PAMDI Music Box
Primarily Analog-Mechanical, Digitally Iterated Music Box

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ABSTRACT

PAMDI is an electromechanical music controller based on an expansion of the common metal music boxes. Our system enables an augmentation of a music box by adding different musical channels triggered and parameterized by natural gestures during the "performance". All the channels are generated from the original melody recorded once at the start.

We made a platform composed of a metallic structure supporting sensors that will be triggered by different natural and intentional gestures. The values we measure are processed by an arduino system that sends the results by serial communication to a Max/MSP patch for signal treatment and modification.

We will explain how our embedded instrument aims to bring to the player a certain awareness of the mapping and the potential musical freedom of the very specific – and not that much automatic - instrument that is a music box. We will also address how our design tackles the different questions of mapping, ergonomics and expressiveness and how we are choosing the controller modalities and the parameters to be sensed.

Keywords
Tangible interface, musical controller, music box, mechanical and electronic coupling, mapping.

1. INTRODUCTION

Sometimes hidden in a box's double bottom [1], the mechanical system involved in the "carillons à musique" is both straightforward and rudimentary, and can require watchmaker's precision. Since clocks and bell carillons in the 13th century, different technologies have been used from the Brachhousen metal disc [2] to paper ribbons mechanisms, not forgetting digital recordings played by a electrical acoustic transducer [3]. The system we focus on is certainly the more commonly imagined when speaking about music boxes. Invented in 1796 by watchmaker Antoine Favre, it is composed of a pinned revolving cylinder and a tuned comb, and the fixed melody is played by rotating a crank with two fingers [5]. Crank turning has been often used as energy source for musical mechanisms, as recalled by Ajay Kapur in his history of robotic musical instrument [6]. In our project we worked on extracting some expressive aspects of this interaction.

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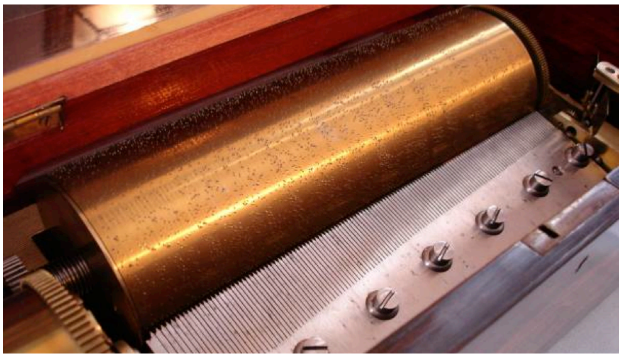

Figure 1. Cartel dit "Boite à ouverture" from [4]

Conceived to be adaptable to a wide range of mechanical music box models, our system adds extensions to the existing mechanism in order to capture different parameters through a tangible and tactile interface.

2. MUSIC BOX CHARACTERISTICS

In this project three aspects of those mechanical systems interested us.

2.1 Three degrees of freedom

Even though they are often defined as 'automatic' musical instruments, those music boxes incorporate a certain dimension of performance personalization, especially when they are controlled manually and not with a motor or a spring. Indeed, we count three dimensions of freedom in the play: the speed and tempo controlled by the celerity of the crank rotation; the loudness of the sound determined by coupling the box with resonating elements (wall, box, desk) and by the force applied to produce the contact; finally, the envelope of the sound produced is a consequence of the material of the resonating object (wooden box, metal plate…). We will see later how we used those parameters in the design of our musical controller.

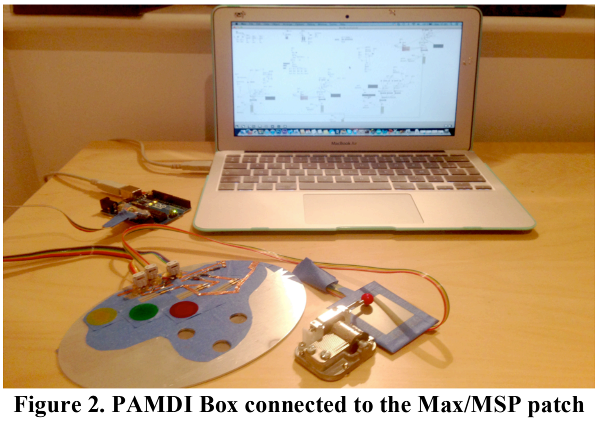

Figure 2. PAMDI Box connected to the Max/MSP patch

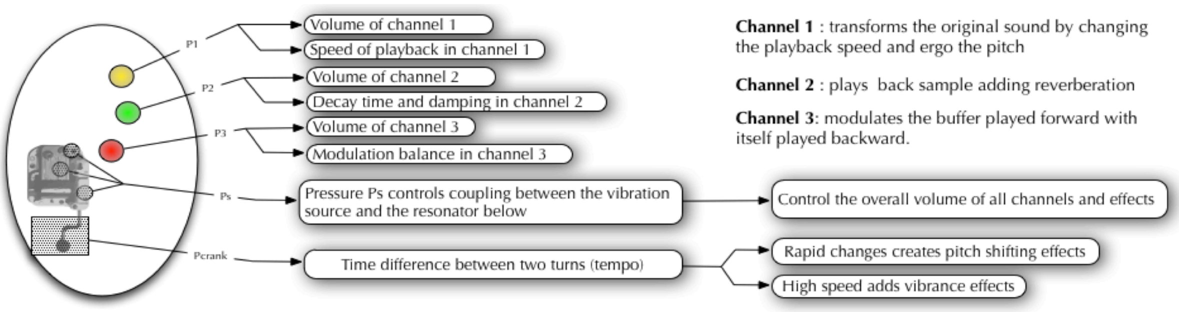

Figure 3: Schematic overview of the system

2.2 Unusual mapping

A second notable aspect is the unusual mapping between the control elements and the variations in the sound and its quality. We can notice the existence of two different tempos in the general rhythm: the musical tempo of the melody and the rotational tempo of the crank (the speed always being reduced by a gear mechanism to about a 28th of the initial rotation speed). This second tempo contains inevitable irregularities, both periodic (acceleration on the crank half turn up and deceleration on the other half) and in the long run, due to the abilities and intentions of the player. Secondly, while coupling the box to other elements, it is generally impossible to prefigure the consequences on the sound because it would require analysis of the physical joint properties of all chain of contact objects.

Those two elements bring a very unintuitive control of the instrument's sonority. When designing our platform, we played on this unusual mapping in using crank rotation speed to determine the general rhythm instead of tracking the musical beat.

2.3 Awareness aspect

One last property of this musical mechanism is the high level of awareness: awareness of the melody line with the visible pinned cylinder and awareness of the mechanism behind the sound production. Having such a visual understanding of the origin of different pitches and immediate and smooth control of the speed is maybe the reason why those antique system are still universally known. We do believe that the approach of music provided by this instrument presents an interest in the music discovery process, especially for young children, that no other instrument offers.

3. SYSTEM DESIGN

The PAMDI system consists of 3 parts: a tangible, tactile and ergonomic board; Force Sensitive Resistor (FSR) sensors on the board connected to an arduino system; and a Max/MSP patch. In this part we will describe what is sensed, how those parameters are sensed and how they are used, and hence how the system sounds and blends with the acoustic sound

The metallic board enables the performer to play the original mechanism freely while recording different performance expressive parameters. The disposition of the sensors on the platform is designed to offer an ergonomic and natural play.

The coupling force between the vibration source and the resonator beneath is measured unnoticeably and without changing the sonority. Many of the common music box brands endow their models with extra screw holes at standard locations to fit different manufactured boxes and enclosures. Based on this specification, we ergonomically located the different elements on the mechanism and on our board: we first added three screws at the standard locations and we places three holes on the board to enable coupling contact between the vibration source and the resonating object. Only the thin layer of FSR is sandwiched between the music box and the surface.

To measure the crank speed, we screwed a sensor to the music box using a preexisting screw hole and we count each rotation of the crank. Thus, we make use of a physical specificity of the "carillon à musique" to bypass the broad and complex issue of beat tracking.

The board also measures the pressure of three fingers of the left hand on the surface to control the parameters of the three extra musical channels.

The technology chosen is composed of 6 FSR's whose measurements are captured by the arduino system. For 5 of them we use the force values to control parameters and for the last one, the crank rotation detection, we extract the tempo value. Once scaled, those data are sent by serial communication to the Max/MSP patch.

The Max/MSP patch we created for this project presents a certain number of modalities in his way to process the digital sound. The first step is the recording of the melody and saving this sample in a unique buffer that will be used for all the sound production functions.

Then, three channels are created whose global loudness is controlled by the pressure of the music box on the surface: the more the real box resonates, the louder the sound coming from the speakers will be. Pressing the red, green and yellow buttons with the left hand triggers those channels, and their characteristic parameters depend on the pressure applied. Channel one transforms the original sound by changing the playback speed and ergo the pitch. Channel two adds reverberation and channel three modulates the buffer played forward with itself played backward (figure 3).

The speed of play triggers and parameterizes the last channel that adds an impression of tension to the musicality. The speed also brings pitch shifting modulation to the other channels, forming a harmony in the general variation of the sonority.

The music box being completely interchangeable (needing only to add the screws and the extra speed tracking element) many plays on melody can be envisaged. As all the sounds come from modification of the same musical line, the original melody is in the center of this "under constraint composition tool".

All the storytelling is guided by the unusual coalescence between the acoustic sound and the processed channels, offering a reverberation of the main voice in a blended mechanical fugue or a cross technology dialogue.

4. REFERENCES

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