RENCON WORKSHOP 2011 (SMC-RENCON): PERFORMANCE RENDERING CONTEST FOR COMPUTER SYSTEMS

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ABSTRACT

The Performance Rendering Contest (Rencon) is an annual international competition in which entrants present computer systems they have developed for generating expressive musical performances, which audience members and organizers judge. Recent advances in performance-rendering technology have brought with them the need for a means for researchers in this area to obtain feedback about the abilities of their systems in comparison to those of other researchers.

The Rencon contest at SMC2011 (SMC-Rencon) is going to have two different stages of evaluation. In the first stage, the musicality of generated performances and technical quality of systems will be evaluated by expert reviewers using a blind procedure for evaluation. In the second stage, performances generated on site will be openly evaluated by the SMC audience and Internet viewers. The SMC-Rencon Awards will be bestowed on the systems exhibiting excellent performances at both stages.

1. INTRODUCTION

Performance expression is as important as composition or arrangement. Performance rendering has been one of the main topics since the dawn of music information science[1]. It is an ideal target to test the potential of artificial intelligence. Research that ushered in performance-rendering systems dates back to the 1980s. Since then, a great deal of commercial software for desktop music, digital audio workstations, and voice-singing synthesizers has been published. Performance rendering has also attracted attention due to its importance as an objective in the design of musical content creation.

Generative-music information processing, including performance rendering, is needed to subjectively evaluate generated performances, and this not only involves investigations into the ratio of recognition and reproduction but also sensuousness and emotionality, which are both important in musical performances. Competition is an effective way of obtaining such evaluations and should promote further advances. The rendering contest (Rencon), which was started in 2002, is an annual international competition in which entrants present computer systems they have developed for generating expressive musical performances, which audience members and organizers judge[2].

Rencon had focused on making an objective guideline of ability and possibility of automatic rendering systems by ranking performances generated by those systems, referring to human performance competitions. Since 2008, the Rencon have held an interactive section, which competes performance rendering by human operators with systems that supports their expression design as a tool.

The competition at SMC2011 will feature a new approach, which involves two different evaluations (http://www.renconmusic.org/smc2011/). In the first stage, the musicality of generated performances and technical quality of systems will be evaluated by expert reviewers using a blind procedure of evaluation. In the second stage, performances generated on site will be openly evaluated by the SMC audience and Internet viewers.

The rest of this paper is organized as follows. Section 2 describes the current state of performance rendering and the necessity for two kinds of evaluations. Then, we present an overview of the competition in Section 3. Details on the two different kinds of evaluations are described in Sections 4 and 5. We end with some concluding remarks in Section 6.

2. PERFORMANCE RENDERING SYSTEMS AND EVALUATION

2.1 Performance Rendering by Automated Systems

Research that ushered in performance-rendering systems dates back to the 1980s [3, 4]. Approaches involving music-recognition theories such as the generative theory of tonal music [5], the implication-realization model [6], learning systems [7, 8], and example-based reasoning [9, 10] have been proposed since the 1990s. In addition, a competition for system-rendered performances has been held since 2002 [2]. Moreover, a great deal of commercial software for desktop music and digital audio workstations has been published.

Figure 1 is a diagram of the flow in a typical performance-rendering system. Automated performance-rendering systems generally take a score as the input, generate a performance of this using an original rendering process, and output the rendered performance in MIDI file format. Performance-rendering systems are often categorized into rule-based and case-based schemes. In the rule-based approach, which is used by many commercial music-software sys-

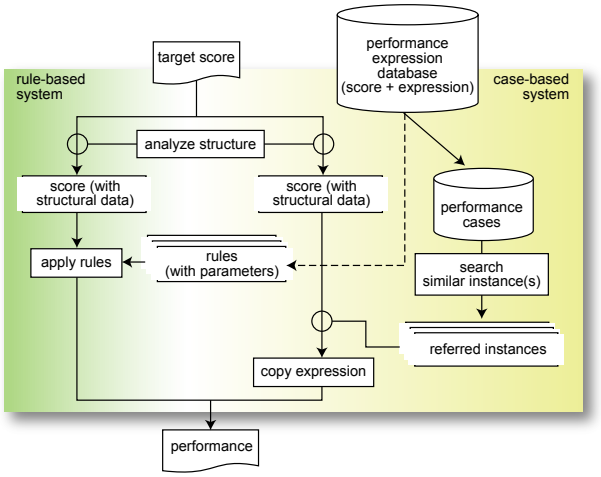

Figure 1. Illustration of typical rendering system

tems, the performance of a score is generated using musical knowledge (rules). In the case-based approach, the system finds a melody (or other sequence) similar to the target melody (or sequence) and directly transfers its expression. This approach enables the user to produce musical expressions even if he/she does not know the rules of expression for the target melody (or sequence).

Some rule-based systems have been applied to extracting rules with parameters from human performances in the same way as case-based systems do[9]. The use of these rules as examples for reference is one trend in performance-rendering studies. Structural information contained in the score has recently been used in both rule-based and case-based systems to emulate the way musicians render musical performances.

2.2 Issues in Evaluation of Musical Performances

It is crucial to introduce subjective evaluation to assess music-related artifacts, including musical performances. This section discusses the designing of a standard to evaluate listening, especially focusing on performance rendering with computers.

2.2.1 Aspects in Evaluation

Of the numerous issues to consider, we address the most crucial aspects in assessment, which are: *musicality*, *adaptability/flexibility*, and *autonomy*.

Musicality: Performances generated with computers should be evaluated in terms of "expressiveness," as is done in human music contests. From the viewpoint of computer science, it is preferable to give more objective standards to subjective evaluations done by human evaluators. We have two options regarding who evaluates performances, i.e., musical experts or the public who vote on performances.

Adaptability/Flexibility: Judging adaptability in performance rendering with computers is more crucial than that with human performers. For instance, simple memory-based performance-rendering systems can reproduce fully human-like performances, when they have examples of performances in their database. However, they cannot add any expressions to a score played for the first time. We need to measure adaptability in how well systems can generate expressions of plural pieces and plural genres.

Autonomy: One of the largest concerns from the viewpoint of artificial intelligence is to what degree humans should participate in rendering performance. We should consider views to evaluate autonomy, or contest frameworks, in which the more autonomous a system is, the greater the advantage given to the system.

In addition, *usability* substituting for autonomy should be evaluated when we evaluate performance rendering with interactive sections.

2.2.2 Contest Framework Management

We should implement the aspects described in Section 2.2.1 into the actual contest framework.

We stated, in our introduction to musicality, that there were two major methods of evaluation, i.e., evaluation by musical experts and public voting. In the former, musical experts should execute judgments carefully using sufficiently long time slots. In the latter, the public should vote within a short time and make their evaluations entertaining. The "blind evaluation" that the scientific review process adopts is likely to bore public audiences. The voting procedure by the public is motivated by them watching the process with which performances are generated and the expressiveness of the entrants.

The basic way the adaptability of performance rendering is measured is to let systems generate their own performances of a newly composed piece of music.

Limiting the time for rendering performances and preventing operators from listening to performances that the system generates is an effective framework to measure autonomy. Another effective way of comparing automatic systems fairly and rationally is that the committee generates performances using each of the systems collected from participants. It is a near future work when each system of the entrants works as a fully automatic one.

A different point of view that cannot be ignored is evaluating the extent to which systems can exhibit musicality, even though humans has to tune these up.

3. SMC-RENCON

3.1 Overview

SMC-Rencon is going to have two different evaluation stages (Stage I, II) and two system sections.

3.1.1 Evaluation Stages

In the first evaluation stage (Stage I), the musicality of generated performances and the technical quality of systems are evaluated by expert reviewers using a blind-evaluation procedure. All participants are required to generate expressive performances of a set piece and encouraged to tune

their systems or elaborate on their performances in two days, after the set piece becomes available at the Rencon webpage.

In the second evaluation stage (Stage II), performances generated on site will be openly evaluated by the SMC audience and Internet viewers. The participants are required to generate expressive performances of the set pieces chosen by lot at the venue within a limited time. Adaptability as well as musicality will be evaluated in this section.

3.1.2 System Sections

There will be two system sections in the competition: an **autonomous section** and an **interactive section**. The autonomous section is for autonomous computer systems, such as those using rule-based or case-based approaches to render performances. Entrants will not be allowed to manually edit the performances during the rendering process. The aim of this section is to evaluate performances rendered by autonomous computer systems using rule-based or case-based approaches, for example. The interactive section is for entrants using commercial music software or original applications to render performances. The aim of this section is to build common ground for evaluating human performances accomplished with computer systems as well as to make Rencon more widely appealing.

3.2 Set Pieces and Data Files

All systems are required to render set pieces of music in each stage.

- Stage I: newly composed piano piece (about 1 min)
- Stage II: existing piano piece (about 30 min)

All of the set pieces will be prepared by using Finale 2010. The data files for input to contestants' systems will be provided from software in two formats of MusicXML and a Standard MIDI file. A printed score will also be provided as a reference for human operators. The data in all three formats will be provided to each entrant at the beginning of the competition.

The document type definition (DTD) for MusicXML was developed by Recordare LLC [1] . Two files described in versions 1.0 and 2.0 will be provided. The files will be generated by the pre-installed plugin of Finale 2010 (Dolet 5 for Finale). Partwise.dtd is adopted as the top-level format. Note that data and expression marks (e.g., ***f***, ***p***, *crescendo*, *andante*, *slur* and *staccato*) will be included. Neither phrase structure nor chords are specified. If the piece includes some specific notation (e.g., trills/tremolo and grace notes), the participants should transform these notations to actual notes by themselves.

All note events will be assigned to Channel 1 for the standard MIDI file format (Format 1). The data will be generated by the pre-installed plugin of Finale 2010 (Dolet 5 for Finale). Any information on notation and expression marks will not be included. All velocities will be set to 64. Tempo (bpm) will be set to the value that the set piece indicates. Any control message including the dumper pedal (Sustain 64) will not be included. The data will not describe the complete music structure, including the phrase structure, harmony, or chord progress.

[1] `http://www.recordare.com/`

System name (section) / Author(s) - Institution(s)
usapi (autonomous) [11]
Keiko Teramura - Kyoto Univ.
Shunji System (autonomous)
Shunji Tanaka - Kwansei Gakuin Univ.
YQX v0.2 featuring The BasisMixer (autonomous) [12]
Sebastian Flossmann, Maarten Grachten, Gerhard Widmer - Johannes Kepler Univ.
Kagurame Phase-II (autonomous)
Taizan Suzuki, Tatsuya Hino, Shibasaki Masahiro, Yukio Tokunaga - Picolab Co., LTD / Shibaura Inst. of Technology
Kagurame Phase-III (autonomous)
Taizan Suzuki, Tatsuya Hino, Shibasaki Masahiro, Yukio Tokunaga - Picolab Co., LTD / Shibaura Inst. of Technology
DIRECTOR MUSICES (ACCENT-BASED FORMULATION) (intaractive)
Erica Bisesi, Anders Friberg, Richard Parncutt - Univ. of Graz / KTH
VirtualPhilharmony (intaractive) [13]
Takashi Baba - Kwansei Gakuin Univ.

Table 1. Candidate Entrants of SMC-Rencon Awards

3.3 Evaluation Process

In Stage I, the musicality of generated performances and the technical quality of the systems will be evaluated by expert reviewers. The final place in Stage I will be calculated from the total of the places in performance and technical quality. In Stage II, performances generated on site will be voted on by the SMC audience and Internet viewers.

3.4 Entrants

Table 1 shows the candidate entrants of SMC-Rencon Awards. Additionaly, the following system is to take part in Stage II.

- **CaRo 2.0** (interactive):
  Sergio Canazza, Antonio Rodà, Massimiliano Barichello and Davide Ganeo, University of Padova

Submission to Stage II would be open until the deadline of SMC2011 Registration. Each system is briefly introduced at the Rencon webpage.

3.5 Rencon Award

The SMC-Rencon Award will be bestowed on the system with the highest number of musicality rank combining the results of Stages I and Stage II. The Rencon technical award will be bestowed on the participant whose technical point evaluated at the stage I is the highest.

4. STAGE I

4.1 Overview

Stage I was held from March 27–28, 2011 through the Internet. The set piece was a newly composed piano piece "A Little Consolation" by Tadahiro Murao that lasts about one minute and twenty seconds shown in Figure 2. This stage focuses on the musicality and technical quality of the systems and their performances. All the submission data

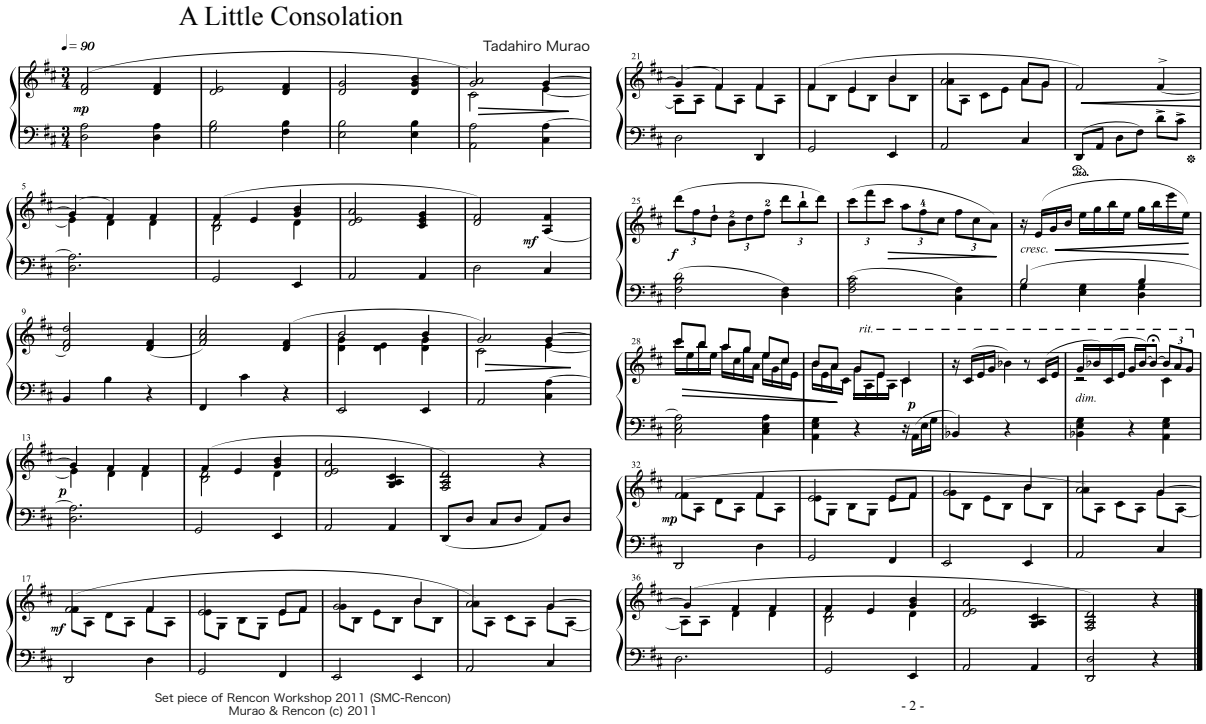

Figure 2. The set piece of Stage I

were sent by email, and the generated performances were attached in SMF format. Participants were given two days to download the set piece to submit their performance.

All of the submitted MIDI data were recorded into mp3 data through playing with a MIDI synthesizer, Acoustic Grand Piano of Yamaha's MOTIF-RACK XS.

4.2 Evaluation Process

In Stage I, the musicality of generated performances and the technical quality of the systems were evaluated by expert reviewers.

Five evaluators were asked to score the musicality of each performance on a scale of 1 to 10, (10: equal to human pianists, 5: mechanical without expression or mediocre, and 1: very poor.) using a method of single-blind evaluation. The places were calculated similarly to the judging system for figure skating (6.0 System[14]). The evaluators were also asked to write comments of 150 words, which were sent back to the contestants. The technical evaluation were executed in the same manner by reviewing the participants' extended abstracts.

The final place in Stage I was calculated from the total of the places in performance and technical quality.

4.3 Results

Table 2 shows the evaluation results of the Stage I.

For the musical evaluation, reviewers graded each of the performances on a scale of 10. And we calculated the place with a modification of prior figure skating scoring system (6.0 system) based on the your evaluation. The result was the same as the result based on the total score.

And also the reviewers stated the five viewpoints with more than 1 sentence to each of them: Level of technical Quality Human(like), Expressiveness Rhythmic accuracy and Musicality. Here we introduce some comments of reviewers:

"This sounds like a well-done computer-generated performance. The rit. in 29-31 is well taken care of; the fermata nicely long. The dynamics in bar 25 also well played." — To No. 7, by Reviewer 4:

"The theme of this melody sounds classical hymn in which tempo should not be fluctuated too much. In this performance, however, the tempo is fluctuated as a romantic piece. ..." — To No. 1, by Reviewer 1:

For the technical quality, each of two reviewers (R3, R5) avoided to review No. 7 and No. 1 because they were coauthor or closely related to the system development. To keep five reviewers for each system, six reviewers in all evaluate the systems. All the extended abstracts were hidden the authors' information to the reviewers. Six reviewers of the seven put 1.0 for No. 7. No. 4 and 5 placement were both 5th.

For the final placement, both of the rank of musicality and technical quality were summed up as (a) + (b) in the Table 2. As the result, the first place were No. 7 (YQX[12]), the second was No. 1 (Director Musices), and the third was No. 4 (VirtualPhilharmony[13]) and 6 (Shunji System).

5. STAGE II

5.1 Overview

Stage II will be held at the SMC2011 venue. Participant systems will generate musical performances on site of limited durations. Table 3 lists the time schedule for Stage

Stage I	place number of musicality						place number of technical quality							(a)+(b)	final rank
	R1	R2	R3	R4	R5	rank (a)	R1	R2	R3	R4	R5	R6	rank (b)		
No. 1: Director Musices	2.0	4.0	4.0	3.5	2.0	3	4.0	2.0	1.0	7.0	-	3.0	2	5	2
No. 2: usapi	6.0	4.0	5.0	6.5	1.0	5	7.0	3.0	6.0	2.0	5.0	6.0	7	12	6
No. 3: Kagurame Phase-II	5.0	6.5	6.0	5.0	7.0	6	1.0	7.0	2.0	4.0	4.0	7.0	4	10	5
No. 4: VirtualPhilharmony	4.0	1.0	3.0	1.0	4.0	2	6.0	4.0	4.0	5.0	2.0	5.0	5	7	3
No. 5: Kagurame Phase-III	7.0	6.5	7.0	6.5	6.0	7	3.0	6.0	5.0	3.0	6.0	4.0	5	12	6
No. 6: Shunji System	3.0	4.0	2.0	3.5	5.0	4	5.0	5.0	3.0	6.0	3.0	2.0	3	7	3
No. 7: YQX	1.0	2.0	1.0	2.0	3.0	1	2.0	1.0	-	1.0	1.0	1.0	1	2	1

Table 2. Table 2. Evaluation results of SMC-Rencon Stage I (R1-R6 means Reviewer 1, Reviewer 2... 6.). Each number of the table is the place number calculated from the obtained point by each reviewer. The ranks were calculated similarly to the judging system for figure skating (6.0 System[14]).

II.

All of the entered systems will first render expressive performances in the autonomous section, and then the rendered performances will be played by an automated grand piano and evaluated by the audience. The entrants will render performances in the interactive section using commercial or original music applications.

5.2 Autonomous Section

The autonomous section is for performances rendered by autonomous computer systems using, e.g., a rule-based or case-based approach. The systems in this section should be able to

- Read score data in MusicXML or standard MIDI format,
- Render an expressive performance (using, e.g., a rule- or case-based approach), and
- Output the generated data in standard MIDI format.

Figure 3 illustrates what the entrants are allowed and not allowed to do. For example, they are not allowed to manually edit the rendered performances.

5.3 Interactive Section

The interactive section aims to build common ground for evaluating human performances by using computer systems. Entrants will perform a musical piece using commercial music software or an original application.

As seen in Figure 4, the entrants are allowed to elaborate on the performance expressions at any step while listening to playback. They are also allowed to generate expressions by using mice, keyboards, or abstracted body movements like hand conducting. They are not allowed to directly play their musical instruments.

Competition Session (2 hours)
Autonomous sections & Interactive section
1. Score input & pre-processing
2. Performance rendering
3. System introduction by entrant
4. Performance playing
5. Audience evaluation
6. Results

Table 3. Time table for Stage II

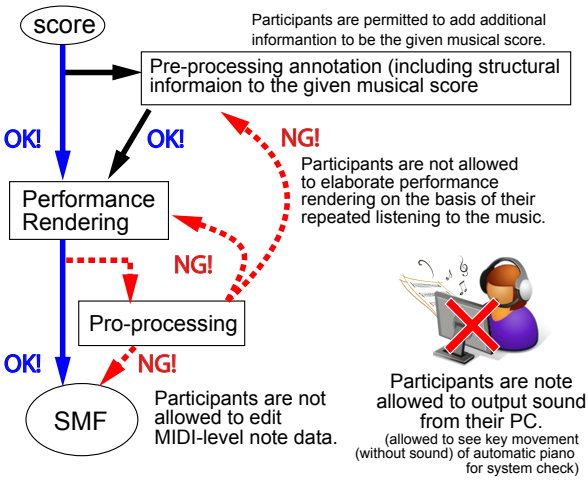

Figure 3. Performance rendering in autonomous section

5.4 Set Piece and Rendering Procedure

The set piece is specified on the day of competition from a list of the following candidates. The candidate pieces will be shown at the Rencon webpage. The participants will be required to render two different styles of performance expressions.

5.5 Entered Systems

As of the beginning of May, five systems would have been entered in the autonomous section and three in the interactive section for Stage II. The latest information will be an-

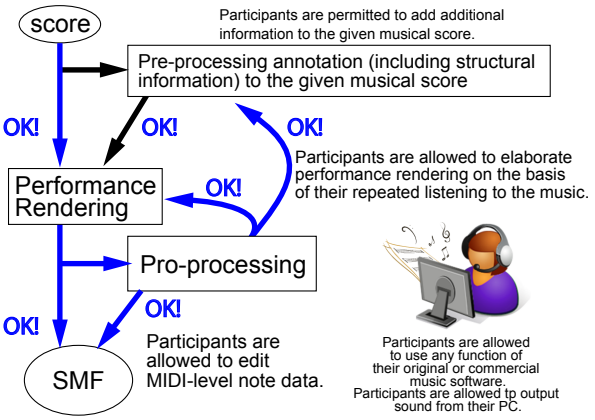

Figure 4. Performance rendering in interactive section

nounced at the Rencon webpage (`http://www.rencon music.org/smc2011/`).

5.6 Evaluation

The rendered performances will be played by an automated grand piano in turn after the 60-min rendering period.

The performances for both the section will be evaluated by the audience, taking into account the degree of goodness. We are planning to broadcast the performances in Stage II on the Internet. Those who are watching it in real time will be able to join in with the online voting.

6. CONCLUSIONS

This paper introduced the current state of performance rendering and summarized the performance-rendering competition that is to be held at SMC2011. We expect this competition will trigger a discussion of interactive design for performance interfaces, music interpretation models, and their applications to music education. We aim to contribute to the development of modeling techniques for human mental activities, the formulation of musical performance expressions, its application to education, and the creation of novel music to enjoy. We intend to make many people aware of performance-generation systems.

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