ENHANCING EXPRESSIVE AND TECHNICAL PERFORMANCE IN MUSICAL VIDEO GAMES

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ABSTRACT

Musical video games are best sellers games. One of their selling point is based on the improvement of players' musical abilities. But interviews made with gamers and musicians show that if the former feel enough freedom in musical expression, the latter are more sceptical and feel more limited in the possibility of express themselves when they are playing. In parallel with the games development, some research works propose to improve control and meta-control on music to allow expressive performance without the user being a virtuoso. The goal of this article is first to present interviews made for knowing users opinions. Some research works about improving musical expressive performance are then presented. Finally, we propose games enhancing the expressive and technical musical performance, linking current game-play with current research.

1 INTRODUCTION

For more than ten years, *Bemani* [1] has developed rhythm video games. In the beginning, this unusual game-play attracted very few players, mainly in Japan. But the generalization of intuitive interfaces, *e.g.* the *Wii Remote*, and the appearance of musical games with Western soundtracklists, make this game-play now attractive to a wide audience. More and more editors therefore propose some musical video games, and *Guitar Hero* or *Singstar* are nowadays best-selling games.

Like the famous *Brain Age* game [2], basing all its selling point on the improvement of extra game capacities (players' intelligence and memorization), these games are partially basing their selling point on the improvement of player's musical abilities. A Guitar Center Survey [3] indicates that 67 percent of rhythm gamers will certainly buy a real instrument in mid-term. So playing musical video games could make players wanted to play real instruments. But do they really learn music playing this kind of game? Do they have enough freedom to express themselves musically? And what about the sensation of playing as a band when several players are allowed?

This article starts with the description of musical video games main characteristics in section 2. Section 3 presents the main categories of musical video games with some famous examples. Interviews with different gamers and musicians illustrate the main assets and limits of this kind of games in section 4. We then present in section 5 some hardware and software developed in a computer music research environment. A way of pooling musical video games and this research in innovative games is finally proposed in section 6.

2 PROPERTIES OF MUSICAL VIDEO GAMES

We distinguish two main components of the musical performance in the games: physical-technical and expressive parts [8]. The physical element is the gamer morphology influence and the contr oller shape used for the performance. The technical element is the gamer technical level influence, considering the interaction quality between the gamer and the controller to reach an given objective. We will group these two elements together in the technique description. The expressive element is defined by what is neither physical, nor technical. It can be considered as the intentional deviations from a reference, *i.e.* deviation in rhythm, articulation, dynamics or the adding of effects such as vibrato or timbre changes.

2.1 Technique

We propose to evaluate musical game technique as the difficulty to reach the proposed goal, or a certain level, with a given controller. We can distinguish two technical parts: the musical technique, *e.g.* the capacity to play in rhythm, and the controller technique, *i.e.* the capacity to control the hardware.

The main technical characteristic of a musical video games is linked to the specific **hardware**. It can be a joystick, or it can more or less imitate a real instrument. Hardware can induce some latency in the game for the sound production.

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[1] `http://www.konami.jp/bemani/`
[2] `http://www.brainage.com/`
[3] `http://www.1up.com/do/newsStory?cId=3171507`

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The **accessibility** of the game is then an interesting parameter. Depending on the controller, the game may be **tiring**, *e.g.* with a drum controller. The technical **difficulty** may be appreciated considering the time needed to pass a level or to end the game. It could be broken down into the difficulty of controlling the hardware and the difficulty relative to the musical technique.

2.2 Evaluation

The evaluation is the feedback provided to the gamer. It may be **global**, with a rank for the whole performance, **semi-global** with a rank for each part of the music, *e.g.* verse1, chorus, verse2. The feedback may be more precise, **local**, to indicate the wrong notes played or the value of a time deviation. It may also be given in **real-time**, with a video environment changing with real-time evaluation during the performance.

Most of the time an **absolute** evaluation is provided, *e.g.* the percentage of matching notes. The player could also be evaluated considering another performance, from another player: it is a **relative** evaluation. Some games propose a **self-evaluation**: the gamer evaluates his own performance.

The **relevance** of the feedback is a very interesting game parameter. Is the evaluation useful to improve the performance or to reach a level of the game ? Is the feedback more precise according to the technical level played ?

2.3 Immersion

The environment is very important in musical video games. A game can be boring or **exciting** regarding to the chance to reach the next level .The **quality of the soundtracks** or the sound synthesis is also relevant. Editors pay a particular attention in the **3D-environment** and 3D-effects for recent games, *e.g.* including virtual avatars. The **controller shape** may be fun too, *e.g.* by imitate famous guitars.

2.4 Expressiveness

The expressiveness is allowed in certain games by giving **musical freedom**, *e.g.* playing notes when no match is proposed or changing the music tempo in real-time. The **level of control** indicates the elements controlled by the player during the game: it may be simply the notes production but also the phrasing or the global tempo. When a **multi-players** mode is available, the degree of interaction between the players is a expressiveness parameter of a musical game.

3 MUSICAL VIDEO GAMES

This section presents best-selling games considering their main goal.

3.1 Scrolling score games

These games, e.g. *Pop'N'Music* [4] , *Guitar Hero World Tour* [5] or *Rock Band* [6] are based on the *Bemani* game-play: a scrolling score is displayed and every time a note crosses a line located at the bottom of the screen, the player must hit the matching buttons (by color and position) on his controller. For *Pop'N'Music*, the controller is specifically designed, and do not look like any real instrument nor joystick. For *Guitar Hero* and *Rock Band*, controllers looks like real instruments, but are significantly simplified since the guitar cords are replaced by buttons for example. After each song played, a rank is given. For *Pop'N'Music*, it is a number between 0 and 100000. For *Guitar Hero* and *Rock Band*, it is a percentage of matching notes.

3.2 Karaoke games

These games, e.g. *Singstar* [7] , are based on singing performance. A pitch-score is displayed with lyrics, and the player knows in real-time if he sings correctly. Rank is given after each song, *e.g.* a grade between "casserole" to "singstar" in *Singstar*.

3.3 Performance games

Wii Music - Conductor Game [8] : this game puts the user in the position of a conductor. By moving the Wii remote, players give the tempo to the orchestra. The nuance and the articulation of the synthesized music are in accordance with moves speed and amplitude. At the end of the performance, a rank between 0 and 100 is given.

Wii Music - Performance Game: this game offers the ability to play music by moving the Wii remote. After the selection of a song and an instrument, the player generates sound by reproducing a gesture associated with the corresponding instrument using the Wii remote. A reference score is displayed, but the player can add or remove notes, but he can not change the tempo. At the end of the performance, the player must evaluate himself.

3.4 Memory games

These games, for example *Space Channel 5* [9] , are based on the *Simon* electronic game: the player must repeat a proposed sequence of notes, in rhythm, with a joystick. A rank is given after each level, and the environment is more and more consistent as the player succeed.

4 INTERVIEWS

We interviewed the *DDR Bordeaux Association* [10] . Its aim is to present musical video games to general public as well

[4] http://www.konami.jp/bemani/popn/
[5] http://worldtour.guitarhero.com/
[6] http://www.rockband.com/
[7] http://www.singstargame.com/
[8] http://www.wiimusic.com/
[9] http://www.mobygames.com/game/space-channel-5
[10] http://www.ddrbordeaux.com/

as gathering some gamers for practicing. We also interviewed musicians who accepted to give their impressions after a first contact with this kind of games.

4.1 Gamers

Several gamers from the association accepted to give us their opinion on their favorite musical video games.

Technique

All presented video games are really accessible. If the main goal is to perfectly read score like in scrolling score games, many levels of difficulties exist to please beginners and expert. If the main goal is more focus on the musical performance, like in *Wii Music* or *Singstar*, levels of difficulties are nonexistent or not really pertinent.

Because scrolling score games are hard over a certain level of difficulties, a practice mode is provided. For *Guitar Hero* or *Rock Band*, the most difficult level could be reached after some months ; after some years for *Pop'N'Music*. To find his technical level in a game, a player will often try a hard level at first, and if he failed, he will try levels that are more and more easy, until he succeeds.

When players are used to scrolling score, the difficulty is mainly because of the hardware. While asking them if they would like to play using real instruments with captors, they say that it is a possibility, but only if this will not decrease the fun of the game.

Evaluation

Every game provides an evaluation. For *Singstar*, the remark was done that this game is not made to be more and more skilled, but for having fun. So the global evaluation is funny but not very precise. For *Pop'N'Music* and *Rock Band*, the evaluation is global too. For *Guitar Hero*, the evaluation is semi-global, based on verses and chorus, and the public reaction in the game helps to know the player level in real-time. For *Space Channel 5*, the evaluation is in real-time too, based on the environment more and more dense if the player succeeds. *Wii Music - Conductor Game* is the only game to propose a relative evaluation: the second player must follow the first one to have a good rank. *Wii Music - Performance Game* is really specific because the player must provide a self-evaluation: he choose a rank between 0 and 100, according to the pleasure he takes listening his own performance.

Immersion

All interviewees insist on the importance of extra-musical environment. It gives a style to games, *e.g.* in *Pop'M'Music* where colored graphics puts gamers in a happy mood. It is also a way for immersing players, *e.g.* in *Guitar Hero* where players could create avatars that look like them. They also like having specialized controller, because they add originality to the game.

About the sound quality, it is noteworthy that when more freedom is given in music performance, it is often at the expense of sound quality. And this quality is important, some players buy Original SoundTrack (OST) of games. All games are considered exciting to play, notably because players want to unlock the next song. The only ones that are physically difficult to play are *Rock Band* and *Guitar Hero* with the drums hardware that emulates the real instrument.

Performance

Except for *Wii Music*, a little freedom is given for the user to express musically. Scrolling score games impose to follow the score, without any agogic modification, *i.e.* dates modification of notes beginning and ending. *Pop'N'Music* allows adding notes even if it is not advised, *Guitar Hero* allows vibrato with guitar and *Rock Band* allows some drums improvisation parts. However, none of the interviewees tell that they lack freedom for these games. They are accustomed to *Bemani* way of playing, and they have competence in it.

They confide that scrolling games give them reading competences but no real musical competences. More surprising, they say that it is possible to play muting music, but it is impossible to play without graphics. It is noteworthy that game with more musical interest, like *Wii Music* or *Space Channel 5*, could be played without watching screen, but they seem less attractive to hardcore gamers.

Gamers tell that the multi-players mode is a value-added for games, but they often play in the same way as when they are alone. The interest is more in being one another instrumentalist or avatar than playing interactively with others.

4.2 Musicians

We asked musicians who have learned music for 10 to 20 years to give an opinion on musical video games after a first experience, and many criticisms were made about performance limits. In *Rock Band* or *Guitar Hero*, the multi-players mode has no real interest because players do not really play with others, and so they do not listen to them. The hardware is really restrictive, except some drums controllers. They had trouble when playing easy mode, because they habitually trend to add notes. Since the scrolling score manages the time, they have the feeling of being too constrained. Contrary to hardcore gamers, they are more comfortable with the games from *Wii Music*, because they have more space to express themselves.

When they are playing musical video games, gamers would appreciate to learn music or a particular instrument, and musicians would be delighted by more musical freedom. Some researches on musical performance could certainly provide such characteristics to this kind of games.

5 RESEARCH ON MUSICAL PERFORMANCE

This section presents existing hardware and software that help the technical element abstraction to focus more on expressiveness, by decreasing the human action frequency. They give the possibility for the user to be expressive without being a virtuoso, by offering controls and meta-controls. Works on music similarity show that a pertinent feedback on the performance could be provided.

5.1 Meta-Control Instruments

The *BAO PAO* is an electronic instrument developed by Jean Schmutz in collaboration with Jean Haury at the *La Puce A L'Oreille* association [11] . This instrument was firstly designed for handicapped people. The user does not directly produce sound neither the pitch: all is generated by a computer linked to the *BAO PAO*. A score is loaded into the computer, and the user could move in it note by note by cutting a laser beam with a stick. If stick speed is fast, the sound is *forte*. If the speed is slow, the sound is *piano*. This device allows musician to focus on expressive interpretation. It also permits a group of handicapped to play together. It is now used as an instrument in many secondary schools for music education.

The *Meta Piano* [12] [4] is an instrument developed by Jean Haury which mainly inspired the *BAO PAO*. It looks like a simplified piano, with just 9 notes. The mechanism is similar to the *BAO PAO*. A score is loaded into a computer, and the user could move in the score by pressing any note on the *Meta Piano*. It proposes more freedom in the performance than the *BAO PAO* thanks to its several notes: the musician could make expressive performance, because it allows working on rhythm, duration, articulation, intensity, phrased and all agogic deformations.

5.2 The Continuator

The *Continuator* [7] is a MIDI device, developed by François Pachet, which listens to MIDI events, and proposes to the musician new notes to follow the sequence by analyzing the previous ones played by the user. In real time, the system can determine the performance style. The continuator is a powerful device that pleases to confirmed musicians and as well as young children. It is mostly used in improvisation, but the way it computes the next notes to be played could be useful for guiding musician in their performance.

5.3 I-Score

I-Score [1] is a system for composing and interpreting interactive scores. It relies on a formal musical scores representation which includes the way a performer can interact with them. The possibilities of interaction with a score are based on an interpretation formalisation of instrumental pieces of music. In the current version of *I-Score*, these possibilities consist of interactively triggering some discrete events of the score (beginnings and endings of notes) during the performance. This liberty for the performer comes with the possibility for the composer to define temporal constraints on the events to fix a partial order between them.

During the execution, the performer is allowed to trigger an interactive event only when the events of the score that *must* appear before him (according to the temporal constraints) have occurred. Symmetrically, if the performer triggers an interactive event at a different date from the date written in the score, the system will automatically adapt the date of the events that *must* appear after it, to respect the order imposed by the constraints.

The ability of the system to automatically adapt the rest of the score according to the triggering of an interactive event, makes sure that the execution will reach the end of the score and respect the limits wanted by the composer. As a consequence, the performer can give his own interpretation of the musical piece while he is guaranteed that the score will be played until its end.

5.4 Classification overview

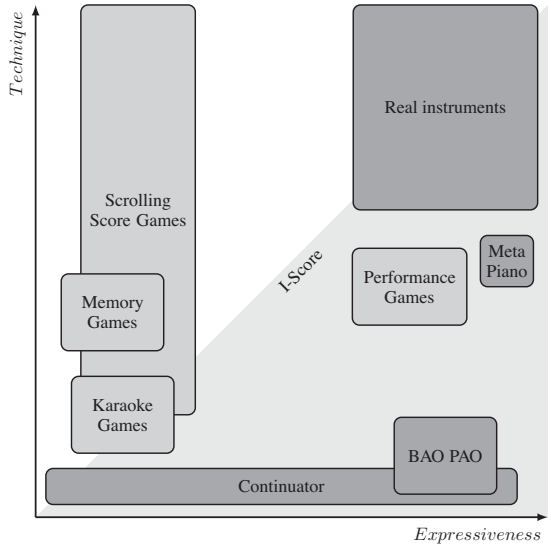

Figure 1. Classification Overview

Figure 1 makes an overview and attempts a classification by technique and expressiveness.

Memory games, even if they permit musical learning, do not gives freedom for expressiveness. The pattern must be perfectly repeated. They require technique because practice is needed to correctly memorize and play in rhythm. **Karaoke games** are very accessible, but the singer must always sing respecting the original pitch. For **scrolling score games**, the technique required could be variable, thanks to multiple control levels. *Guitar Hero* has a "novice" mode that allows the musician to play by pressing any note on time, and *Pop'N'Music* required years of practice to succeeded the higher level. The expressiveness is limited in theses games, but each one gives a little freedom in different manner. **Performance games** required practice to understand the link between the controller and generated music. They give freedom, but it is either on tempo or on notes addition, not both.

Real instruments like guitar, drums, bass... are the most expressive, but also the most technique. The **BAO PAO** is very simple to use, notably by handicapped peo-

[11] `http://lapucealoreille.free.fr/`

[12] `http://dept-info.labri.u-bordeaux.fr/~marczak/MetaPiano/`

ple and young children, and allow agogic deformation. The **Meta-Piano** is more expressive, notably by allowing expressiveness on transition, but it requires some habit for playing notes. The **Continuator** is very accessible, and the expressiveness depends on the expressiveness given by the musician. Finally, **I-Score** allows any levels of expressiveness with any level of technique (depending on the number of trigger points, and on the controls or meta-controls given to the musician).

5.5 Musical Similarity

Estimating the similarity between musical performances is a difficult open problem. From a computational point of view, it consists in determining algorithms calculating a measure which indicates the degree of similarity between two musical segments. Each musical segment may be represented by a sequence of symbols, related to musical properties such as timbre, rhythm, melody, etc. Several techniques for evaluating similarities between symbolically encoded music have been introduced during the last few years. Geometric algorithms consider geometric representations and compute the distance between these objects [5]. Algorithms adapted from string matching domain and based on N-grams techniques are proposed in [11].

Other methods, generally applied in computational biology, compute a similarity measure between two strings of symbols as the maximum score sequence of elementary operations (insertion, deletion, substitution, etc.) needed to transform one of the strings into the other. For example, *local alignment* algorithm finds and extracts a pair of regions, one from each of the two given strings, that exhibits high similarity [10]. Applications to the estimation of the musical similarity show that such approaches are very accurate [6], since adaptations specific to the musical context have been proposed [3].

6 PROPOSITION OF GAMES ENHANCING TECHNICAL OR EXPRESSIVE PERFORMANCE

The main goal of this section is to link current research with musical video games, by proposing a timing improvement and two video games that enhanced respectively technical and expressive performance.

6.1 Improvement for timing

In music, time must never be completely delegated to computer. The principal risk is to have gestures precipitated and not felt. In order to have a personal expressive performance, the player must operate following his **own internal rhythm**. Then, the player could express himself by changing the speed of the gesture. When a score is presented as a notes scrolling, the player looses his thinking and feeling because he totally focuses on the current note.

Thanks to presented research (section 5), a player can have the freedom to **modify the tempo** of the music. Instead of giving him note onset, a score can be made with bounds in which he could play the note. Using the Continuator mechanism (subsection 5.2), the score would propose **bounds more and more restrictive and precise** to respect the player way of performing.

Figure 2. Example of local feedback. The upper line is the score to perform. Below, the performance contains green matching notes, red notes which have been inserted and yellow notes with the bad pitch.

We can also imagine a behavior like *BAO PAO*, *Meta Piano* (subsection 5.1) or *I-Score* (subsection 5.3): the score stops as long as players do not hit the good note. It would give time to players to understand how to make this note. This is a good improvement for practicing a difficult score.

6.2 Learning game

We make here propositions for a learning game, i.e. a musical video game that makes the player progress in musical technique. First, if the player wants to acquire the technique of a particular instrument, **the controller must be this instrument**, or a very good copy of it, like some existing drums controllers for example. The choice of a controller is important since the player acquire naturally a technique depending on the controller he used. MIDI instruments are particularly well adapted, but we can imagine to use real monophonic instrument with sound analysis, like with existing voice games.

A very important point is also to propose a **pertinent evaluation** to the player. If he knows exactly what was wrong, and if the feedback is adapted to his level, he would know how to perform better. One application from researches in music similarity is presented by figure 2. Integrating this kind of feedback could provide for a musical game player a local evaluation: he would know where he was not in tune, or where the vibrato was not regular. He can **identify his weakest points** and can choose to focus on particular technical exercises that could be provided in a practice mode.

Another point is to propose a **relative evaluation** by comparing different performances thanks to similarity methods again. A player could be evaluated by comparing his performance to a score, but also to his last performance, or to the performance of a professional musician or other players[9]. If the data are centralized on a server, a player could then evaluate himself to a particular group of people, with the same age or from a conservatory of music for example.

6.3 Band game

This parts is a game proposition that would enhance the impression of playing as a band.

Controllers would look like **real instruments**. Works with handicapped people point out the importance of "social instruments". Moreover, the sensation of playing real instrument is a key point to enhance the motivation.

Concerning the evaluation, the final rank would mostly take into account **relative evaluation**. The drummer would **influence the tempo** of the performance (subsection 6.1), and the evaluation would be based on how other players respect drummer's tempo. Because the tempo could be different from the original, a similarity test (subsection 5.5) would be made on the drummer performance. Since absolute evaluation is important for hardcore gamers, it must also be provided, but it would have a minor influence on ranking.

This game must give the impression to play together, as a band. Firstly, **watching other players** instead of the screen is primordial. For this, two modes would be available: **filming players** (*e.g.* with web-cams) and displaying them on the screen with the scores; or **using augmented reality**[2], and displaying scores on other players or their instruments.

Then, this game would be based on **patterns**, *i.e.* macro-structure of notes, instead of single notes. Working with children show that is more effective to talk about gestures or patterns rather than notes. A musician-player could then focus more on expressiveness. For enhancing band play, a player would also have an **action over other players' score**. This would be done using *I-Score* (subsection 5.3) in which scenarios could send information to other scenarios for triggering an interactive event. Thanks to this, if a player has difficulty to make a pattern, the game will give him more time by repeating other players' patterns as long as he does not succeed. When he succeeds, an action on others players scores would unlock the next pattern. If all players are lost, a trick could be used to again synchronize all scores.

Finally, a good way to play together is to **learn the score**. The video game would then propose a mode in which the score slowly disappear if the player succeed. It is important for this mode to be a real part of the game, because hardcore gamers like trying to reach high score in difficult modes. If a player knows the score, he could play together without being distracted by the screen, and can focus on the interpretation. Another mode proposed would be a dialog mode, like in *Space Channel 5*, but in multi-players: a player plays a parts, and the other player try to repeat it.

7 CONCLUSION AND PERSPECTIVES

Nowadays, gamers get a strong enthusiasm from musical video games, but these games do not give significant freedom for expressive and technical performance.

By applying current research, developed in the community of computer music, both parts could take benefits. Games would became more expressive and technique, and research could use games for analysing feedback, *e.g.*, to evaluate the relevance of a ranking algorithm.

In relation with the games proposed in this paper, we could consider the following perspective. Because sound quality is a key point for enhancing motivation, we would like to use original versions of songs. When significant freedom is given, music is mainly synthesized to allow effect application, *e.g.* time-stretched or repetition. To use original versions of songs, we must apply high-quality audio transformations [12].

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