Issues and Strategies of Rhythmicality for MotionComposer

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ABSTRACT

The paper discusses issues of rhythmicality in the MotionComposer, a therapy device for persons with different abilities that turns movement into music using video-based motion tracking. Aiming at both a low entry fee, and that the result should be rhythmical enough to induce further movement, the design of the device faces an inherent challenge, namely that since users are both dancing to the beat of the music, and creating it at same time, then they must be rhythmic enough in their movements to produce a satisfying result, or the feedback loop will break down. In addressing the problem, we apply a number of strategies named *triggering*, *accenting* and *adaptive*. This paper discusses the pros and cons of the various approaches, referring to experiences gathered in the field, and concludes by summarizing possibilities for improvements in the next version of the device.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design theory, concepts and paradigms** • *Human-centered computing* → *Activity centered design* • **Applied computing** → **Sound and music computing**

KEYWORDS

music therapy, interactive dance, motion tracking, rhythmicality

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1 INTRODUCTION

The MotionComposer (MC) is a device that turns movement into music, developed especially for persons with *different abilities*, a preferred term for 'disabled' as "a sign of respect, emphasizes the strength of all individuals, and allows any special treatment to be given according to the needs of each individual, and not according to assumed limitations" [16]. The MC uses video-based motion tracking to generate data from the movements of the users and then feeds this data to sound-generating software so that the users' movements in front of the camera are converted into sound and music in real time. Since 2010, the team behind the MC has been seeking support for the claim that interactive digital movement-to-music technologies can play a role in affording dance and music engagement among highly diverse users, including those with severe physical or mental conditions.

The tendency of rhythm to encourage body movement finds support in recent research. E.g. Janata, Tomic and Haberman found that music with high "groove" ratings also scored high on enjoyment ratings, was easier to synchronize to, and elicited more spontaneous movement than music with low "groove" ratings [14]. Movement and enjoyment in dance and music contexts have well-documented benefits [19], and thus fit well with our design principle of promoting health and well-being [3]. Independent of any interactive aspects, making music with a good groove is clearly an important part of our task.

Making rhythmical interactive music, however, presents special challenges: Keeping in mind that most users are neither musicians, nor dancers, there is a likelihood that giving control of the rhythm over to the users will so weaken the music's rhythmicality as to destroy the very quality that made them feel like dancing in the first place. But if, on the other hand, the means by which the user controls the music, i.e. the mapping, is too subtle or sophisticated, then the user will fail to perceive the effect they are having on the music. Either pitfall can quickly lead to the environment no longer encouraging movement.

2 BACKGROUND

With a focus on therapeutic, healthcare and pedagogic contexts, the MC falls among a small but growing number of devices and applications developed over the last few decades, which 1) use novel sensor and music technology, 2) let all kinds of users play music, and 3) do all this as part of a therapeutic or other health-related agenda [6; 15; 20; 26-28]. Although the MC may in some sense be thought of as a musical instrument, it is at least in equal part a dance device, encouraging creative movement of the whole body. While dance and music are obviously interconnected, the kinds of movements used to play a musical instrument differ from those we use when we dance: Generally-speaking, musicians use their extremities in a range of movements restricted by the affordances of their instrument,

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while dancers tend to use their whole bodies and with fewer body-external restrictions [11].

The MC can also be seen as belonging to a tradition of interactive dance/music systems. *Variations V* from 1965, involving Cage, Cunningham, Mathews, Paik and many others, started a revolution when it comes to exploration of the collaboration between music, dance and technology, with dancers exerting as much influence over the sonic landscape as the musicians [17; 18]. From the 1990s, people like Robert Wechsler, Todd Winkler, Mark Coniglio and Wayne Siegel started using computers in the creation of interactive systems that analyzed dance-related body movements with sensors and translated these into sound and music. More recently, others have designed and/or used similar systems for artistic, as well as entertainment and therapeutic purposes [7; 24; 25; 29; 31]. While the MC is primarily being developed with the latter in mind, all three functions have been influential in its design [1-3].

The currently-available version of the product, the MC2.0, was released by the German electronics company, IMM electronics GmbH, in June 2015. The MC3.0 is scheduled for release in 2018. The development process involves on-site workshops, circa 50 so far, with persons with different abilities around the world. This affords use-case experience and consultation with therapists. Observations described in several studies [3; 8; 21; 22] point to two kinds of user experiences which could be described in terms of their underlying psychological processes – one might be called cognitive, and the other intuitive. The former refers to situations where the causal relationship, *what is causing what*, is understood, while the latter refers to a more general engagement that can occur independent of any clear understanding of cause and effect.

The MC2.0 comes with six Musical Environments (MEs), each offering a different collection of mappings as well as different types of sound and music. Together they allow a variety of interaction metaphors and ensure variations for the user's individual taste and ability. We have described these in detail elsewhere [3]. Three of the six MEs are based on rhythmic music, while two of the remaining three have rhythmic variants that can be chosen by the user. The remainder of this paper is dedicated to the strategies for implementing rhythmicality as they apply to these MEs or ME variants.

3 STRATEGIES FOR RHYTHMICALITY

There are at least three strategies implementing rhythmicality in the MC, labeled *triggering*, *accenting* and *adaptive*.

3.1 General explication of strategies

3.1.1 Triggering. Triggering - i.e. letting one single gesture play one single sound - is probably, as Bevilacqua and colleagues suggest, "one of the most simple and common processes used in interactive systems" [4]. Triggering sounds with video-based techniques can be implemented in a number of ways and be based on different body parameters; position, position delta, activity and more. The mapping of energetic movement within or towards a particular spatial location to generate a particular sound plays on the cognitive schema of hitting/striking object => impact sound. It may engender a sharp temporal articulation that can be the basis of a rhythm if repeated at more or less regular intervals. Todd Winkler reports of solo work for interactive dance that he created in collaboration with choreographer Walter Ferrero, where they used robotic/machine-like body movements letting each part of the body trigger a single machine or percussive sound to produce complex rhythms with the VNS system [31]. While this way of mapping movement to sound does not in and of itself generate rhythmicality, it can be set up in such a way as to encourage it, e.g. by the choice of sounds, by playing together with others, or by playing alongside additional rhythmic music. In any case, triggering is important for establishing the sense of causality necessary to convince the user that they are in fact making the sounds they hear.

3.1.2 Accenting. This refers to the accentuation of parts of a underlying rhythm, and resembles the *volume envelope* approach by Blaine and Perkis [5]. This strategy is based on some pre-recorded or pre-structured rhythm that is continuously unfolding temporally, and where the user's movements are mapped to intensify or accentuate parts of the rhythmic flow. For example, in sections of Wayne Siegel's *Movement Study*, made with the DIEM Digital Dance system using bend sensors on the dancers' joints, the activity data from the sensors (the difference between present and previous angles) is mapped to the number of notes filling in pre-composed rhythmic structures so that the rhythmic matrix is filled up densely with high activity, and sparsely when the activity is low [23].

3.1.3 Adaptive Strategies. These strategies adapt or modify rhythmic aspects of the music according to movement-derived data. This can be approached in two ways: One is to adapt the tempo of a rhythm to the tempo of the dancer's movements. This can be seen in e.g. Guedes' *Etude for Unstable Time* [12].

A second method is directed towards the timing of single events. In this case, quantization is used to essentially force the mover into a given rhythm. If, for example, the user is triggering beats with a certain gesture, and they move too soon, then the sound is delayed slightly so that it matches the beat in the music. If on the other hand, they are too late, then the gesture is either ignored, or its effect is delayed until the next appropriate moment in the rhythm.

It is possible to identify other strategies, like the *generative* strategy used to control several musical parameters of the SICIB system used by Morales-Manzanares et al. [18], but such has not yet been explored by the MC team.

3.2 Strategies for rhythmicality for the MC

Table 1 shows which of the strategies discussed above have been implemented in, or are planned for, the MC device:

Table 1. Type of rhythmicality strategy used in MC's Musical Environments (MEs).

MEs	Type of rhythmicality strategy		
	triggering	*accenting*	*adaptive*
Tonality	✔	-	-
Particles	-	✔*	-
Fields	-	✔	-
Drums	✔	✔	✔
Techno	✔	✔	-
Accents	-	✔	-

* Has been tested in a development version of the MC2.0 and is planned to be included in the MC3.0.

Now let us look in some detail at how each strategy is employed within the MC:

3.2.1 Triggering. This strategy clearly associates with the design principle of providing intuitive mapping and clear causality, even when both objects and sounds have a virtual status [3]. In the MC's *Drums* environment, the user is surrounded by five virtual drums, represented by five movements, or hit directions away from the body – low left, high left, over the head, high right and low right. A hitting or striking gesture in one of those directions activates one of the percussion instruments. To achieve rhythmicality in this situation, however, the user obviously needs to hit rhythmically and, without a haptic or tactile response, this is not easy. We ameliorate this situation using adaptive strategies, discussed below.

3.2.3. Accenting. The accents strategy has been highly useful for the MC, and it is implemented, at least in part, in four of the six ME's.

Used in its simplest form, the accents strategy is found in the ME called *Fields*. Here, Quantity of Movement (QoM) is mapped to the overall intensity of a pre-recorded rhythmic loop, so that when the user keeps still, there is no sound, and where he/she moves the intensity of the rhythms will follow the energy of the movements. This is simplest way of applying this strategy.

For the musical environment called *Accents*, the accents strategy is, not surprisingly, the dominant paradigm. When you turn on this environment, a metre-less pulsing drum sound is immediately heard. The effect of any sharp movement is not to play the drum, since it will play no matter what, but rather to put an accent on the beat coinciding with the movement. With a chain of subsequent movements, the user will thus 'pump up' the musical intensity, but he/she can also build metres into the music by alternating between moving and not moving. Additionally, the user's height or the height of his/her arms can affect the pitch of the drum.

In the *Techno* ME the accents strategy is also important. Based on the popular contemporary dance form with the same name, the user is given an underlying beat to which he/she can dance. This beat is always present. The system reacts to the user's movement by making the music more active and engaging in temporal alignment with the energy of the movements. The user 'pumps up' the music, first by his/her presence and then by moving to the beat. Other mappings used in this environment include bending low (low pass filtering), extending the arms over the head (high pass filtering) and extending the arms to the side (melodic layering).

3.2.4 Adaptive strategies. With the goal of inclusion of different abilities in mind, we have implemented an adaptive strategy in the *Drums* environment (written by the composer Andrea Cera using Pure Data software). If the user plays more than a certain number of notes in a given period of time, a quantising function is activated, so that the sounds are temporally shifted according to a pre-defined grid. Thus, when the user is testing individual notes, the MC gives a direct causal response, but as they build up a groove, they are helped to play rhythmically.

Once the quantizing function has been engaged, if the user continues to play for a while, a rhythmical background layer is added to which the quantization is synchronized. Thus, even as the sense of causality is reduced, the blending of the background rhythm and foreground quantized drum sounds leads to a satisfying, if somewhat unintelligible result. This balancing act between one-to-one directness and clarity, and support techniques that assure the user a low entry fee is discussed in the section that follows.

4 DISCUSSION

The effectiveness of any given strategy, or combination of strategies obviously depends in part on the skills of the user in question. Skill, is an issue often discussed for digital musical instruments (DMIs) [9; 10; 30] and is a stated design goal for the MC [3]. On one side DMIs offer the possibility of lowering the so-called "entry fee" of performers, but on the other they do not always provide possibilities for users developing virtuosity, i.e. expert skills.

If we relate this to the strategies presented in this paper, the *triggering* can reinforce a strong and intuitive sense of causality, and thus provide a basis for learning simple gesture-sound couplings, i.e. a form of skill with a clear cognitive component. As for skills in recognizing, identifying, retaining, analyzing and reproducing rhythm, as discussed by Holland and colleagues, applying this strategy in interactive environments like the MC might not be the ideal tool for the playing of rhythmic material which requires complexity and a steady beat [13]. The MC may, on the other side, have a role to play concerning basic beginner impulses and rhythmic instincts.

The *accenting* strategy, for its part, relies on synchronization of movement and the intensity of the sound to maintain causality, and largely keeps rhythmic aspects like tempo, coordination of streams and hierarchical organization of patterns out of the user's control. At the same time this strategy is not especially dependent on hard skills, and thereby invites a much more intuitive approach.

We have been investigating ways to make the *accents* strategy more varied and dynamic. For instance, in a development version of the *Particles* environment (planned for the MC 3.0) the accenting strategy is not the core paradigm, but an alternate mode that expands upon an existing mapping paradigm, i.e. that the users' different locations in space will determine which of a large number (often several hundred) of short sound particles will be triggered, and that the quantity of movement (QoM) of the users determines the rate with which they are triggered. Thus, in the *Rhythms* mode of *Particles*, this basic mapping is modified so that it aligns with the accents strategy. Instead of QoM determining the frequency of triggered sound particles, it accentuates a pre-defined rhythm made up of a smaller group of particles mapped to the user's location in space. The sound particles are also organized in layers, with each playing according to a sub-division of the underlying meter and emphasizing a particular frequency range through band-pass filtering. To create a more dynamic and responsive feeling, a total of seven layers are mapped with different linear functions so that they respond to QoM values. Thus, soft movements make a few layers audible, whereas for large movements all 7 subdivisions are active [2].

Thus, we can see how there is no one-size-fits-all answer to the question of how to balance causal directness and low entry fee. Different implementation strategies as well as different kinds of music require a variety of creative solutions.

One might ask why we do not use a "levels" approach, like the skill-based levels in a video game. We reject this model first because it introduces a degree of complexity that we want to avoid, and second for the reason that it implies quantitative, better-and-worse ways of being involved in a dance-music experience.

Having said this, the MC developers are planning to release a pro-version of the MC3.0, which may be of interest to professional artists. It will provide high-quality movement-derived data in a platform for defining one's own musical environments.

6 CONCLUSION

While clearly rhythmic music is one of the easiest ways to get people engaged in a music-dance experience, ironically, rhythms also present large challenges for interactive system designers. By combining different strategies of body-mapping and rhythmic music, and implementing them with care, the authors have found that healthy movement can indeed be stimulated through such systems. The developers of the MotionComposer, a new product based on this general concept, are thus encouraged to continue working on rhythmic environments for future versions of the device.

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