VARIANCE IN REPETITIVE GAMES MUSIC

Axel Berndt

Institute of Software and Multimedia-Technology
Faculty of Computer Science, Technische Universität Dresden
Dresden, Germany
Axel.Berndt@tu-dresden.de

ABSTRACT

The musical scoring of video and computer games is faced with the unpredictability of interaction. Music has to follow the process of the interactive scene but this leads to two basic problematic situations: (i) the player is too fast and the music has to react before the current piece is finished, and (ii) the player is too slow and music has to bridge a longer period than the current piece does. While earlier papers were mainly treating the first problem this paper focusses the second.

As the length of an interactive scene is usually impossible to predict it is likewise impossible to say how much musical material is needed. The common way to bypass this problem is to loop the music for as long as the scene lasts. This approach involves an existential danger: Sooner or later the player becomes aware of the repetition; the game scenario emerges as a mere mechanical arrangement and loses much of its integrity. Variance is needed that renews the music each time it repeats. This paper presents several views to this problem and introduces a variety of possible approaches.

1. INTRODUCTION

An important basic principle of audio-visual media scoring is that musical change indicates (and therefore necessitates) a corresponding change in the scene, the narration, or the dramaturgy, even if not visible [12]. In interactive media such changes are highly dependent on user interaction. It is generally impossible to predict the amount of time a player will spend in a scene or how long a certain situation lasts until the player makes that triggering interaction. Thus, it is equally impossible to plan the length of the corresponding music in advance. The endless loop is the most common means today to musically stay at a situation for an uncertain period.

But the exact repetition of a complete musical piece is a very specific means too that can become very conspicuous to the player and, therefore, desires a corresponding (narrative) reason. Most commonly, it indicates the recurrence of scenic content or action. Its symbolic quality and associative power can evoke a déjà vu like effect. But this is not the case in the common gaming situation where the music is just waiting for the player. The player did not reenter a scene, nothing recurs, time passed on. Exact repetitions emit the unnatural aura of a time warp which usually contradicts the scene's actuality. Music becomes a foreign object to the scene, disturbing the dialectic unity of the multimedia. This effect is perceived even more intense since the player, when recognizing repetition, becomes consciously aware of the music and its contradiction to the scene. At this point even the best musical compositions is in danger to disturb, bore, and annoy. Collins reports that in this situation the players even interrupt the gameplay and manually switch off the music in the game settings menu [7].

To prevent such undesirable effects the repetition has to concealed from the listener. There is a variety of ways to do this which ultimately lead to the concepts of musical variation. In the following we will introduce and discuss different views and approaches to variance in repetitive games music.

2. THE COMPOSER'S APPROACH

Memorable features of the compositional structure are the primary hints that listeners recognize and remember. Derived from this insight, games music composers try to conceal repetition by a more diffuse structural layout that impedes the recognition of specific features [14].

A leading melodic part is one of the strongest catchers of attention. It is very often built of motivic figures that recur and vary over time. Due to its inherent formal principles, the melody mediates a strong feeling of structure and form [8]. A common way to conceal this is to abdicate motivic work and to split the melody into multiple preferably overlapping figures, diversified into a polyphonic formation. This technique is also well known from composers of the romantic era.

Furthermore, clear structural borders are easily memorizable features. Fluent structural borders can be achieved by polyphonically overlapping structural layers and seamless connections of consecutive form elements.

Most effective is a clever timely disposition. Preliminary user studies can determine the average playing behavior. This gives clues to dispose the appropriate length of the accompanying pieces of music. Structural diffusion is a cheap and easy way to conceal musical repetition. But it works only for the average player. Repetition itself is not eliminated and recognition is just delayed, in the best case for long enough.

3. THE ARRANGER'S APPROACH

Variety can be achieved by varying the sequence of musical pieces or segments. A very coarse musicbox like approach in implemented in the *The Elder Scrolls* roll-playing games *Morrowind* and *Oblivion*[1]. For each state of gameplay there is a set of musical compositions with alike characters of expression from which one is randomly chosen. When the piece is over, another one is selected.

A more fine-grained approach is to arrange on the level of inner-musical phrase and section structure as proposed within several research prototypes (e.g., [6, 22]). They introduce two types of segments: *One Shots* and *Loop segments*. So called *One Shot* segments are played back only during the first iteration of the musical loop and skipped later on. The *Loop segments* remain. Thus, the first repetition appears to be a rearrangement instead of a repetition. Furthermore, by providing multiple alternatives for each segment (just as in musical dice games [17]) a huge number of recombinations with big diversity become available [1].

But still, after a while, when all the precomposed musical material in enough permutations and combinations was introduced to the listener, its recurrence can become conspicuous again. More variance and a less binding memorable structure can be approached by very short musical snippets that play single figures or even just single sound events (tones and chords) that fade in and out and may overlap with others. This *cue collage* may sound very diffuse but it features the possibility to be combined with (or triggered by) interactive events, creating a very reactive musical score.

4. THE ORCHESTRATOR'S APPROACH

Orchestration deals with the different timbres of instruments, their playing techniques and articulations in order to implement a certain aesthetical concept, emphasize structural properties of the composition, and promote a desired mood [2, 20]. Varying the instrumentation can shed different light on the otherwise unchanged musical material.

The musical polyphony offers further potentials for variation. Music set in multiple counterpoint allows the transposition and interchange of parts; a tenor part can, for instance, serve as a soprano and vice versa. Examples can be found in J. S. Bach's "The Art of the Fugue".

Moreover, the building set principles of the baroque manner of the so-called rural compositions offer prospective potential. Building set music can be performed in more than one combination of parts, see [4] for examples. We implemented a music engine concept that uses location based sound sources and fading techniques to add/remove musical material to/from the playback according to the position and movement of the player in a virtual environment [6].

[1] developed by Bethesda Softworks and released in 2002 and 2006.

5. THE GENERATIVE APPROACH

Variation and improvisation are probably the oldest concepts of music. We can find printed evidence for sophisticated variation techniques already in medieval music. Later, variation became a kind of a compositional aspect. Performers had to learn how to vary a musical material correctly. The baroque was the era were variation and improvisation became a high art and necessary ability for the performers [19]. Up to the extensive variation works of the classic era the development of a multitude of variation techniques can be posted. Todays musical morphology distinguishes variations by two aspects [3]:

Subject of Variation: The *direct variation* is applied to the theme/motif, whereas the *indirect variation* retains the theme/motif unchanged and varies its accompaniment.

Type of Variation: The *strict variation* saves the harmonic and architectural characteristics of the theme/motif. Its shape and gestalt quality remain unchanged. On the other hand, the *free variation* changes not just melodic and rhythmic aspects, but also harmonic and formal. Each one of such variation can afford new gestalt and quality.

The variation, adaptation, and improvisation over a given musical material is also a classical subject in computer music research. We have chosen representative prominent approaches from the last decade for discussion.

5.1. Embellishment

A strict and direct type of variation is the melody embellishment. A given plain melody is enriched by various ornaments. In this respect the systems *MeloNet* and *JazzNet* are very interesting. They utilize a neural network to learn melody ornamentations, i.e., ornamentation figures/patterns, including the melodic and harmonic context where they were applied [11]. This is demonstrated with melody variations in the style of J. Pachelbel and Jazz improvisations imitating Charlie Parker. The learning set directly influences the stylistic imprint of the network.

A generative music approach that utilizes genetic algorithms is described by Gartland-Jones, *MusicBlox* [10]. It combines several (predefined) input patterns to create variants. The fitness function can measure the relational distance to the input patterns. Thus, it is possible to apply mutation and recombination operations and vary the result within the domain spanned by its input patterns. This is ment to be used as a combinatorial tool or toy for music composition. But it can also be used to combine, for instance, a plain melody and several embellished versions to create new embellished versions.

5.2. Improvisation

The improvisation can be seen as a free variation. It can change all aspects of the original, its structure, melodic, rhythmic, and harmonic properties.

A genetic algorithm based approach is John Al Biles' *GenJam* system [16]. The musical input of a co-performing human musician is varied by mutation and crossover operations to generate an improvisational response. It is melody based; the chord progression scheme, the tempo, rhythmic pace, and overall arrangement are predefined. *GenJam*'s stylistic repertoire reaches from Jazz over Latin to New Age. The musical quality and variety of its improvisations strongly depends on the quality and variety of the human performer's input. In the games scenario, where we have static precomposed music to be varied, this may lead to over-fitness problems over time.

A very popular means in computer music, Markov models, was used by François Pachet in his system *Continuator* [18]. It builds a Markov model based structure from realtime musical input of a human co-performer. New patterns are generated not just for the melody part but also for its accompaniment. Since it directly analyzes the realtime input the system is stylistically independent to a certain amount. The system can run in standalone mode like a music generator, as a collaborative improviser and composer that creates continuations to the musician's input.

5.3. Reharmonization

The harmonization of a melody determines a sequence of chords and creates a polyphonic counterpoint. *Re*harmonization changes one or more of these chords and adapts the voice leadings, accordingly. Well known is, for instance, the change from major to minor to achieve a darker more pessimistic mood. To "minorize" a major triad only one tone, the third, has to be transposed down by a semitone. Changes to completely different chords imply more and greater adaptations. This may also affect the melody. Hence, reharmonization is not necessarily only an indirect variation.

Yoon and Lee describe a planning approach for affective reharmonizations [24]. A system that implements reharmonization is described by Livingstone [13]. It implements the relatively unproblematic major-minor changes. Changes to completely different chords are implemented in the system by Stenzel [21]. However, it also proves that great changes do harm to the musical coherence and conclusiveness quite quickly. Naive changes in voice leading tend to be unmelodious. Furthermore, the gesture of the new harmonization can be opposed to the gesture of the melody; a situation that is very hard to detect and to avoid. Thus, reharmonization can be seen as a non-trivial optimization problem that is not solved, yet.

6. THE PERFORMER'S APPROACH

The expressive performance introduces a series of transformations to the musical material. They affect its timing, dynamics (loudness), and articulation properties. By these means a piece of music can be performed very differently and feature a variety of characters of expression reaching from slow, soft, cantabile over harsh, marcato to fast-paced, and energetic.

For timing and dynamics of a performance we can distinguish macro and micro features. The macro features define the overall tempo and loudness curve. These can be varied completely which creates a new performance, or they are kept and only the curve shape of transitional features (ritardando, accelerando, crescendo, decrescendo) is varied which is more like another rendering of the basically same performance.

The micro features are rubato (timing distortions that are self-compensating within a certain timeframe), metrical accentuations, and articulation. These features can be considered as additional details that enrich the macro plan but do not change it fundamentally. We can apply any shade of a swing timing. We can perform more neutral or very pronounced accentuations. One accentuation scheme may establish a fast-paced quarter meter whereas another may realize a more relaxed half meter. The overall articulation may be legato in one performance and portato in another, this creates either a tight or a brittle sound.

Most subtle differences can be achieved by random variations of note onset times and velocities, aspects that we know as random variation in human performance. Furthermore, the synchrony of the parts can be changed. A leading part may be ahead to mediate an active progressive mood or it can be behind creating a laid-back kind of feeling. However, these means may already be too subtle and not suffice to give enough variety to the music. Hence, they should be used in combination with the other features discussed so far.

Approaches to create such expressive performances are knowledge-based [9], machine learning-based [23], and derived from a mathematical music theory [15]. The performance engine described in [5] implements a technique to seamlessly transition and combine different performances and orchestrations.

7. CONCLUSION

We have introduced a variety of approaches to tackle the problem of repetitive music in games. The compositional and arrangement approaches can already be found in todays video and computer games. But they are restricted to the variety of its limited precomposed material. The same applies to the polyphonic and orchestrational approaches which are based on static precomposed material as well.

This restriction can be overcome by introducing generative aspects to the music processing. Embellishment and reharmonization edit the precomposed music on the compositional level. Improvisation contributes new material. The expressive performance renders the music in different shades. All these approaches are not mutually exclusive but can be combined and thereby open up a much wider range of possibilities.

8. REFERENCES

[1] S. Aav, "Adaptive Music System for DirectSound," Master's thesis, University of Linköping, Department of Science and Technology, Norrköping, Sweden, Dec. 2005.

[2] S. Adler, *The Study of Orchestration*, 3rd ed. New York, USA: Norton & Company, June 2002.

[3] G. Altmann, *Musikalische Formenlehre—Ein Handbuch mit Beispielen und Analysen. Für Musiklehrer, Musikstudierende und musikinteressierte Laien*, 8th ed. Mainz, Germany: Schott, Jan. 2001.

[4] A. Berndt, *Liturgie für Bläser*, 2nd ed. Halberstadt, Germany: Musikverlag Bruno Uetz, Jan. 2008, transl.: Liturgy for Brass.

[5] ——, "Decentralizing Music, Its Performance, and Processing," in *Proc. of the Int. Computer Music Conf. (ICMC)*, M. Schedel and D. Weymouth, Eds. New York, USA: International Computer Music Association, Stony Brook University, June 2010, pp. 381–388.

[6] A. Berndt, K. Hartmann, N. Röber, and M. Masuch, "Composition and Arrangement Techniques for Music in Interactive Immersive Environments," in *Audio Mostly 2006: A Conf. on Sound in Games*. Piteå, Sweden: Interactive Institute/Sonic Studio, Oct. 2006, pp. 53–59.

[7] K. Collins, "An Introduction to Procedural Music in Video Games," *Contemporary Music Review*, vol. 28, no. 1, pp. 5–15, Feb. 2009, issue on Generative Music.

[8] D. de la Motte, *Melodie*. Deutscher Taschenbuch Verlag, Nov. 1993.

[9] A. Friberg, R. Bresin, and J. Sundberg, "Overview of the KTH Rule System for Musical Performance," *Advances in Cognitive Psychology, Special Issue on Music Performance*, vol. 2, no. 2–3, pp. 145–161, July 2006.

[10] A. Gartland-Jones, "MusicBlox: A Real-Time Algorithm Composition System Incorporating a Distributed Interactive Genetic Algorithm," in *Proc. of EvoWorkshops/EuroGP2003, 6th European Conf. in Genetic Programming*, G. Raidl, Ed. Berlin, Germany: Springer, 2003, pp. 490–501.

[11] D. Hörnel and W. Menzel, "Learning Musical Structure and Style with Neural Networks," *Computer Music Journal*, vol. 22, no. 4, pp. 44–62, 1999.

[12] Z. Lissa, *Ästhetik der Filmmusik*. Leipzig, Germany: Henschel, 1965.

[13] S. R. Livingstone, "Changing Musical Emotion through Score and Performance with a Compositional Rule System," Ph.D. dissertation, The University of Queensland, Brisbane, Australia, 2008.

[14] A. Marks, *The Complete Guide to Game Audio: For Composers, Musicians, Sound Designers, Game Developers*, 2nd ed. USA: Focal Press, Dec. 2008.

[15] G. Mazzola, S. Göller, and S. Müller, *The Topos of Music: Geometric Logic of Concepts, Theory, and Performance*. Zurich, Switzerland: Birkhäuser Verlag, 2002.

[16] E. R. Miranda and J. A. Biles, Eds., *Evolutionary Computer Music*, 1st ed. USA: Springer, April 2007.

[17] W. A. Mozart, "Musikalisches Würfelspiel: Anleitung so viel Walzer oder Schleifer mit zwei Würfeln zu componieren ohne musikalisch zu seyn noch von der Composition etwas zu verstehen," Köchel Catalog of Mozart's Work KV1 Appendix 294d or KV6 516f, 1787.

[18] F. Pachet, "The Continuator: Musical Interaction with Style," *Journal of New Music Research*, vol. 32, no. 3, pp. 333–341, Sept. 2003.

[19] J. J. Quantz, *Versuch einer Anweisung, die Flöte traversière zu spielen*. Bärenreiter, 1752, Reprint (1997), H. Augsbach.

[20] E. Sevsay, *Handbuch der Instrumentationspraxis*, 1st ed. Kassel, Germany: Bärenreiter, April 2005.

[21] M. Stenzel, "Automatische Arrangiertechniken für affektive Sound-Engines von Computerspielen," Diploma thesis, Otto-von-Guericke University, Department of Simulation and Graphics, Magdeburg, Germany, May 2005.

[22] H. Tobler, "CRML—Implementierung eines adaptiven Audiosystems," Master's thesis, Fachhochschule Hagenberg, Medientechnik und -design, Hagenberg, Austria, July 2004.

[23] G. Widmer and W. Goebl, "Computational Models of Expressive Music Performance: The State of the Art," *Journal of New Music Research*, vol. 33, no. 3, pp. 203–216, Sept. 2004.

[24] M.-J. Yoon and I.-K. Lee, "Musical Tension Curves and its Application," in *Proc. of the Int. Computer Music Conf. (ICMC)*. New Orleans, USA: International Computer Music Association, Nov. 2006, pp. 482–486.