49 keyboard on port a. See below for more details of how the MIDI information should be interpreted.
	Note velocity data	
	Pitch bend data	
	Modulation wheel data	
	Switch between 8 note polyphony and monophonic mode.	Controller 1 on the Oxygen 49 (see Table 2 for the default Oxygen 49 controller numbers; these should be used for all controllers). The lower half of the controller range switches the patch to monophonic mode and the upper half of the controller range switches the patch to polyphonic mode.
	Portamento rate	Controller 2 on the Oxygen 49.
	Vibrato rate	Controller 3 on the Oxygen 49.
Preset sounds	1 (minimum)	The synthesiser should have at least 1 preset sound, although you are not limited to a single preset sound. In addition to how well the patch matches the sound of the original instrument, the marking will take into account accurate modelling of the transient portion of the sound and the excitation of the model, modelling different articulations specific to the emulated instrument (e.g. pick position for guitars) and correct tuning for high notes.
Articulation options	Dynamics	The amplitude and timbre of the synthesised sounds should be controlled by the MIDI note velocity information in an appropriate way.
	Vibrato	The vibrato depth is to be controlled by the modulation wheel MIDI data. The vibrato rate is controlled by controller 3 on the Oxygen 49 keyboard.
	Pitch bend	Controlled by the MIDI pitch bend data. The default pitch bend range should be ± 2 semitones.
	Portamento	The portamanto rate is controlled by controller 2 on the Oxygen 49 keyboard (see Table 2). The portamento should only be active when the patch is set to its monophonic mode (i.e. has 1 voice rather than 8 voices).
Polyphony	Switchable between 8 voices and 1 voice (monophonic)	This should be implemented using the poly$\sim$ object (see Tutorial 21 in the MSP Tutorials and Topics document [1])

Table 1: Technical specifications of the Max/MSP patch.

5 User interface

This should satisfy the following criteria:

- Intuitive to use.
- Clearly labelled.
- All dials/sliders and number boxes on the interface should always be in agreement (i.e. if a slider has a number box associated with it then the numbers on the slider and the number box should always match).
- If a number box, etc. is purely for display (rather than control) then it should be locked.

6 Notes

Note that marks will also be lost for the following:

- Any files without the correct suffix (this includes Max/MSP patch files with ".pat").
- Any demo recordings or samples of instruments not submitted as wav files.
- Lack of commenting in the patch.
- Messy / unstructured patches.

30% of the marks are for submitting the demo recording which will then be played in a lecture, followed by a discussion.

No Max/MSP external elements developed by third parties specifically for physical models, such as from the STK or PeRColate libraries, may be used in your patch. This does not preclude you writing your own Max/MSP external in Java or C, in which case you must also include the source code in your coursework submission.

Note that the only difference from the first piece of coursework is that the sounds must be generated using a physical modelling technique instead of an additive synthesis technique. Hence, if you used a modular approach to building the patch for the first piece of coursework then you should be able to reuse most of this.

The Max/MSP example patches on the Tonmeister Sound Synthesis website may be useful.

Controller	Hex	Decimal	Description in Appendix A of Oxygen 49 manual
C1	4A	74	Cut-off Frequency
C2	47	71	Resonance
C3	5B	91	Reverb Depth
C4	5D	93	Chorus Depth
C5	49	73	Attack Time
C6	48	72	Release Time
C7	05	05	Porta Time
C8	54	84	Portamento Control
C9	07	07	Channel Volume
C10	4B	75	Controller 75
C11	4C	76	Controller 76
C12	5C	92	Tremolo Depth
C13	5F	95	Phaser Depth
C14	0A	10	Pan
C15	4D	77	Controller 77
C16	4E	78	Controller 78
C17	4F	79	Controller 79

Table 2: Default control change numbers for the sliders and knobs on the Oxygen 49.

References

[1] Cycling 74, San Francisco, California. *MSP Tutorials And Topics.*

This is one of the Max/MSP documents included with the software as a pdf. Tutorials 27 and 28 are relevant to digital waveguides.

[2] Cycling 74, San Francisco, California. *MSP Reference Manual.*

This is the other of the Max/MSP documents included with the software as a pdf.

[3] P. Cook. *Real Sound Synthesis for Interactive Applications.* A K Peters Ltd, 2002.

Chapter 4 discusses modal synthesis, chapters 9 and 11 discuss digital waveguides. This is available as an ebook from the university library.

[4] C. Dodge and A.J. Jerse. *Computer Music: Synthesis, Composition and Performance.* Macmillan Library Reference, 2nd edition, 1997.

Chapter 9 discusses physical modelling.