Resonant Bits: Controlling Digital Musical Instruments with Resonance and the Ideomotor Effect

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ABSTRACT

Resonant Bits proposes giving digital information resonant dynamic properties, requiring skill and concerted effort for interaction. This paper applies resonant interaction to musical control, exploring musical instruments that are controlled through both purposeful and subconscious resonance. We detail three exploratory prototypes, the first two illustrating the use of resonant gestures and the third focusing on the detection and use of the ideomotor (subconscious micro-movement) effect.

Author Keywords

Tangible User Interfaces, Design, Music, Resonance, Ideomotor Effect, Mobile Device.

ACM Classification

H.5.5 Sound and Music Computing, H.5.2 User Interfaces

1. INTRODUCTION

This paper proposes the use of resonant interaction and the ideomotor effect in the design of new musical instruments. Resonant Bits [1] is a technique based on giving digital information, or 'bits', resonant properties, creating a dynamic and rhythmic link between the physical manipulation of a tangible user interface and the information and functions within. As the scale of this physical manipulation is reduced to almost unobservable levels, the ideomotor effect starts to occur in the form of small muscle movements in subconscious response to suggestion; either in response to seeing someone else making that movement (perceptual induction) or willing that action to occur (intentional induction) [6]. An example can be seen in the simple experiment of getting a subject to hold a small pendulum perfectly still (a paperclip on a thread works well), and then attempt to move the paperclip in small circles purely through the power of the mind. In nearly all cases, after a short delay the pendulum will start to move in the direction suggested (fig. 1). This effect occurs due to small movements of the hand gradually pushing the pendulum into the desired swing. The effect feels 'spooky' as you can't actually perceive these small movements, and this is the effect we wish to achieve in musical interaction with Resonant Bits.

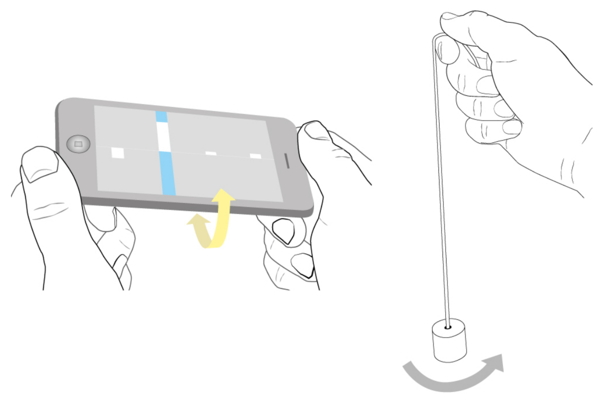

Figure 1: Harmonic Tuner and ideomotor effect.

In terms of previous research within HCI and NIME, Resonant Bits relates to a variety of different areas. Musically, resonant bits can be seen as lower frequency versions of devices such as the eBow, where the player acts as the resonant input to the system. Works such as 'Hybrid Resonant Assemblages' [2], have explored how resonant feedback can create complex systems from simple component. The use of physical metaphor (as we are using with the pendulum) has been seen in a number of projects such as Sound Bounce [4], where a player bounces a virtual ball to produce sounds. Although the use of the ideomotor effect and 'common coding' has been explored in it's application to video games [3], the area is novel in the control of musical instruments.

2. MUSICAL RESONANT BITS

A series of prototypes have been developed to explore musical interaction with Resonant Bits. The first two prototypes presented use observable macro-scale resonant gestures and the third uses micro movements to encourage ideomotor control.

2.1 Harmonic Tuner

The Harmonic Tuner was developed to explore macro-scale resonant interaction directly with a device and allows a player to fade between a number of music tracks. The interaction in this prototype was inspired by Bottles [5], where music is released from a bottle by simply lifting the cork. The player is shown virtual pendulums, that through rocking motions of the device can be made to swing back and forth. By carefully matching the speed of the rocking motion with that of the desired pendulum, the amplitude of the swing of that pendulum is increased. This amplitude is mapped logarithmically to the volume of a music track associated with each virtual pendulum.

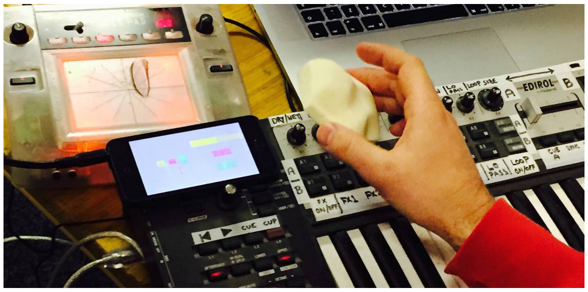

Figure 2: Using a magnetic puck to resonate with the virtual pendulums during a performance.

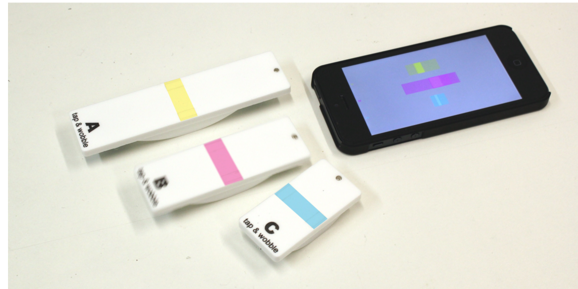

Figure 3: Tap & Wobble resonating with phone.

Interesting results of this resonant interaction include: constant energy needing to be supplied for the tracks to continue playing, creating a strong link between a persons actions and the resulting music; inability to play all the tracks at once, as it is only possible to fully energise one pendulum at a time through the rocking motion; and smooth fading between tracks as the energy moves from one pendulum to the next. Developments of the Harmonic Tuner have involved using the magnetometer to allow control with tangibles embedded with magnets (fig. 2).

2.2 Tap & Wobble

In this prototype, wobbly tangible interfaces are used to resonate with virtual pendulums on the phone. This is achieved through magnets in the tangibles that are sensed by the phone's compass. Tangibles of different length, and hence frequency, can be used to resonate with the different sounds. Currently the sounds chosen include field recordings with repetitive elements such as a sounds recording of waves lapping against the shore. Tap & Wobble (fig.3) can also be used to explore the effect of interaction *through* another medium — if the tangibles are placed on the opposite side of the table to the player then individual notes can still be activated by simply nudging the table at their corresponding frequency.

2.3 Ideomotor Tuner

The design of an interface that works at the ideomotor level brings many challenges. Our aim is to reduce the level of movements used in the Resonant Bits prototypes down to a level where a player can barely feel their own input to the system, allowing the ideomotor effect to take place. In this prototype, large movements are penalised in order to encourage the use of small movements making the ideomotor effect more likely to occur. Movements are made along the z-axis of the phone (up and down when phone is held parallel to the floor) and the three circles on screen appear to oscillate towards and away from the player. Use of a magnet as an input device was also explored, which had the advantage of obfuscating the mapping between input movement and pendulum, meaning that the players body could find multiple ways of resonating in the right manner. Informal testing has shown that the ideomotor effect can be occasionally obtained using the current prototype with further work required to achieve this more consistently.

3. FUTURE WORK

Our primary finding from the prototypes is that resonance requires continual concentration, allowing even simple actions to become very engaging. Also, resonance can encourage a very exploratory mode of playing, where the mapping between input and output is not immediately clear and can be gradually revealed and interpreted. In addition to concentration and engagement, we are keen to explore:

Selection of resonant frequencies. Harmonic relation between the resonant frequencies would allow for quick swapping between related frequencies, or even playing two at once in a resonant 'octave'.

Relation of sound to movement. The oscillatory nature of resonant interaction lends itself well to use in sound production techniques such as scanning synthesis, transposing the slow rhythmic movements up into the sound domain. Another direction may involve using physical models for more complex sound generation.

Tenseness and Anxious Interaction. Resonant interaction involves ongoing concentration that may lead to the development of instruments that promote tense interaction.

4. CONCLUSION

This paper has introduced the use of Resonant Bits as a method for musical interaction, and given an overview of the current prototypes. The prototypes indicate the possibilities that integration of the Resonant Bits technique into a fully fledged instrument may achieve. With further development, we envisage that the integration of Resonant Bits in new instruments would allow for a very engaging and subtle form of musical instrument control.

5. ACKNOWLEDGMENTS

This work was developed in the Tangible Memories project, AHRC grant AH/L007886/1.

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