UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Soundcool®: User manual

April, 2019

Soundcool® version 3.1

Android OSC App version 3.1

iOS OSC App version 3.1

Contents

1. Introduction

Soundcool® is a collaborative system for sound, music and visual creation using mobile phones, tablets, the Hololens augmented reality glasses Kinect and MAX / MSP / Jitter. *Soundcool®* has been introduced into educational centers at primary and secondary levels. The core of the *Soundcool®* system is available for free. *Soundcool®* is being developed at the "Universitat Politècnica de València, UPV" (Spain). The key projects relating *Soundcool®* are:

- Collaborative Music and Video Creation (GJIDI/2018/A/169)

UNIÓN EUROPEA
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ESTRATEGIA DE EMPRENDIMIENTO Y EMPLEO JOVEN
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- Daniel and Nina Carasso Foundation grant 16-AC-2016: VideoArt software developments 2016/2019.

fundación daniel & nina carasso
Afiliada a la Fondation de France

- Aid for educational and professional shows with *Soundcool®,* Institut Valencià de Cultura (192/2018), and CulturArts (FM-148/16) and (84/2017) of the Generalitat Valenciana.

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- Telefonica Foundation and the Universitat Politècnica de València, co-funded in 2017 the development of a Soundcool® technological demonstrator with the acquisition of a number of Android and iOS mobile devices.

Cátedra Telefonica
Tecnologías para la Innovación Social y Ambiental
Universitat Politècnica de València

- *Soundcool®:* Generalitat Valenciana (Spain) grant AICO/2015/120: "New Technologies for Music Education and Sound Creation" (2015-2016), led by Dr. Jorge Sastre. This project aims to continue developing and improving *Soundcool®* as a modular software system based on low-cost interfaces such as tablets, smartphones and Kinect.

- New Technologies and Interfaces for Education and Production in Electronic Music, Spanish Ministry of Education, Culture and Sports, Salvador de Madariaga grant for Stays of Senior Teachers and Researchers in Foreign Centers PRX12/00557, with Roger Dannenberg Computer Music research Group at the Department of Computer Science from Carnegie Mellon University (Pittsburgh, USA), one of the first Computer Science departments in the international rankings (2013).

- Universitat Politècnica de València (Spain) project PAID-05-12-SP20120470: "New Audiovisual Technologies and Interfaces for Education in Music and Sound Creation" (2013), directed by Dr. Jorge Sastre. This project led to the birth of *Soundcool®*.

- *Soundcool®* has been adopted in the European project Erasmus+ KA201 "Technology to support learning and creativity: building European networks through collaborative music creation" ("Tecnología al servicio del aprendizaje y la creatividad: tejiendo redes europeas a través de la creación musical colaborativa", 2015-2017), led by Dr. Elizabeth Carrascosa, and with the following reference 2015-1-ES01-KA201-016139. As a result, *Soundcool®* has been introduced into several European educational centers.

The following are two key publications:

- "New Technologies for Music Education", Sastre, J. Cerdà, W. García, C.A. Hernández, N. Lloret, A. Murillo, D. Picó, J. E. Serrano, S. Scarani, R.B. Dannenberg. Presented on the 2nd International Conference on E-Learning and E-Technologies in Education (ICEEE2013), and considered one of the most relevant papers of the conference. Available at:

https://www.researchgate.net/publication/259900796_New_Technologies_for_Music_Education

- "Soundcool®: New Technologies for Music Education", J. Sastre, A. Murillo, E. Carrascosa, R. García, R.B. Dannenberg, N. Lloret, R. Morant, S. Scarani, A. Muñoz. Presented on the International Conference of Education, Research and Innovation ICERI2015. Available at:

https://www.researchgate.net/publication/284183213_SOUNDCOOL®:_NEW_TECHNOLOGIES_FOR_MUSIC_EDUCATION

1.1 Requirements

For the *Soundcool®* modules to operate properly, the following components are needed:

- ***Soundcool®* system** that you can download from the *Soundcool®* website: http://Soundcool®.org/downloads

- ***Soundcool® OSC App*** for Android and iOS (free). It enables wireless control of modules, sending messages and receiving feedback from remote devices.

  Android:
  https://play.google.com/store/apps/details?id=org.Soundcool®.upv.oscapp

  iOS:
  https://itunes.apple.com/us/app/Soundcool®-osc/id1195976787?l=es&ls=1&mt=8

- ***Kinect.*** *Microsoft's* sensor that controls some *Soundcool®* modules by using physical movement, as though the whole body is an instrument. The device model compatible with *Soundcool®* is *Kinect for Xbox 360, Model 1414.*
- ***Synapse.*** Program to process movement detected by the *Kinect* sensor. Free download here.

1.2 Installation Instructions

1 - Install *Soundcool®* system on your computer

After the above mentioned download proceed to unzip it. Then, on a PC run *Soundcool®.* On a Mac install the .dmg file. For a full functionality you need to install Java.

At this point you can use *Soundcool®®* on your computer, even without using mobile devices or Kinect. For an example, follow the tutorial described on the "Basic Operation" section below. If you have *Kinect for Xbox 360, Model 1414* available, you can install *Synapse* for using it with *Soundcool®*.

3 - Download our free *App Soundcool® OSC* in your mobile device, Android and iPhone:

Visit http://Soundcool®.org/descargas from your mobile device and click "*Soundcool®OSC for Android"* or *"Soundcool®OSC for iOS"* or search those apps in your app store.

1.3 Links to free audio files and VST instruments

Links to free VST instruments:

- HELM VST
- CRYSTAL VST
- ALTER EGO VST
- DSK Asian DreamZ

Links to free samples and sound effects:

- ROYALTY-FREE SOUNDS EFFECTS
- 2.000+ FREE SOUND EFFECTS
- FREE SOUND FX
- Freesound: collaborative database of creative-commons licensed sound for musicians and sound lovers

More resources are available on our site http://Soundcool®.org

2. Basic operation

In this section you will be guided to produce your first sounds.

2.1 Modules

The *Soundcool®* system consists of different **modules** that can be interconnected together to produce different effects and sounds. Modules are typically opened from the visual interface or Launcher.

Figure 1: Visual Launcher

Now, you will open two modules, *MPlayer* and *MSpeakers.*

2.2 Relocating a module

The modules can be placed on the screen wherever you want them. To change the location, place the mouse cursor over any part of the module's background area. By left-clicking the mouse, the hand icon holding an object will appear . Then, by dragging without releasing the mouse button, the module can be moved to wherever desired.

You can arrange the two modules as shown in the following figure:

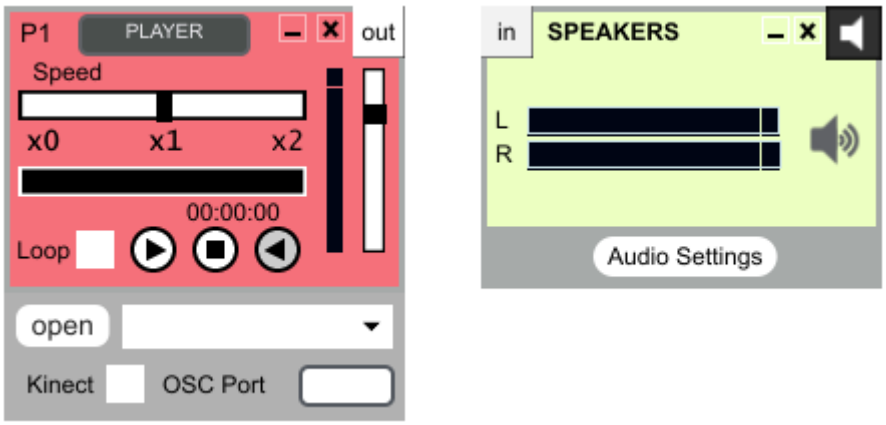


Figure 2: Two modules opened

2.3 Editable Names and Identification Numbers

In all the modules that can be controlled from mobile devices there is a box where the original name is written. This box can be edited to change its name, for example, to the name of the person who controls that module with their mobile device.

Note that all modules generate an **identification** number, so that if two or more instances of the same module open up, each will be identified with a different number. If all instances of the same module close, the count is reset.

2.4 Connecting the two modules

Soundcool® modules can have inputs and/or outputs. To **connect** the two modules, first click on the output button of *MPlayer*, labeled ***out,*** to activate it. After that, the originally square button becomes round . At the same time, the ***in*** button on the modules which are available to be connected with it will become round . At this point, if you click on any of these ***in*** buttons, the connection between the two modules will be established. In our example, we only have the ***in*** button of *MSpeakers.*

Once connected, the output button will change to having a black background. In addition, the new input button will display the initial and identification number (here P1) and the background color of the module it originated from. The result can be seen in the following figure:

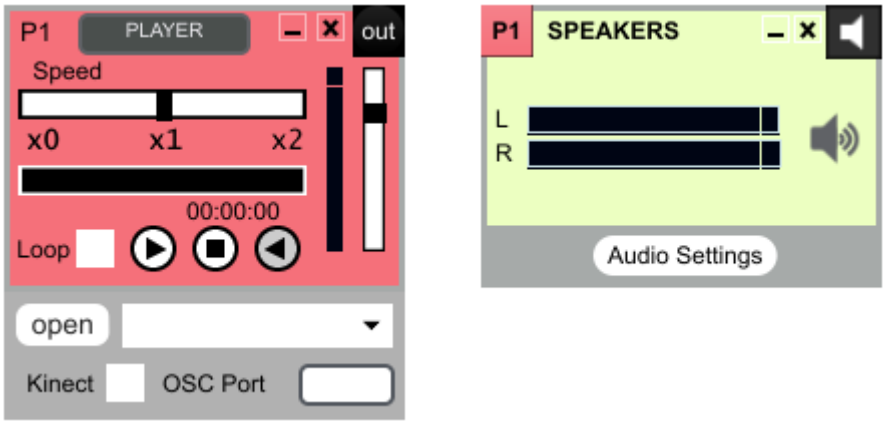


Figure 3: Connecting two modules

2.5 Producing the first sounds

To make this arrangement sound, follow these steps:

- Click the *Open* button of *MPlayer* .
- Select an audio file that is stored in your computer.
- Press the *Play* button ▶.

2.6 Disconnecting modules

To disconnect two modules, simply hover over the ***in*** button. At that moment, an "X" will appear on the button. If you then click, the associated modules will be disconnected.

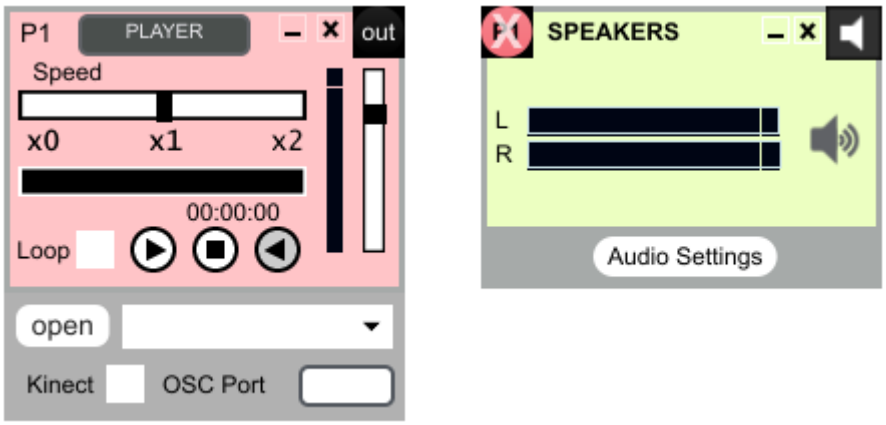


Figure 4: Disconnecting two modules

Also, if any module that is part of the connection is closed, the connection is automatically broken.

2.7 Multiple connections between modules

Now, we are going to make another arrangement using four modules. We will connect the *MPlayer* to two modules at the same time. This is because the output of an ***out*** button can be connected to one or more modules. In contrast, the ***in*** buttons only accept one connection. If you hold the mouse over the **in** button of certain module, the module which is connected to it will light up, and if you hover over the ***out*** button all the modules which are connected to if will light up.

In addition to the *MPlayer* and the *MSpeakers*, please, open the following modules: *MPitch* and *MMixer*. Initially, please, disconnect all the modules as explained above. The arrangement is shown in the next figure:

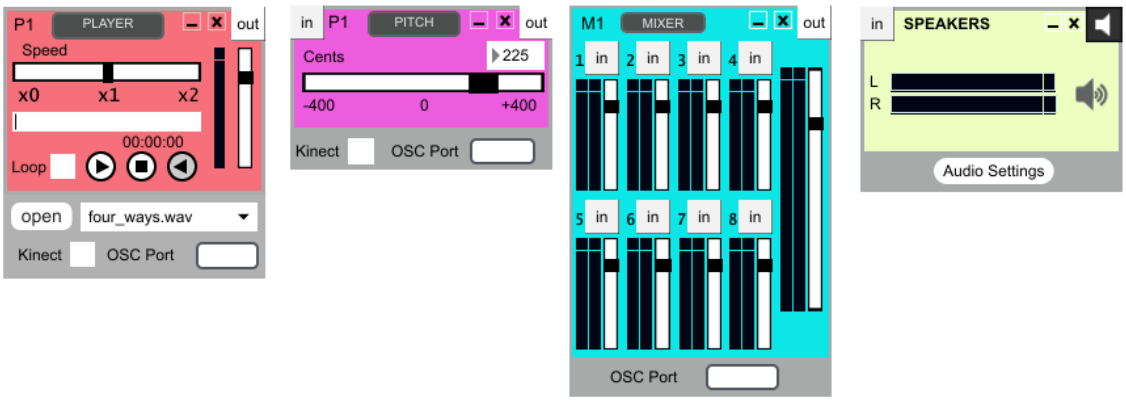


Figure 5: Arrangement disconnected

MPitch is an effect module that changes the pitch of its input. Similarly, *MMixer* has inputs and one output. Whatever is input into these kind of modules is processed and then output from the same module. In turn, whatever is output from any of those modules (usually audio) may lead into one or more other modules.

Please, make the following connections:

- *Mplayer's* output will have a multiple connection: one to the input of *MPitch* and the other to the input 1 of *MMixer*. Please, proceed as explained above for multiple connections.
- *MPitch's* output will be connected to the input 2 of *MMixer.*
- *MMixer's* output will be connected to the input of *MSpeakers*.

The arrangement is shown in the following figure:

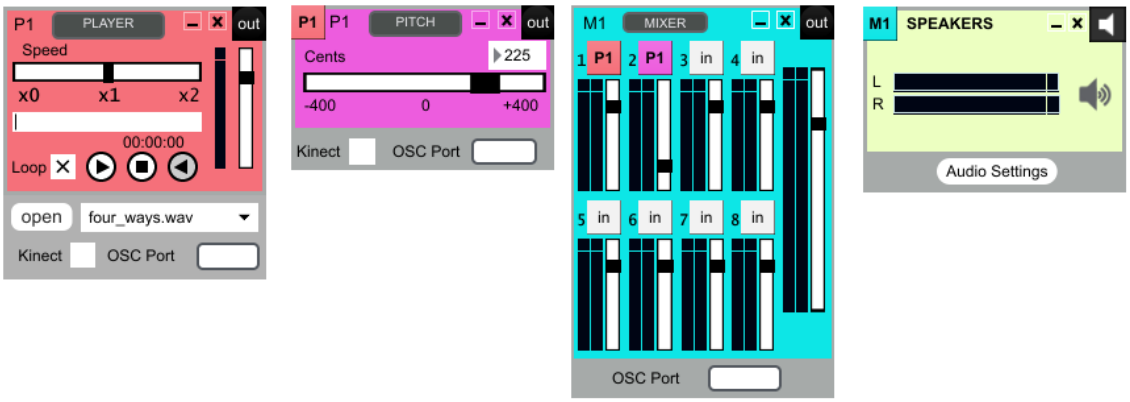


Figure 6: Arrangement with connections

Now, we have a typical arrangement where the original sound source and its processed version enter a mixer. By changing the levels of the mixer we can control the proportion of original and processed sound that we can listen through the speakers. That is, by increasing the volume of *MMixer's* channel 1 

you will hear the original sound louder, while by increasing the volume of *MMixer's* channel 2 

you will hear the effect, or processed sound, louder (move the Pitch 1 slider to change the pitch of the sound played by Player 1).

Please, note that we have not used the mobile devices, yet. That will be covered at the end of the manual.

2.8 Minimizing modules

All modules have a minimize button ⊟ which compacts all modules to the same size, no matter what size they were when maximized. Once minimized, you can return to the previous size by clicking on the maximize button ⊡. The following figure shows how several modules are minimized to the same size:

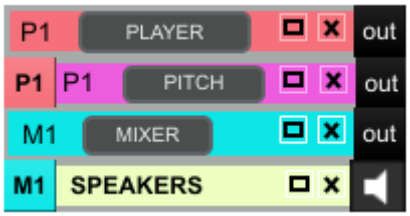


Figure 7: Minimized modules

The next manual sections describe every *Soundcool®* module in more detail, as a reference manual.

3. Launcher

The Launcher is the graphical interface where all the Soundcool® modules can be opened by clicking on their icons. There is also a control to select the language used in pop-up help messages (English/Spanish). In addition, there is a *Close All* button to close all the open modules simultaneously.

Figure 8: Launcher

Finally, you have the *Save* and *Load* buttons, which are explained below.

3.1 Save

The *Launcher* allows you to save any configuration of the modules that you wish to. In this context, the Save function saves the names of open modules, the settings between the modules, the value of the parameters of each module, and finally, its location on the screen. To do this, click on the Save icon. Then, the classic window for each operating system opens, in which you much choose the folder and the name. Note that, in addition, a popup window appears with the word Saving. This will automatically disappear when the setup is saved.

3.2 Load

The MSpeakers module also allows you to load files that were previously saved. To do this, you must press the folder icon and select the name of the file. Saved modules and connections, the value of each module, and its location on the screen will be automatically loaded.

3.3 Router IP

When this button is pressed, the *Launcher* will facilitate the IP of the computer. This will be useful to later connect the mobile devices. The IP will be shown provided that the computer is connected to a local or home router, therefore, with a 192.xxx.x.x type of address.

4. Operation of the audio modules

4.1 MSpeakers

This module corresponds to the audio output of a computer, so it will always be the **final point** in any configuration made with *Soundcool®*. Audio output can be enabled or disabled instantly, with the speaker button . The *Audio Settings* button opens a new window in which you can configure different parameters related to the computer's audio card.

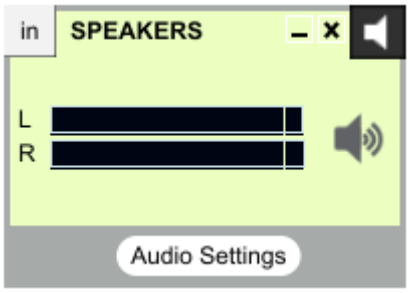


Figure 9: The *MSpeakers* module

4.2 MPlayer

This module allows you to **play** audio files. Through the *open* button, different audio file formats can be loaded: .wav, .aiff, .mp3, etc. (The files created with Windows Media, .wma, are not compatible). Once the audio file you loaded starts playing, you can pause and/or stop it by using the traditional playback control buttons, *play* , *pause* and *stop* . To the right of these buttons is a third button which toggles between play forward or go backward . In addition, a check box labeled *Loop* enables looped playback; the vertical slider on the right controls volume; and the horizontal slider, labeled *Speed*, controls the playback speed. Finally, it also has a time bar that shows the temporal progress of the track being played. If you click anywhere on this bar, playback will move to that point in time. Note that there is not an input button in this module, since it gets its input by opening an audio file, and so, there is only an output button.

Figure 10: *MPlayer* Module

The *Kinect* and *OSC Port* boxes that appear on this, as well as on most of the following modules, will be explained below.

4.3 MDelay

This module has two controls: *delay* and *feedback*. With the *Delay* slider, you can control the delay of the signal that goes to the output. The *Feedback* slider indicates the proportion of the delayed signal that will be send again to the input to produce new delays. The number boxes above each slider allow you to manually modify the value of each parameter. Among each pair of number boxes the ones on the right side allow you to modify the maximum value of the slider range. To return to slider control, simply click again anywhere on the horizontal bar.

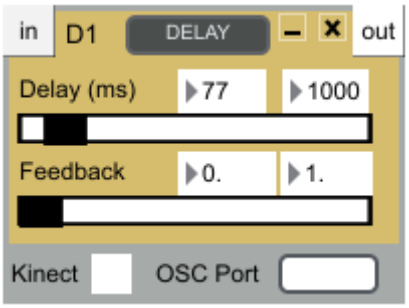


Figure 11: *MDelay* Module

4.4 MDirectInput

This module outputs the signal picked up directly from a computer's input device, such as a microphone. It also has volume control and a mute button. The default audio input of the computer can be changed in the *Audio Settings* window of the *MSpeakers* module.

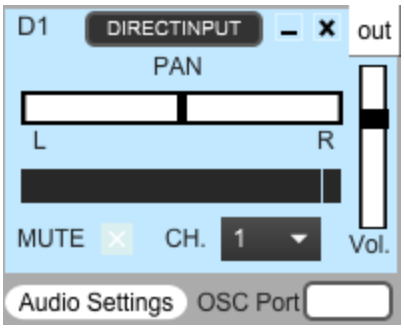


Figure 12: *MDirectInput* Module

4.5 MKeyboard

The main element of this module is the piano keyboard. The name of the notes associated with each key (with the solfeggio nomenclature) can be activated or deactivated with the "N" control. By clicking the *X* located above the keyboard, on the right side, the mode of operation can be changed:

- **Check box activated**: by pressing keys on the piano keyboard the module will send to the output information in the form of MIDI note and velocity, which can typically be sent to a *VST* module that will use a virtual instrument.
- **Check box deactivated**: this will use the computer's internal synthesizer to directly produce sound. There is no need to connect to another module. When working in this mode, you can select any MIDI instrument from the selection box located just above the keyboard. You can also select up to 16 MIDI channels from the MIDI CHANNEL dropdown menu.

To control the volume, there is a vertical slider on the right side of the module. It also has an octave control C3 at the bottom left of the module.

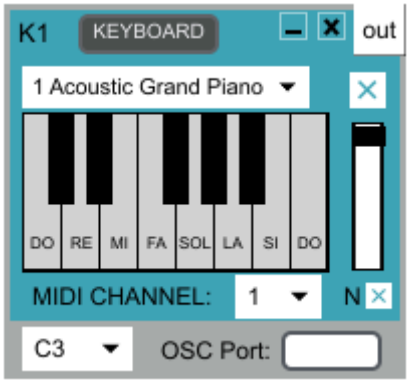


Figure 13: *MKeyboard* Module with the keyboard activated

4.6 MVST

With this module, you can use either instruments or effects, via the VST (*Virtual Studio Technology)* software interface:

- VST **effects** are used when there is audio connected to the *MVST* input.
- VST **instruments** will be used when there is a MIDI instrument connected to your computer or when *MVST* has a connection coming from the module *MKeyboard*.

To load the effects/ VST instruments, press the *Load* button and locate the effect/ VST instrument on your computer. Once loaded, the *Open* button gives you access to its own graphical interface where make the desired changes. Under these buttons, there is a selection button *Module Input/ MIDI Input.*

- Select *Module Input* when working with a **module connected to the *MVST* input**. The input might be audio, or MIDI coming from the *MKeyboard* module.
- Select *MIDI Input* when working with a **MIDI instrument connected** to the computer. If you have multiple MIDI instrument connections, you can select which one you want to work with by using the selection box at the bottom of the module. The *refresh* button will renew the list of connected instruments. If it appears that the MIDI instrument is not detected correctly, restart *Soundcool®* after reconnecting the instrument.

With the MIDI Channel drop-down menu you can select one among 16 channels useful when the VST you have loaded is compatible with MIDI. Select the *Bypass* checkbox when an audio signal is connected to the *VST* Host module input but you want the audio to pass directly to the output, without applying the *VST* effect.

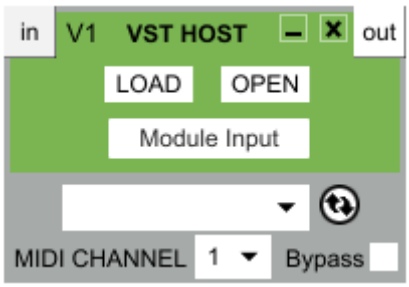


Figure 14: *MVST* Module

4.7 MMixer

This module has eight audio inputs. Each has an individual volume control, and the sum of all the signals goes to the output. The output also has a volume control. This module enables you to send more than one audio signal to the audio output of our computer (*MSpeakers* module).

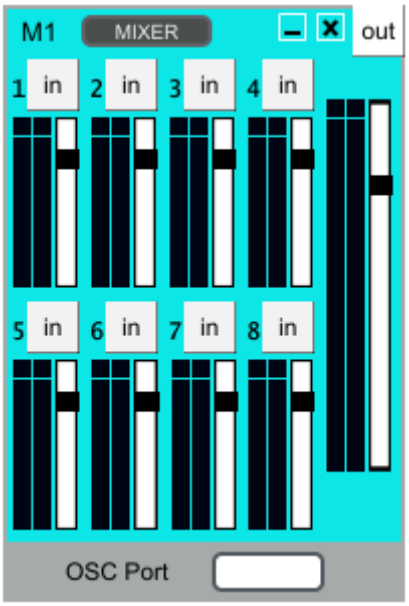


Figure 15: *MMixer* Module

4.8 MPan

This module has a horizontal slider to control the left/right audio panning. If the slider control is on the left extreme, the audio will be entirely on the left channel with nothing on the right channel. As the slider moves to the right, the audio will move to the right channel until it is entirely on that side and the left channel disappears. Therefore, you are controlling the ratio between what is on the left and right channels.

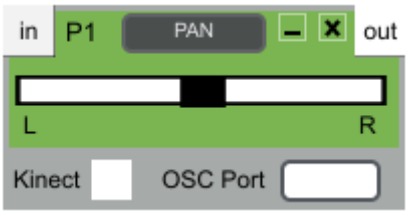


Figure 16: *MPan* Module

4.9 MPitch

This module allows you to change the pitch of incoming audio. To do this, there is a horizontal slider that changes the pitch, ranging from - 400 cents (- 2 whole tones) to + 400 cents (+ 2 whole tones). If the input of this module is connected to one *MPlayer* module, pitch control comes exclusively from *MPitch*, so that when the playback speed is changed in *MPlayer,* **the tuning is not modified**.

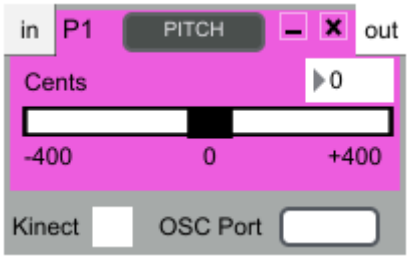


Figure 17: *MPitch* Module

4.10 MRecord

This module allows you to record audio from its input, or audio that comes directly from your computer's input device, such as a microphone or other device. Typically, we are interested in recording the output of an *MMixer* module, where all the elements of our *Soundcool®* circuit merge. To do this, there is a button at the bottom (*Module Input / Input Device*) to choose what you want to record, that can be either the module's input ***in*** or the computer's input devices (microphone...).

After pressing the New File button ⊕, a dialog box opens, where you can choose the file name and recording format (.wav or .aiff). Then you can start the recording by pressing the button record ●. The stop button ■ can be pressed to stop the recording.

You can stop the recording after an exact time frame with the *Max Time* option. To do this, there is a timer which you can drag up or down in order to introduce the exact time frame (hh:mm:ss format). Then you have to press the New File and Rec buttons and after that time the recording will stop.

The module provides a horizontal slider to control the final volume of the recorded file, and also a time indicator at the bottom of the module (*Module Input / Input Device*) to choose what you want to record.

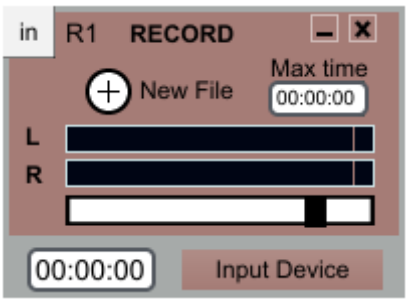
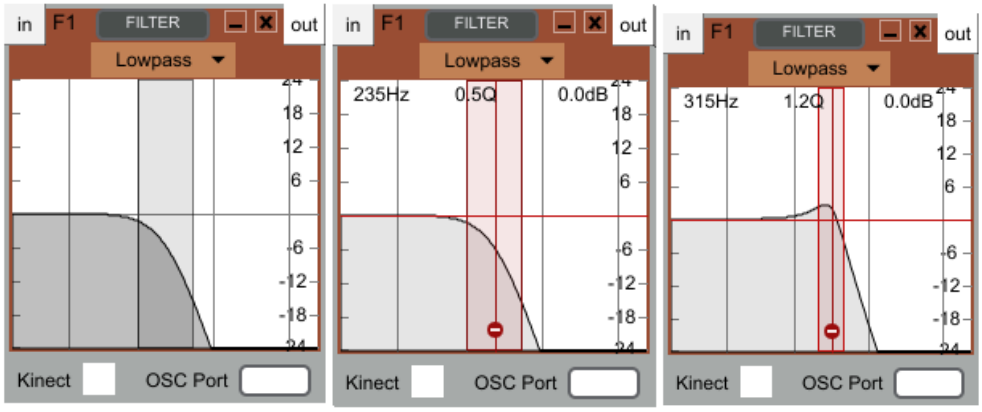


Figure 18: *MRecord* Module

4.11 MFilter

This module allows you to filter its input in different ways. In the dropdown menu, which defaults to *Display*, you can change the type of filter you want to use.



1) Nothing is selected. 2) Manipulating the cutoff frequency. 3) Manipulating the Q parameter.
Figure 19: *MFilter* Module, using the Low Pass Filter

The available filters are as follows:

- ***Lowpass***: This is a **Low Pass Filter**: it lets low frequencies pass through and reduces those that are above the cutoff frequency. In the filter graph a vertical zone appears, which can slide sideways, allowing you to control the cutoff frequency and the quality factor or Q, which adjusts the filter slope. To change the cutoff frequency you can click inside that zone (see Figure 19.2). Note that to change the Q factor while on the computer, you need to place the cursor on one of the vertical lines at the two ends of that zone (see Figure 19.3).
- ***Highpass***: This is a **High Pass Filter**: it passes high frequencies through and reduces those below the cutoff frequency. To modify the filter's parameters, follow the same steps as for the *Lowpass* filter.
- ***Bandpass:*** This is a **Bandpass Filter**: it only lets those frequencies near the cutoff frequency pass through and reduces other frequencies. Parameter modification is the same as for the *Lowpass* Filter.
- ***Bandstop***: This is a **Band Rejection Filter**: it reduces those frequencies around the cutoff frequency. By modifying the Q factor (see *Lowpass* filter), the width of the frequency spectrum to be canceled can be widened or narrowed.
- ***Peaknotch:*** This is a filter that allows you to reduce or amplify the gain on a certain frequency. This filter is at the top of the dropdown menu. Besides the previously described horizontal movements (see Lowpass filter) it also allows you to control the gain by means of vertical movements.
- ***Lowshelf:*** This filter allows you to modify the gain for all the frequency spectrum that are to the left of the cutoff frequency–lower frequencies. Vertical movements allow you to control the gain.
- ***Highshelf:*** This filter allows you to modify the gain for all the frequency spectrum that are on the right side of the cutoff frequency–higher frequencies. Vertical movements allow you to control the gain.
- ***Resonant:*** This is a special type of bandpass filter. The difference between the two lies in what happens when the Q parameter is modified: increasing or decreasing the Q in *Resonant* entails an increase or decrease of the gain at the cutoff frequency–see *Lowpass* filter to learn how to modify the Q.

- ***Allpass:*** This filter does not reduce any frequency. It is the default filter configuration. Notice that modification of the parameters does not produce any effect on this filter.
- ***Display:*** This option will lock the filter, so it cannot be manipulated.

The following table shows the maximum and minimum values for each configurable parameter:

Parameter	Minimum	Maximum
Cutoff Frequency *Hz*	0*	22050
Gain *dB*	0	16
Q Factor	0.5	25

*Despite showing a zero on the graph, for mathematical reasons, that value will never be reached.

4.12 MRouting

This module has two audio inputs and two audio outputs. Each of the two inputs (*Input 1* and *Input 2*) can be routed to either *Output1*, or *Output 2,* or can be left unconnected, in the *Off* position. Each of the two outputs is associated with a bar that shows the volume of whatever is connected at that moment to the output in question.

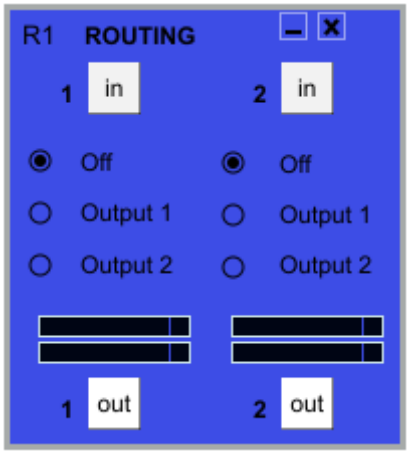


Figure 20: *MRouting* Module

4.13 MSamplePlayer

This module is designed to playback the different sounds that can be loaded in the 10 available positions. To load an audio track it is necessary to press the arrow located under the *Stop* button for each position. Once you finish loading the files, you can start playing back any combination of sounds. The *Play* button of each loaded file does not pause the ongoing playback but instead adds to it.

Next to the Play is the stop button to stop the playback at the time you wanted. Additionally, there is a vertical slider to control the volume and a horizontal slide to control the playback speed. Notice that the x0 speed position is equal to *Pause*.We can choose to play backwards or forwards using the button to the right of the horizontal slider. Finally, this module also allows you to choose random playback, by checking the RANDOM box on the top-left corner, and play it in a loop, by checking the LOOP box.

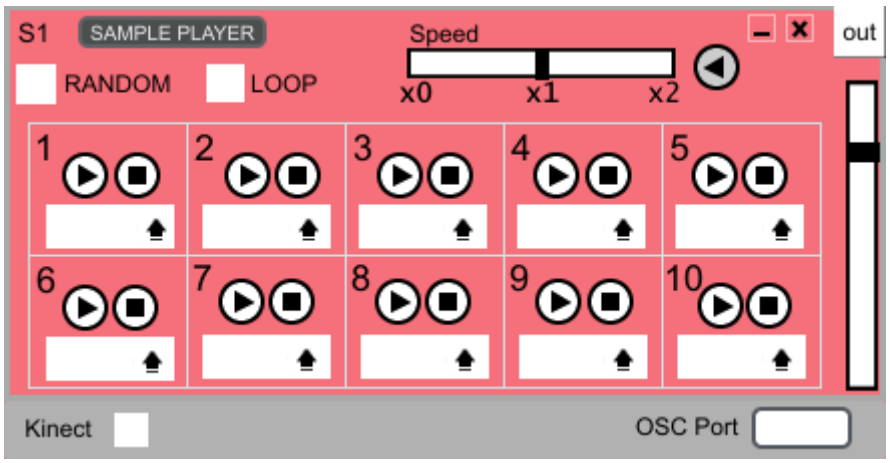


Figure 21: *MSamplePlayer* Module

4.14 MScope

This is a module that emulates an oscilloscope; which is a device that displays the variations of the audio signals over time. Since it is a display device, it only has the option of connecting just one input, which is the sound source for its functioning. Additionally, the size of the module can be enlarged with the *Enlarge* button which can be found on the bottom-right corner. The oscilloscope begins to work when the module or combination of modules connected to it (as one input) are working.

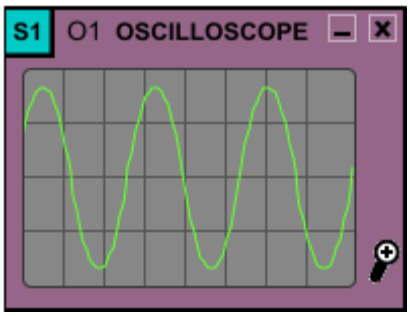


Figure 22: *MScope* Module displaying a 4 Hz pure tone

4.15 MSpectroscope

This is a module that works like a spectroscope or spectrometer. This device displays the frequency spectrum by analyzing and separating the audio input into different frequencies. The size of the module can be enlarged with the *Enlarge* button which can be found on the bottom-right corner. The spectroscope begins to work when the module or combination of modules connected to it (as one input) are working.

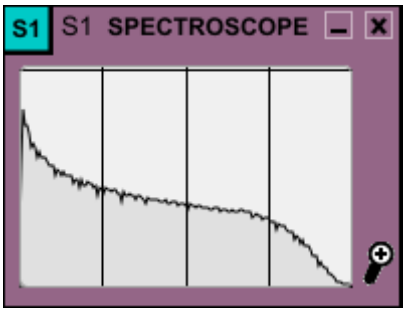


Figure 23: *MSpectroscope* Module displaying a 200 Hz saw-tooth signal

4.16 MSignalGen

This module generates sound signals. Their frequency can be adjusted with the horizontal slider *Frequency (Hz).* The frequency value can be also entered numerically by using the box that is to the right of the words "Frequency (Hz)", either by using the keyboard or by clicking on the box with the left mouse button and then scrolling the mouse up or down. The latter option allows for the frequency to be changed faster than with the slider.

The dropdown menu which is initially in the *Silence* position, allows you to select the type of signal:

- ***Silence:*** the signal generator is off.
- ***Sine wave:*** sinusoidal waveform.
- ***Triangle:*** triangular waveform.
- ***Square:*** square waveform.
- ***Sawtooth:*** sawtooth waveform.
- ***White noise:*** one type of colored noise.
- ***Pink noise:*** another type of colored noise.

There is also a dropdown menu to choose the type of modulation, which is located to the right of the abovementioned dropdown menu for selecting the type of signal. You can choose between *No Mod (*without modulation), *RM, FM* and *AM.* Each modulation is explained in more detail as follows:

- ***No Mod:*** The module output will be the signal generated with the abovementioned menu for selecting the type of signal. Regardless of the module or combination of modules that are connected to the input *in*, no modulation is applied. The output is just the signal generated by *MSignalGen*.

$$\boldsymbol{Signal\ out = Signal\ generated\ with\ MSignalGen}$$

- ***RM:*** Ring Modulation, which is based on the multiplication of two signals.

$$\boldsymbol{Signal\ out = Signal\ in \times signal\ generated\ with\ MSignalGen}$$

- ***AM:*** *Amplitude Modulation.* It consists in multiplying the input signal of the module by the *MI* factor (*Modulation Index)*, adding the constant 1 and all that will multiply the signal generated by *MSignalGen.*

$$\boldsymbol{Signal\ out} = [\mathbf{1} + \boldsymbol{MI} \times \boldsymbol{Signal\ in}] \times \boldsymbol{signal\ generated\ with\ MSignalGen}$$

- ***FM:*** Frequency Modulation. In the FM technique, the input signal connected to the module *"in"* is multiplied by the *FD* parameter (which in turn is related to the frequency deviation of the FM technique). This controls the frequency of the signal generated by the module. When *FM* modulation is selected, the value of *FD* is controlled with the horizontal slider or the corresponding number box.

$$\begin{gathered}\boldsymbol{Signal\ out} = \boldsymbol{Signal\ generated\ with\ MSignalGen} \\ \boldsymbol{whose\ output\ Frequency} = \\ \boldsymbol{FD} \times \boldsymbol{Signal\ in} \pm \boldsymbol{Frequency\ signal\ MsignalGen}\end{gathered}$$

FM Chowning: When **FM** is selected, the *MSignalGen* module will show two additional number boxes that allow you to use the methodology developed by John Chowning. Such parameters are *modulation index* ***I*** and *harmonic rate* ***HR.*** The two number boxes will function both as a display (their values change when other dependent parameters are changed) and as a control (their values can be adjusted).

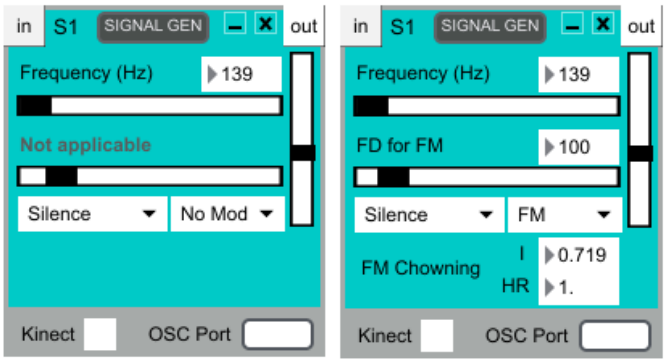


Figure 24: *MSignalGen* Module (left) and *MSignalGen* Module with FM modulation selected (right)

When **AM** modulation is selected, the modulation index value can be controlled with the horizontal slider or the *MI* number box. Notice that the *FD for FM* and *MI for AM* are only available when *FM* and *AM* modulations are selected respectively from the menu. For any other case the slider will show *Not applicable,* and its movement will not affect the output of the module.

Finally, there is a vertical slider for controlling the volume.

4.17 MSequencer

This module has the same purpose as a classic sequencer that controls a function generator. In *Soundcool®*, the function generator is the *MSignalGen* module. Thus, the first thing to do is to select the ID number of the module that you want to control.

Selection of an MSignalGen module

The *MSequencer* module has a number box which selects the *MSignalGen* you want to control. Enter its ID number here. Then, *MSequencer* will send an automated sequence to it.

Figure 25: Selection of the *MSignalGen Module that you want to control*

4.18 Parameters for each of the eight boxes

To produce a sequence, you can use up to 8 independent boxes, whose parameters are described below. The order chosen for the description below is optimal to understand its functioning.

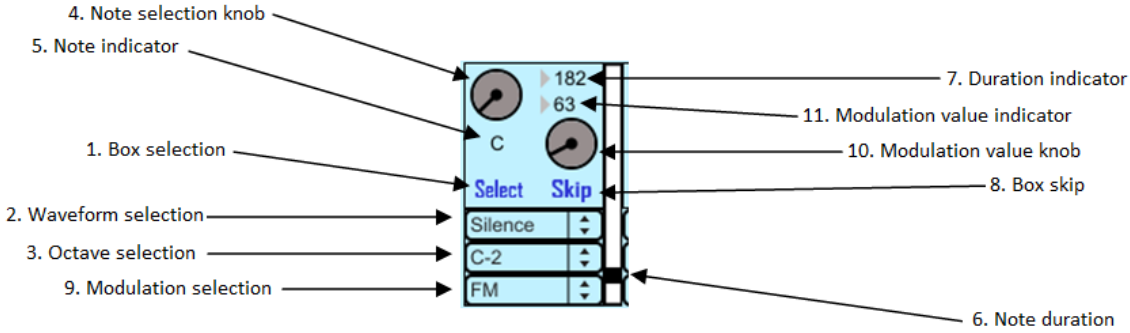


Figure 26: Parameters for each of the *MSequencer* Module boxes.

1. **Box selection:** To activate any box it is necessary to click the Select switch. A box that does not have this switch activated will not produce any effect on the *MSignalGen* module.
2. **Waveform selection:** As in the explanation given for the *MSignalGen* module, it is necessary to select the type of waveform that you want to produce in the generator.
3. **Octave selection:** Before deciding which note you want to produce in *MSignalGen*, it is necessary to choose an octave where the note selection knob (see below) can operate.
4. **Note selection knob:** Once the octave has been selected, the note selection knob can be used to choose the desired note. The note selection knob has 24 positions, which are the number of quartertones in an octave.
5. **Note indicator:** This is a display message that shows the symbol of the note that has been selected with the above knob (in the Anglo-Saxon music notation system). This message cannot be directly manipulated by the user. The quartertones between a natural note and a sharp note will be represented by a dot “.”. Thus, the note symbols that a knob can show are the following:

C · C# · D · D# · E · F · F# · G · G# · A · A# · B ·

6. **Note duration:** Each of the eight boxes has a vertical slider that modifies the note duration for that particular box.
7. **Duration indicator:** Here, the final value selected with the above slider is displayed. Additionally, this indicator can be modified manually to reach the desired value.
8. **Box skip:** As in the classic sequencers, the Skip switch allows you to skip that particular box, resulting in a silence whose duration is equal to its chosen note-duration value. Notice that the *Skip* function is not equivalent to the Select switch being off. In order for the *Skip* switch to work, the *Select* switch must be activated.
9. **Modulation selection:** As in the *MSignalGen* module, the modulation will only be applied if another *MSignalGen* module is connected to the first *MSignalGen*. In this context, we could choose between *RM, AM* and *FM.*
10. **Modulation value knob:** In the same way that the *MSignalGen* module has a horizontal slider to control the value of the modulation, this value is controlled here with a knob.
11. **Modulation value indicator:** Under the duration indicator (7), there is a similar indicator for the value of the modulation. This indicator appears only when *FM* or *AM* are selected, which are the modulation types that allow the use of the above knob (10).

Launching the sequence

Once you have selected the *MSignalGen* module that you want to control, and all the desired parameters of the boxes have been configured, you can launch the sequence whenever you wish, using the buttons shown and described below (left to right):

Figure 27: Buttons to launch the sequence of the *MSequencer* Module

- **Direct launch**: The order of the sequence is as follows: the first of the eight boxes to be launched will be the one at the top-left corner, while the last box will be the one at the bottom-right corner. If not all eight boxes are used, the sequence can only be launched by using this button.
- **Inverse launch**: The order of the sequence is the reverse of direct launch: the first box will be the one at the bottom-right corner and the last box will be the one at the top-left corner. This type of launch is only possible if all eight boxes are activated and configured.
- **Direct/inverse launch** : This type of launch concatenates a direct launch, followed by a inverse launch. This type of launch is only possible if all eight boxes are activated and configured.
- **Loop selection** : This is not a standalone launch. It is a switch that makes the sequence repeat indefinitely. Notice that when it is active, you can press as many subsequent launches as you like; all of them will be heard simultaneously.

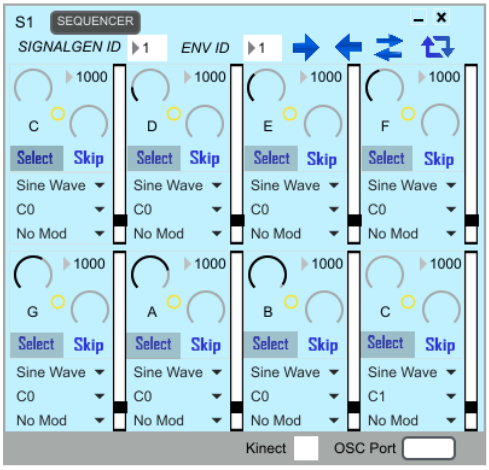


Figure 28: *MSequencer* Module

4.19 MTransposer

This module allows you to raise or lower the pitch of the audio that is connected to its input. The functioning is as follows: the *flat* ♭ and *sharp* ♯ buttons allow you to decrease or increase the pitch one semitone, respectively. Notice that the *Cents* box will change in steps of 100 cents (exactly the number of cents that a semitone has). Thus, those buttons represent a coarse tuning. For fine tuning, a horizontal slider is available that allows you to make changes with step sizes as little as one cent. We can combine both controllers to achieve the desired pitch. Notice that the *Cents* box is display-only and cannot be directly manipulated. Finally, to return to the original pitch we can click on the *Natural* button ♮.

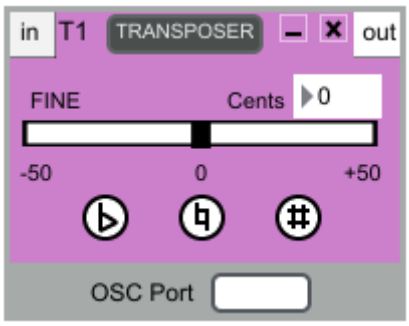


Figure 29: *MTransposer* Module

4.20 MEnvelope

This module allows you to create an amplitude envelope. To that end, a series of points can be created by clicking with the mouse. These points will be connected by a black-color line. This line will control the volume of the audio signal. The duration of the envelope can be established with the *Dur* number box. Additionally, there is a *Loop* switch causing an endless repetition of the envelope. To activate the envelope it is necessary to click the button to the right of the *Dur* number box.

To illustrate all this, suppose that you want to increase the volume gradually, up to an end value. Then, you simply need to create two points, as in the following figure:

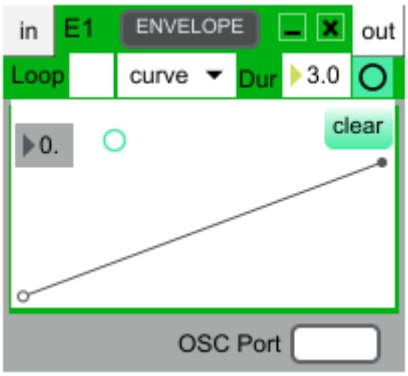


Figure 30: Example of a linear envelope

Notice that the white-color background is like a plane with X-Y coordinates, where the horizontal coordinate X represents the time (within the duration established above) and the vertical coordinate Y represents the amplitude of the audio signal. Additionally, if an existing point is dragged to the bottom edge (the zero value of the Y axis), it will change from solid color to hollow and will represent the volume 0 or mute.

The user is free to design any type of envelope. Additionally, any point can be deleted by using the combination "Shift + Click". The *Clear* button will delete all the points at once.

Finally, this module allows you to use two types of envelope:

- ***Curve:*** Besides allowing you the freedom to create points, it also allows you to modify the curvature of the line that joins those points. The curvature of each line segment can be modified with the number box on the top-left corner of the panel. You have to enter the value of the curvature (the allowed values are between -1 and 1) and press *Enter* on your computer keyboard. To change the line segment that you want to modify, you have to press the button next to the number box. You will identify the line segment that is ready to be modified because it automatically changes its curvature at the moment of being selected. The following figure shows a number of curves with positive and negative values:

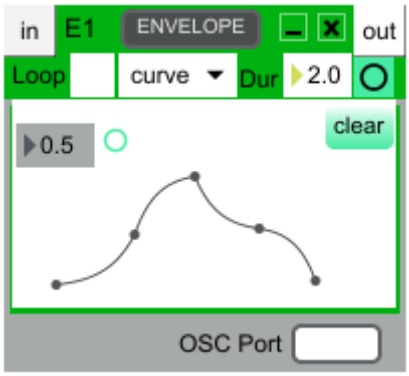


Figure 31: Example of curved envelope

- ***Line:*** This mode only allows you to create points but not to modify the curvature of the line, which will remain straight.

5. Operation of the video modules

5.1 MScreenV

This module is analogous to the Speakers module, it is the end of the video chain and the one in charge of reproducing the final video in full screen for its projection. We recommend using HD videos, with an aspect ratio of 16: 9, for a proportionate reproduction.

The white button on the bottom allows you to watch the video in full screen. You can leave this mode by pressing ESC on your keyboard.

For its correct projection on Windows computers we have to go to Control Panel > Appearance and personalization > Screen > Screen Resolution, and change the second screen to be on the left of the main screen.

For its correct projection on Mac computers we have to go to System Preferences > Displays > Arrangement, and change the second screen to be on the left of the main screen.

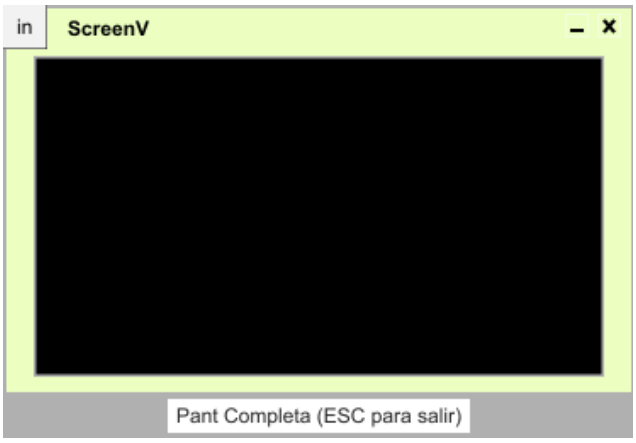


Figure 32: MScreenV Module

5.2 MSwitcherV

This module allows you to select one output video from among eight input videos. Once all the videos that we want are connected to the module, we can select one of them by clicking on the corresponding screen. When doing so, the preview of the video chosen for the output will appear in the lower screen.

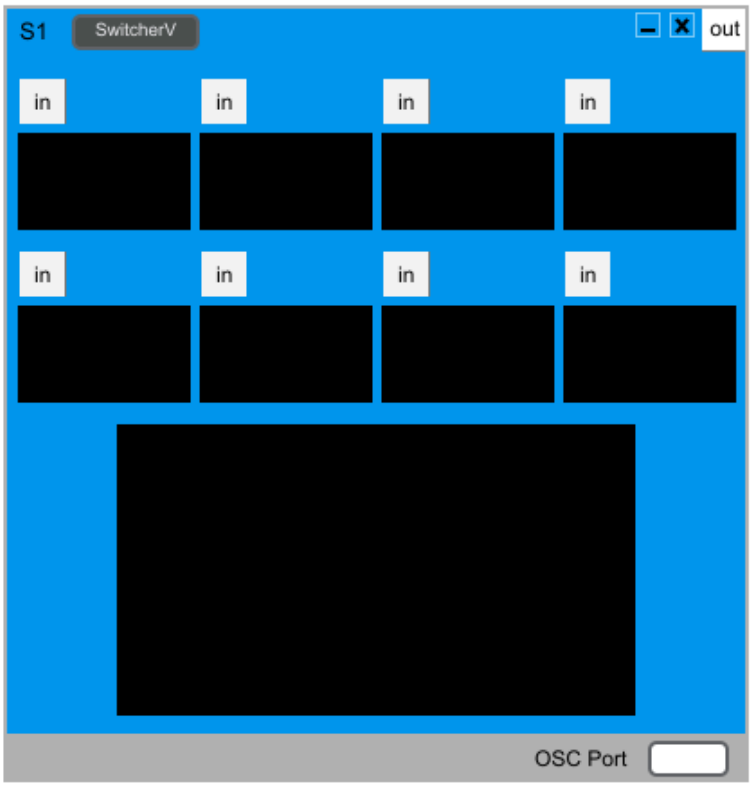


Figure 33: MSwitcherV Module

5.3 MDirectInputV

This module allows you to stream any video source that is connected to the computer, e.g., a WebCam. The checkbox on the bottom-left corner activates or deactivates this streaming. When the streaming begins, the blue dropdown on the bottom-right side allows you to choose the desired video format. Additionally, the blue dropdown on the bottom-left side allows you to choose the desired video input. The white button on the bottom-right side opens up the computer's own menu, where you can configure any video parameters that the device allows you to.

Figure 34: *MDirectInputV* Module

5.4 MPlayerV

As with the audio player (*MPlayer*) this module allows you to load any video file stored on your computer. The *Open* button allows you to select the desired file. Next to this button, there is a dropdown displaying the history of files used, allowing you quick access to them. The player has these controls: a *Play* /*Pause* toggle, *Forward* or *Backward* and the ability to select the following video sequences:

- : The video will be repeated indefinitely.
- : The video is played forwards and then backwards, endlessly.
- : The video is played only once.

Figure 35: *MPlayerV* Module

5.5 MSamplerV

This module allows you to play one video from a specific point within the FRAME mode and also to play a region of the video in loop mode within the LOOP mode.

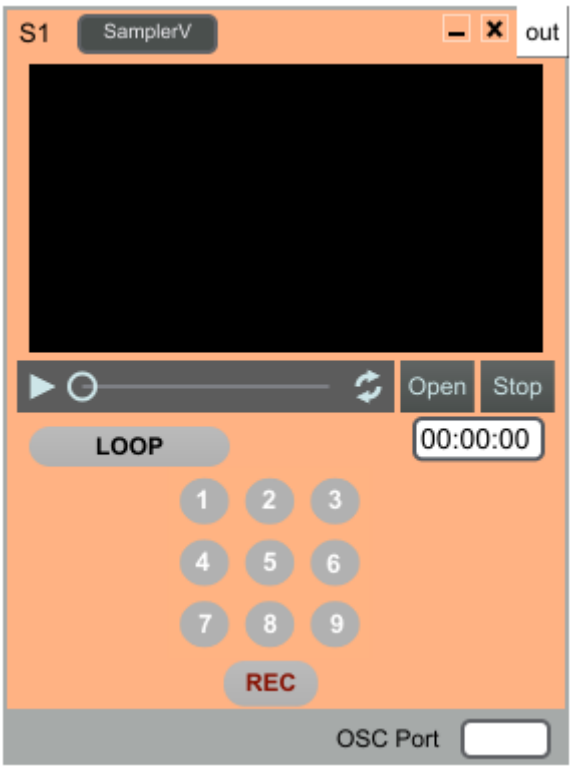


Figure 36: MSamplerV Module

FRAME MODE

In this mode the options we have will be to record specific positions of the video in REC mode and to play the video from these moments recorded in the PLAY mode. This module allows you to load any video file saved on your computer. The Open button allows you to select the desired video file.

The player has these controls: a *Play* /*Pause* toggle, and the ability to select the following video sequences:

- : The video, or video region will be repeated indefinitely.
- : The video, or video region is played forwards and then backwards, endlessly.
- : The video, or video region is played only once.

First we must save within the REC mode. Press one of the 9 buttons just at the point of the timeline you want to memorize. When doing so, the corresponding button will change to red to indicate that this memory position is saved.

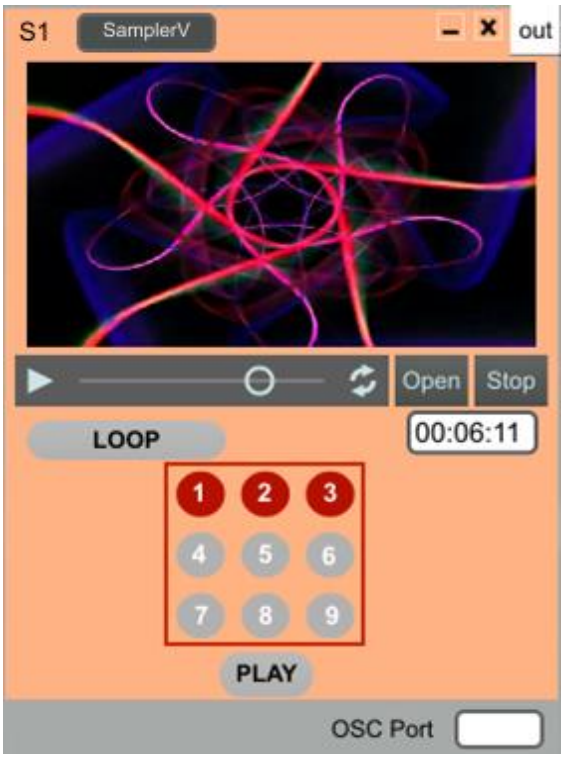


Figure 37: FRAME-REC mode

Then we will play the video from these saved moments within the PLAY mode. In this mode you can see which buttons have information saved by having their corresponding numbers in red. The last button pressed will be highlighted in orange.

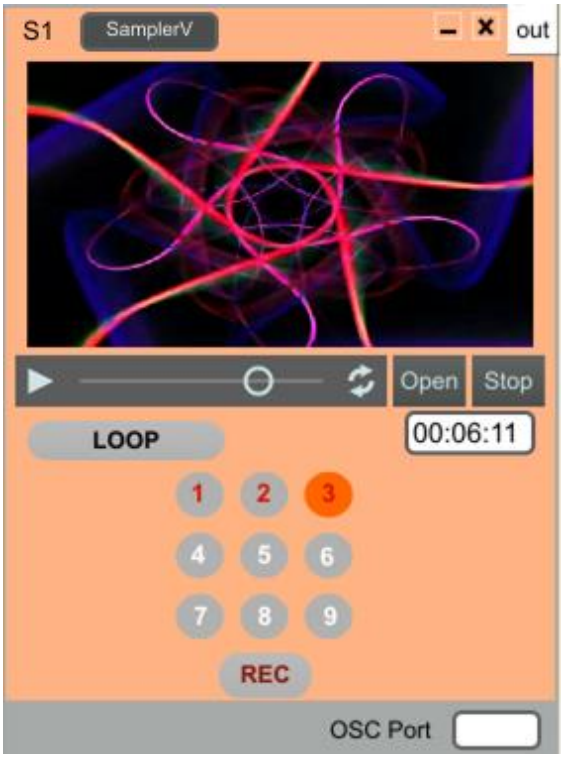


Figure 38: FRAME-PLAY mode

LOOP MODE

This mode allows you to record specific regions of the video within REC mode and to play the corresponding loop from these saved regions within the PLAY mode.

First we must save within the REC mode. Simply select a region of the dark gray bar corresponding to the video with the mouse and press one of the 4 buttons. When doing so, the corresponding button will change to red to indicate that this memory position is saved.

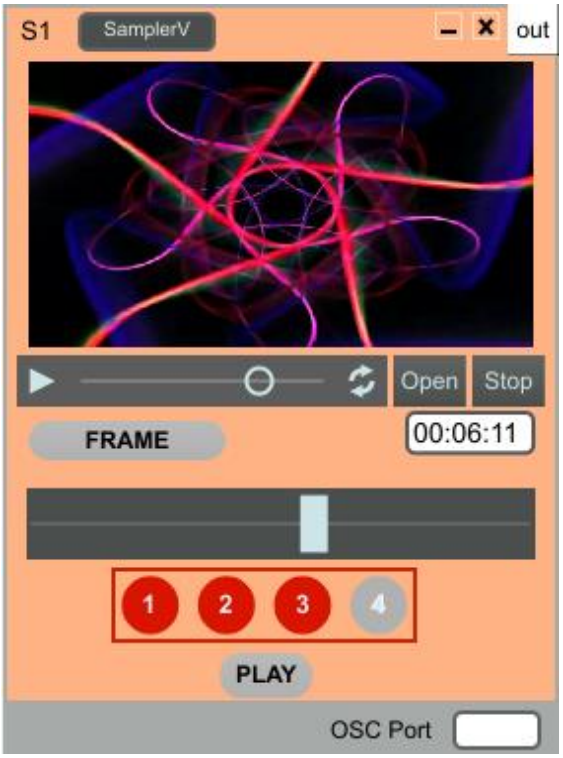


Figure 39: LOOP-REC mode

Then we will be able to play these regions of the video within the PLAY mode. In this mode you can see which buttons have information saved by having their corresponding numbers in red. The last button pressed will be highlighted in orange.

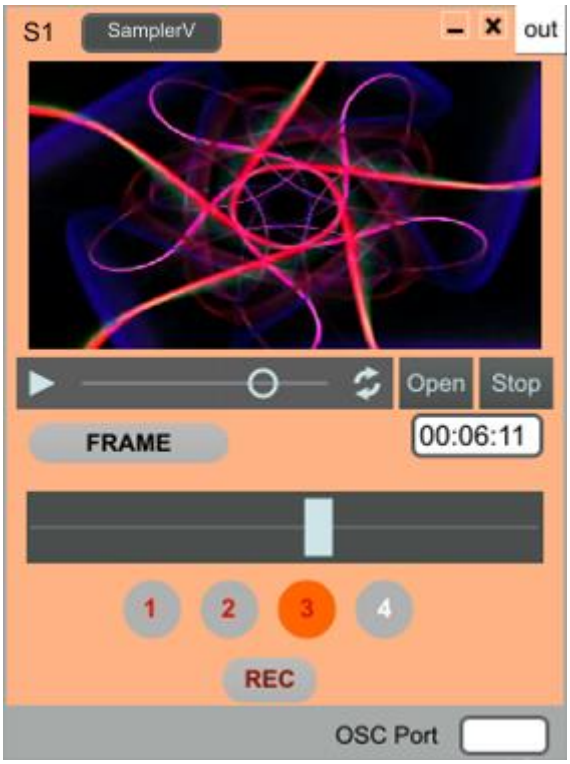


Figure 40: LOOP-PLAY mode

5.6 MColorV

This module allows you to change image properties such as brightness, saturation, contrast and hue. These four parameters can be controlled both by the mobile app and the Kinect. The right hand will be in charge of controlling these four parameters when moving it horizontally. Additionally, this module also has a button to reset the values, that is, to have the same properties as the original image.

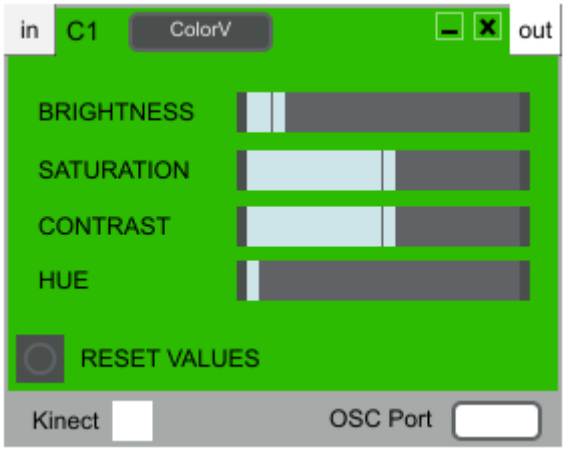


Figure 41: MColorV module

5.7 MImageSamplerV

This module is similar to a sampler, since it can "touch" some fixed images anchored to certain keys of the piano. Each key corresponds to an image which can be selected and loaded by pressing the "LOAD" button associated with each of the 13 keys. The module has a "slider" to control the fade-to-black that exists when changing from one image to another. The greater the value of the "slider", the greater the duration of the fade. There

is another control called "Rand" that allows the automatic reproduction of the loaded images. The "slider" that it has associated controls the speed of change between the images. The name of the notes associated with each key (with the solfeggio nomenclature) can be activated or deactivated with the "N" control.
This keyboard acts in conjunction with the MKeyboard sound keyboard if we assign the same port to both. The controls that are activated simultaneously are the keys, the vertical "slider" on the right and the "N" control mentioned above. With this, users can experience synchronization effects between music and image.

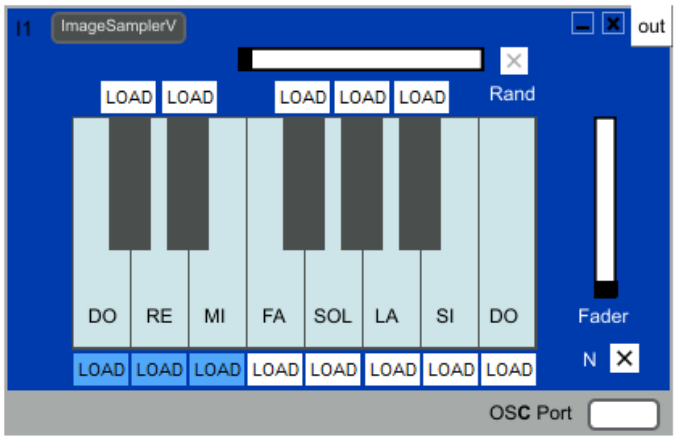


Figure 42: MImageSamplerV module

5.8 MBlendingV

This module adds effects to the input images or videos. There can be either one or two input images or videos. There are 20 operators to apply effects to the inputs. When there is only one image or video, which must be on the first input, the selected operator is applied between the image and a value determined by the "slider" of the module. The higher the value of the "slider" the greater the effect applied. When there are two input images or videos the "slider" disappears as it has no effect and the operator is applied between the two inputs.

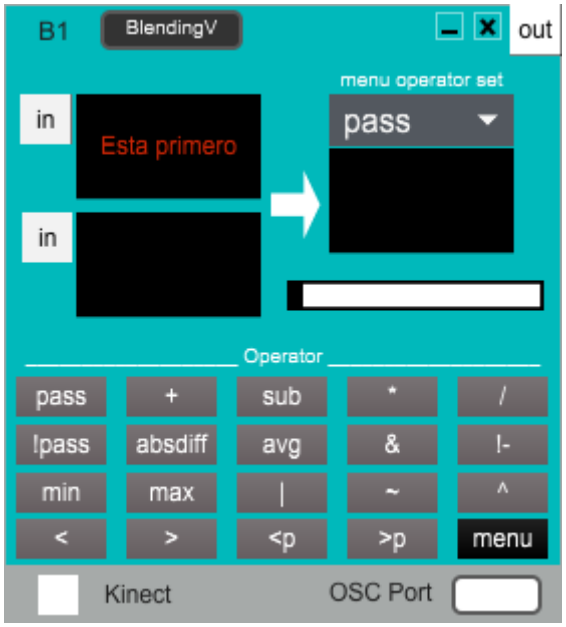


Figure 43: MBlendingV module

6. Controlling Soundcool® from Smartphones and Tablets

Most *Soundcool®* modules can be controlled from a mobile device (Tablet or Smartphone). To do that, it is necessary to:

- **Connect** the device to the same WiFi network as the computer on which the modules are open.
- **Install** our free apps on the mobile device (available both in the *Apple Store* and *Google Play).*

This app has been developed in Unity and is available for Android and iOS devices. Each student can use one interface to control the Soundcool® modules that run on the computers, for the synthesis and processing of sound, music, image and video.

The app includes a number of control surfaces. Each control surface is a screen of the app, which has different controllers (sliders, buttons, toggles,…). All these controllers incorporate the Open Sound Control protocol (OSC) to send their control values remotely through WiFi from the mobile device to the computer where the Soundcool® modules are running. These Soundcool® modules are controlled from the mobile devices using a few control surfaces, being the first one a generic surface that can be used to control more than one module.

The first opening screen shows the Soundcool® logos. Additionally, it shows the app credits. It also shows the OSC settings and connection options. After connecting the device we have to select to open the control surfaces either for Audio or for Video.

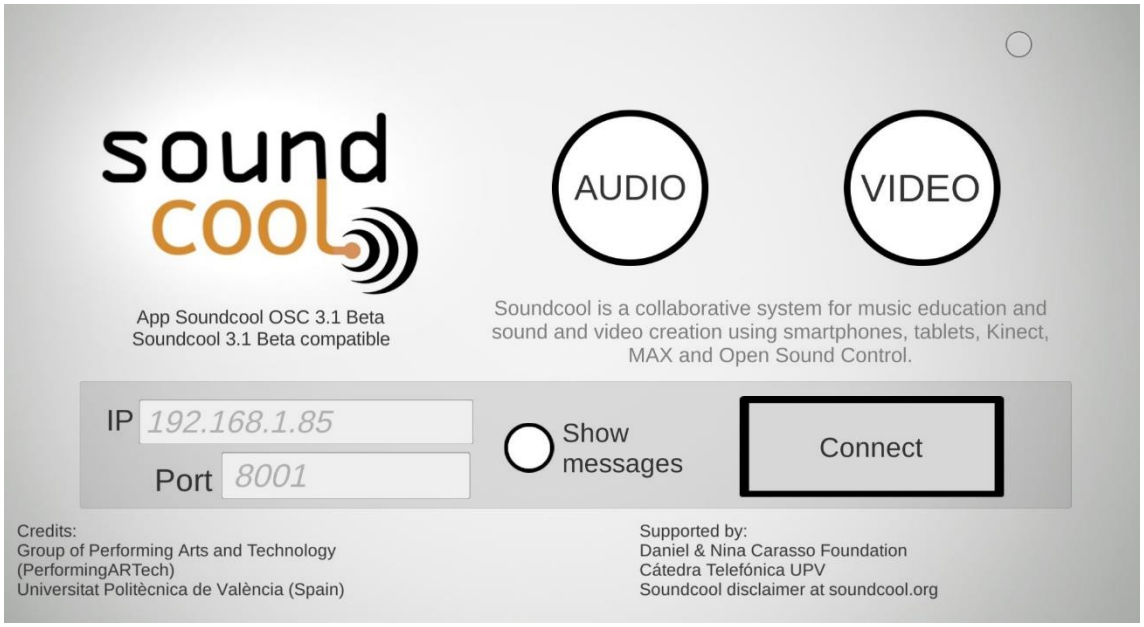


Figure 44: Opening screen

In the following lines the Audio control surfaces are described.

Player / Effect: This control surface has two horizontal sliders, one vertical and several generic buttons. This control surface is used with different modules such as the Player, and some effects such as echo, transposition, panoramic, pitch, etc.

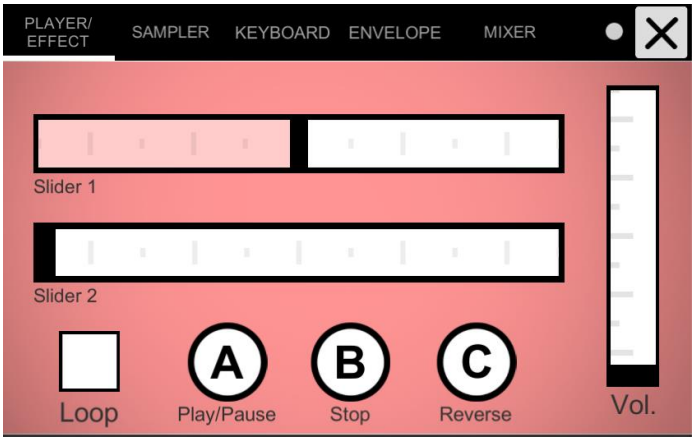


Figure 45: Player / Effect Control Surface

Sampler: This control surface has 10 buttons that control the Sample Player module. Each of these 10 buttons, have the option to play and pause ⏯ any combination of sounds and in the lower right part of each button, there is the option to stop ⏹. Additionally, that module allows for playing back in a handy manner the different sounds that can be loaded in the 10 available positions. It also has additional sliders a toggles.

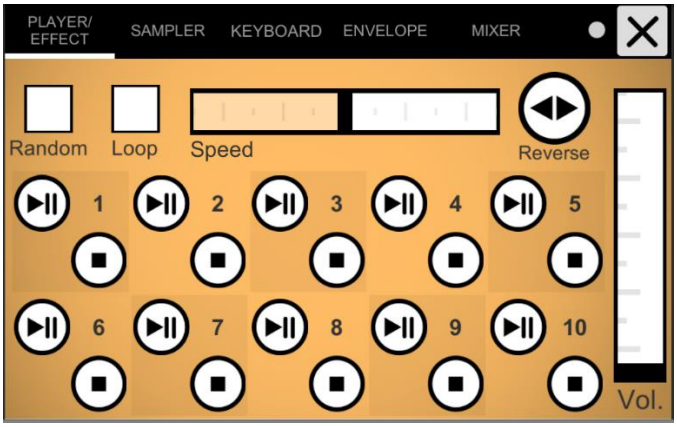


Figure 46: Sampler Control Surface

Keyboard: This control surface includes a piano keyboard with additional sliders and buttons. It controls the piano module that runs on the computer, which can generate MIDI sounds itself or that can be used to control other VST instruments (https://es.wikipedia.org/wiki/Virtual_Studio_Technology).

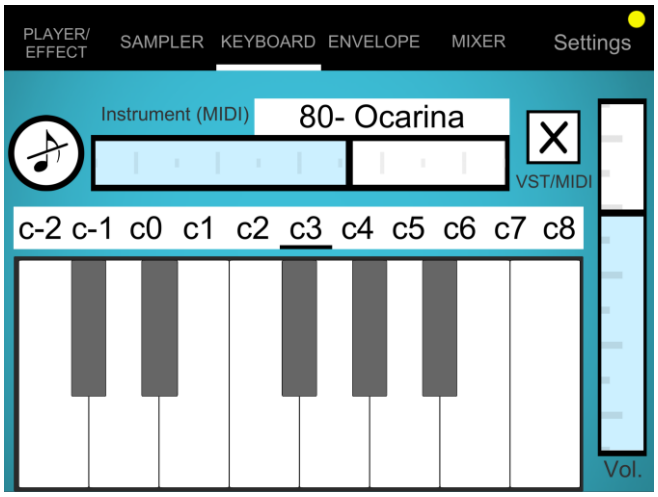


Figure 47: Keyboard Control Surface

Envelope: This control surface implements a multislider that is a group of 20 sliders which can control each of the 20 edit points of the Envelope module that runs on the computer.

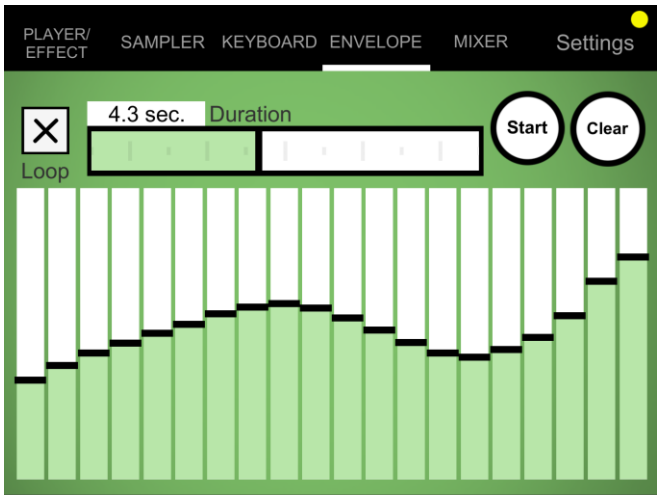


Figure 48: Envelope Control Surface

Mixer: This control surface has 8 vertical sliders and allows for controlling the sound Mixer module. Each slider corresponds to an input sound stream or track. There is also one “slider” to control the volume of the output mix.

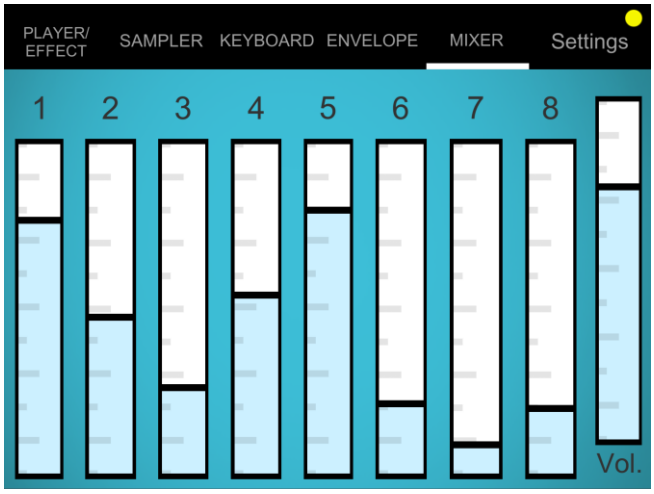


Figure 49: Mixer Control Surface

In the following lines the Video control surfaces are described.

Sampler: This control surface has 2 panels, LOOP and FRAME. The FRAME panel has 9 buttons, on the other hand, the LOOP panel has 4 buttons. The navigation between LOOP and FRAME is made using a toggle. This control surface is used to control the SamplerV module whose functionalities have been described above.

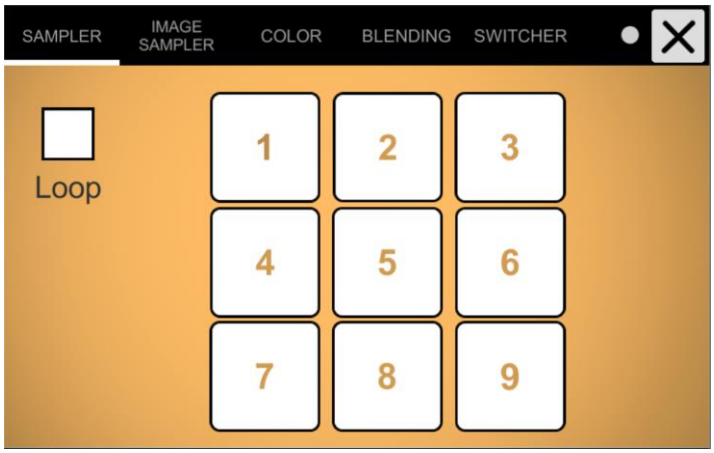


Figure 50: Sampler Control Surface in FRAME mode

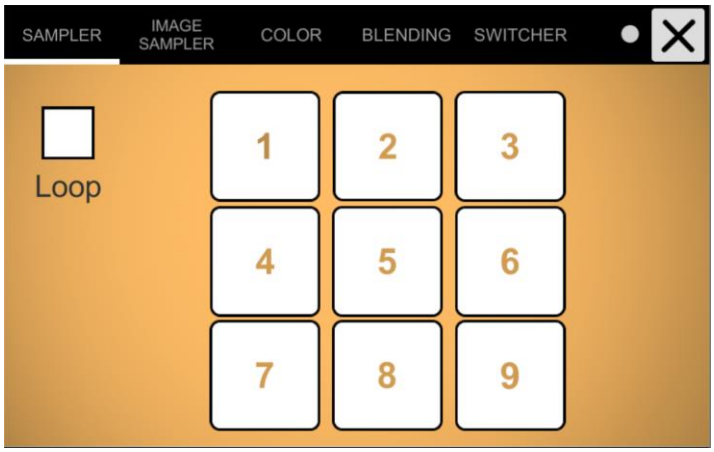


Figure 51: Sampler Control Surface in LOOP mode

ImageSampler: This control surface has a piano keyboard appearance, with 2 toggles and 2 additional sliders. This control surface is used to “play” with the images loaded on the keys of the keyboard. With the sliders we can control the fading to black and transition time between images.

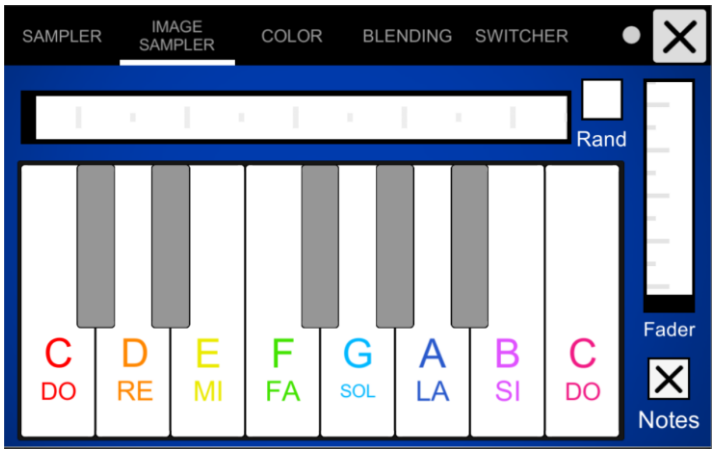


Figure 52: ImageSampler Control Surface

Color: This control surface has 4 horizontal sliders and one button to reset sliders values. This control surface is used to control image values like brightness, saturation, contrast and hue.

Figure 53: Color Control Surface

Blending: This control surface has one horizontal slider and 20 buttons. This control surface is used to apply real-time effects between images and/or video clips.

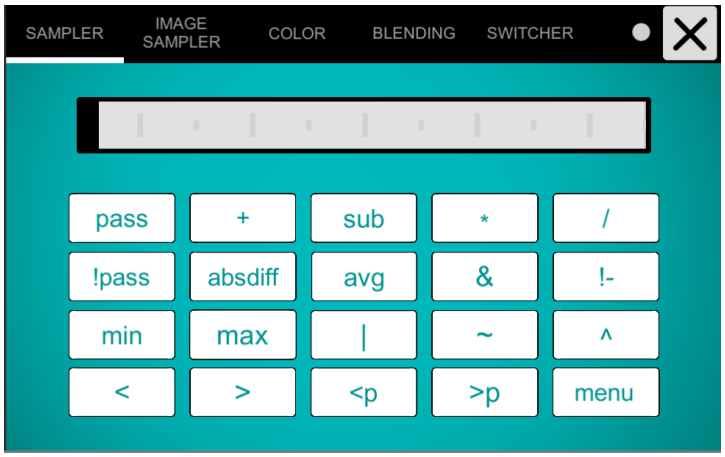


Figure 54: Blending Control Surface

Switcher: This control surface has 8 buttons that control module “SwitcherV”. With this control surface we can quickly select the different images or videos that are loaded in the 8 available positions.

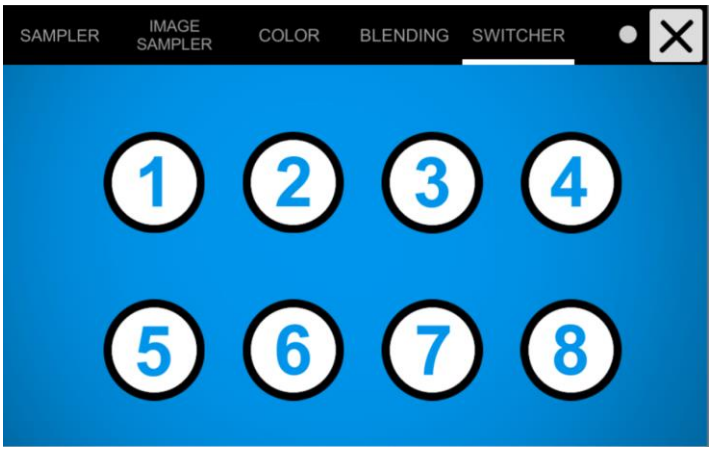


Figure 55: Switcher Control Surface

7. *Kinect* body control of modules

Soundcool® modules allow manipulation of some of its parameters by means of body movements captured and processed in real time. This control is possible through the use of *Kinect*, a computer-vision camera developed by Microsoft. *Kinect* was originally included as a supplement to the Microsoft Xbox 360 video game console. However, the *Kinect* sensor can also be used without the Xbox console, so you can buy it separately and use it without restrictions.

Figure 56: *Kinect* sensor

To connect *Kinect* to your computer (PC or MAC) you must use the USB cable that Microsoft provides for that specific purpose (power adapter included). This cable is included in *Kinect* if it is bought separately from the Microsoft Xbox 360 console. If *Kinect* and the Xbox are bought together as one unit, the cable needs to be purchased separately.

Figure 57: *Kinect* USB Cable with power adaptor

7.1 Installation of *Kinect* drivers for *Synapse*

Synapse is the program responsible for processing the information coming from the *Kinect* sensor. We recommend not connecting *Kinect* before doing the installation process described below. Synapse is free and can be found here:

7.2 Installation process on a MAC

It is only needed to connect *Kinect* to a USB port and the adaptor to the power.

7.3 Installation process on a PC

It is recommended to strictly follow the sequence described in this section to install the necessary drivers. **Do not connect the sensor until installation is complete**. Otherwise, it is not guaranteed that the device will operate correctly. Furthermore, it is required the removal of any driver whose purpose is also the control of *Kinect* but not mentioned in this section. Otherwise, having multiple drivers installed for the same purpose can lead to errors.

- Install the ***OpenNI*** library*:*
- Instalall ***NITE*** software, by ***PrimeSense****:*
- Instalall the ***SensorKinect*** driver*:*
- Reboot (the computer).
- Connect the *Kinect* sensor to power and to a USB port on your computer.
- Open *Synapse.*

If, despite having followed the steps, the Synapse program does not work; you can find a list of common errors that are easy to fix, on their website:

http://synapsekinect.tumblr.com/post/6698860570/windows-install-instructions

Note: *Synapse* does not work on Windows 8.

Note: All the above links to software are provided by the *Synapse* website. However, these programs may have been subsequently improved. You can look for up-dates at the following link at which the driver downloads are packed in .zip files named **RGBDemo... Win32**:

http://sourceforge.net/projects/roboticslab/files/

7.4 Using *Kinect* with *Soundcool®* modules through *Synapse*

All *Soundcool®* modules that are compatible with body control incorporate a check box on the bottom left side that enables the *Kinect* sensor. To begin controlling any module using body gestures it is necessary to open the *Synapse* program and follow these steps:

- Once the *Synapse* is opened, the image captured by *Kinect* will be shown on the screen, as well as a colored dot on the top-left corner. It will initially be red meaning that it is not detecting any user in its vision field. As soon a user is detected, it will change to green.

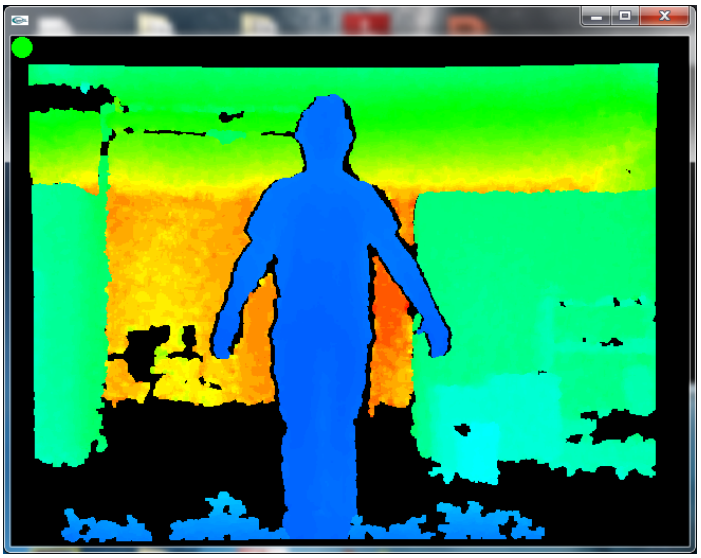


Figure 58: User detected using *Kinect* and *Synapse*

- When the user is detected, he or she must adopt a T position with their arms and hands up until Synapse is able to detect the joints of his/her body (only a few seconds are needed). Joints appear as black rectangles. We recommend to move the elbow upwards from the T position to favor a quicker detection.

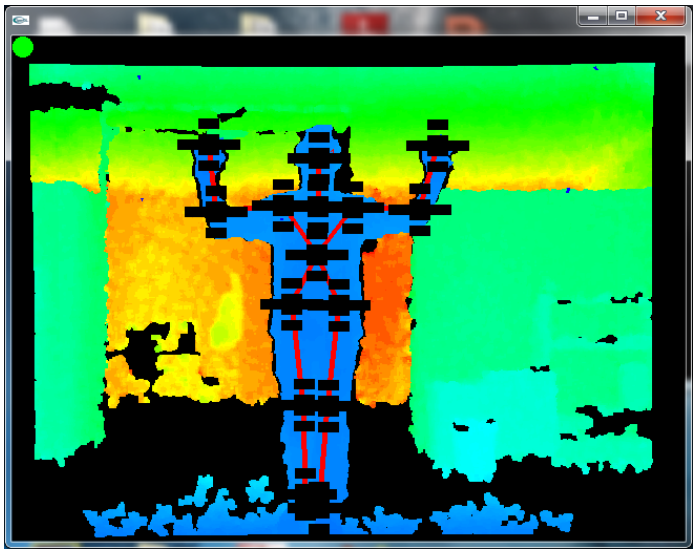


Figure 59: The user's joints are detected

These black rectangles will be captured as a reference for controlling the different parameters of the modules. At this moment you can activate the desired *Kinect* check box and immediately you will see that the movement of the body will produce changes in the parameters of the module.

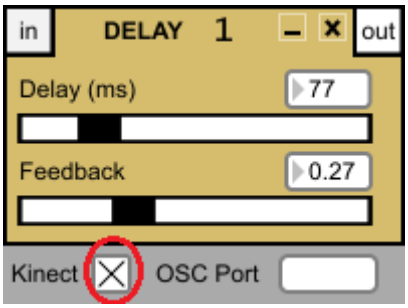


Figure 60 : The *Kinect* check box is selected in the *MDelay* module

7.5 Movements for controlling the parameters

Sliders are controlled with the following movements:

- ***Horizontal Sliders*** can be controlled by moving your arm in the horizontal direction (left and right). *Kinect* captures the horizontal pathway of your hands as a reference for moving the horizontal sliders. Generally, one horizontal slider is associated with the left hand. If there are two sliders, one will be controlled with your right hand and the other with your left.

- ***Vertical Sliders*** can be controlled by arm movements in the vertical direction (up and down). *Kinect* captures the vertical pathway of your hands as a reference for moving the vertical sliders. Generally, one vertical slider is associated with the right hand. If there are two sliders, one will be controlled with your right hand and the other with your left.

8. Credits

http://Soundcool®.org/about