Nature Sound Ensemble Learning in Narrative-Episode Creation with Pictures

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Abstract. This paper presents a Web-based nature sound ensemble learning system that allows students to create a narrative-episode with "visual", "auditory", and "experimental" effects. Main component of our system is implemented in the Web environment and can be easily introduced to PCs in a classroom for nature sound ensemble lessons among remote learners, classes, and schools. In this study, we show the feasibility of our Web-based ensemble learning system, where several learners actually participate in the remote nature sound ensemble lessons using example "narrative-episode" with pictures and nature sounds.

Keywords: music, nature sound, collaborative learning, physical expression, sensor, Web-based system, sensibility expression, sensibility education.

1 Introduction

It has been important issues in computer-assisted music learning that the design and development of interactive learning materials for fostering learner's skills and abilities of performing musical instruments. In this paper, we focus our discussion on the ensemble lesson at school, where it is pointed out that not only the progress of playing technique is important, but also the development of each learner's abilities in collaboration and creativity in expression should be focused on. For example, the new textbook for elementary school teachers from the Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) defines the objectives of music education for the next generation as "fostering not only basic ability of musical activities but also love, Kansei (Sensibility in Japanese) and sentiment for music by appreciation and expression focusing on musical elements and mood." [1]

On the contrary, as seen in consumer game products, there are advanced computer-based technologies that allow users to play instruments by simple combinations of physical gestures without a high playing technique for musical instrument. By applying such computer-based technologies, we have designed ensemble lessons focused on the development of the learner's sense of collaboration with tempo, rhythm and melody. In music education, it is an important issue to teach concepts of rhythm, structure, and musical expression using movement [2].

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Eurhythmics proposed by Émile Jaques-Dalcroze [10] and *Eurhythmy* promoted by Rudolf Steiner [11] are famous methodologies to cultivate learners' sense and interest for music and help learners to discover the way to compose music not only by teaching playing techniques, but also by physical awareness and experience of music in the pleasure. Several researches based on similar approaches have been studied and developed to realize interactive and physical music learning environment using computer-based technology and physical music devices as well as lesson curriculums. For instance, Antle and Bakker focus on the learning of music creation and suggest lesson curriculum by leveraging embodied metaphor learning methods [3, 4, 5]. In addition, many researches attempt to make a new music instrument for improving performance skill of music players or giving more opportunities to express a person's ideas using music [6, 7, 8, 9]. Gao et al. [6] propose an adaptive learning approach based on maximum a posteriori to adapt a player's foot-tapping to synchronize with music based on the knowledge perceived from the previous excerpt. Holland et al. [7] present a Haptic Drum Kit for teaching and refining drumming skills as well as fostering skills in recognizing, analyzing, and composing rhythms.

Based mainly on these music learning methodologies and concepts such as Eurhythmics, we present a prototype of Web-based music learning system that allows students to create a narrative-episode with "visual", "auditory", and "experimental" effects. Our system is designed for nature-sound ensemble lessons among remote learners, classes, and schools. We have implemented our prototype in the Web environment where ensemble information can be delivered broadcast/multicast. In addition, our system can obtain sensor data from acceleration sensor devices (Nintendo Wii controller) so that students can play nature sound according to their actual physical motions.

In our ensemble learning system, nature sounds caused by such objects as wind, river, leaf, animal and insect, can be assigned to each animated picture for narrative-episode creation. In the lesson, attendees/learners make "narrative music" by improvisation according to their feelings and imagination. To support their imagination process, other multimedia such as still-images (photos or pictures), motion pictures (films, animations, or video clips), audio (reading poetries, BGM, or narrations), or text data are provided as materials indicating a theme of the improvisation. For example, a nature-themed narrative music is created based on a sequential three images: (1) clear sky, (2) sudden rain, (3) rainbow. The participants/learners perform improvisation by playing natural sounds associated with the photos or pictures. By using these kinds of multimedia, the participants/learners can make collaboration based on the theme and their imagination even if they cannot read musical score.

In this paper, in addition to practical lesson scenarios using our prototype system, we present the feasibility of our Web-based ensemble learning system, where several learners actually participate in the remote ensemble lessen using narrative-episode with pictures and nature sounds. By using this prototype system, we conducted initial studies focusing on the capability of ensemble data transmission and ensure that nature sound ensemble and animation effects can be performed at proper timing in each remote PC client.

2 System Architecture and Implementation

Fig.1 shows the architecture of our system. Our system provides a remote ensemble learning system using nature sounds and pictures for narrative-episode creation by sharing ensemble information among remote clients on the Web environment.

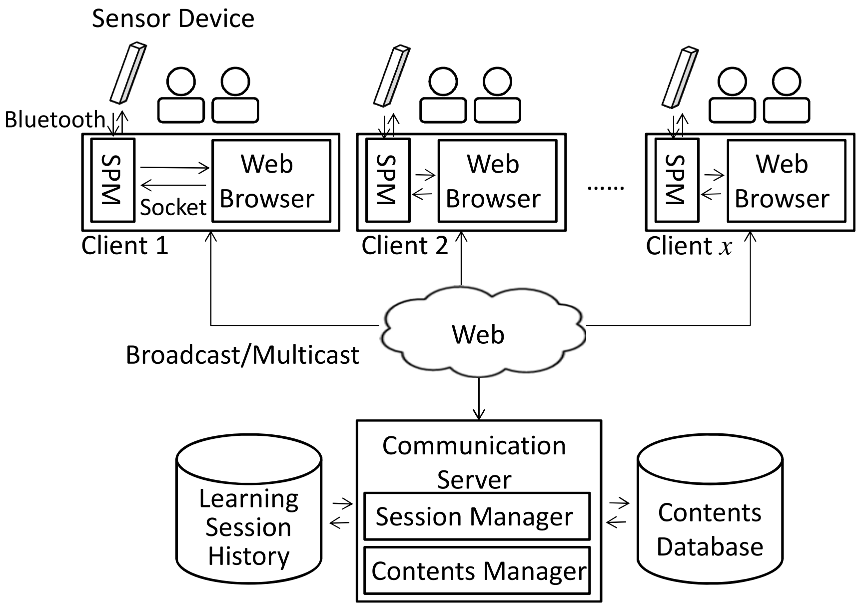


Fig. 1. Architecture of proposed system

Each client's component consists of a Web-based GUI, a sensor device, and a sensor processing module. The sensor processing module receives sensor values such as acceleration data from the sensor device via Bluetooth connection, and sends them to a main component of the ensemble system running on a web browser. Our ensemble learning system uses the sensor values for making nature sounds and changes a movement of animation object on the GUI.

2.1 GUI of Nature Sound Ensemble Learning System

The GUI of our system is provided on the Web browser, and consists of (A)(B) a current picture of episode with animation objects, (C) pictures for making an episode with time-line, and (D) CG instruments (Fig. 2).

As shown in Fig. 2, in the component of the "current picture of episode with animation objects", leaners shows animation objects that assorts well with pictures and episodes and add suitable motion representation to the animation objects. The motion representation of animation objects is changed according to sensor values received from sensor devices by learner's physical expression. Fig. 4 indicates basic motion of animation objects based on learner's physical expression that we defined in [2]. In the component of the "pictures for making an episode with time-line", user can sort pictures and photos by drag and drop them, and create an original episode on the time-line (Fig. 3).

In addition, the CG Instrument is a user interface for visualizing timing of making a sound by physical expression, and consists of images or simple shapes such as blocks and balls. For instance, the animated ball moves to a direction given by learner's physical expression and a nature sound assigned to a block is made at the timing when the ball hits to the block.

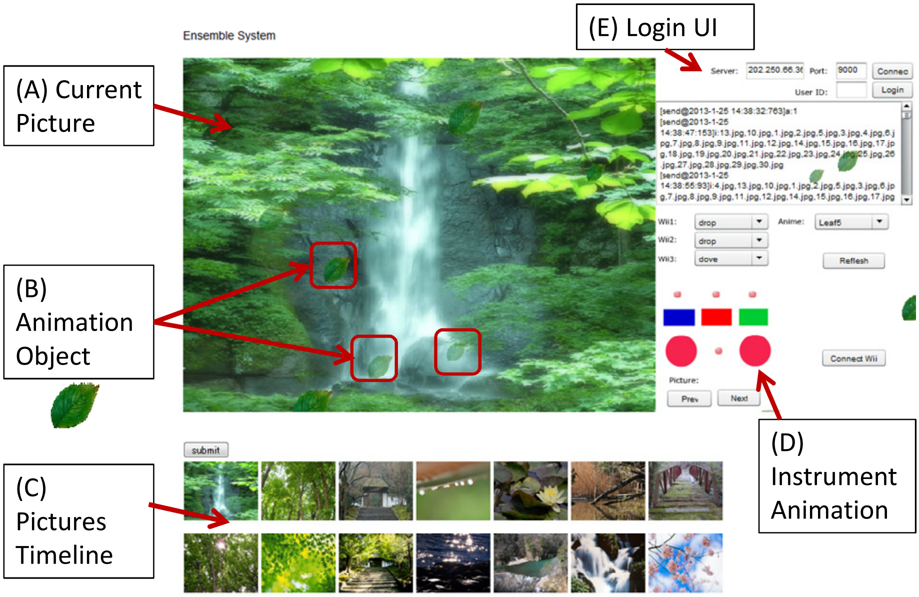


Fig. 2. Web-based GUI of our nature sound ensemble system

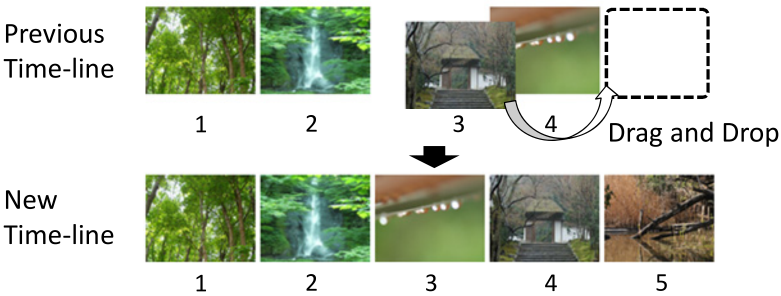


Fig. 3. Pictures for episode with time-line

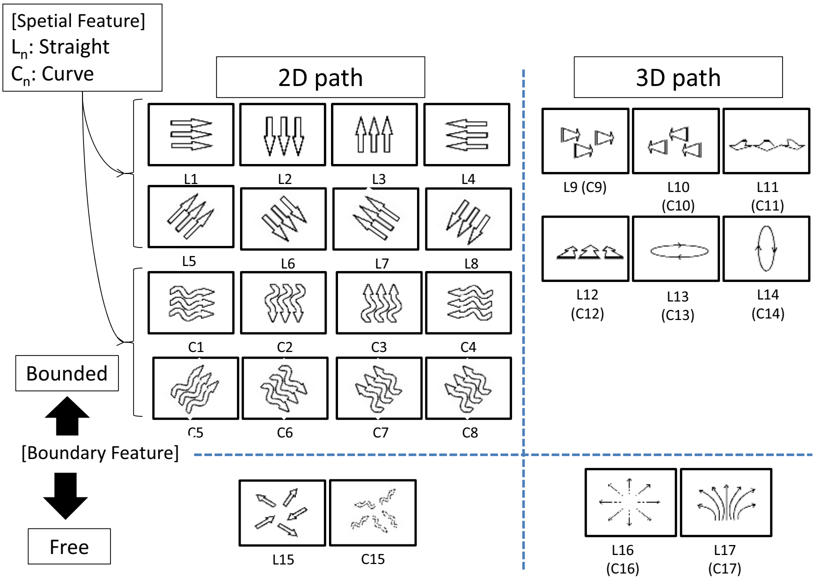


Fig. 4. Basic motion of animation object by physical expression

2.2 Network Communication Server

Network communication server is running on a single host. Clients communicate ensemble information each other via TCP/IP connection. The clients share an ensemble learning session by logon to the communication server. The ensemble information from each client is transmitted to the communication server using commands as shown in Table 1, and delivered to each client from the communication server by broadcast/multicast.

Table 1. Commands of transmitting/receiving ensemble information

	Command	Argument	Example
Sound	s	ID of sound	s:1
Picture	p	ID of picture	p:2
Animation objects	a	ID of animation object	a:1
Order of episode	i	Array of picture ID	i:1.jpg,2.jpg,…,*n*.jpg
Basic motion of animation objects	l	ID of basic motion	l:1
Additional motion of animation objects	m	8 direction	m:1

3 Lesson Scenario and Example Narrative-Episodes

In lesson scenario, attendees/learners make “narrative music” according to their feelings and imagination. To support attendees/learners imagination process, multimedia such as still-images (photos or pictures), motion pictures (films, animations, or video clips), audio (reading poetries, BGM, or narrations), or text data are provided as materials indicating a theme of the improvisation. The lesson is basically performed in the following steps:

[Performance Knowledge]

1. Participants/learners listen to the example sequences of performing instruments based on a specific theme and a set of multimedia.
2. Participants/learners play improvised music based on a specific theme and a set of multimedia prepared by an instructor/teacher.

[Performance Context]

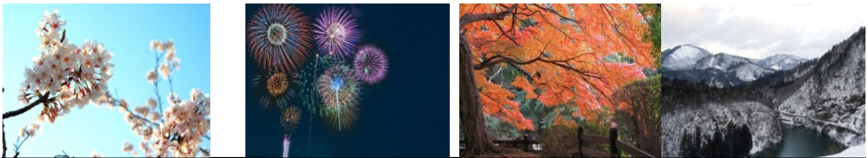
3. Participants/learners select favorite multimedia data and sound in CG instrument, set the theme, and compose a story/narrative.
4. Participants/learners play improvised music under the condition fixed in step 3.

[Performance Adaptation]

Participants/learners complete narrative music by changing the sounds in CG instruments and play them repeatedly in the collaboration.

Here, we show three examples of narrative-episodes that consist of 4 images that selected for representing each theme such as “four seasons” and “walk through a mountain in early summer”. The example episodes are as follows:

[Episode 1]



	Scene 1	Scene 2	Scene 3	Scene 4
A	Cherry blossom	Fire flake	Maple	Snowflake
L	C2	L15	C2	C2
S	bird	fire flower	wind bell	wind

A: animation objects, L: basic motion, S: sound

[Theme] Nature and seasonal tradition in four seasons

[Episode and performance instruction]

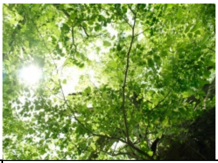
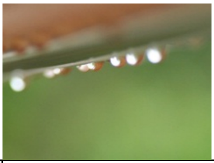
Scene 1: A bush warbler is idyllically singing in full cherry blossom.
<Performance> Move to Scene 2 after second singing of the bush warbler

Scene 2: Fireworks are rising in the night sky.
<Performance> Add suitable motions to “fire flake” at the timing of “fire flake” sound

Scene 3: Maple is beautifully in red leaf, and a wind bell is ringing in silence.
<Performance> Move to scene 4 after third ringing of the wind bell

Scene 4: The weather is fine in a snow mountain, but cold wind is blowing.
<Performance> Add to right and left motions to “snowflake” at the timing of wind sounds.

[Episode 2]

	Scene 1	Scene 2	Scene 3	Scene 4
				
A	Clover	Leaf	Drop	Blink star
L	C2	C2	L2	C2
S	Frog, tiny bird	Walk on grass, buzz of a cicada	Water dropping	River

[Theme] Waking through a mountain in early summer
[Episode and performance instruction]

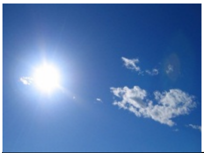
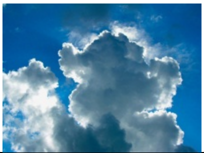
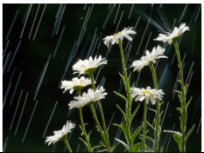
Scene 1: Red bridge is in our view and we can hear frogs and tiny birds sing.
<Performance> Tiny birds begin to sing after singing of frogs, and move to Scene 3.

Scene 2: We walk through trees with young leaves.
<Performance> Cicada starts to buzz after sound of walking. Then move to Scene 3.

Scene 3: When taking a break, we can see water is dripping from leaf of grass
<Performance> Move to scene 4 after repetition of water-dripping sound

Scene 4: We can see river stream and hear its sound.
<Performance> Add right and left motions to “blink star” at the timing of wind sounds

[Episode 3]

	Scene 1	Scene 2	Scene 3	Scene 4
				
A	Blink star	Drop	Rain	Blink star
L	C2	L2	L8	C2
S	Wind bell	Thunder, water dripping	Rain, wind	Cicada, wind bell

[Theme] Sudden rain
[Episode and performance instruction]

Scene 1: Wind bell is ringing in the brisk blue sky of summer.
<Performance> Move to Scene 2 after second ringing of the wind bell.

Scene 2: The rain cloud begins to cover sky, and we can hear clap of thunder.
<Performance> Rain drop starts to fall after the clap of thunder. After the sound of rain-dropping, move to Scene 3.

Scene 3: The rain is strongly falling.
<Performance> Make a sound of strong rain at switching Scene 3. Make a sound of wind at a proper timing, and add left motion to “rain” with the sound of wind. Move to scene 4 after repetition of the wind sound

Scene 4: We can see rainbow in the sky after the heavy rain.
<Performance> Cicadas start to buzz. Make sounds of wind bell in the last.

4 Experiment

In the experiment, we conducted a nature sound ensemble lesson using three example episodes and scenario as described in Section 3. Three learners participated in the lesson using their own client PCs. Learner 1 and 2 connected to the same university network where the communication server is located, and learner 3 used an external Internet connection provided by a commercial Internet provider. The rolls of each leaner are as follows:

Learner 1: Picture (p), order of episode (i)
Learner 2: Sound (s)
Learner 3: Animation objects (a), additional motion of animation objects (m)

In order to make a sound or add an animation motion, the learners 2 and 3 use Nintendo Wii controllers as acceleration sensor devices.

In the evaluation, we mainly focus on the capability of ensemble data transmission in order to test that nature sound ensemble and animation effects can be performed at proper timing in each remote PC clients. Table 2 shows the performance time of each episode in the lesson, and Tables 3, 4, 5, and 6 show the average time of data transmission in each command. All participants synchronize clock on their PCs using Internet Time Server in advance, but, we could not synchronize clocks in a milli-seconds unit. So, we checked the difference of time on each PC's clock in a milli-seconds unit, and correct the latency time in Tables 3, 4, 5, and 6.

From these results, we can confirm that the network latency of each command by multicast is within 200[ms], and it is deemed that this latency is not affected to perform nature sound ensemble among remote clients. Actually, all participants could feel that their ensemble of each example episode was performed smoothly without any stresses arisen from the network latency.

Table 2. Performance time of each episode

	Time
Episode 1	1 min.
Episode 2	1 min 40 sec
Episode 3	2 min 10 sec

Table 3. Average time of data transmission in episode 1

	Command	Frequency	Average time of data transmission [ms]
Sound	s	9	180.08
Picture	p	3	142.08
Animation objects	a	3	179.16
Order of episode	i	1	148.75
Additional motion of animation objects	m	39	192.70
		[Total] 55	[Average] 168.55

Table 4. Average time of data transmission in episode 2

	Command	Frequency	Average time of data transmission [ms]
Sound	s	7	158.46
Picture	p	3	96.08
Animation objects	a	3	171.50
Order of episode	i	1	131.75
Additional motion of animation objects	m	65	171.50
		[Total] 79	[Average] 147.92

Table 5. Average time of data transmission in episode 3

	Command	Frequency	Average time of data transmission [ms]
Sound	s	11	136.65
Picture	p	3	104.08
Animation objects	a	4	181.50
Order of episode	i	1	109.75
Additional motion of animation objects	m	68	160.60
		[Total] 87	[Average] 138.51

Table 6. Average time of data transmission (Average of episode 1 to 3)

	Command	Frequency	Average time of data transmission [ms]
Sound	s	27	158.40
Picture	p	9	114.08
Animation objects	a	10	177.38
Order of episode	i	3	130.08
Additional motion of animation objects	m	172	178.37
		[Total] 221	[Average] 151.66

5 Conclusion

In this paper, we have presented a prototype of Web-based nature sound ensemble learning system with "visual", "auditory", and "experimental" effects.

In the evaluation, we mainly focus on the capability of ensemble data transmission in order to test that nature sound ensemble and animation effects can be performed at proper timing in each remote PC clients. From the experimental results, we confirmed that the network latency of each command by multicast is within 200[ms]. We conclude that this latency is not affected to perform nature sound ensemble among remote client. Our Web-based ensemble learning system can be developed as a practical application where multiple learners actually participate in the real-time remote ensemble lessons for making narrative-episode creation with pictures and nature sounds.

As future work, we will perform demonstration experiments at an elementary school. Through the practical use in the class, we will validate the effectiveness of our proposed music system based on the feedback from teachers and learners, as well as improving our system and lesson curriculum.

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