Real Time Interaction Course – NIME Paper

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ABSTRACT
This paper includes the design and implementation process of our instrument for Real Time Interaction course. The instrument has rhythm, bass, chords and solo section. It is programmed with Pure Data and it can be controlled by a smartphone interface.

Author Keywords
NIME, synthesizer, RTI, instrument, Mrmr

1. OBJECTIVES
There is no doubt that performing music is a social experience. This social nature of music encourages performers to express themselves accordingly. Hence, one of the main criteria for the expressiveness of a music instrument relies on is the social interactiveness that it provides to its users. In our new digital musical instrument design, we aim to provide a platform so that each performer in the band has the same control and the same degree of freedom when producing live music. In the case of traditional instruments performers need some time to expertise or to produce something musical with the instrument in general. One of the objectives of our design is to apply this idea to our instrument.

The main idea behind the interface design is to divide the concept of a typical musical performance into four main categories: Rhythm section, Bass section, Harmony Section and Solo Section. These four distinct aspects of a musical performance are to be controlled separately. To build such a device, our objective was to create a synthesizer that can be controlled with a smartphone.

As in terms of the style & genre of the performance, our synth can be used in create and play several electronic music genres such as drum&bass, dubstep, house, etc. With the harmonic capabilities of the device, composition is made easier. Except the sampled drum loops, all the sounds will be synthesized and with changing filters, envelopes etc., the user can create different tones.

2. CONCEPT
Our digital musical interface design has the idea of allowing each player to experience different aspects of a musical performance, like rhythm section, bassline, harmony or solo. The philosophy behind our design was allow people without any musical background to experience deeply the aforementioned aspects of a musical performance, in a convenient, but not perfect manner. Our instrument has various sections, each having distinct mentality of producing music. To perceive every aspect of the instrument and have the real experience out of it, performers are encouraged to spend time with it to expertise and output good musical results. Our instrument can be played by multiple people, each player having the same privileges in the process of creating music. Furthermore, in order to create something musical, there are two main steps for each individual player. First, the players are to observe and discover the different possibilities they could experience for each part and understand the behavior and responsibilities of each section. Secondly, they need to be able listen and 'be at the same moment' with the rest of the players. Ideally, each player should have a clear understanding of the distinct characteristics of each section and be aware of what is going on in the music.

3. FIRST ITERATION DESIGN AND IMPLEMENTATION
The first version of our design consists of four distinct parts. By separating the whole system into four parts, we aimed to reflect three different aspects of a typical musical performance: Rhythm, bassline, harmony. All of these parts can be controlled individually and simultaneously. This allows the synth to be controlled conveniently by multiple people.

The rhythm section of the design is a drum machine. The bassline is a 128-step digital bass sequencer. The harmony is provided with chord-machine.

An important issue that determines the usability of a digital music instrument is the design of the interface. Our system is played through a mobile device. All of the controller parameters are controlled through the touchscreen of a smartphone device. Some strategies, like bypass, etc. are exploited to ease the control of parameters.

Rhythm Section
The rhythm section of the instrument is a loop player that takes a ".wav" file. After reading, it divides the file into 8 equal-length parts and gives the user the possibility of different manipulations to each part. The basis for our design is from [2]. In the original design, the user can change the order of which the parts can be played, perform reverse operation and create drills for each part. In our design, we set the order fixed and it plays all the parts in the original order. We left the reverse and drill operations for each part as the original design. The reverse operation is controlled with toggles and if it is on, it plays that specific part from back to beginning. There are 8 toggles to perform reverse for each part of the audio file. The drill operation is controlled by vertical sliders and when it is 0, it plays the original part. When the user changes the value of the vertical slider, it changes the tempo of the part without changing the duration. Therefore, lower values in the slider result in faster drills. There are 8 vertical sliders to control the drill operation for each part.

For the first performance, we used 3 free drum&bass drum loops. We also implemented buttons to change which loop to be played.

Bassline
The bass section of the instrument is a 128-step bass sequencer. The main approach is the subtractive synthesizer for this part of the whole system. Both of the rhythm section and bass line are connected to a global counter. Thus, the sequencer could is in-sync with the rhythm section with a control button. The metronome of the bassline could also be changed independently with three options: half tempo, double tempo, same tempo. However , through our initial experiences, we observed that this control reduces the controllability of the instrument

due to being too unstable. The controller seen in Figure 1 is removed in the second iteration.

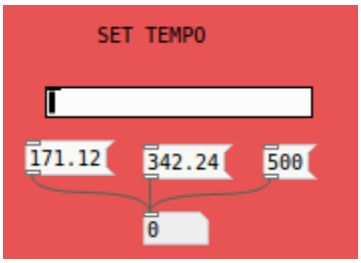

Figure 1. Tempo control, horizontal slider & half, double, same tempo with the rhythm section

The bass synthesizer part had many sections, perhaps even too many. Among these abilities of the bass sequencer are a Filter LFO, Bass Envelope, Glide & Wobble, Additive Synthesis, Bass Patterns (Figure 2). The bassline is read from a prewritten .txt file from the pattern bank. The bass sound is synthesized, in which the waveform could sine or sawtooth. The subtractive synthesizer approach is utilized for the design of the bass synthesizer. The ADSR envelope in adsr.pd is used for the envelopes. The envelope parameters can be controlled to obtain different timbres on the bass sound. There is Filter LFO, inspired by the vcf-LFO-sample&hold example provided within the course. The glide & wobble sound is added as an independent bass sound, which is connected to the global counter. The details of this part is provided in the second iteration. Additive synthesis is another part of the bass sequencer that allows to create inharmonic timbres. This part is removed in the second iteration.

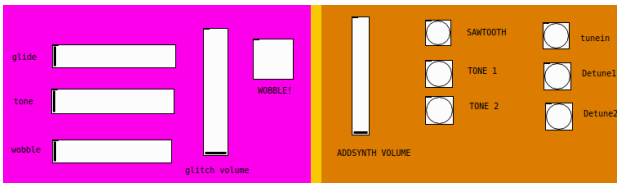

Figure 2. Glide & wobble control (left), Additive synthesis control (right)

Harmony

The control of the harmonic content of the musical performance in the first version of our design is provided through a chord-machine. Our chord-machine could play the major and minor triads in all 12 pitch-classes. But four of them could be accessed for each musical performance, depending on the song. For our first performance, the chord progression of our song was inspired by Get Lucky – Daft Punk.

We implemented used the adsr envelope implementation that is also in the bass section to change the tone of the chord-machine. Also there is a toggle button to control whether the chords are played with sustain-mode or not. There is also a sustain/non-sustain control for the chords to be played.

4. FIRST PERFORMANCE AND EVALUATION

As mentioned earlier, in our first iteration, we have observed that there was too much things to control, reducing the playability and even musicality. Even though these abilities could be interesting, some of them removed in the second iteration and we will discuss them later.

The song we created for our first performance had several parts with different bass patterns, drum loops, bass and chord tones etc. We created our instrument in a way that gives the user a lot of freedom to control many parameters. The user could create reverse and drill operations on drum loops, change drum loops, change the parameters of adsr envelopes of bass and chord machines, change the parameters of LFO and additive synthesis for bass section. Our initial idea was to give as much as freedom to the user so that she/he can create a wide range of sounds.

Another part of preparing for the first performance was the mapping. Since our instrument is controlled with a smartphone, we had to design the interface for the smartphone application and do the appropriate mapping. While doing that we put almost all the parameters we had for our instrument in our smartphone interface. Although at first it seemed like a good idea in a way that it gives more possibilities to the user, during the performance we experienced that the degrees of freedom of our interface was more than we could handle during a live performance. Especially for one song, we did not need to control too many parameters because it makes following the song hard for the user. We needed a more controlled, limited interface and we will discuss it in the performance part of the second iteration.

5. SECOND ITERATION DESIGN AND IMPLEMENTATION

In our second iteration, we have modified almost every aspect of our instrument, only keeping the main philosophy behind the design. Moreover, a new aspect of musical performances is added to the whole-system: the solo instrument. The solo section is trained with a MIDI file which is a monophonic waltz (3/4) solo performance in style of swing-manouche (gypsy swing) using 2nd order Markov Chain.

Also, we have provided a better interface for the users who would like to use to patch on Pure Data. (Figure 3 & 4) The upper left section is the drum machine, the upper right belongs to the bass part, the lower left section is the harmony part and the chords and finally the last part is the solo generation. Figure. Shows the control panel that indicates the main objects of the whole system. Control panel also serves as the gate to access the other parts of the whole system (counter, beats, pattern bank, envelopes, chord-machine, Markov Chain - solo generation, etc.) Also the loadbang object sets the initial values for the timbre of the bass part.

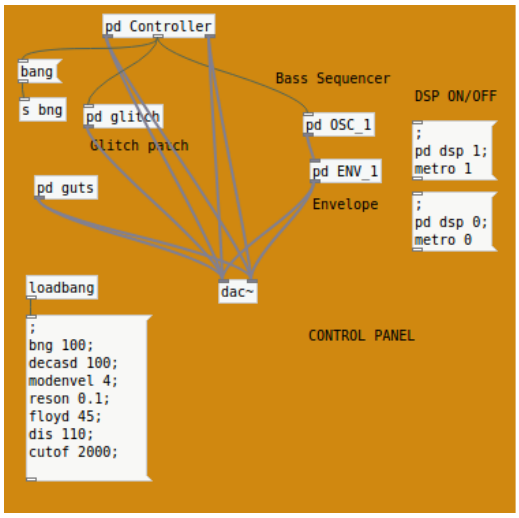

Figure 3. Control Panel, to access the configurations

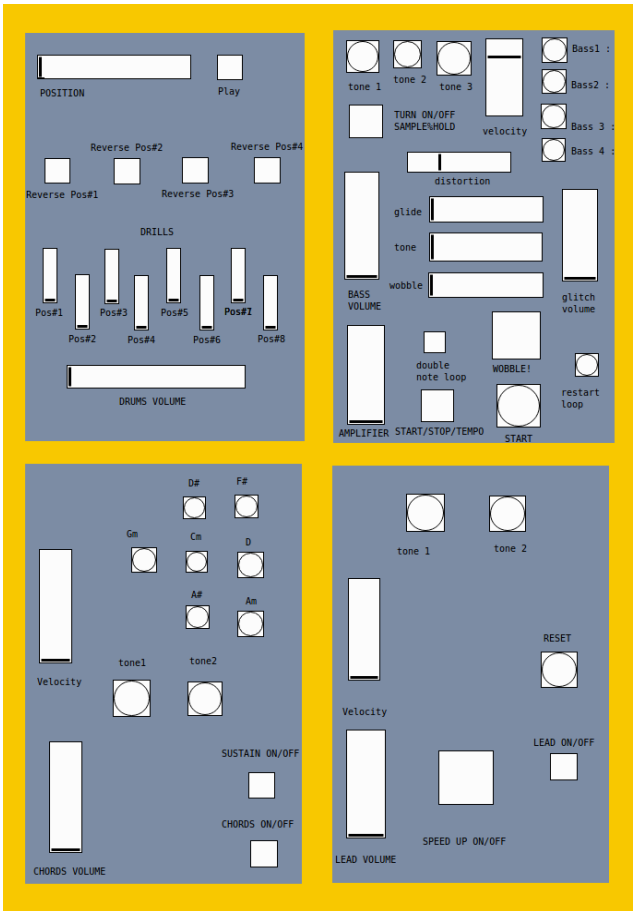

Figure 4. The Pure Data interface of the second iteration design. Drum machine (upper left), Bass section (upper right), Chords (lower left), Solo (lower right)

Rhythm Section

The rhythm section of the second iteration has the same design as the first iteration. To simplify the controls, we included the reverse operation only for the 1st, 2nd, 3rd and 5th part of the audio file. The drill operations stayed the same. We also got rid of the buttons to change the audio file to be played and we used only one audio file for the rhythm.

Bassline

The bass section has the same main idea as in the first iteration of our design, with some major modifications. The additive synthesis is removed. The users have less degree of freedom on the timbre of the bass sequencer. The tempo of the bassline is invariant and in always in-sync with the rhythm section.

Notes are played with their one-octave lower pitches simultaneously, to obtain a certain timbre. Different than the first iteration, the sound of the bass sequencer is a combination of sawtooth and sine waves.

There are 4 different bassline. The basslines for the second performers are written more melodically. All four of them are in the same key, written to be played for distinct sections of the song. Also they are written considering the harmonic background of the composition. By doing this, the chords in the chord-machine part and basslines in the bass pattern bank sound musical.

Glide & Wobble

Other than the sound produced by OSC_1 in our synthesizer, there is also another bass synth, played simultaneously (optional) and in-sync with the sound produced by OSC_1 as they are both connected to the same clock source. It has four controls: volume, wobble, tone and glide.

The implementation of this part of the synth is inspired by the example from [1]

Harmony

For our second performance, we composed our song in G Harmonic Minor tonality. Thus the design and control of the chords to be played are chosen accordingly. The order of the chord controls are placed to provide the user a sense of harmonic hierarchy. The leftmost chord button is the tonic of the piece. The rightmost buttons have functionalities as either the dominant, tritone or the passing-note. The middle buttons belong to the functional harmonic category of either the sub-dominant or the super-dominant. By this way, we aim to allow users that have no idea about music theory, to improvise on the harmony.

Moreover, the timbre of the chords to be played have less control in the second iteration. There two distinct tones to be chosen for the timbre of chord-machine.

Solo Section

The solo section of the song uses a 2nd order Markov Chain. We used the design of Joan Carles Cardell Gayà and made few changes to adapt it to our instrument. First, we use only one midi file to train the model and it loads automatically when the patch is opened. The MIDI file is a solo performance in style of gypsy swing and in tonality of G harmonic minor, which is the key of the composition. Secondly, we synchronized the tempo of the solo section with the tempo of the rhythm section. There is an option to play the section in double time. Lastly, to avoid a monotone melody, we implemented silent notes. The instrument plays a silent note with ⅙ probability at all times.

6. SECOND PERFORMANCE AND EVALUATION

For our second performance, we discussed our decisions on smartphone interface design and mapping for the first performance and improved our instrument. Although we added some extra sections to our instrument, the control interface became much simpler in order to help the user. For this part we wanted to create a song that is influenced by several genres such as dubstep, gypsy-swing etc.

To have a less complicated performance experience, we started to use presets for bass, chord-machine and solo tones. We reduced the degrees of freedom of our instrument so that we could pay more attention to the song during the performance.

One aspect we need to solve for the future versions of our design is the gain levels of each of the sound source in the whole system. For instance, we have observed that the glide & wobble sound could be dominating the entire performance if not carefully adjusted, while the gain range of chords do not allow them to be heard in the case of too loud bass/drums/solo. Hence a fine tuning needs to be done on the slider parameters.

The smartphone interface can be found in Figure 5.

7. DISCUSSION AND LESSONS LEARNED

During this process, we had the opportunity to experiment with various aspects of visual programming with Pure Data. Since our instrument has many sections like rhythm, bass, chords and solo, we have improved our skills about reading and manipulating an audio file, synthesizing sounds and using envelopes and filters, algorithmic composition etc.

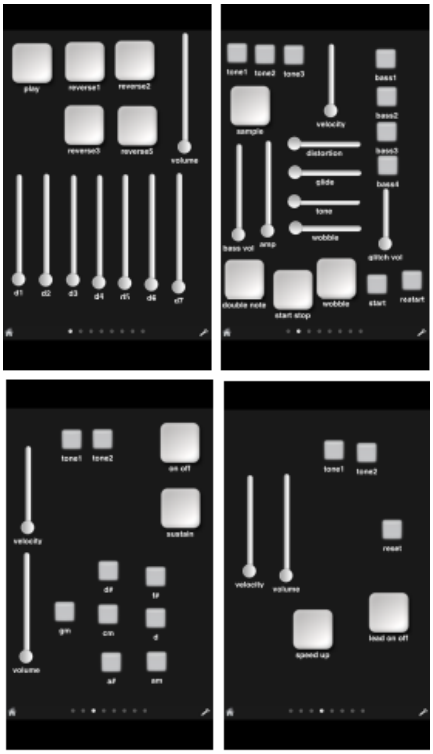

Figure 5. Smartphone interface using Mrmr

One of the most important lessons we have learned while preparing for our performances is that creating an instrument that can does everything can distract the performers and affects the creative process in a negative way. Although having a high degree of freedom seems like it may improve the possibilities a user can experiment, it comes with a disadvantage that the user may get lost during this process. We can understand the concept of "what defines an instrument is its limitations" more now.

Another thing we have observed is that since this process was performance oriented, it is crucial to spend enough time on rehearsing the performance. Spending all the time on improving the instrument can increase the variety of sounds but if the users are not confident about manipulating those sounds, the resulting work may not reveal all the potential of the instrument. Working on the instrument and working on the performance should go hand in hand.

8. FUTURE WORK

In the future implementations, some modifications, additions and fine tunings are necessary for the sake of playability and musicality. First of all, the loudness levels of each distinct sound source in the whole instrument should be normalized so that they all perform in the same loudness range.

We will aim to achieve simpler looking interface. To do this, one feature we would like to modify in our design for the future implementations is adding accelerometer when changing the tones of the related section. By doing so, we would be able to get rid of several buttons on the interface screen. The volume sliders could be mapped to volume buttons of the smartphone, which would clear up a lot of space. Moreover, the playing of the bass part will be modified so that it could be played without the need of prewritten bass sequences. One option is adding a one octave midi keyboard.

Also, to provide more independence for each performer and to enhance expressiveness, looper could be added. With the looper in each section, players would not have to perform always in real time. The need for prewritten samples will be gone as well.

9. REFERENCES

[1] https://forum.pdpatchrepo.info/topic/4264/dirty-dubstep-bass
[2] https://forum.pdpatchrepo.info/user/diplipito