K_messages

hyper-cello

PRESENTATION

The work is a cycle of four interactive compositions inspired by Kafka's short novels.
Every "message" can be performed as a single piece or as a part of a complete work in four movements. The optimal duration of the whole cycle is about 45’, though reduced versions until 30' are possible. The composition is focused on the central role of the soloist (the hyper-cellist), who develops the electroacoustic music in real-time, sharing part of the responsibility of the composer. It is not essential to be skilled in computer music in order to perform the work, but the appropriate equipment is necessary. The interaction and its performance trajectories are visually monitored by the cellist on the laptop screen (replacing the classic score and music stand).

Sound is the absolute means of communication between the cellist and the electronics. In other words the cellist feeds the live electronics with his/her sound, but at the same time the cello sound gives the machine some information necessary to execute compositional choices in real-time.

By understanding the essence of the composition and properly monitoring the sounds and functions, the cellist will be able, by playing, to drive and influence the music composition in real-time.

However, this compositional empowerment is driven through the computational language of the machine, which is not exactly the same “language” as perception, performance and composition.
The machine "understands" the cello sound through spectral analysis, while the cellist drives the interaction by listening and playing.
True connections and true distances can be found between these languages and dimensions of experience, allowing for non-obvious interactions, which require new symbols and performance styles.
The cello sound is exploited by the performer as a mediating technology between acoustic music and composition processes.
The musical results (maybe powerful or illuminating, maybe conflicting or complicated) are dynamically linked to the poetic realism of Kafka, where hyperbolic desires, inflexible laws, unexpected reflexions drive human situations towards extreme conditions of appearance.

Fig.1 Franz Kafka

Simple animated graphic/verbal scores are provided in order to properly mediate the interactive composition, autonomously evolving without the help of any external Live Electronics performer. This total autonomy puts the cellist in the condition of a direct contact with the electronic processes through an expanded knowledge of his/her sound and musical actions.

PLAN

Message_1) *Vor dem Gesetz* (duration from 6 to 15 minutes, default 10')
Message_2) *The Wish to be a Red Indian* (duration 4')
Message_3) *Odradek* (minimal duration approx. 10’)
Message_4) *The Trees* (from 10' to 15', default 13’)
The duration of the “messages” (movements) 1 and 4 has to be set in advance by the performer, otherwise it is left as default.
Message 2 has a fixed short duration.
The section-advances of message 3 are dependent on the sound of the cellist,
who decides the durations in real-time.

RECORDINGS

<u>Studio recordings</u>

<u>Audio</u>

K_1 https://soundcloud.com/nicola-baroni/vor-dem-gesetz
K_2 https://soundcloud.com/nicola-baroni/the-wish-to-be-a-red-indian
K_3 https://soundcloud.com/nicola-baroni/odradek
K_4 https://soundcloud.com/nicola-baroni/the-trees

<u>Video</u>

K_1 **(Antonello Manzo)** https://www.youtube.com/watch?v=FW3ho-6fPfk
K_4 https://youtu.be/-7NAoElhXPQ

<u>Live recordings</u>

Compilation https://www.dropbox.com/s/441azkw88z2usfo/kafkas.mp4?dl=0
K_1 https://youtu.be/KiivIwgPM7I
K_1 **(Clea Friend)** https://youtu.be/jbMAJYYDoOA
K_2 https://youtu.be/UwzEVNd_rjA
K_2 **(duo)** https://youtu.be/X9lqKw64TSE
K_3 https://youtu.be/MHpixGI1xMQ
K_4 https://youtu.be/-7NAoElhXPQ

EQUIPMENT

Movements 1, 2 and 3 require:
1 microphone for the audio,
1 pickup for the sound analysis
1 sound card (at least 4 outputs)
1 laptop containing the Applications (or the native MAX patches)
My personal equipment involves DPA4099, Cello-Fishmann pickup, RME UCX.
A different set of equipment needs careful calibration of the analysis data
(see technical section below).
Some main calibration parameters should anyway be checked before any performance,
at least for movements 1 and 3.
The pickup input has to guarantee a full isolation of the cello sound from the environment (not always gained through piezoelectric or directional microphones)

Movement 4 "*The Trees*"

Movement 4 requires the same equipment, but with the addition of:
- 2 small speakers
- 2 condenser microphones (possibly omnidirectional)
- 1 inertial sensor (3 axis accelerometer and gyroscope)

The extra speakers and microphones have to be positioned on stage, close to the cellist in order to produce controlled audio feedback. In case of a small sound card,
1 mini-mixer is necessary in order to allow the additional phantom power inputs.

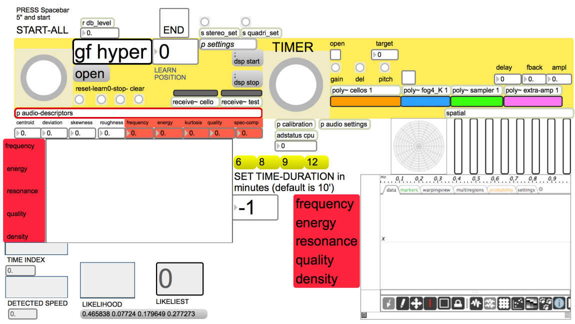
Every single piece is a dedicated MAX Application working on MAC OS 10.8 (or above).
The performance is also possible through the original code if MAX/Msp 6.1 (or above) and the externals listed in the appendix are installed: a Mac dual core is sufficient, more powerful HD is suggested at least for Message_3. In Message_4, running the Orients_15 Motion Tracking system, a native Bluetooth 4 Mac version is the minimal requirement (see page 49).
The spatialization is quadraphonic. Options for 8 speakers are foreseen.
Stereo diffusion is allowed but not ideal.

Message_1 “Vor dem Gesetz”

Video instructions at: https://www.dropbox.com/s/x6t37zoczi67xrg/K_1_instructions.mov?dl=0
Novel at: http://www.kafka-online.info/before-the-law.html

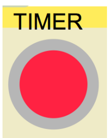
COMPOSITION

Invent and perform a music introduction segmented into **four contrasting phrases**.
Don't think of your music too much in terms of notes, but mainly in terms of contrasting timbres, dynamic shapes and pitch registers, organised in four "phrases".
Every "phrase" should be best conceived as a well characterised sound-gesture, a sculpted sound expression internally changing and moving towards the next one.
Each gesture ("phrase") lasts **20"** and the overall duration of these four divisions is precisely **1' 20”.**



The machine "listens" to your music, but instead of recording your sound it records, as flowing numbers, five features of your analysed sound: *pitch, loudness, resonance, quality, density.*
Your initial task is to find and perform music contrasts and developments in these terms.

Fig.1-K_1 The interactive screen *(Message K_1)*

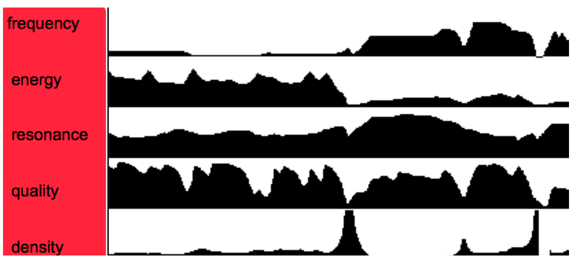


Two close red flashes in the upper part of your screen signal the beginning of every phrase.

One single red flash (after 10") tells that you are passing the middle portion of the phrase.

Fig.2-K_1 The Timer flash

You can see in the left part of the screen the monitor of what is tracked in real-time by the system, and on the right how it is stored inside the memory machine.



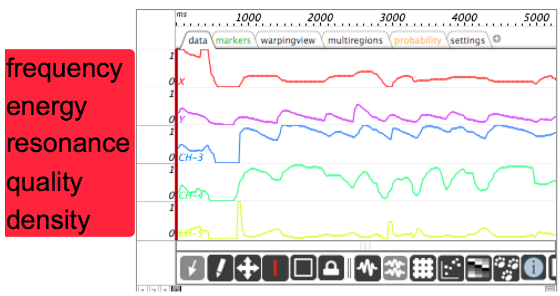


Fig.3-K_1 Sound analysis in real-time

Fig.4-K_1 Sound features stored in memory and later recalled during the performance

INTERACTION

After 1' 30" from the beginning the computer starts to play electronic music, and from this moment until the end your cello performance is interactive. During the continuation of the piece, the software predicts which one of the four "phrases" (the **previous 20" sound-models**) is matched by the music you are **"currently playing".**

Technically, the process happening in your 1' 20" initial acoustic performance is called **"machine learning"**, and the continuation until the end is called **"gesture following"**.

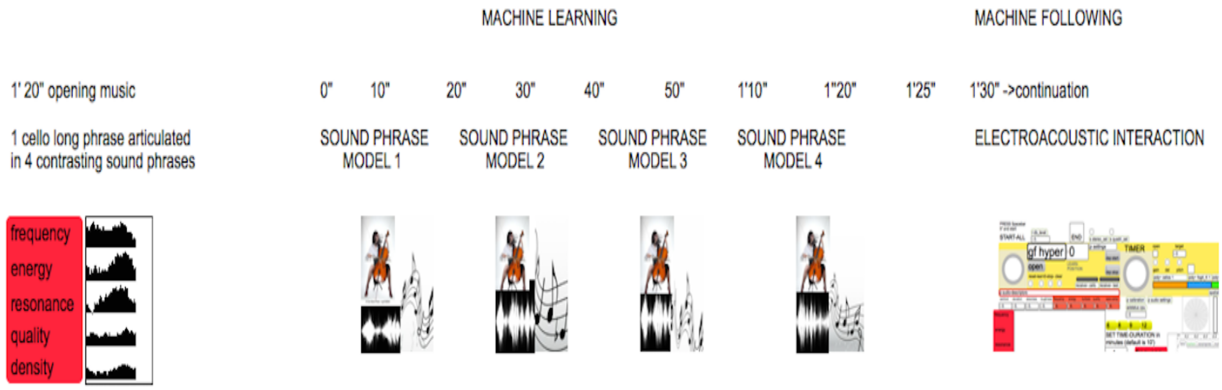


Fig.5-K_1 Machine learning and machine following

The computer performs a "data driven" work of **"feature recognition"** within the time of your music. In machine learning mode you define and perform four music models, in machine following mode you vary these models in order to creatively interact. Compositionally you have to:

-carefully invent the four contrasting **cello "sound-gestures**" and shape them in an overall music introduction (you can write sketches, partial pentagrams or playing by memory)

-vary these models in order to improvise a new cello music, which contextually drives the electronics by means of parameters of similarity/difference between the current and the previous music (you will follow the screen monitors as an interactive score).

Machine following and music variations:

-If you try to repeat one of the opening phrases perfectly, the system should be able to tell you precisely which portion of the phrase you are currently playing and if your speed of execution is the same or different.

-If you insert some variations compared to your previous performance, the machine starts to jump in order to identify which part of your previous music you are imitating.

-If you radically change your sounds the machine still attempts (with unpredictable results) to recognise which is the model phrase and which is the point and speed of reproduction.

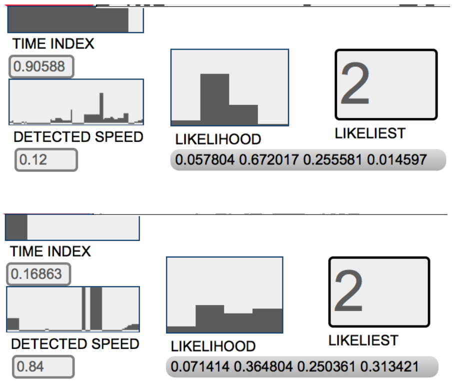
You can see all of this in the monitor on the right of your screen.

The machine is natively built in order to recognise perfect imitations of previous models and slight time variations upon them, but I have increased its "tolerance" parameter in order to allow for some more variations inside your performance.

SYSTEM

In the bottom part of the screen you see which one of the four initial gestures the machine is telling you are performing. Since it is a **statistical system** you can see the percentage of probability with which your performance is pertaining to one model instead of the other ones. The more you perform strict imitations of a previous phrase, the more the machine recognition should be straightforward. The more you vary the music, the more the machine starts to take time to gain a consistent response, and the four models of similarity could be moving around middle ranges of probability.

The figure shows two different possible states of sound recognition.
In both cases it appears that the current sound recalls the second phrase (“likeliest”), but the parameters of **“likelihood”** are different.



In the first case the system shows that the currently played sound is similar to the second model-phrase, but it also has some degrees of similarity with the third phrase.

In the second example the currently played music should be quite different from any previously played model because all the parameters of similarity are quite low and levelled.

Fig.6-K_1 Pattern recognition

The Time-Index parameter shows, from “the point of view“ of the machine, which portion of the 20” model you are currently imitating (the upper example detects the final part of the phrase, and the second example the initial part), the same detection is shown through a **moving bar** inside the bottom-right monitor (see fig. 8-K_1).
The Detected-Speed predicts if the imitation of the model is performed more slowly or faster.

We are using **this system as a musical instrument**. You can influence the machine predictions as you wish: any different prediction about how you are playing creates a different electronic music.

Through previous rehearsals you will gain a refined technique of electroacoustic sound modelling in real-time. Obviously a careful choice and timbre contrast of the sounds performed in the four opening 20" music gestures is extremely important.

In other words you can compose live electronic music by carefully balancing imitations and variations of your initial cello performance. The four parameters of “likelihood” act as a **mixer** because they are mapped to the amplitude of four different **Virtual Music Instruments**
(each VMI processes the live sound of the cello in a radically different way).
Therefore as an example, if your current music is detected as totally similar to your second initial phrase you will interact with the sounds of VMI nr. 2 at full amplitude, but if your music ambiguously matches different initial models (as in the shown cases of the figures above) you will produce a mix of different Live Electronics (VMIs) with variable relative amplitudes.

THE NOVEL

Kafka's novel presents a country-man who asked for a meeting with the emperor. The man stands in front of the door of the fabulous palace waiting for admission. A porter tells the country-man how difficult and dangerous it is to get inside, the country-man waits an immensely long time to get in until the porter closes the door telling him: "the door was opened for you, but now you are dying and I have to close it”. The music interaction asks the cellist to dramatise **the theme of expectancy,** by provoking the question: "What if you were the country-man?".

The computer response could sound alien in terms of sound (and maybe also in terms of pattern recognition!) as in the case of the Kafka novel, but the cellist is provided with many possible solutions in order to gain "desired" music responses (in terms of music narration, experienced anxiety, or interactive music play).

REAL TIME COMPOSITION AND ANALYSIS

The common language between the cellist and the machine is the **real-time analysis of the cello timbre** as it is performed, therefore spectral analysis is the grammar of the computer and sound is the means of control by the cellist upon the machine and the **real-time composition** (RTC).
Obviously **sound and spectrum** are different aspects of a unique entity, and the cellist’s means of control upon the system involves complex strategies of musical navigation, whose output could be technically successful, confused or unexpected. The machine can “listen” differently to the cello sound compared to human expectancies, because its system is abstract and computational.

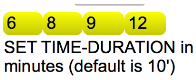
The conceptual and technical virtuosity of the cellist could be in the direction of finding a deep reciprocal common control and understanding with the machine, but also challenging the system with unexpected sounds, or otherwise musically exploiting possible reciprocal misunderstandings as an opportunity to produce interesting music.
The theme of the interaction is real-time composition through expectancy and variation, in which Kafka’s novel represents the state and the affect of a "threshold of failure”.

The cellist is free to repurpose sequences perfectly identical, varied or mingled in order to extract in real-time different machine evaluations of similarity between music sequences. The parameters of these evaluations are mapped to a **macro-form** (the **"sound narrative"**) of the current electroacoustic music. In this way the musical choices of the cellist, as high-level decisions, drive the composition, treating the parameters of similarity vs. variation as means to control the overall result.

The choice to help or to confuse the machine through linear vs. scrambled patterns is a possible option involving the possible misunderstanding of the HCI interaction as a musical instrument and opportunity. On the other hand the success of the machine is not absolutely guaranteed and it could sometimes suggest the need for possible revised music strategies on-the-fly by the cellist.

The whole composition is driven by the cello sound which feeds the audio of the electronics, and at the same time modifies the kinds of electronic sound treatments interacting with the audio analysis of him/herself. This last compositional interplay can be developed by the cellist **intuitively or through a deeper understanding** of the spectral data and mappings.

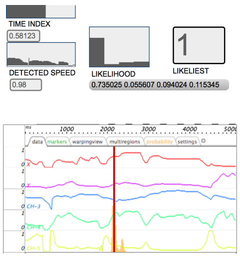
PERFORMANCE NOTES



The overall duration of the pieces is 12 minutes by default, but it can be set differently beforehand by the performer, by pressing the dedicated message-number.

Fig.7-K_1 Setting time-duration

Press the "Spacebar" to begin:
-during the first part (the acoustic interactive seed of the work) you will follow the red **"Timer" flashes** (see p. 3) and the increasing section number.
The two bottom monitors show the incoming analysis of your cello sound.



During the electronic continuation you will follow the **interactive mixer (called "likelihood").**
The **bottom-right monitor** will be showing the stored analysis data of the "phrase" model in action, and the predicted point of time-occurrence of your music inside the currently active model-phrase.

Fig.8-K_1 Monitors of interaction

A number shows (in minutes) the time point of the current performance.

Fig.9-K_1 Monitor of duration

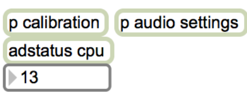
When the piece is ending the electronics fade out.

Rehearse mode:

It is possible to **simply explore the sound analysis system without starting the piece**, or when you **calibrate,** press the icon "DSP start" using the mouse.

Fig.10-K_1. Rehearse mode

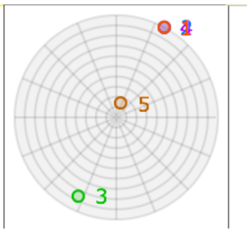
Calibration:



A following section explains how to set up optimal parameters of sound analysis

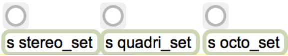
Fig.11-K_1 Calibration icon

Spatialization:



Spatialisation is driven by *Ambisonics* (azimuth, distance, velocity of source shifts). Each of the VMI outputs are automatically positioned in space accordingly with features coming from their individual real-time sound analysis. You can monitor them.

Fig.12-K_1 *Ambisonics* interface



Spatialisation is quadraphonic by default, but it can be **differently set** to 8 speakers or as a stereo.

Fig.13-K_1 Setting the speakers

MICRO-SHAPES

If the overall sound narrative is shaped by the main mixer called "likelihood" (see above), multiple mappings allow for local and micro controls/influences upon the electronics.

The electroacoustic sound is in fact made from four Virtual Music Instruments, dynamically mixed by the main parameter of likelihood.

The VMIs are fed by the cello sound, processing itself in real-time through variable parameters; these variables are at the same time modified by the same cello input.

In other words the cellist creates the material and the means of control of the electronics through the same sound gestures. Despite the aurally distant result, the electronics thus keep an intimate connection with the cello sound in terms of textural and gestural distributions of common materials.

This mixed music is not created before-hand by a composer, nor driven by a score, but it is functionally designed as a creative interaction in order to be explored and revealed on-stage by the cellist, who feeds the open system in terms of sound and control.

Artificial sounds are not intended as extensions, direct processing nor responses to the cello, they are instead conceived as a parallel music.

The complexity of the performance underlines that it is a compositional task, sonically driven by the cellist.

INSTRUMENTS

The software composition is based on the final mixing of the following VMIs:
1) Harmonizer, 2) FOG synthesis, 3) Sampler, 4) Delay plus feedback.

The output of the VMIs is strongly influenced by the cello sound through local mappings. A detailed analysis of the complex internal mappings of each single instrument can be done by navigating inside the MAX application and reading the annotated comments inside every abstraction.

The **index number** of each of the VMIs is the same number as tagged inside the **main mixer called "likelihood"** which controls the referenced amplitudes of every single VMI.
The parameters **"time-index" and "detected speed"** shown in the bottom part of the screen, influence in many ways the electronic sounds of each instrument. They refer to the time location and speed of performance as they are predicted by the computer recalling the initial music phrases (see the section "system", p.5).

The VMIs are called: **1) cellos; 2) fog4_K; 3) sampler; 4) extra-amp**.
It is suggested, but not mandatory, to feed the initial four phrases
(which reference the four instruments) with:

1) light/expressive sonorities;
2) dense textures;
3) extreme gestures;
4) subtle extended techniques.

Sonorities well fitting with the reciprocal VMI should be found and explored.

A few small monitor cues are given, including the amplitude monitor of each effect.

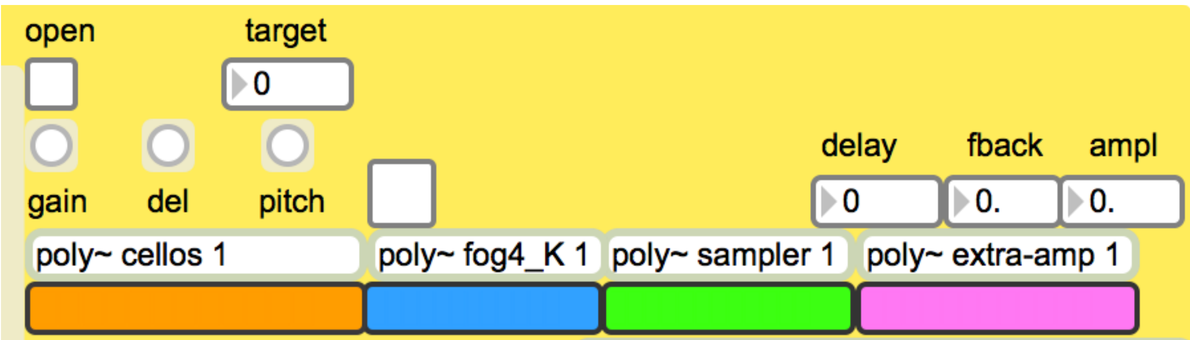


Fig.14-K_1 VMIs interface"

-1) "Cellos".

The four voice harmoniser multiplies the cello output.

Each voice can be independently pitch-transposed and shifted in time. The system drives a **non-continuous transformation** of these parameters: globally an increasing **variability and contrast** of the live cello timbres pushes towards a much more dynamic and changing behaviour of the voices, which conversely tend to be fixed in delay and transposition when the cellist plays softer and more stably. **Extreme sounds** allow for bigger changes: very **high/low pitche**s drive extreme transpositions (until 2 octaves high and low), while **spectral centroid** tracking pushes away the individuated delayed copy of the cello sound by 10 seconds (when the performed timbre is harsh and high-pitched), or approaches it by less than 1 second when the performed timbre is low, soft and fat. The performed **noisiness** increases the feedback (the density of transposing delays). The whole harmoniser is modified in timbre, especially by the parameters of "**time-index"** and **"speed-detection"** (the "imitation" parameters of the referenced "phrase" 1, shown by the monitors in the bottom part of the screen). As shown in Fig.14-K_1 small yellow flashes signal when the main parameter are changing, and the number box called "target" signals which of the four voices is involved.

-2) "Fog4_K".

FOG synthesis granulates the cello sound cyclically live recorded.

The most prominent influences on the parameters of granulation are:

-**live cello density**: full live sound increases the speed of the effect making it more intense, rhythmic and similar to a recognisable cello sound; airy sounds and pizzicato slow down the effect until a sort of "spiritual drone".

-**live cello amplitude**: by playing loud you rarefy and distance the grains of sound output, by playing soft you intensify the textural overlapping. Moreover, by lowering the "fog parameter" inside the calibration module (from the default 10 until 5 or less) you can anyway gain more textural overlapping, by setting it higher (until 20 or 25) you increase the tendency to granular rarefaction (see the calibration section, and the referenced calibration patcher)

-**pitch and brightness of the live cello** playing influence different timbre qualities of the FOG synthesis (which are to be mainly experienced by listening).

-again the parameters of change in the granulation are **not continuou**s: the **rate of change** of the granulation parameters is faster if the **"time-index"** of the imitated phrase approaches the end of the model, and slower if it is at the beginning. High "**speed-detection"** lessens the smoothing parameter, driving for impulsive changes.

-3) "Sampler"

outputs chunks of a prerecorded cello sound file (rhythmic and aggressive)

-**the sound character of the live cello** recalls similar sounds stored in the file

-high **pitches and brightness** of the live cello increases the overall density

-a high **"time index"** (final portion of the referenced phrase) decreases the overall density, while the detection of its initial portion increases it.

-c**rescendos** allow for upward glides, **decrescendos** for downward glides

-**pitch classes** of the live cello like C, C sharp, D dramatically increase the density of the output; B, B flat, A instead scatters the sampling into detached groups of sounds, the other middle notes (in a chromatic scale) maintain the effect at middle ranges

-4) ”Extra-amp” (variable delays)
-the output gain is set to high amplitudes in order to allow **special effects** such as noisy sounds, extended techniques or subtle textures
-the **“time index”** crucially modifies the delay line and its feedback: when the initial portion of the phrase is detected the output produces short delays (reverb-like), on approaching the final part of the phrase the delays are distanced.
-**live sound amplitude** is mapped to up-down glides of the output
-inside instrument 4 the time-index parameter is much more prominent, therefore it is advised to invent the model-phrase 4 (at the beginning of the performance) in order to start with a textural sound developing towards a rhythmic patterned continuation
-a small monitor of the parameters is given above the patcher

TECHNICAL REMARKS

AUDIO ANALYSIS
The five "timbre" descriptors feeding the interaction need a brief discussion.
Traditionally the word "timbre" indicates a sort of ill-defined condition (we clearly perceive timbre features but it is hard to objectively define them with shared words).

The five audio parameters centrally involved in the interaction are:
pitch, loudness, resonance, quality, density.
- *Pitch* and *loudness* are extracted by the central frequency and the amplitude of the cello sound. Classical theory considers them as quantifiable aspects of sound independent from “timbre”. They are indeed timbre aspects of sound, but in any case clear concepts to be experienced, and straightforward to be spectrally tracked in real time (respectively through the “yin” algorithm and the envelope-following).
Loudness needs calibration.

The other three parameters are more concerned with the traditional idea of timbre and they need specific levels of treatments, filtering and compression.

- *Quality* is the most direct timbre descriptor in this context, referencing the noisiness vs. periodicity of the spectral components (through the “yin” algorithm). The noisy vs. purely tuned cello sound can be intuitively monitored by the performer (but note that chords and double stops are tracked as much less pure in “quality” than single notes). The numeric output in any case needs compression in order to be tuned to the physical specs of a cello and to the individual character of different performers: therefore it could be calibrated in order to get better nuanced responses.
  - *Resonance* tracks the gradients of response between free vibration (i.e. after a soft pizzicato), a soft airy bow conduction, a “full-tone”, a compressed sound production.
  The more the cello bow stresses the string, the more the value of “resonance” falls down to zero. The parameter is obtained through filtering, compression and scaling of the flowing value of the spectral statistical distribution called “kurtosis", detecting the peakedness vs. flatness of the real-time spectral envelope.

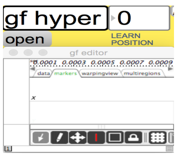
- - *Density* deals together with the different parameters of spectral centroid, spectral spread, central frequency and amplitude in order to approach the tracking of “sul tasto” effect vs. full-expressive/near-the-bridge sound, generally obtained by variations in speed and point of contact of the bow. Pizzicato styles should result as zero “density”.

A double threshold sets the main values to zero when the loudness is very low or when the sound is definitely noisy. In this way noisiness can be detected as a special effect. Moreover in this way the sound tracking can be performed within the range of a normal cello playing (avoiding false detections of environmental sounds, and unreliable analysis of noisy components)

All the values are filtered in order to smooth meaningless peaks. These five parameters feed the main motor of the composed interaction, through the *Gesture Follower* system.

Detailed local mappings drive the behaviours of the four VMIs, exploiting further audio descriptors such as *roughness, spectral flux, spectral centroid* and *spectral spread.*

GESTURE FOLLOWER



The GF is a statistic data-driven software developing the technology of machine learning.

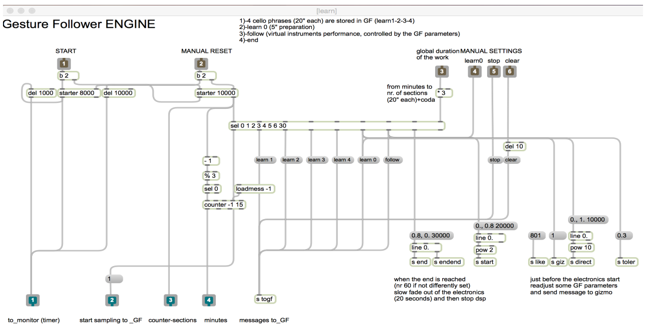
Fig.15-K_1 The *GF* editor

It stores and indexes in its memory different lists of incoming numbers (learning): having completed the learning phase and on receiving a new list, the GF evaluates and compares any new lists with the old items previously stored (following). By applying sensing data such as the descriptions of human physical movements (gestures) as inputs to the GF, the system is able to reconstruct and compare previous gestures (stored and indexed during the learning phase) with the new ones, (following phase).
In this way it is possible to extract patterns of similarity between different gestures, and also compute the identity, the percentage of deviation, and the predicted speed of their execution compared to the identified initial models.

In this composition the cello sound is segmented and treated as a shaped sound-gesture.
For this reason the cellist is initially asked to invent and perform the four different “sound gestures” (conventionally called “phrases”), feeding the GF as learning models.
The continuation of the music (gesture-following mode) is the creative interplay between the cellist and the GF: the found patterns of similarity feed the main mixer, which is responsible for the macro-form continuation of the piece. In addition the secondary GF parameters “time-index” and “speed detection” (the temporal point of performance and the speed of imitation of the “learned” model with respect to the currently played sound) are mapped inside each of the four VMIs. In this way the reproduction/deviation modes of the cello music from the previous models have a further influence upon the electronic sounds.

COMPOSITION

In this way the technique of machine learning is framed inside the composition since the four initial cello phrases (corresponding to the four machine-learning steps) are inscribed in the interaction as automatic time lines.



After that (1’ 30” from the beginning) the GF is automatically set in “follow” mode, while the player continues to perform with the free task of recalling his/her previous phrases, choosing the different degrees of similarity with his/her initial music.

Fig.16-K_1 The timeline to the *GF* and to the composition

Therefore the performer assumes the responsibility for the overall form-building and the electronic developments. The performance could be considered as a "timbre-motivic" interplay driven by time remote connections between sound gestures, through the mediation of the machine.

Expectancy could be viewed as a non-obvious means of communication between the past, the present and the future of the music through similarity, identity and variation of musical and timbre patterns performed live.

The system is designed as a novel means of real-time-composition (RTC). A high focus is given to timbral descriptions tuned to the cello behaviours in terms of sound and performance techniques. The four sound models segmented by the GF are conventionally called “phrases” inside the performance instructions, but they lack "syntactical" lattice-based structuring: in fact the intention is to segment their features in terms or timbre gestures/textures in order to foster an electro-acoustical approach.

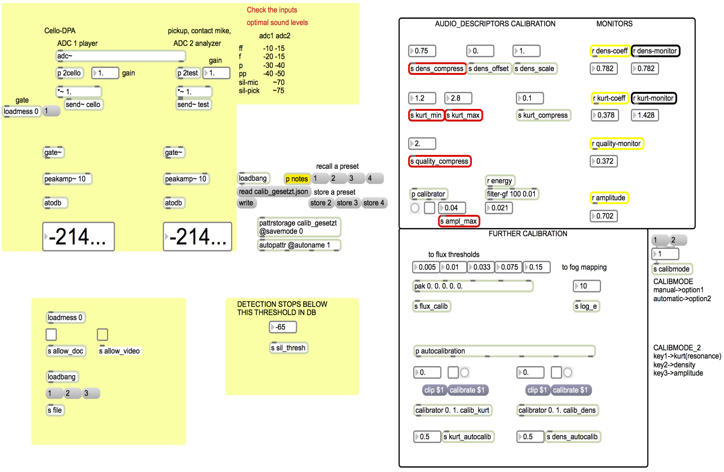
In this context the problem of a cultural continuity between Western instrumental practices and electronic musical thought is far from obvious, and the integration of their approaches is a principal aim of this project. Giving a central creative role to the classical performer raises the problem of which music theory acts behind the composition.

The first of the four K_messages explores this question more radically since the entire macro-form is dramatically dependent on the communication between timbre as it is performed on a cello (and indirectly as it is perceived by the audience), and how it is tracked and reordered by a computational machine.

Moreover timbre is non-linear and involves music strategies that cannot be framed inside any conventional mapping strategy or theory.

Kafka’s novel acts as a metaphor and a mirror of interaction.

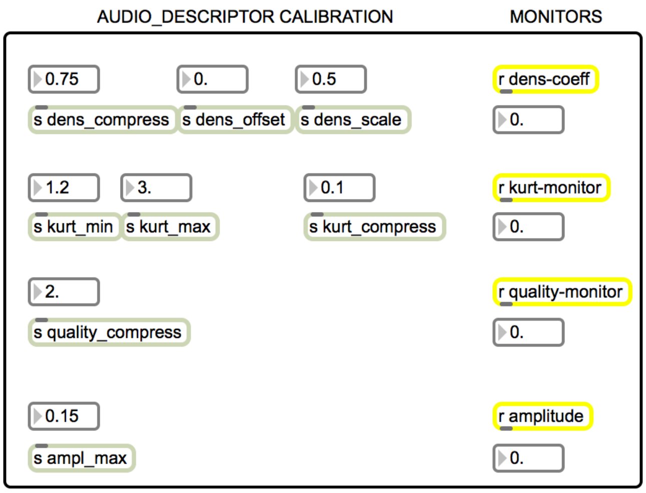
CALIBRATION



All the functions are contained in the main patcher “calibration” allowing for:
-optional software balance of the two inputs (microphone and pickup)
-main calibration settings
-min/mean/max balance for the complex calibration of *density* and *resonance*
-storage of the new values
-simulation from sound files
(in case of conferences)

Fig.17-K_1 The calibration patcher

The storage/recalling of the last calibration setup is automatic (after saving the patcher before closing it) only if the system works as a MAX/Msp patch.
If the system is a MAX standalone application, the calibration values are to be manually stored by pressing the message “store 1”: they will be automatically loaded at the next opening (this manual procedure is obviously possible also inside the native MAX patch).



Calibration has to be performed when the system is in “rehearse mode” (DSP on, without starting the interaction). The monitors coming from the yellow “receives” show the raw values coming from the analysis modules, the calibration numbers on the left have to be set in order to gain the most meaningful normalisation, which is shown on the fly inside the main monitor positioned in the left part of the performance patch.

Fig.18-K_1 Main calibration parameters

The calibration should be done by playing the cello and with the main data monitor visible.

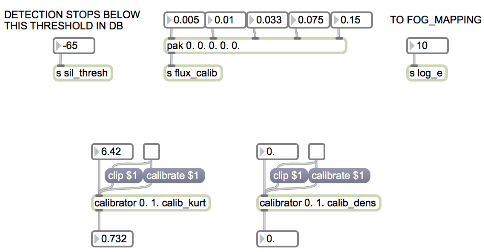
- The *compress, offset, scale* parameters for density allow for a full ranged normalised output between 0. (soft pizzicato) and 1. (dense “saw-teeth-like” sound). The middle ranges should be well shaped by the calibration in order to detect intermediate values for “sul-tasto”, and “ordinario”, and soft vs. full sounds. The density curve cannot be truly flat with respect to the central frequency, therefore the cellist has to be aware that the system unexpectedly interprets some specific notes as “more dense” than others: this makes sense since the timbre responses of a cello are not linear.

- The *min, max, compress* parameters for kurtosis (“resonance”) require compression values near to zero (this means very high compression): min and max are the thresholds of clipping between 0. and 1. This calibration is a trial process that can be checked in relation to the flowing *kurt-monitor* number. A soft-low-resonating pizzicato will rapidly rise to the maximum (clipped to 1.), but the lower values should be calibrated in order to give room to some meaningful differences between “airy” and “intense” timbres.

- The *quality_compress* parameter (set to power 2 by default) should give focus to the middle ranges of noisiness vs. pureness of the cello sound. Increasing the power number should improve the tuning of the detection, but when the power coefficient is below 1 it could instead raise the values of half-noisy sounds.

- The *ampl_max* calibration number has to be set at the same value as the maximum amplitude performable by the cellist, in order to set the maximum amplitude as 1.

The threshold below which the analysis is interrupted (detecting silence) is set by default to -65 Db (with respect to the signal coming from the pickup).
It can be optionally modified.



New adaptations of the 5 thresholds of the *spectral.flux* can be optionally set differently.

The “FOG” parameter is explained in the above “Instruments” section (pag. 9), it refers to a specific threshold of amplitude following.

Fig.19-K_1 Further calibrations

After the main calibration, a fine-tuned further calibration of *density* and *resonance* is possible by pressing respectively keys 1 and 2 of the laptop keyboard.
After 2” the automatic calibration starts, lasting 5”: the cellist will be performing in order to store on the fly the Min and Max threshold values, the last number received is stored as the Mean value. Min and Max will be clipped as 0. and 1.; the Mean will be fixed as 0.5. The procedure is performed through the abstraction “calibrator” borrowed from the CNMAT MAX library.

Message_2 “The Wish to be a Red Indian”

Video instructions at: https://www.dropbox.com/s/3o9vdfw3jtd5xs3/K_2-nstructions.mp4?dl=0

If one were only an Indian, instantly alert, and on a racing horse, leaning against the wind, kept on quivering jerkily over the quivering ground, until one shed one's spurs, for there needed no spurs, threw away the reins, for there needed no reins, and hardly saw that the land before one was smoothly shorn heath when horse's neck and head would be already gone.

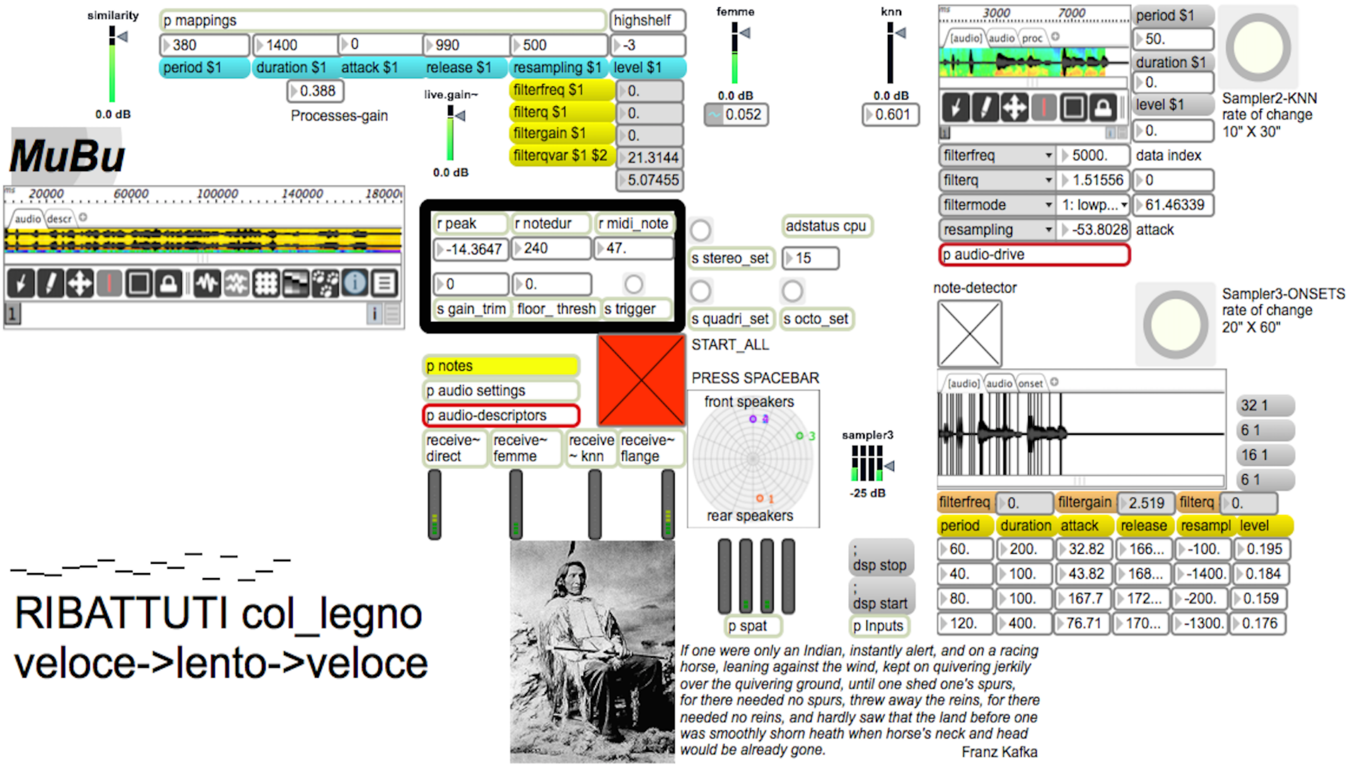


Fig. 1-K_2 The main interactive patch *(Message K_2)*

COMPOSITION

Following the interactive instructions, play with rhythmic flexibility and freedom.
Don’t avoid extreme variance in pitch loudness and timbre. In a short time you should cross distant sounds and techniques, including scraping sounds and Bartok-pizzicatos.

The system records your sounds, and you recompose them in many ways in real-time through the sounds of your cello performance.

SYSTEM

This 2nd movement of the "K_messages" is a strict interaction between the performer and a set of live-cello sound memories stored as audio files.

The files are cyclically loaded by the system, and the output sounds are interactively treated and transformed through different cello playing styles. Again the hyper-cellist is responsible for creating the input to the live electronics, and to drive, through performance, the methods of the interaction.

Two different modes of performance are allowed:

a) the audio files come from live recorded portions of the 1st movement automatically stored in the HD and recalled during the 2nd one.

b) the sound contents are directly live recorded on-stage, as a part of the performance.

Press "Enter" to start the performance in mode a)

Press "Spacebar" to start the performance in mode b)

The electronic sound is created by four modules:

Sampler_1, Sampler_2, Sampler_3, Amplified/Flanged-cello.

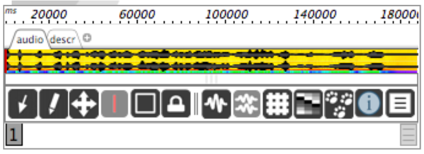
All the electronic treatments are musically driven by the cellist interacting with the sound analysis of his/her incoming cello signal. The live cello is analysed in pitch, amplitude, note onset, note duration, and timbre (brightness, noisiness, centroid and spectral distributions).

These analysis data transform the sound of the audio recordings in order to drive the samplings through a large-grain mosaic technique. The engine of the samplers is granular, but the file fragments (scattering or accumulating) are mainly treated at a note-length time level.

The performer must be aware of the sound interactions described below, designed by an overall automatic time segmentation (macro-form) inscribed in the software.

The performance will be improvised according to functional lines of interaction chosen in advance by the cellist, following some essential graphic animations.

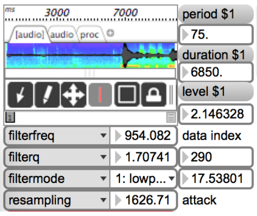
SOUNDS



1) Sampler_1 “femme” (upper left part of the screen) processes a fixed external prerecorded file.

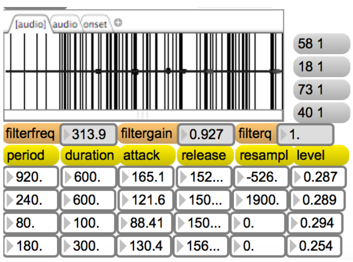
Fig. 2-K_2 Sampler_1 (sound file interface)

The file is quite energetic and rhythmic and has to be freely recalled by the cellist in order to increase music contrast in the course of the performance.
Sampler_1 is a slightly varied version of the instrument called “sampler” operating in the 1st movement. This is a means of continuity between the two movements.



2) Sampler_2 “knn” (upper right part of the screen) is filled with live recorded cello material. New materials are loaded every half minute. The sound transformations partially and continuously alter the timbre/textural contents coming from the cello sounds.

Fig 3-K_2 Sampler_2



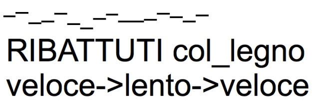
3) Sampler_3 “onsets” (bottom right part of the screen) is also filled with live recorded cello material. New materials are loaded every minute.
Sampler_3 is the main module of the piece: it doesn’t transform timbre, but it fragments, overlaps and transposes the sound contents at differentiated note time-lengths in order to operate as an algorithmic composer in real-time.

Fig. 4-K_2 Sampler_3

4) Direct sound: the amplified cello is sometimes “distorted” through a flanging technique, incremented when the cello input is more aggressive and noisy.

TIME MACRO-FORM
Overall duration 3' 40”.
The development is created by the alternating fillings of Sampler_2 and _3 with new sound materials, and their treatments in real-time.
You are required to play in sequence:
- 0’ -> ribattuto col legno;
- 1’ -> pizzicato;
- 2’ -> espressivo;
- 3’ -> tremolo.

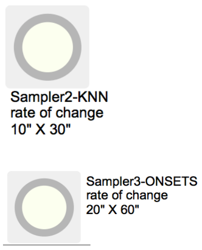
Other interactive instructions regarding playing styles such as Accentuato; Legato/Staccato; Aggressive-pizzicato are intermingled in order to drive the sampling treatments.



Every half minute you are suggested (through graphic-verbal screen animated indications) to feed the music system with a different music style, which at the same time interactively drives the methods of sampling.

Fig.5-K_2 Example of the animated score

The number, width and position of the small graphic bars suggest the density, power and pitch register of the music gestures verbally described.
Sampler_3 is filled with new sound material (lasting 20”) every minute.
Sampler_2 is filled with new material (lasting 10”) every half minute.



You can see two red flashes near the buffers of the samplers, which signal the beginning of this process. The filling process happens in real-time therefore Sampler_2 loads sound material (and processes it at the same time) for 10” and during the following 20” the processing works on the fixed already stored sounds.

The same happens with Sampler_3 at doubled time intervals.

Fig.6-K_2 Flashes signalling the beginning of the recording process

The buffers have a graphic interface: you can see some of the sound qualities of the stored sounds, and the principal processing parameters whose evolutions depend on the sound you are producing (see figures above and below).

The whole interaction starts immediately at the beginning of the piece: therefore every minute the electronics radically process new sound materials (Sampler_2 plus Sampler_3) and every half minute the processed materials will be only partially replaced (Sampler_2 only).

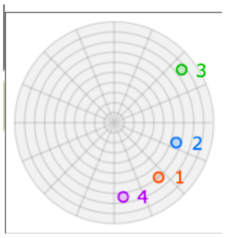
In this way Sampler_3 will be fed with four different and contrasting cello sound materials (every minute), and Sampler_2 with seven different cello sound materials (every half minute). This overall macro-form is shaped and underlined by a chain of automatic amplitude gains, which drive the interaction from:
-an initial long fade in,
-three mid culminating points,
-a last faster fade out allowing a possible brief acoustic cello conclusion.

SPACE MACRO-FORM

The spatialisation is organised in a mixed fashion.

Sampler_3 (the principal electronic instrument) outputs four layers of sampling, each located in a fixed position of the quadraphonic field.

The other 4 electronic sources (Sampler_1, Sampler_2, Amplified_cello, Flanged_cello) are spatialised through dynamic parameters tuned to some live cello sound features:



-the locations in space of the amplified and flanged direct cello are dependent on the pitch of the live performed cello

-Sampler_1 and Sampler_2 spatial movements mainly depend on the brightness of the live cello sound.

Fig.7-K_2 Spatial monitor

Timbre and note densities of the live cello affect the velocities of the spatial displacements of each source, whose distance from the centre of the audience room depends on the periodicity vs. noisiness of the live cello.

Fig. 7-K_2 shows the monitor interface of spatialisation, each sound source is numbered and the monitor shows its current position inside the audience space of listening (the front speakers are represented as being in the upper portion of the diagram, the rear in the bottom).

PERFORMANCE NOTES

The main interactive tasks for the cellist are:

-1-The choice of contrasting sound materials filling Sampler_3 and _2

-2-The amplitude balance between Sampler_1 and Sampler_2

-3-The interactive strategies towards each of the three samplers.

The controls of the flanger and of the spatialisation could be considered as byproducts of the cello performance, not necessarily to be strictly controlled and focused by the cellist.

1) SAMPLING MATERIALS

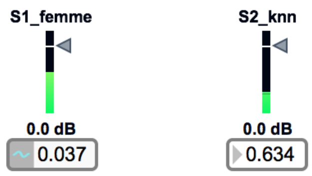
In case of performance mode A, Sampler_3 will be filled by the same cello sounds as played during the beginning of the 1st movement. In this case the four contrasting cello model-phrases (lasting 20” each) already performed in the 1st movement make up the sound contents of the four subsequent contents of Sampler_3.

In case of performance mode B the contents of Sampler_3 will be fed in real-time by the cellist.

In this last case the filling sound contents are to be contrasting in sound (as indicated by the verbal animation).

2) AMPLITUDE BALANCE

The output amplitudes of Sampler_3 are directly responsive to the live cello resonance.



The final gains of Sampler_1 and Sampler_2 are instead balanced by the cellist:
-high pitches proportionally increase the amplitude of Sampler_1 (intensifying aggressive-rhythmic contrast)
-low pitches proportionally increase the amplitude of Sampler_2 (adding colour and textural density to the music)

Fig.8-K_2 Sound monitors of samplers 1 and 2

Middle range pitches obviously mix these sound contents with different proportions.

Sampler_1 is especially suitable for brief energetic commentaries matching the rhythms of the sampler with high-pitched live cello excursions.

3) SAMPLERS

The samplers granulate the sounds after being recorded in their buffers, and output them with a sound-mosaic technique.

Their main parameters are:
-period: defining how many sound grains are output.
The parameter is set in milliseconds (i.e. period 1000 = 1 new sound grain is output every second; period 50 = 20 sound grains are output every second)
-duration: defining the time length of the grain (in milliseconds); if the grain duration is lower than the period the result will be a scattered sequence of sound pulses, if the duration is higher than the period the grains will be overlapping. In case of a large difference (as in the extreme case of figure 10-K_2, where the period is 50 and duration 8700) the result will be a dense overlapping texture of very long sound grains.
-resampling: it means transposition, computed in cents of a semitone (i.e 1200 = 1 octave)
-level: it defines the amplitude increase or decrease with respect to the internal sound materials.
-attack/release affect the clarity and definition of the sound grains
-filtering is also influenced by the live cello

Sampler_3 is the main engine of the music.

Sampler_1 and _2 have a subsidiary role affecting the overall sound character.

Sampler_1: (upper left of the main patch).
Its internal file is pre-recorded and **very rhythmic**.

The more the cellist plays high notes, the more this sampler plays loudly.

The internal sound file is pre-analysed[1], a similar analysis is performed in real-time upon the live cello sound: the system is therefore able to **select and output the file sound portions more similar in timbre with respect to the sound gestures performed by the cellist.** The different portions of the sampled sounds are then "sewn" in real-time through a sound-mosaic technique.

In addition the cellist can influence the length, the density and the intonation of the output sound-mosaic portions in the following way:
-if the cellist plays louder, the sound-file "grains" are transposed higher, but at the same time they become shorter (extremely strong cello sounds output grains lasting less than a second until a fifth of a second, soft cello sounds increase the length of the grains until a few seconds): the file-grains are anyway output at regularly time-cut "note" lengths.
-the density of the events coming from the audio file (the number of grains output within a second) increases **if the cellist plays the first notes of the chromatic scale starting on C** (C, C#, D .....) but progressively decreases on reaching A, A#, B…..).

By interacting through amplitude and pitch (pitch-classes) the cellist can obtain extremely varied methods of sampling in terms of grain density, length and transposition.

More subtle timbre variations of the grains are dependent on timbre variations of the live cello.
The values of the grain-mosaic processing can be monitored on the screen as shown
in figure 9-K_2.

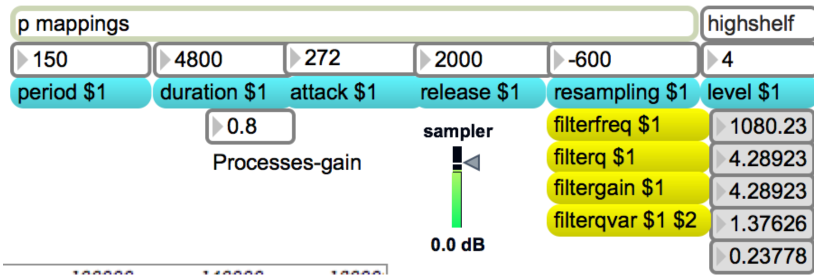
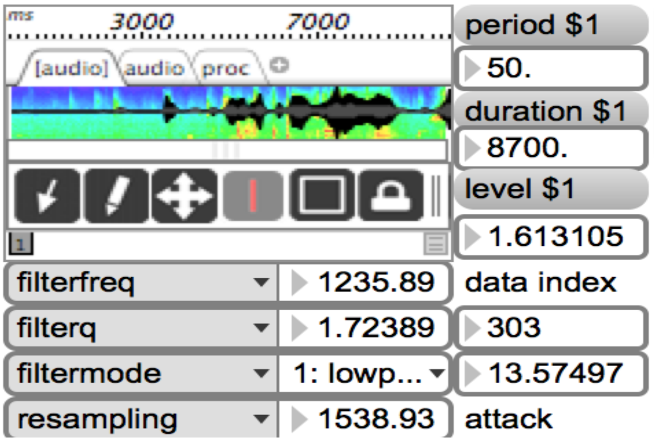


Fig.9-K_2 Sampler_1 engine

[1] The timbre analysis is performed through Mel-cepstral coefficients stored in the software, and the similarity between the stored and the real-time coefficients is computed in real-time by a "KNN" algorithm (key nearest neighbour search).

<u>Sampler_2</u>: (upper right of the main patch)
The sounds coming out from Sampler_2 have a **textural/background quality.**

Their amplitude increases **when the live cello is performing low pitches/sounds**, and decreases in the presence of high pitched sounds. The amplitude balance and the sound character of Sampler_2 are opposite to Sampler_1, and easily controllable by the performer.



The main algorithm of Sampler_2 is also driven by the KNN search (see note 13). The core system is a varied version of Sampler_1, but instead processing dynamic sound contents loaded on the fly. The output is a mosaic of sound fragments (like Sampler_1).

Fig.10-K_2 Sampler_2

The graphic interface of Sampler_2 shows the waveform and the dynamic parameters of interaction.

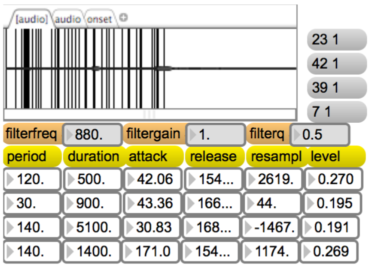
Pitch, amplitude and brightness of the cello are the principal means of interaction. The density of the sound texture (shorter grain periods) increases proportionally to **low cello pitches.**

High pitches, soft sounds and bright timbre contribute together to increase the length of the grains (i.e. a soft high pitch performed near the cello bridge will contribute to a maximum grain length, as in the example of figure 10-K_2).

Cello amplitude affects transposition. The overall filtering of the sounds is also dependent on the main live cello pitches, passing from no filtering for the lowest pitches, through different light filtering options, until resonant options in case of mid range notes (from middle C upwards).

Brightness, resonance and noisiness of the cellist have a role in the filtering and clarity of the sound mosaics, whose final sounds must be explored through performance rather than intellectually.

Sampler_3: (bottom right of the main patch).
Sampler_3 is the main sound engine of the system.

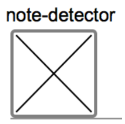


The sound filling its buffer (20” long) is segmented taking into account the **onset energy of the incoming sound.**
Therefore rhythmic sounds will produce much more segments than smoother sounds. The buffer interface shows the attack-segments as black vertical bar lines. The output will be driven by an onset-detection internal system describing the live cello **rhythmic behaviour.**

Fig. 11-K_2 Sampler_3

The sampler outputs the sound segments following a mosaic technique (similarly to the other samplers), but in this case the segments are output in the same sequence as they were recorded.

The sound segments are distributed in **four separate channels,** each of them with different velocities and densities of fragmentation: the final output will be a “four voice polyphony” of differently fragmented portions of the live-recorded sound, where the segmentation will be guided by the rhythmic salience (onset detection) of the cello sound.



The note (onset) detector is placed above the sampler, detecting (inside the live cello performance) the presence of **a note when a cross appears, and a pause when the cross disappears.**

Fig.12-K_2 Note detection monitor

The note is analysed in terms of its duration, onset distance (time distance from the previous onset), initial pitch, amplitude and quality factor (periodicity vs. noisiness), all affecting the kind of output segmentation inside the sampler. The last four “note detections” determine the parameters of each of the four overlapping output channels of the sampler.

Fig. 30 shows the four groups of parameters organised in rows. When the “period” is lower than the “duration” the sound segments will be output overlapping each other in a dense rhythmic fashion, on the other hand low durations will output brief noise-like sounds, and higher durations will make the sound qualities of the stored segmented sounds recognisable (possibly allowing for more sound overlaps). Period and duration are computed in milliseconds. The parameter called “resampling” is connected with the pitch transposition of the referenced sound segment (i.e. 100 = 1 semitone higher; -100 = 1 semitone lower).
Further timbre details vary in accordance with the cello playing (as it is possible to verify inside the commented abstractions of the application)

The system detects a cello note when an amplitude threshold is passed.
A pause is detected through a double threshold detecting a partial decrease in amplitude.
A new note can be detected only after a pause (tiny or longer).
The system has good reactions with staccato, pizzicato or accented styles.

A straight legato style (with no amplitude decrease between notes) could behave unexpectedly (showing one extremely long note until a next amplitude decrease happens).
Be careful when long notes are really your interactive intention; in general the **music system is preferentially conceived for nervous staccato styles** as suggested by the screen instructions and the subject of the piece.

-A **high density of sound attacks (note-onsets)** by the cellist increases the density of sound events (the sound segments output by the sampler) in the proportion of
Inter-Onset-Interval (of the live cello) -> Period (of the sampled sound segments)
-The **duration of the live cello performed note** proportionally affects the duration of the sampled sound segments.
-**The last detected pitch interval performed** determines the transposition of the segments with respect to the original recorded sound.
-Only one of the four streams of sampled sound segments continuously follows in transposition your cello intonation, the others remaining fixed at their onset interval value.

TECHNICAL NOTES

CALIBRATION
The main calibration parameter concerns the note-detection.
Two thresholds work in parallel detecting the note-on and note-off when the cello amplitude crosses one of the values of -20 and -30 Db.
Should the cello playing and sound card adjustments be insufficient for focusing the average amplitudes around these Db values, a software calibration is suggested.

If you type inside the “gain_trim” number box a positive or negative value, the nominal amplitude detection will change accordingly (“gain_trim” simply adds or subtracts its value to the actual Db detection). Find the appropriate value in order to better focus an effective note detection.

The system should remember any new calibration by just saving the patch before closing it. A safer way to store data is available by pressing the “write” label inside the calibration set. Further calibrations are present in the system, and they can be explored inside the internals of the patch.

The sound diffusion is quadraphonic by default, in case of a different choice you need to remember, before playing, to press the button above the chosen different option.

Message_3 “Odradek”

Video instructions at: https://www.dropbox.com/s/b84puaj3ovmkyyu/K_3_instructions.mov?dl=0

Novel at: http://www.kafka.org/index.php?aid=284

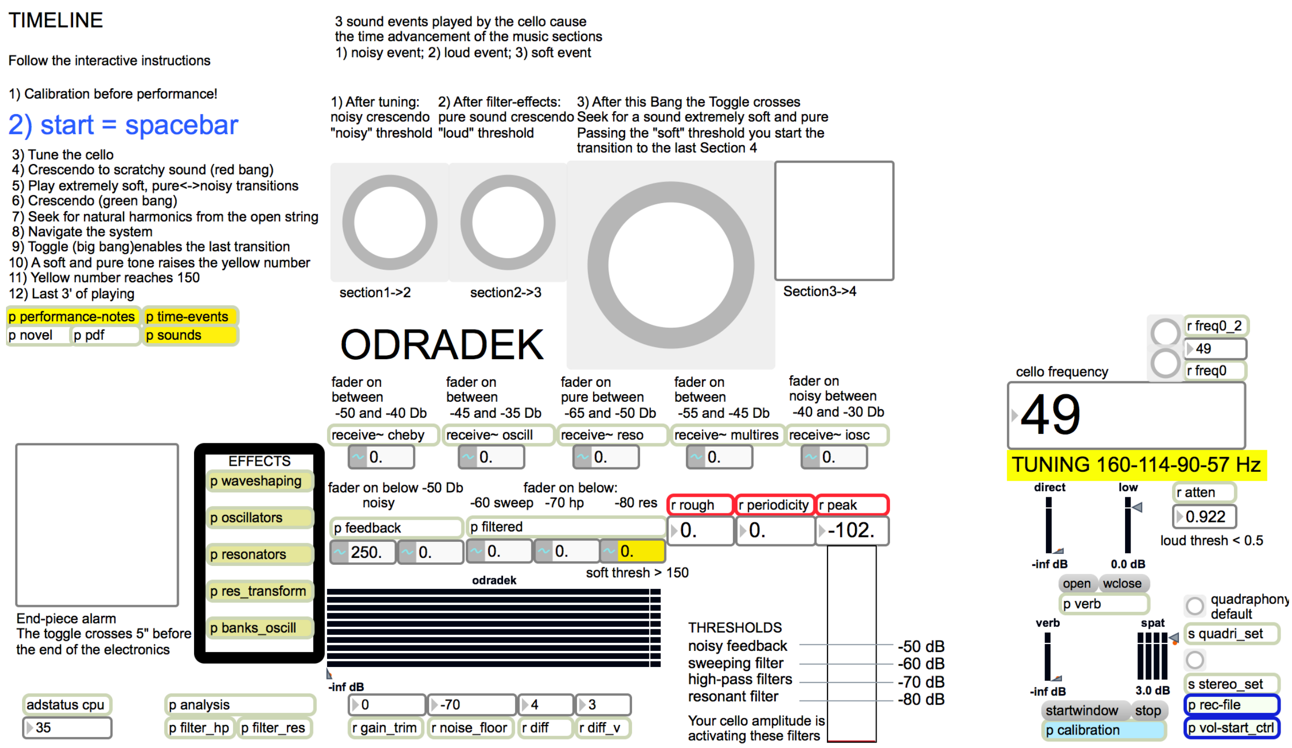


Fig.1-K_3 *Odradek*’s application *(Message K_3)*

<u>COMPOSITION</u>

PERFORMANCE STYLE

By only using the bow on the open strings (no pizzicato and never exploiting the left hand) you will produce different **overtone pitches**.

If the bow pressure is extremely soft, a specific overtone will arise, whose high pitch mainly depends on the bow-bridge distance (the portion of the vibrating string).

Play with extreme softness (below the loudness-threshold of the normal cello tones), gently sliding between different quantities of bow hair and different distances from the bridge.

Keep the bow-motion regular and wait the due time in order to let the harmonic sound grow, as much as possible beyond the loudness of the fundamental frequency of the string: you can softly change the pitch of the overtones as you wish.

You can also create transitions between the purest sounds and soft but rougher and gently scraping tones. You can sometimes play full notes, even loudly, or even loud and noisy, taking into account that all these choices affect the electronic interactive sound results.

When you play low notes with full tone, you can hear that your sound is doubled one octave lower.

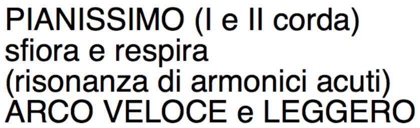
This performance style can be considered as a study on the construction of harmony through timbre.

In this way you extract actual significant components of the sound spectrum, building their sound against the fundamental frequency of the open string.

In this work the main string pitch always acts as a background, just like Odradek's "voice without lounges".

The spectral components of the sound are instead the main sound characters, reversing the importance of note/timbre categories with respect to the classic performance styles: the electronics simply enhance this timbre based attitude, since they only expand what is actually contained in your sound.

INTERACTIONS



The performance is guided by interactive verbal instructions appearing on your screen.

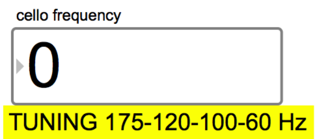
Fig.2-K_3: an example of interactive verbal instructions

The electronic sounds, upon which you have a total control through cello timbre nuances, follow you like a shadow. After a starting section, the electronics will be alternating between two different states, which correspond to **performance mode A and performance mode B.**

The time transitions between music sections and performance modes are the consequence of **three main sound events**. You decide when performing these three events, therefore the advancement of the piece (and its global duration) is at your will.

Performance modes A and B require two different cello modes of interaction, since the electronics will be slightly different, even if the general sound palettes are acoustically rather similar.

At the beginning of the piece you are requested to tune the cello strings unconventionally from high to low as: F, H (quarter tone lower), G (sixth of tone higher), H (quarter tone lower),
at frequencies 175, 120, 100, 60.
Some of these relations foster special string resonances.



The number on the right of your screen tells you which frequency you are currently playing.

Fig.3-K_3 Cello frequency monitor (tuning section)

SECTIONS

Beginning

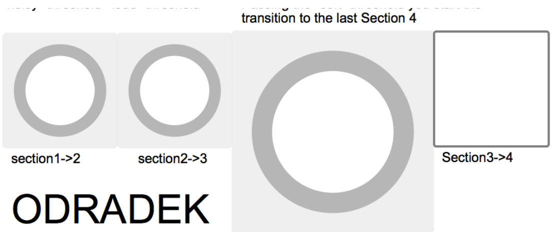
The opening scene consists in the narrator's voice against your **initial cello tuning**.

Tuning should be accurate by means of long, soft, airy bowing (maybe intermingling with a few pizzicatos).

This provocative inclusion as the beginning of the performance requires a theatrical focus, notice that your sound transforms the quality of the spoken voice (as a consequence of single note vs. double step, sound vs. pause, different volumes).

Events

After this prologue, the whole composition advances as a consequence of the three main cello timbre events "noisy, loud, soft”: they have to be performed during special moments of the composition.



In the central part of your screen you can see the detectors of these events represented by color flashes and one squared button: the events cause the transitions through sections 1, 2, 3 and 4.

Fig.4-K_3 The event-to-sections monitors

Further monitors, but principally the electronic sounds, make you aware of every new section.

-Event 1 (noisy) is a loud-scraping crescendo:

from section 1 (tuning plus narrator's voice) to section 2 (performance mode A)

-Event 2 (loud) is a crescendo with full-pure sound

from section 2 (performance mode A) to section 3 (performance mode B)

-After 1’ 30” the system automatically folds back to performance mode A

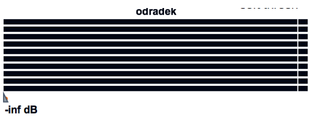
-Event 3 (soft) is a long and extremely pure and soft sound

from section 3 (performance mode A) to section 4 (performance mode B)

The advancements of the sections allow the alternate performance of modes A and B.

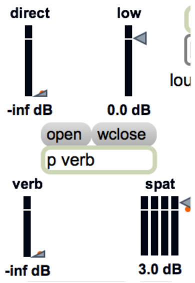
In this way the composition develops 2 principal electronic sound states:

Performance modes A-B



A) filter-resonator effects come out of the 10-channel virtual mixer (bottom portion of the patch). In performance mode A the volume-slider of the mixer is open, but it is closed in performance mode B.

Fig.5-K_3 The 10-channel main mixer (performance mode A)



B) direct/reverberated enhanced cello sound (right bottom monitors)
"direct" displays the volume of your sound coming from the main microphone,
"verb" tells you the quantity of reverberated sound,
"low" tells you when your sound is doubled at the lower octave.

Fig.6-K_3 Direct-verb gain faders (performance mode B)

During the performance mode A the sliders of "direct" and "verb" are closed.
During the performance mode B they move following automatic envelopes.

Sounds A) are produced by filtering and additive synthesis, mirroring the spectral analysis of your sound, captured from the input pickup.
Sounds B) enhances the microphone output, boosting the overtones that you are performing.

When the system is **in mode A you can mix 10 different effects**, **just by playing and balancing at different volumes** full tones vs extremely soft overtones, or alternating very pure sounds with soft bow-string noises.
Put briefly, you control the mixer by means of your amplitude and sound pureness (vs. noisiness).

In mode B you will play only extremely soft overtones, in order to prolong and overlap them through the reverberation, but you will need to be cautious in order not to increase this effect too much, because of the risk of the audio-feedback.

STRUCTURE
You will follow the interactive verbal instructions appearing at the upper right portion of the screen.
You are totally free in choosing the times and the characters of your timbre interaction.

The crucial aspect is the **quality, continuity and harmonic interest of the overtones** performed.
Alternating them with soft bow noises and full tones, represents the main means to navigate the system and the compositional form of the piece (in performance mode A).
A special sensitivity towards the chordal harmonic nature of performance B offers a means of balance.

Below is a detailed description of the event-section time structure, and later on some details are given about the sound effects. The last part of the document involves calibration instructions.

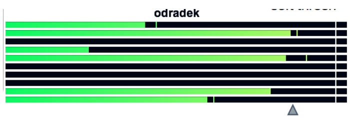
PERFORMANCE

CELLO EVENTS AND MUSIC SECTIONS

After having opened the main application, and checked the presence of the audio card:

0) **press the spacebar** (start music)
tune the cello to the indicated frequencies,
the overlapping voice of a narrator (reciting Kafka's novel) is diffused;
you modulate the voice through frequency, amplitude and cello sound periodicity.
After completing the tuning, keep a long sound on the D open string avoiding full tones:
by playing extremely softly with little hair, search for and keep sounding one D overtone
or alternatively play a short sequence of D overtones, gently shifting the bow
(ordinario->sul-tasto->ponticello) with slow, free and continuous patterns of bow “drains”.

1) **perform a noisy crescendo** until the red flash informs you that the "noisy" threshold is reached.
After that, maintain the previous overtone performance style: you can occasionally change the string you are playing on, but remember that you will be performing only on open strings throughout the piece. After this “noisy” event, the gain of the 10-channel virtual mixer arises: the effects are strong filtering and artificial resonators linked to the spectrum of your current sound.

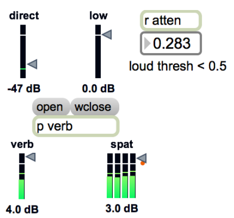


The effects are distributed through the 10 channels of the virtual mixer visible in the bottom part of the patch: you mix the 10 channels through cello amplitude and timbre.

Fig.7-K_3 Main mixer in action (performance mode A)

Keep playing very softly, shifting between the effects. This is the performance mode A.

2) after 30” or 1’ ca. (as you wish)
perform a full tone crescendo until the green flash detects that the "loud" threshold is reached.

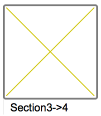


At this point the direct-cello gradually crossfades with the reverberated cello, whilst the 10-channel effects slowly fade out. The artificial effects disappear, and the overtones that you keep playing are now simply increased and sustained by natural amplification and reverb.
This is the performance mode B.

Fig.8-K_3 Reverb in action (performance mode B)

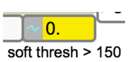
3) **after 1' 30" of this performance state**
the 10-channel artificial effects automatically and gradually fade in again, while the direct and reverberated gains fade out (performance mode A').
After 1 further minute a big flash (and the crossed big button) inform you that the "soft" threshold is now in listening state: freely perform following the interactive instructions until you decide to enter the last section.

4) the last transition starts when you **reach the "soft" threshold:** the yellow number called "soft_thresh" has to surpass 150 (if not differently calibrated).



When the big white button is crossed, the "soft threshold" starts its listening mode, you do not need to reach the "soft threshold" immediately, and you can delay the section advancement at will, navigating the performance mode A in different ways.

Fig.9-K_3 Crossed button (listening mode of the "soft_thresh" enabled)



When you are ready for the last section, you have to raise the yellow number, performing extremely soft and pure tones until the number reaches the set threshold.

Fig.10-K_3 Soft threshold monitor (high numbers = softer sound)

This process could be fast or longer, depending on the quality of your sound. This not trivial task requires a sustained sound possibly lower than the -80 amplitude level, but highly periodic at the same time (keep the "periodicity" and "peak" number monitors under your view).

When this last section is enabled, performance mode B' starts to be in action:
reverberated and direct sound gains fade in again, and the narrator's voice reappears softly.

5) after 1' 30" direct and **reverberated gains automatically crossfade a last time** (now reaching higher gain values), until the whole electronics fade out as underlined by the crossing of the bottom in the left part of the patch.
You can continue to perform overtones without any electronics if you wish.

PERFORMANCE MODES

The whole performance will therefore be segmented by these 3 sound events (as displayed through flashes and crossing buttons) and by a set of automatic gain fades. The principal performance style is the overtone production throughout the whole performance: but the timbre variations and an **extreme control of the cello loudness** permits you to fully navigate the interactive system.

<u>Performance mode A</u>

The 10-channel virtual mixer outputs:

-5 artificial voices produced by the "effects" modules called:

waveshaping, oscillators, resonators, res_transform, banks_oscill

-3 strongly filtered cello voices (controlled by the module "filtered")

-2 delayed-feedback filtered copies of the cello sound (controlled by the module "feedback")

All these artificial and filtering treatments are direct consequences of your sound, analysed as: fundamental frequency, spectral periodicity, amplitude, roughness, and individual frequency/amplitude of the first 30 cello partials.

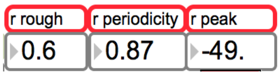
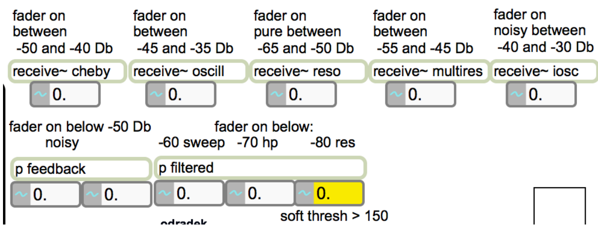


Fig.11-K_3 Cello timbre monitors (roughness-periodicity-loudness in db)

The **5 artificial effects** "sonificate" the spectral cello data as they are tracked in real-time.

The **3 filters** excite the overtone dynamics as they are performed

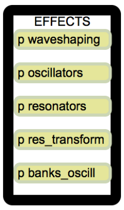
The **2 feedback voices** problematise the noisy components performed



More importantly **the 10 effects are mixed by the cellist through the amplitude and periodicity** of the cello sound. Visually the sound intensities of each effect appear from top to bottom inside the central mixer (the green moving lines indicating the energies of the output sounds, Fig.7-K_3).

Fig.12-K_3 Gains of each effect (and notes about the cello peak-amplitudes enabling each effect)

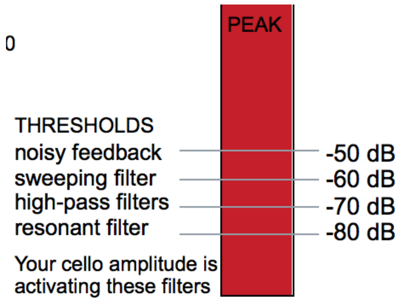
Some details of the relations between the cello loudness and the gains of each individual effect can be monitored in the central part of the screen (Fig.12-K_3).



The upper green lines of the main mixer represent the 5 artificial voices: they appear when the cello plays louder, possibly with full tone (contrasting the main soft overtone conduct). **The 3rd effect (resonators) is boosted by Mezzo-piano** with very pure full tone, the others by different graduations of higher intensities and timbre periodicity.

Fig.13-K_3 Artificial-effects modules

The lower green lines represent filters and feedback (the latter appearing in the 2 lowest lines).



Under the numeric gain monitors of these effects you can see the visual peak monitor containing 4 main thresholds driving the most important mixing functions. You can see **the red monitor** showing your current cello amplitude and the points at which the different filtering channels are activated.

Fig.14-K_3 Cello amplitude tracker (and connections with the filtering channels activation)

The 5 artificial effects better respond to louder cello full tones

1) "Waveshaping" returns a vibrating copy of your played note;
it is excited by playing pure tones Forte (-50->-40 dB),
your timbre roughness increasing the artificial vibrato

2) "Oscillators" returns a slightly inharmonic copy of your played note;
it is excited by playing slightly rough tones Fortissimo (-45->-35 dB),
your noisiness increasing its resonance

3) "Resonators" returns a little-bell-like image of your sound spectrum;
it is excited by playing extremely pure tones Mezzo-piano (-65->-50 dB),
your periodicity highly increasing its resonance

4) "Res_transform" returns a harmonic copy (sometimes gliding) of your played note;
it is excited by playing pure tones Mezzo-forte (-55->-45 dB),
your periodicity increasing its volume

5) "Banks_oscill" returns a scattering image of your sound if played noisily;
it is excited by playing very noisy tones extremely Fortissimo (-40->-30 dB),
your noisiness increasing its effect

The 3 filter effects require extremely soft and pure sounds, only playing overtones instead of full notes. These 3 effects will be your main focus during performance mode A.

6) "Sweeping filter" (variable cutoff): this is excited by playing Piano overtones (-> -60 dB),
preferably responding to whistling al-ponticello sounds

7) "Hp filter" (high-pass): this is excited by playing Pianissimo overtones (-> -70 dB),
preferably it requires quick shifts between different bow-bridge distances maybe mingled with small wood/string infra-sounds

8) "Res filter (resonant): this is excited by playing extremely Pianissimo overtones (-> -80 dB),
it requires the most soft amplitude and pureness, and it can sustain the most subtle overtones

9)-10) **The 2 feedback filters react to soft-noisy sound** stimuluses (-> -50 dB);
they time expand (through delay-feedback) the filtered cello noise,
one filter is high-pass and the other one is resonant

Most effort and time focus will be spent on the filtered overtones, taking the noisy-delays and the full tone artificial sounds as a musical contrast. The transitions between filtered and artificial effects will be spontaneously bridged by the "resonators" (3rd effect); the "banks_oscill" harsh effect should instead be possibly performed only once during the whole performance.

By accessing the calibration section you can see that the above amplitude values are nominal, and you can recalibrate the amplitude detection if necessary, in order to make your timbre controls easier.

Performance mode B

This sound state captures the microphone sound allowing for a refined almost naturalistic timbre quality. It ordinarily requires the soft overtone main way of performance, and especially when the reverb is high, it has the power to capture any overtone, raising it as a sustained resonance: by changing overtones you can develop steady polyphonic textures.

But if the resonant system acquires too much power, it can produce unwanted feedback frequencies (outside the natural harmony of the interaction): in this case you can soften the electronics just by playing louder, maybe momentarily killing all the reverbs by playing brief cello noises.
The more you play pure and soft, the more you raise the resonant electronics of mode B
(thus the natural enhancing of your overtones); and obviously, by performing in the opposite way (louder and/or scraping) you can counterbalance possible resonance excesses.

Despite the strict connections between cello and electronics, the work develops as an open form steered by the choices of the cellist. The work is considered as minimalistic because of:

- the continuous search for natural overtones allowed by a special bow technique
- the challenging control afforded by extremely subtle volume balances

Sound tracking (and sound outputs as well) depends on different channels of calibration.
It is likely that the default values do not suit different cellists and instruments.
By double clicking the label “calibration” you can access the module, and the relative
“notes” embedded section.

CALIBRATION

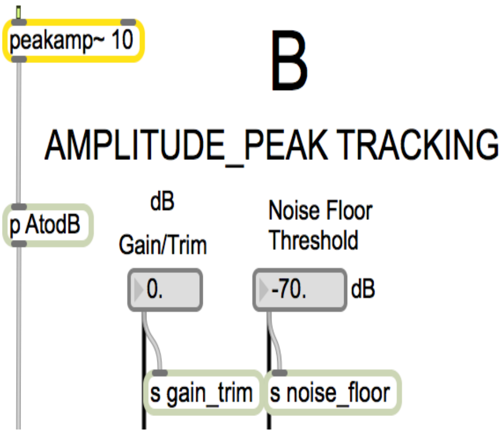
The cello is fitted with 1 microphone (possibly a DPA) routed to **adc~1, feeding the outputs only of performance mode B**. A contact pickup (possibly Fishman) is additionally routed to **adc~2 feeding the outputs of performance mode A, and the sound analysis upon which all the controls and processes rely.** After having set the amplitude balance of the 2 input channels from the audio card, further balance should be set inside the software.

The most important parameters are contained inside the calibration section B (amplitude peak detection) and inside the section C-1 (direct-cello and reverberation expander).

Every new calibration should be remembered by the system after having saved and closed the “calibration” patcher if the system is a native MAX patch. The option of pressing the "write" message can be used, but it is mandatory if the system is a MAX standalone application.

A: cello inputs attenuation.
This is a general purpose gain balance, which could be left unchanged, since more specialised calibrations are contained inside sections B and D.
It can be useful as a pre-calibration amplitude balance test between the two inputs.

B: peak detection



Peak tracking is the main motor of the system in performance mode A. The cellist balances the 10 effects through his/her performed loudness.
The "noise floor" parameter allows for a useful expansion of the salient cello amplitude region: the value set inside the "noise floor" number box shifts that value in dB to a nominal -120 (noise floor). In this way the piano and pianissimo sounds can be better controlled, since their nominal values are expanded. Optionally the “gain/trim” message linearly adds its value (positive or negative) to the nominal dB tracking.

Fig.15-K_3 Peak amplitude calibration

This calibration should be accomplished by taking principally into account the red monitor of the main patch, in order **to ensure a comfortable control of the lower thresholds by the cellist.**

C: parameters calibration

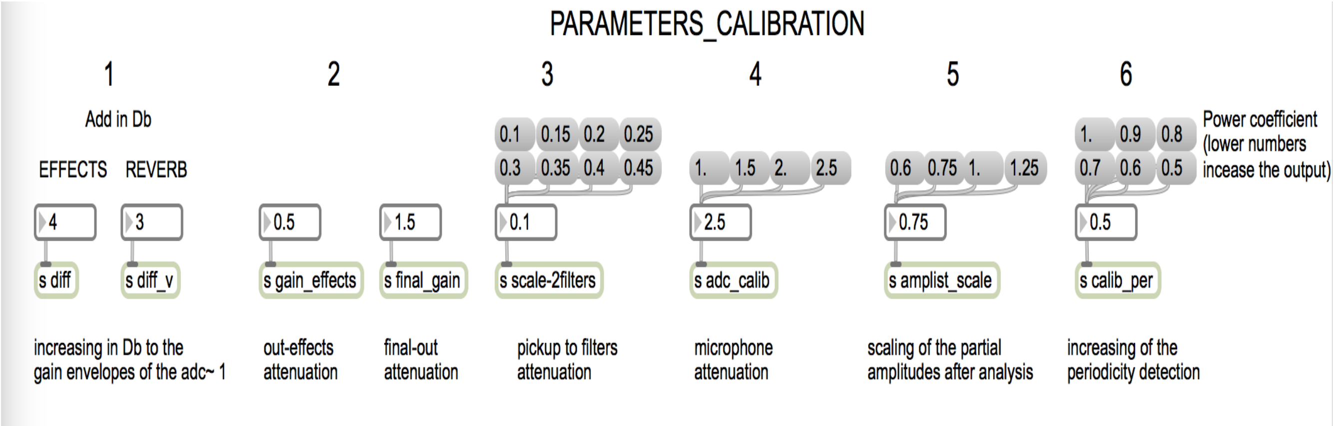


Fig.16-K_3 Multiple calibrations

1) **The values "diff" and "diff_v" add or subtract amplitude in dB to the automated gains which dynamically modify respectively the direct and reverberated cello:** both signals come from adc~1, therefore they are active only during the performance mode B. These gains shift throughout the whole performance (and they are slightly higher during the last part).
Depending on the room/equipment specs, a maximum on stage amplitude has to be gained without instantiating feedback, since the direct and reverberated cello outputs must be enhanced in order to raise and prolong the very soft cello overtones (if the cellist plays louder the internal gains automatically decrease).
These additional gain factors may need to be checked before the performance.

2) attenuation/boosting of: a) the effects coming out of the 10-channel virtual mixer b) the overall final gain. Obviously < 1. attenuates and > 1. increases these final signals.

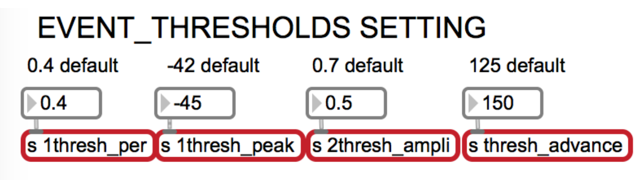
3) the sounds feeding the 10-channel mixer (performance mode A) need a strong attenuation, which can be differently set.

4) the microphone signal (from adc~1) generally needs to be increased due to the soft performance required, but a lower boosting could maybe help the C-1 calibration.

5) "amplist" scaling affects the amplitude of different filters and resonators: this involves the amplitude scaling of the partials tracking inside the fft module.

6) the periodicity coefficient compresses the output values towards "noisy" when it is lower and towards "periodic" when it is higher. Its mappings particularly affect the final gains of the filters. In case some more nominal "periodicity" is needed, you can very slightly decrease the coefficient (i.e. the power to which the periodicity tracking is raised).

D: threshold setting



The parameters underlined in red set the thresholds detecting the 3 cello events which make the composition advance.
After having balanced the B and D sections, some of these thresholds could be changed in case they do not fit a fluent cello performance.
Fig.17-K_3 Thresholds calibration

1) the tags "_per" and "_peak" regard the event 1 "noisy".
   They reference the "periodicity" (0 -> 1) and "peak" (-120 -> 0) main monitors: by increasing their values the loud-noise detection is made more sensitive, by decreasing them the cellist has to put more effort to accomplish event 1, respectively in terms of noisiness and loudness.
2) the tag "_ampli" regards event 2 "loud".
   The small number (0 -> 1) on the right of the direct-verb gain sliders is referenced. Increasing the cello loudness this number decreases. Therefore, if this threshold is too sensitive (triggering an unwanted event) you have to lower it. In the opposite case, you have to slightly raise it.
3) the tag "_advance" regards the event 3 "soft".
   The default value should be preferentially higher than 100, making the task hard but not too difficult. The referenced yellow number "soft_thresh" rises when the (nominal) cello peak amplitude is below -80 dB in the context of a high periodicity.

Message_4 “The Trees”

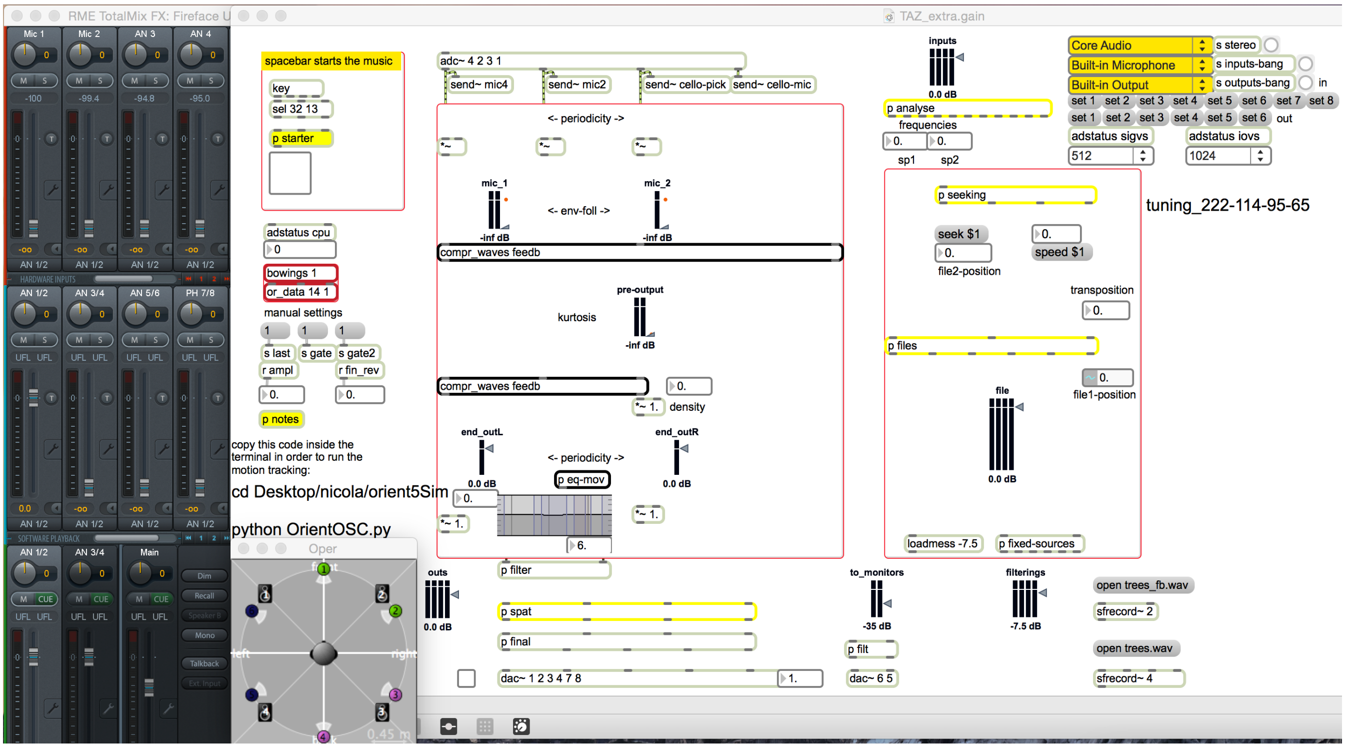


Fig.1-K_4 The main application interface *(Message K_4)*

“For we are like tree trunks in the snow. In appearance they lie sleekly and a little push should be enough to set them rolling. No, it can't be done, for they are firmly wedded to the ground. But see, even that is only appearance.”

Video instructions at: https://www.dropbox.com/s/cb9sdraxga0102x/K_4_instructions.mp4?dl=0

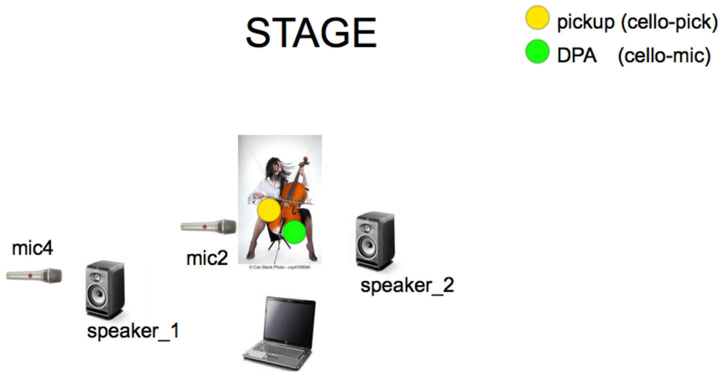
SETTINGS

Arrange on stage a small ensemble of microphones and studio-speakers, in order to conduct a Trio for cello, audio-feedback and tape, through sound-gestural interaction.

The cello is fitted with a microphone and a pickup, exactly as it is in the previous movements of the Kafka cycle.
These 2 cello inputs (possibly DPA and Fishmann) are placed on the cello body.
In addition 2 small speakers (placed on supports c. 1 mt. high) **and at least 2 more microphones** are positioned on stage in order to raise a sound-magnetic field around the cello.
-1st speaker on the right side of the cello (c.1 or 1 and a half meters distance)
-2nd speaker on the left side of the cello and quite close to it in order to resonate with the cello microphone
- 1 omnidirectional microphone diagonally facing the main cone of the first speaker
- 1 additional microphone should be positioned close to the right side of the cello bridge.

SOUND ENSEMBLE.

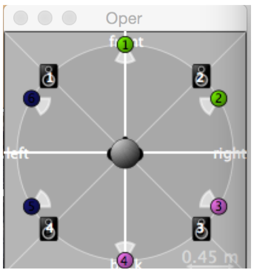
Stage space



-Cello
-Speaker_1: right
-Speaker_2: left
-Microphone_1:
on the cello (“cello-mic”)
-Microphone_2:
front/right of the cello (“mic2”)
-Microphone_3:
contact pickup (“cello-pick”)
-Microphone_4:
close to Speaker_1 (“mic4”)

Fig.2-K_4 Stage

Audience space



Quadraphonic spatialisation

Fig.3-K_4 Audience speakers

MAIN INTERACTIONS

The cello is moved and turned within the sound-magnetic field in order to alter the individual contributions of each microphone, collectively creating dynamic “chord” shifts: the resulting **audio-feedback** will be **a small choir of whistles and modulations.**

During the opening part of the work the cellist modulates the audio-feedback only by modifying the cello position, inclination, and distance from the individual pieces of equipment; during the continuation of the performance the cello sound will be treated also as an active source of modulation of the feedback pitches.

-Microphone_1 should be placed in a way so as not to allow an exaggeratedly fixed pitch from its speaker (distance and angle should be experimented beforehand).

-Special cello drifts with respect to Microphone_2 increase, attenuate or modify the sound contribution of this microphone: approaching the right sound-hole, it mostly picks up the first mode of resonance between 90/100 Hertz, while different and not fully predictable resonances will be raised by turning the sides and the back of the cello towards the microphone.

-The pickup has the function to isolate cello noises independently of the environment

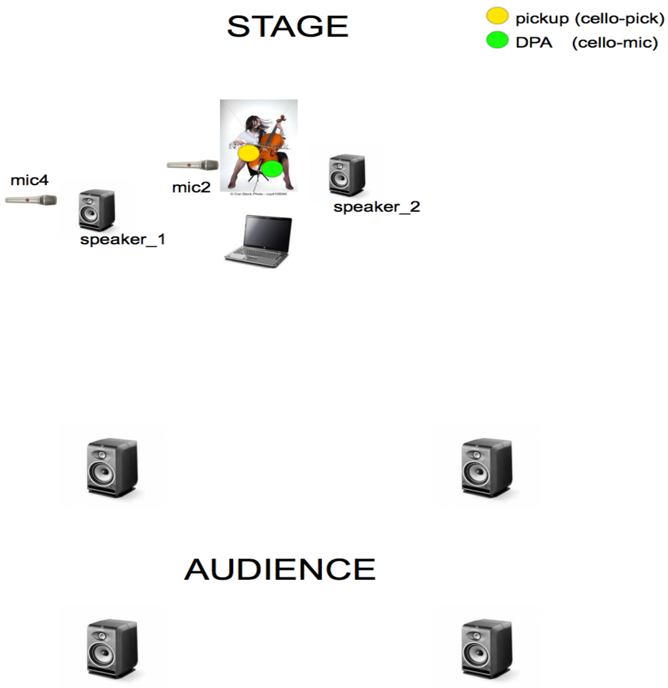
-Microphone_4 is responsible for the cello direct sound, naturally mixed with the feedback occurring on the stage. By occasionally approaching the Speaker_1, the chordal feedback state can be modified.

1 inertial sensor (3axis accelerometer + 3axis gyroscope) is positioned under the frog of the bow (tracking Orientations, Energies and Bowing styles), in order to control the spatialisation for the audience, and further balances and interactions during the composition.

Fig.4-K_4 Bow motion tracking

COMPOSITION

SPATIAL SOUND



The overall sounds come from
2 clearly detached sound fields:
-The stage space
(physical cello plus stage monitors)
-The audience space
(four speakers around the audience)

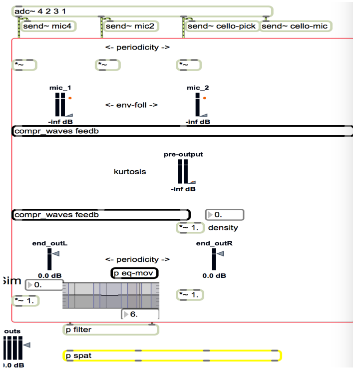
Portions of the outputs are mixed inside these two spaces, but the opposite locations are to be clearly perceptible, as a main central stage source and a distanced mirroring audience space.

Fig.5-K_4 Overall setup

Reflecting the theme of reality and appearance, the spatial distributions are quite ambiguous.

The Stage Space mixes the acoustic sounds (cello plus audio feedback, with their natural patterns of spatial radiation) with the 2 local speakers (routing opposite cello sound features and selected portions of the processed sounds).
The Audience Space mixes the direct and processed sounds, fixing every source at a given location, but also moving their images inside the outer quadraphonic space.

AUDIO FEEDBACK



The system is provided with multiple internal high-amplitude expanders chained with compressors, filters and signal routings.
In this way feedback becomes an active eco-systemic component of the music, and it can be **modulated by the cellist in terms of sound, and of gain controls as well.**
This multilayered system in part follows automations and in part the performing actions of the cellist.

Fig.6-K_4 The audio feedback channels

TIME SECTIONS

TIME	0'00"	0'20" <-> 0'30"	1' <-> 2'	3'	5'	10'20"	10'20"
SECTIONS	slow fadein	SECTION A'	SECTION A"	SECTION A'"	SECTION B	SECTION C	fadeout
GAINS	from silence to very high	very high	very high	dynamically controlled by the cello timbre	quite high	very high	to silence
INTERACTION	waiting	cello movements inside the eco-system	cello pitches modulating the audio feedback cello movements still in action	cello timbre as a main mixer pitch + movements feedback modulations still in action	tape with cello accompaniment tape fragments live triggered feedback modulations still in action as a background	tap-delays upon: audio feedback, triggered tape fragments, cello sounds feedback modulations scattered by the delays	fadeout
SOUNDS	silence	audio feedback (variable pitches)	cello sound feedback chords amplitude modulations	the cello controls 2 channels: -audio feedback -cello enhanced noises	tape + tape fragments cello commentaries occasional feedback	overall mix, delays	fadeout

Fig.7-K_4 Time sections

The overall duration is 13’30” (a 10’ reduced concert-option is allowed). The different sections of the composition afford different kinds of cello interaction with the eco-systemic.
Sections A are mainly focused on the audio feedback.
Section B involves the diffusion (in part interactive) of a 5’ long tape mixing recorded sounds of audio feedback, cellos, environment, and everyday objects.
Section C is a final commentary mixing previous elements

A’ (beginning)

On pressing “start”, multiple chains of amplitude gains progressively reach high levels.
The audio-feedback slowly emerges: the cellist modulates it by moving and turning the cello.
Different distances and angulations increase or stop emergent feedback frequencies coming from stage-speakers and microphones.
Bow circular motions in the air slightly spatialise the sounds inside the audience space.

A” (until minute 2’)

The **audio-feedback** is now principally **modulated by the sound of the cello**
(without refraining from modulating through cello movements, as before). Slow microtonal waving ornamental glides of the cello at the edges of the feedback pitches can induce:
-beats (particularly perceivable in low cello-feedback registers).
-the emergence of unexpected and changing feedback pitch patterns.
-resulting amplitude modulations (relating high, loud and steady feedback pitches).
Almost-in-tune 5th and 8th intervals can also influence the chordal feedback response.
In case of high volumes, quasi-haptic string resonances can induce further pitch shifts.

A’” (3’ -> 5’)

The **input/output gains** inside the system are no longer fixed. From this section till the end, **the cellist can balance them through the amplitude-noisiness-resonance of the cello sound** (see performance notes below). The interaction is now more complex and requires an increase in the cello sound contribution to the performance.

B (5’ -> 10’ 30”)

A pre-recorded sound file (treating cello sounds, recorded audio-feedback, real-life noises) is diffused. The cello plus feedback performance “accompanies” the sound-file.
Impulsive bow movements output and treat in real-time **selected chunks of the audio file.**

C (10’ 30” -> 13’)

After the end of the previous “acousmatic” section, feedback, cello and file chunks are mixed and scattered through the lens of **a variable delay line controlled by the bowing styles,** until the final fade out.

INTERACTIONS

The performance is improvised and requires knowledge and rehearsal of the software circuits as they change over time. The interactive components of the work are:
-setting of the analogue equipment in order to find an optimal response fitting with the cello. This arrangement will be site-specific with respect to the concert room, in order to find a balance of the principal frequencies coming out the audio-feedback system.
-cello sound (microtonal sustained glides, melodic fragments, harmonic contributions).
-cello rolling positions inducing feedback.
-automatic dynamic equalisation of the main feedback sources. The EQ curve continuously varies throughout the piece, readapting the feedback sound colour.
-part of the quadraphonic main output treated with artificial reverb, whose intensity is dependent on the cello pitch: high cello frequencies increase the reverb, low cello frequencies dry the output.
-spatialisation, in part fixed and in part driven by the bow movements.
-cello pitch and timbre modifying the filter parameters and the internal gains.

SOUND CIRCUITRY

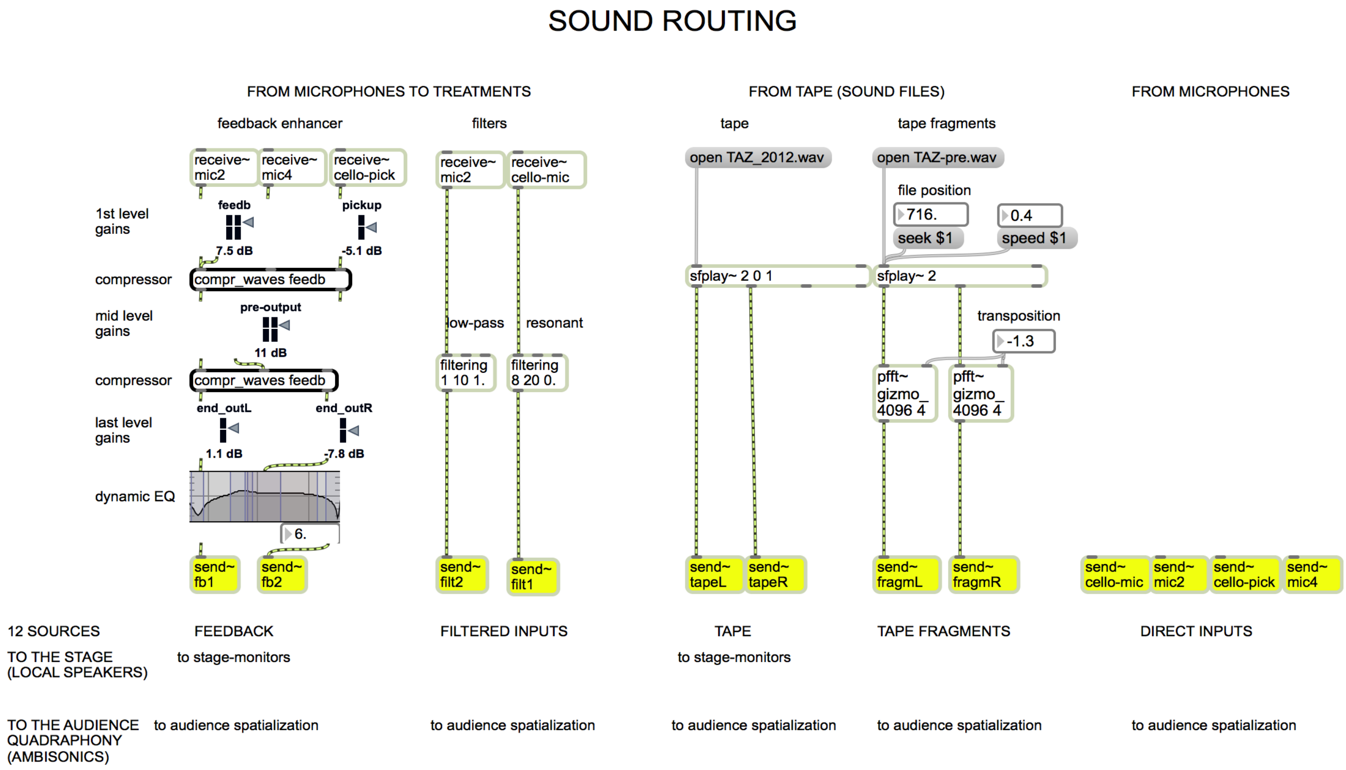


Fig.8-K_4 Processing and routing of the 12 sound sources

Inputs:

4 channel live inputs:

-cello microphone and cello pickup (adc~1 “cello-mic”, adc~ 3, “cello-pick”)

-feedback microphones (adc~2 “mic2”, adc~ 4, “mic4”)

4 channel tape inputs

-stereo tape (active in section B)

-tape stereo fragments (active in section B and C)

Internals:

The 4 live inputs are processed:

-“filt1” = “cello-mic” resonant-filtered

-“filt2” = “mic2” lowpass-filtered

-“fb1” = “mic4+mic2” passing through a chain of high gains, compressors and EQ

-“fb2” = “cello-pick” passing through a chain of high gains, compressors and EQ

“fb1” is the main channel boosting the audio feedback,

“fb2” increases soft-noisy cello sounds, attenuating and lightening the audio feedback.

Audience Outputs:
4 live channel, 4 tape channels, 4 live-treated channels = 12 sources
The quadraphonic audience output mixes the 12 sources, assigning them to fixed locations.
Additionally they are moved in a circle by means of the Ambisonics system: the source movements are driven by bowing styles and orientations through inertial motion tracking.
Section C foresees a multiple delay line of all 12 sources, with fixed output distribution.

The audience spatialisation creates a remote moving image of the sounds produced on stage.

Stage:
Central eco-system (cello, 4 microphones, 2 local speakers).
From the stage are diffused:
-the cello sound
-the emergent audio feedback
-the sounds routed to the stage-speakers:
2 feedback channels "fb1" and "fb2", plus the tape stereo output (during section B).

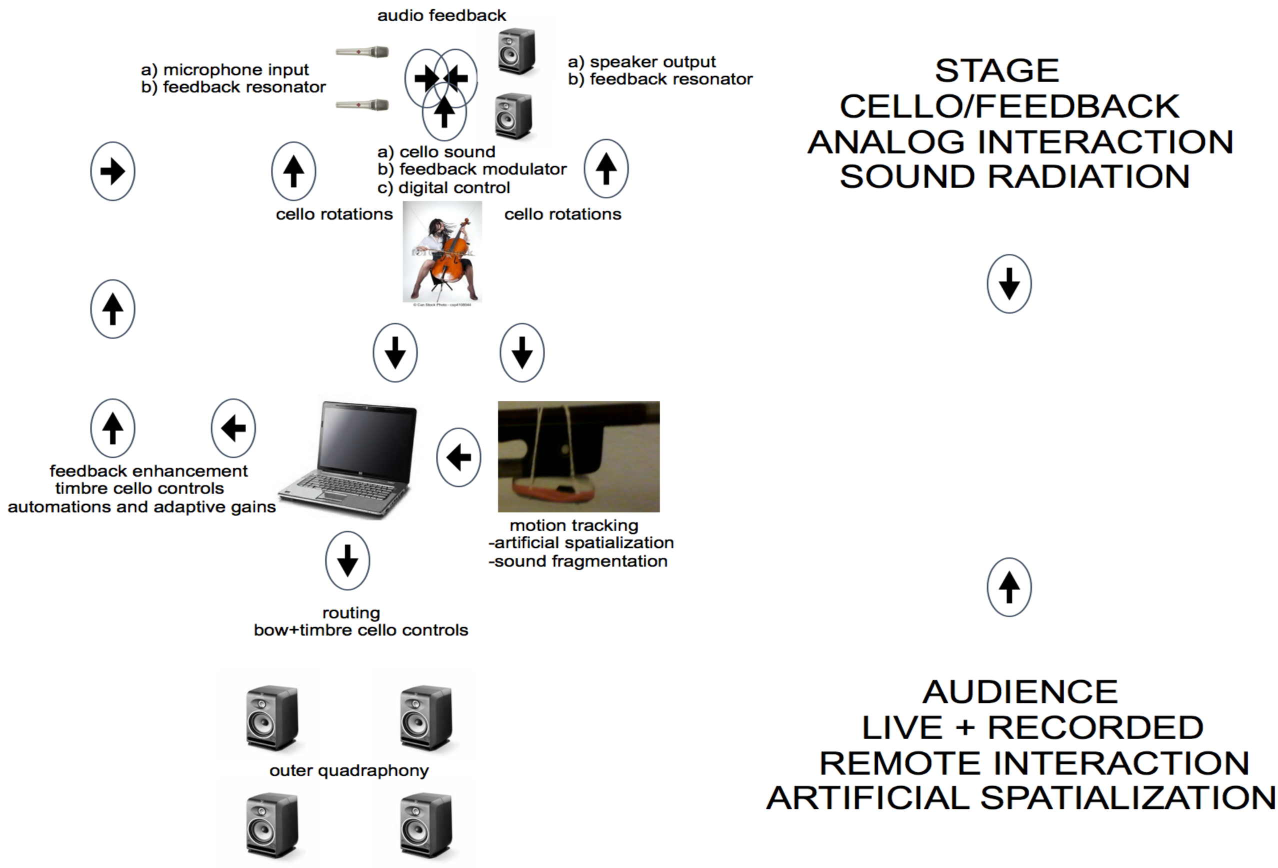


Fig.9-K_4 Analog/digital map

I/O:
Taking into account the central role of the audio feedback, the inputs (microphones) are to be considered as outputs at the same time, and vice versa the speakers (at least the stage monitors) are outputs and inputs at the same time.

The system (including the cello performance as an agent among other agents) is not conceived for a target music result, but instead for **a final balance of different patterns of emergent sound behaviours.**

The sections A-B-C simply shift the essential conditions of the live interaction, in a sense putting the same autonomous system inside different and pre-determined contextual conditions of "survival".

PERFORMANCE

No special software calibration is required, besides the analogue and site-specific setting of the eco system. Quick performance notes are embedded in the software (module "notes").

Position the charged IMU under the frog of your bow, and connect its basestation to the first USB port; the file "OrientOSC.py" needs to be running inside your HD.

By default the folder "nicola" has to be located inside the Desktop, and you need to open the patch, copy the code provided by the patch, "cd Desktop/nicola/orient5Sim python OrientOSC.py" and past it inside the terminal.

Any different folder name and path obviously has to be typed or replaced inside the message.

SECTIONS
Press the Spacebar in order to start the interaction.

-Section A' involves the silent interaction between cello positions and equipment. From the beginning the amplitude sliders slowly fade in and after a short period the audio feedback will be rising, emerging from the silence.

-When you feel the introduction is accomplished (not less than 1', or more than 2'), **you start to play the cello, entering section A".** The cello performance will primarily be involved in giving rise to **different kinds of amplitude modulations** (beats, roughness, phantom glides) **and pitch/chord shifts with respect to the audio feedback.**

-Section A"' starts when the amplitude sliders are no longer fixed, but shifting. Now **you control them through the amplitude, noisiness and resonance of your sound.**
You can see on your screen 3 chained levels of gain and compression.

The upper part distributes your sound in **2 channels, higher amplitudes increasing channel 1 and softer amplitudes increasing channel 2 (channel 1 coming from the feedback microphones, channel 2 from the cello pickup).** The mid gain level depends on the resonance of your sound. The final gain level boosts channel 1 the more your sound is periodic, and vice versa boosts channel 2 the more your sound is noisy.
In this way the balance of feedback vs. soft cello-noises constitutes an added control to the previous activities of sections A' and A''.

-Each new section does not substitute modules or qualities of interaction: it just adds a new means of control. No special music patterns nor music languages are suggested, the cello sounds will be focused on the concept of interplay and modulation.
Melodic and ornamental cello patterns can be performed by alternating as a foreground with the other sound components of the interaction.

-Section B triggers the **audio file** (developing in embedded contrasting sections containing recorded audio feedback). Some preselected noisy portions of the file are to be output through impulsive bow movements in the air.
Different **file fragments** are output through different directions of impulsive bow rotations (see the last section "bow interactions").

The tape must be accompanied by the cello improvisation. The gains of the live sources are again fixed in order to output a reduced portion of audio-feedback.
The stereo components of the audio file are spatialised through bow-tremolo (stereo right portion) and bow rotation (stereo left portion).
The overall amplitude of the file increases proportionally to the global velocity of the bow.

Details about the interactive controls can be explored by navigating inside the internal commented modules of the application.

-At the end of the tape **section C** starts (you can notice the transition also by looking at the tape sound monitor on the right). A system of 4 parallel tap-delays scatters all the sounds, while the audio feedback emerges again. The sound sources most actively involved in this scattering sound process are the **audio feedback, cello percussive-noisy-aggressive sounds, the tape fragments** (still enabled despite the end of the main tape diffusion).

The delay lengths individually increase in response to the intensities of your bowing styles (*Tremolo, Staccato, Balzato, rotation*).

-Final fade out.

SOUND SOURCES
-1) The four input microphones are subdivided into cello and feedback input couples.
Cello inputs:
-DPA (Microphone_1 “cello-mic”) focuses on cello full sound, in part mixed with the Speaker_1 feedback.
-pickup (Microphone_3 “cello-pick”) in particular amplifies and enhances low-amplitude cello noises, which feed channel 2
Feedback inputs:
-Microphone_2 (“mic2”) mainly picks up the feedback coming from the cello sound-hole (low frequencies) and/or any resonance/interference coming from the closed cello placement.
-Microphone_4 (“mic4”), the most distant from the cello, is mainly involved in the feedback coming from Speaker_2 (higher frequencies).
The ensemble of cello/microphones/stage-speakers is a partially predictable analogue circuitry, whose complex interactive sound response (comprising the audio feedback) is naturally mixed because of their close distances, and in which inputs and outputs therefore feed each other.

-2) Each input follows an individual treatment in terms of filtering.
The cello inputs are autonomously enhanced/compressed and equalised
The feedback inputs are filtered respectively Low-pass and Resonant with cut-off depending on the current cello fundamental frequency.
The main inputs are routed in 2 channels: the 1st enhancing feedback, and the 2nd enhancing noisy/high-frequency soft cello sounds.

-3) We therefore have 3 groups of sound sources:
-direct sources (the 4 microphones);
- 2 channels of enhanced sources, plus 2 channels of filtered sources
- stereo tape, plus 2 channels of tape fragments
Section A is mainly involved with the 2nd group (enhanced/filtered sources).
Section B is focused on the 3rd group (file sounds) with the addition of the 2nd group.
Section C is an overall mix.

BOW INTERACTIONS
The bow gestures act indirectly as digital controllers: the gestures can be impulsive (triggers) or continuous (shapes). As detailed inside the above Fig. 10 the system interacts through:
-4 rotational and 1 horizontal triggers
-Orientation (vertical and horizontal)
-Energy (quickness and rotation)
-Styles (tremolo and balzato)
The continuous bow movements affect the spatialisation (circular movements of the output sound sources around the audience space).

These movements can be more effective when performed in the air, but they are active also when the bow interacts with the strings, while playing the cello normally.

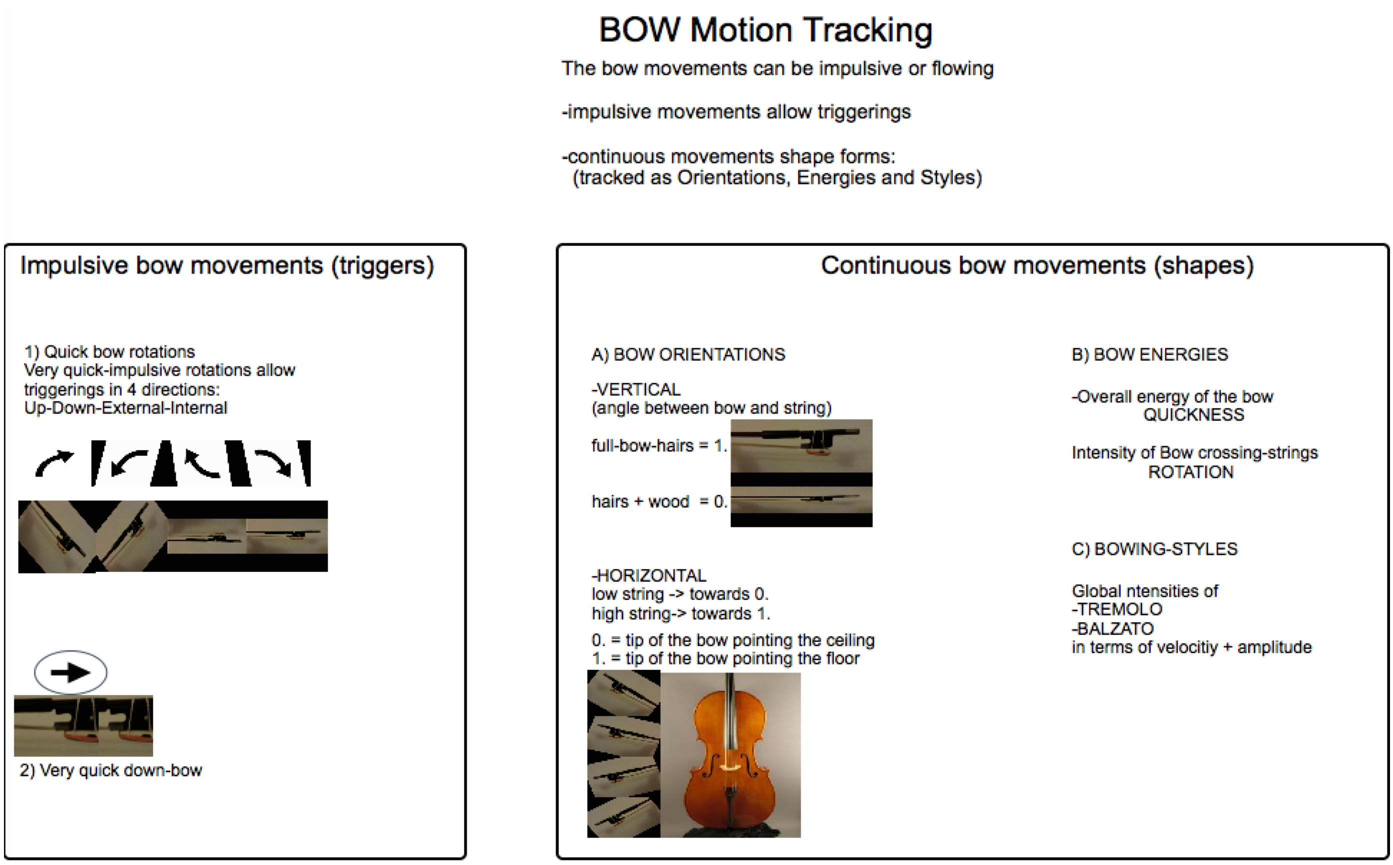


Fig.10-K_4 Bow as a digital controller

Through **Horizontal and Vertical Orientations**, the bow spatializes the 2 main direct sources ("mic4" and "cello-mic"): the microphone close to speaker_1 and the cello DPA.

Through the **intensities of *Tremolo* and *rotation***, the bow spatializes the 2 channels of enhanced signal ("fb1" and "fb2"): respectively the most influencing part of the audio feedback and the small cello noises.
The 2 channels of the stereo tape are spatialised in the same way.

Through the **intensity of *Balzato***, the bow spatialises the file fragments, and the 2 channels of filtered inputs ("filt1" and "filt2").

Impulsive bow *rotations* in the directions Up-Down-Internal-External trigger different portions of tape fragments during sections B and C.

A very quick down-bow (preferably performed in the air, since more powerful as a gesture) freezes the values of horizontal and vertical bow orientation at the moment of the triggering.
These orientation values affect the speed and transposition of the audio fragment when it is triggered. (see inside the module "seeking" for more details).

MOTION TRACKING

Inertial Motion Tracking is tested with the Orients_15 System, developed by the Centre for Speckled Computing of the University of Edinburgh, [2] running through the orientMac application.This application and the related Readme.txt document are contained in the main folder of this software. The system needs a native Bluetooth 4 Mac version as minimal requirement.

A different Motion Tracking system is allowed by substituting the abstracion “or_data” with a different OSC udpreceive module, which must contain proper scaling and normalisation.
Details are given inside the module “or_data” and in the Readme text file.

SOFTWARE

K-Message_1
MAX/Msp 6.1 or *K_1-GESETZ* standalone application

LIST OF EXTERNALS AND ABSTRACTIONS

ambiencode~, ambidecode~, ambimonitor (Jan Schacher)
http://trondlossius.no/articles/743-ambisonics-externals-for-maxmsp-and-pd

banger (Peter Elsea)
http://peterelsea.com/lobjects.html

bonk~ (Millar Puckette et al.)
http://vud.org/max/

chroma~ (Adam Stark)
http://c4dm.eecs.qmul.ac.uk/people/adams/chordrec/

f0.fold (Fredrik Olofsson)
http://www.fredrikolofsson.com/pages/code-max.html

ftm, ftm.copy, ftm.mess, ftm.object,
gbr:fft, gbr.slice~, gbr.wind=, gbr.yin,
mnm.delta, mnm.moments, mnm.onepole,
FTM-Gabor library (Norbert Schnell et al.)
http://ftm.ircam.fr/index.php/Download

fiddle~ (Millar Puckette et al.)
http://vud.org/max/

---

[2] www.specknet.org

fog~ (Michael Clarke and Xavier Rodet)
http://eprints.hud.ac.uk/2331/

gf (Frederic Bevilacqua et al.)
http://forumnet.ircam.fr/shop/en/forumnet/59-mu.html

M4L.gain1~, M4L.delay~ (abstractions)
https://cycling74.com
multiconvolve~ (Alex Harker and Pierre Alexandre Tremblay)
http://www.thehiss.org/

imubu, mubu, mubu.granular~, mubu.knn, mubu.process, mubu.track,
readaptation of the abstraction mubu-mfcc-matching
pipo~ (IRCAM IMTR)
http://forumnet.ircam.fr/shop/en/forumnet/59-mu.html

roughness (John MacCallum)
readaptation of the abstraction rzcalib (Michael Zbyszbynski)
http://www.cnmat.berkeley.edu/MAX

sadam.stat (Ádám Siska)
http://www.sadam.hu/en/software

supervp.trans~ (IRCAM Analysis/Synthesis Team)
readaptation of SuperVP.HarmTransVoice
http://forumnet.ircam.fr/product/supervp-max-en/

zsa.flux~ (zsa.easy_flux) (Mikhail Malt, Emmanuel Jourdan)
readaptation of the abstraction zsa.consonant tracking
http://www.e--j.com/index.php/download-zsa/

K-Message_2
MAX/Msp 6.1 or *K_2-INDIAN* standalone application

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http://trondlossius.no/articles/743-ambisonics-externals-for-maxmsp-and-pd

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http://vud.org/max/

chroma~ (Adam Stark)
http://c4dm.eecs.qmul.ac.uk/people/adams/chordrec/

dot.smooth, dot.std (Joseph Malloch et al.)
http://idmil.org/software/digital_orchestra_toolbox

ej.line (Emmanuel Jourdan)
http://www.e--j.com

f0.fold, f0.round (Fredrik Olofsson)
http://www.fredrikolofsson.com/pages/code-max.html

fiddle~ (Millar Puckette et al.)
http://vud.org/max/

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gbr.bands, gbr:fft, gbr.resample, gbr.slice~, gbr.wind=, gbr.yin,
mnm.list2row, mnm.moments, mnm.onepole, mnm.winfilter
FTM-Gabor library (Norbert Schnell et al.)
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readaptation of the abstraction mubu-mfcc-matching (IRCAM IMTR)
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http://www.cnmat.berkeley.edu/MAX

K-Message_3
MAX/Msp 6.1 or *K_3-ODRADEK* standalone application

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chebyshape~ (Alex Harker)
http://www.alexanderjharker.co.uk/Software.html

ej.line (Emmanuel Jourdan)
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f0.fold (Fredrik Olofsson)
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gbr:fft, gbr.harm, gbr.slice~, gbr.wind=, gbr.yin,
mnm.alphafilter, mnm.list2row, mnm.list2vec, mnm.onepole, mnm.winfilter
FTM-Gabor library (Norbert Schnell et al.)
http://ftm.ircam.fr/index.php/Download

fiddle~ (Millar Puckette et al.)
http://vud.org/max/

ircamverb~ (IRCAM Espaces Nouveaux)
http://forumnet.ircam.fr/product/spat-en

list-interpolate, resonators~, res-transform, sinusoids~, (Adrian Freed)
delta (Matt Wright, Michael Zbyszynski)
roughness (John MacCallum)
http://cnmat.berkeley.edu/downloads

sigmund~ (Millar Puckette et al.)
http://vud.org/max/

yin~ (Norbert Schnell)
http://imtr.ircam.fr/imtr/Max/MSP_externals

K-Message_4
MAX/Msp 6.1 or *K_4-TREES* standalone application

LIST OF EXTERNALS AND ABSTRACTIONS

dag.statistic (Pierre Guillot)
http://www-irma.u-strasbg.fr/~guillot/

ej.line (Emmanuel Jourdan)
http://www.e--j.com

f0.distance, f0.round (Fredrik Olofsson)
http://www.fredrikolofsson.com/pages/code-max.html

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gbr:fft,, gbr.slice~, gbr.wind=, gbr.yin,
mnm.alphafilter, mnm.delta, mnm.list2col, mnm.list2row, mnm.list2vec, mnm.moments, mn-
m.onepole, mnm.winfilter,
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quat2car (freeware)
http://www.mat.ucsb.edu/~wakefield/soft/quat_release.zip

spat.oper, spat.spat~ (IRCAM Espaces Nouveaux)
http://forumnet.ircam.fr/product/spat-en

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