Songrium: Browsing and Listening Environment for Music Content Creation Community

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ABSTRACT

This paper describes a music browsing assistance service, *Songrium* (http://songrium.jp), which enables visualization and exploration of large amounts of user-generated music content with the aim of enhancing user experiences in enjoying music. Such a huge amount of user-generated content has yielded *"web-native music"*, which we define as musical pieces that are published, shared, and remixed (have derivative works created) entirely on the web. Songrium has two interfaces for browsing and listening to web-native music from the viewpoints of scale and time: *Songrium3D* for gaining community-scale awareness and *Interactive History Player* for gaining community-history awareness. Both were developed to stimulate community activities for web-native music by visualizing large amounts of music content spatially or chronologically and by providing interactive enriched experiences. Songrium has analyzed more than 680,000 music video clips on the most popular Japanese video-sharing service, *Niconico*, which includes original songs of web-native music and their derivative works such as covers and dance arrangements. Analyses of more than 120,000 original songs reveal that over 560,000 derivative works have been generated, contributing to the enrichment of user-generated music content.

1. INTRODUCTION

When many amateur musicians started releasing their new original songs on video-sharing services, a new type of music content that was born, listened to, and distributed on the web became popular. Many derivative works such as cover versions and music video clips of those songs have also been created and shared actively by other creators. Such music contents, called *web-native music* [1], have continued to increase. The contents differ from commercially distributed songs, which are released originally on the market and are then copied to video-sharing services.

Creators and listeners of web-native music form an interesting community that grows and continues to update its own history dynamically on the web. This dynamics makes it difficult for people to grasp a comprehensive picture of the community. Although ranking and recommendation are powerful and typical ways to find popular and similar music contents, they are insufficient to elucidate the entire community. The goal of this research is to enable people to browse and listen to web-native music efficiently while grasping its nature and history.

This paper therefore presents a proposal to extend our web service, *Songrium* (http://songrium.jp) [1, 2], by adding *Songrium3D* and *Interactive History Player*, two interfaces that help people to be aware of the scale and history of the music content creation community through visualization of music content. Songrium3D presents visualization of the whole content in three-dimensional (3D)

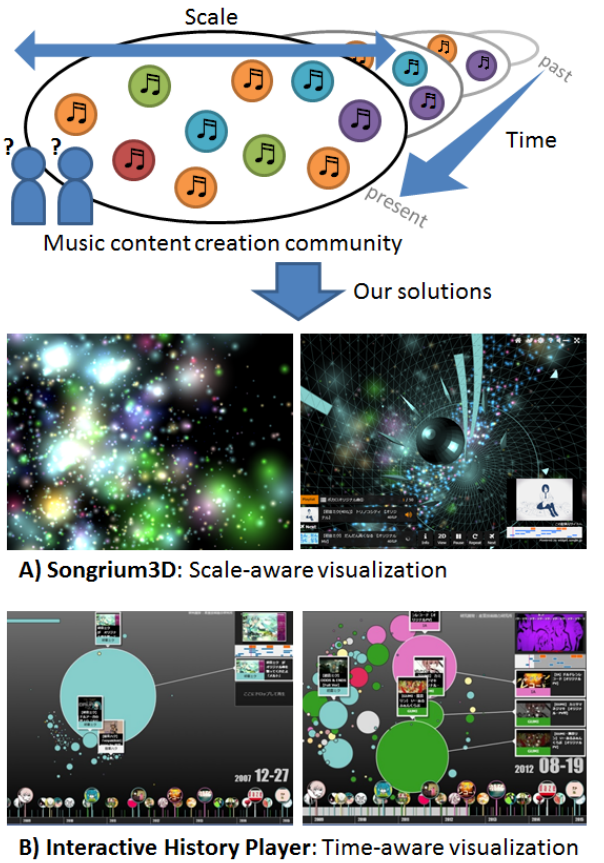

Figure 1. Songrium3D and Interactive History Player. The former is scale-aware visualization. The latter is time-aware visualization for music content creation community.

space to facilitate community-scale awareness (Fig. 1-A). Interactive History Player visualizes the content chronologically to gain community-history awareness (Fig. 1-B). The current target content of Songrium is original songs using *VOCALOID* [3] singing synthesis technology and their derivative works on Niconico, the most popular Japanese video-sharing service.

Songrium3D visualizes original songs as if they are stars in a planetarium. Their positions are arranged automatically so that songs with similar moods can be closely located. Additionally, it seamlessly visualizes overviews of the whole content and details of each content. Furthermore, Songrium3D shows automatically synthesized visual effects for each user-generated music content during music playback. The effects comprise predefined elements. Their compositions are based on the analysis of music structure, both contributing to high-quality visuals.

Interactive History Player shows growth in the popularity of songs, arranged by published date, in an animated display. This feature enables users to experience a group of songs in one continuous movie, providing a clear, intuitive picture of how trends related to video-sharing services have changed.

We launched Songrium in August 2012. More than 147,000 users have used our service since. More than 120,000 original songs and 560,000 derivative works have already been registered. New songs are also registered automatically every day. For those reasons, Songrium is the only large-scale web service that can provide a comprehensive overview of the music content creation community for VOCALOID.

This paper is organized as follows. Section 2 explains music content creation community within the VOCALOID community on Niconico. Section 3 introduces basic functions provided by Songrium. Section 4 presents a description of Songrium3D. Section 5 presents a description of Interactive History Player. Section 6 presents our experiences with Songrium. Section 7 presents related work. Section 8 presents a summary of this paper's contributions.

2. WEB-NATIVE MUSIC ON NICONICO

Niconico is an extremely popular video communication service in Japan today. As with similar services (YouTube LLC, etc.), users can upload and view videos. User-generated music content is the subject of many videos. Among them, music contents related to VOCALOID are popular. They differ from the rest, as explained below.

VOCALOID is a singing synthesis technology [3] and it is used to synthesize the main vocal melody of songs. Many examples have been published as original works on the web. Despite the impressive technology used for the songs, the vocals produced by VOCALOID are readily identifiable as not of human origin, meaning that both creators and listeners naturally accept that these songs are first published on the web. Niconico therefore serves as a common space for VOCALOID creators and listeners to do meeting, communication and even collaboration as we discuss later.

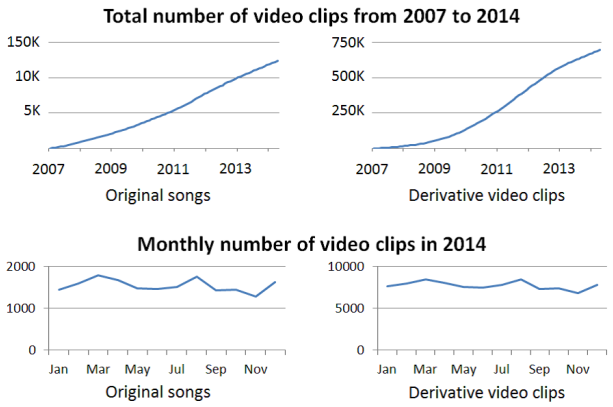

Figure 2. Two top graphs show that the total number of published original songs and their derivative works in the period September 2007 – December 2014. The two bottom graphs show the monthly number of published original songs and their derivative works in 2014.

Many different singing synthesis products are based on VOCALOID; each has a different vocal timbre. Most products have an associated character image, with Hatsune Miku[1] being the most well-known. Soon after releasing Hatsune Miku, Crypton Future Media (the developer of Hatsune Miku) officially started allowing users to reuse its character for derivative works with their original license: Piapro Character License[2] . Subsequently, users started to create music videos for Hatsune Miku, with such original songs and drawings. Some users even went so far as to create 3D models of Hatsune Miku and to create 3D animation videos [4, 5]. Thereafter, many songwriters published karaoke (full song without vocals) versions of their own original songs, prompting some users to sing these songs and to publish derivative works recorded in video clips.

We designated music having such characteristics as *web-native music* [1] and defined the conditions of web-native music as shown below.

(1) It is generally assumed that new original songs are first released on the web (without CD release or radio play, for example), with a unique URL identifying the source and release date.

(2) Creators do not hesitate to create and release derivative works of original songs on the web.

(3) After releasing original or derivative works, their creators can publicly receive feedback on the web and be encouraged to create more related materials.

Under the conditions described above, web-native music naturally encourages the creation of derivative works. In fact, many derivative works are uploaded on Niconico. Figure 2 shows the number of total published original songs and their derivative works from September 2007

[1] http://www.crypton.co.jp/mp/pages/prod/vocaloid/cv01_us.jsp

[2] From December 2012, they use Creative Commons license for foreign users.

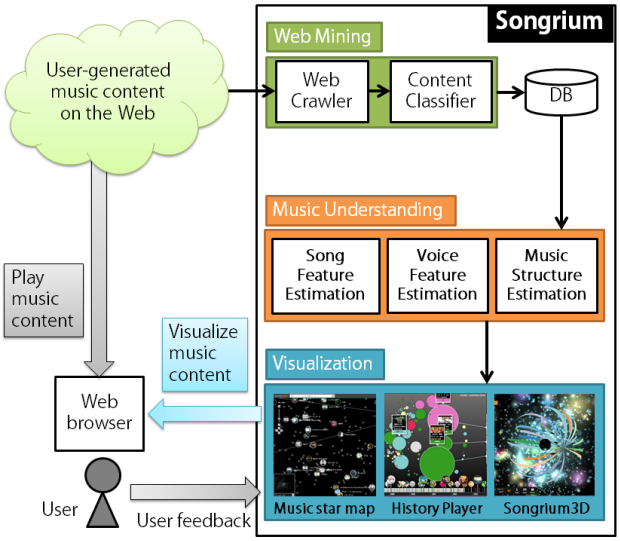

Figure 3. System overview of Songrium.

through December 2014 and the number of monthly published items in 2014. As described herein, we define the term 'derivative work' as a video clip that reuses a part of or whole of video clip of VOCALOID original song. According to this figure, the number of uploaded original songs and derivative works has been increasing constantly. In 2014, about 1,500 original songs and 7,000 derivative works were published month by month. 80% of derivative works are published after one month past the original publication date, whereas 40% are published after one year, showing that derivative works help original works to keep the attention of audiences for long periods. Furthermore, 14% of original songs have a derivative work with page views higher than the original work, indicating that derivative works are attractive contents.

3. SONGRIUM

3.1 Overview

Songrium, a music browsing assistance service, facilitates understanding of the great amounts of user-generated music content within the VOCALOID community on the Niconico service. Figure 3 portrays an overview of Songrium. Songrium automatically gathers information related to original songs and their derivative works, which are expanding day-by-day. It then classifies these contents and estimates the relations between original songs and derivative works. Songrium presents a visualization using results obtained from music understanding.

By visualizing the web-native music, Songrium improves a user's understanding of various relations in the web-native music and enriches an interactive experience in the music content creation community. It was difficult for people listening to original songs to notice that there exist various derivative works related to them, such as cover versions, singing or dancing video clips, and music video clips with 3D animations. By providing people with easy, intuitive access to those derivative works, Songrium enables them not only to find interesting music video clips but also to know and respect the creators of music and video clips.

Table 1. Classification results of 564,623 derivative works. Some derivative works have multiple categories. Therefore, the total number of classifications is greater than the number of derivative works.

category	# of works
(a) Singing	379,342
(b) Dancing	30,159
(c) Arranging and Performing	35,584
(d) Featuring 3D characters	33,270
(e) Creating Music video	9,062
(f) Others	84,137

Songrium uses web mining and music understanding technologies together with advanced data visualization techniques to achieve unique function, such as a Music Star Map, Songrium3D (in Section 4), and Interactive History Player (in Section 5).

3.2 Web mining of Songrium

Every music video clip on Songrium is classified automatically as an original song or a derivative work. Social tags of some kinds such as "Original Song" and "be enshrined in the Hall of Fame song" are usually put on original songs on Niconico. Therefore, these tags are reliable. However, even if some original songs have no such tag, Songrium automatically classifies them correctly by crawling a set of related web sites to generate the "white list" of VOCALOID original songs. In the case of derivative works, these can be readily identified when the description text of the video clip includes a hyperlink to the original video clip from which it was derived. These hyperlinks almost always exist on Niconico because users prefer to acknowledge the original video clip.

When a derivative work is incorporated, its relation to the original song is estimated automatically. The derivative works are classified into predefined categories. We defined six categories of derivative works: (a) Singing a song, (b) Dancing to a song, (c) Performing a song on musical instruments, (d) Featuring 3D characters in music video, (e) Creating a music video for a song, and (f) Others. The first three categories are derived from official categories used by Niconico; the other two categories are derived from our previous work [4, 5]. "Others" includes, for example, videos which review or rank existing videos, or which is karaoke version, or which use VOCALOID songs as the background music to other video contents. It also includes videos that are not classifiable. With the exception of category *Others* all have their own unique social tags on Niconico. Using these tags, Songrium can produce a reliable classification of derivative works. Table 1 shows classification results of derivative works.

Moreover, Songrium enables users to report an error in any of the above classification of video clips, extraction of links, or estimation of relations easily to improve the user experience further.

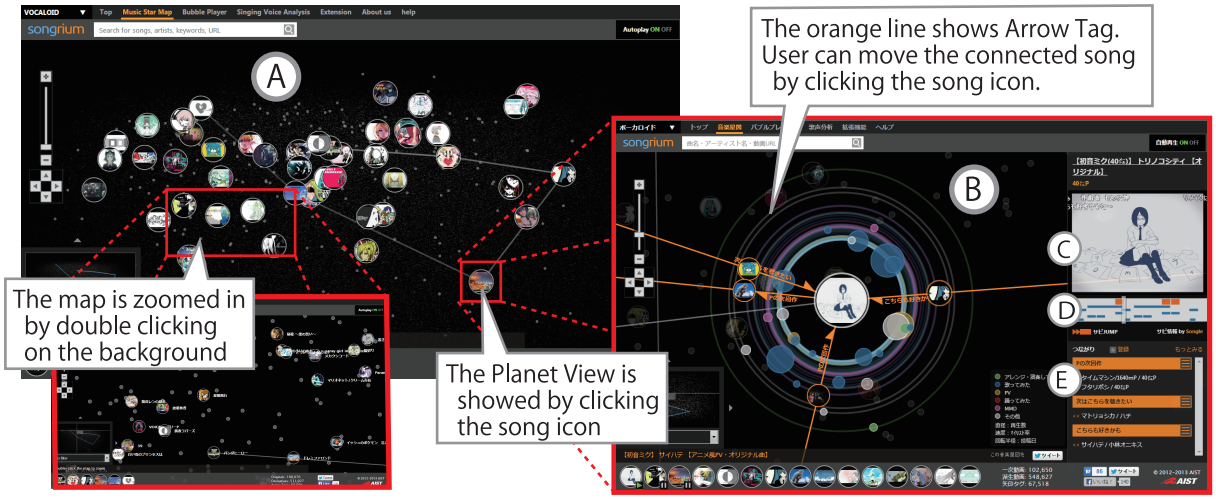

Figure 4. Screenshot of the (A) "Music Star Map" and (B) "Planet View" interface in Songrium: the former visualizes original songs; the latter visualizes their derivative works. Both are connected seamlessly. (A) All original songs are arranged in a two-dimensional space with similar songs positioned in proximity. Any particular area can be expanded for viewing by double clicking. It can then be scrolled to by dragging. (B) After selecting an original song on Music Star Map, users can view its derivative works rotating around the selected song in the center. (C) Embedded video player of Niconico for video playback. (D) Playback interface for trial listening (SmartMusicKIOSK). (E) Social annotated relations called Arrow tags [2] to and from this song instance.

3.3 Music Understanding and Visualization of Songrium

Songrium has various functions of visualization for music content [2] [1] using music audio analysis. *Music Star Map* is a function that visualizes original songs. Original songs are embedded in a two-dimensional space, mapped automatically based on audio feature similarity. The position of each original song is mapped to a two-dimensional space of the Music Star Map based on analysis of audio features. Although any feature vector designed for computing music similarity could be used, in our current implementation, we use a 200-dimensional audio feature vector obtained using learned latent representations [6]. To determine the (x–y) position of a song on the Music Star Map, its 200-dimensional feature vector is projected onto two dimensions using principal component analysis (PCA), where only the first two components are retained. Figure 4-(A) portrays a screenshot of this function.

When a user clicks an original song on Music Star Map, its derivative works appear as colorful icons and orbit the selected song. We designate this view as the "Planet View." Figure 4-(B) presents a Planet View screenshot. Each circle icon denotes a derivative work with attributes represented by the icon orbit, size, color, and velocity. Table 2 shows correspondence between visual features and metadata.

The official embedded video player of the Niconico service, shown at the upper-right corner, can play back a video clip of the selected original song (Fig. 4-(C)). Our music-listening interface has a chorus-search function for trial listening, *SmartMusicKIOSK* [7], which is shown below the embedded player (Fig. 4-(D)). Songrium has an original social tagging framework called the 'Arrow Tag' that allows to annotate a relation between music content [2]. Figure 4-(E) shows a list of Arrow Tags.

Table 2. Correspondence table with visual features of the icons and metadata of derivative works.

Visual feacture	Metadata
Radius of orbit	Publishing date
Size	Number of page views
Velocity	Number of favorite users
Color	Derivative categories

4. SONGRIUM3D

Songrium3D is a novel visualization interface based on the *Music Star Map* of Songrium . The Music Star Map visualizes original songs and their derivative works in two-dimensional space, but Songrium3D visualizes them in three-dimensional space. Using three-dimensional visualization, Songrium3D (1) visualizes many contents simultaneously, and (2) visualize songs, derivative works, and music structure seamlessly.

Figure 5 presents a screenshot of Songrium3D. The spherical object represents an original song in the center of the figure. When it plays a song, this object and peripheral objects move rhythmically, synchronized to the song. The (x–y–z) position of a song is determined based on the first three principal components (see Section 3.3). Many colorful circumjacent materials indicate derivative works of an original song. Color denotes a category of derivative works in the same manner as PlanetView (Fig. 4-(B)).

Above, we describe that Songrium3D visualizes music structure of a song, derivative works of a song, and other songs at a time. The important point is that it is not only

Figure 5. Screenshot of the “Songrium3D”. (A) Users can search songs using keywords. Similarly, users can search playlists in Niconico using keywords or a URL. When users choose a Mylist, it starts auto play. (B) It shows a playlist. (C) This spherical object indicates an original song. Some objects and ribbons near the song are visual effects that are synchronized to a song. (D) A song is encompassed with many colorful particles which mean its derivative works. (E) Other original songs are apparent way out there. (F) Embedded video player of Niconico for video playback and SmartMusicKIOSK for trial listening.

visualizing them at once but also visualizing them seamlessly. Figure 6 shows the transition from the top page to a user-specified song. First, all original VOCALOID songs are visualized in a three-dimensional space where songs which sound similar are positioned in proximity, similar to stars in the cosmos (Fig. 6-(1)). The colors of these stars correspond to VOCALOID characters, with brightness representing its popularity (number of plays). When a user chooses a song, a camera starts to move to the song (Fig. 6-(2)). Users can gradually see more of the song and its derivative works (Fig. 6-(3)(4)). It displays all derivative works of the song as a mass of particles.

After arriving at the song, it displays visual effects that are synchronized with sounds of the song (Fig. 6-(5)). Derivative works and other songs are shown in the background when it shows visual effects that can be regarded as a visualization of the music structure. In this manner, Songrium3D visualizes all contents seamlessly, which is an important benefit of three-dimensional visualization. It helps users to be aware of the scale of this music content creation community.

Songrium3D visualizes music descriptions such as the beat and music structure, supported by signal processing and music understanding technologies. Figure 7 shows the manner in which Songrium3D generates visual effects that are synchronized to a song. Many music players have visual effects that are synchronized to audio signals. However, in the Songrium3D, visual effects can be changed according to the music structure that consists of a chorus and repeated sections. One visual effect is mapped to one repeated section. Songrium3D has only six patterns of visual effects, but each song has a different music structure. Then Songrium3D can generate various visual effects that are synchronized to a song. Handcrafted visual effects can

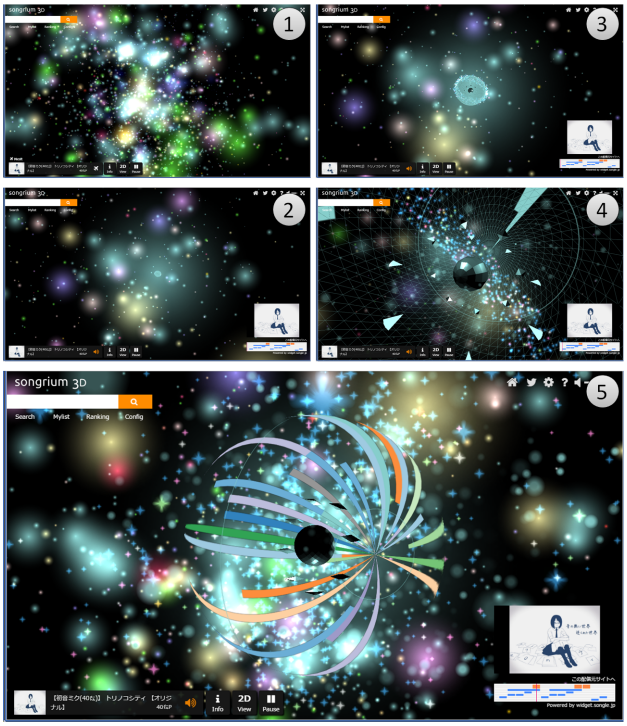

Figure 6. Transition from top page to a user-specified song in Songrium3D. All original VOCALOID songs are visualized in a three-dimensional space. The colors of these stars correspond to VOCALOID characters, with brightness indicating popularity (number of plays).

represent the deep meaning of a song, but they have high cost.

While there are music visualizers built into existing media players that can show music-synchronized animation of geometric patterns, their music analysis is usually based on the amplitude or spectrogram of audio signals. Such a visualization approach entails low costs because it can be fully automatic, but it can represent only the shallow meaning of a song. Our approach is a combination of handcrafted and automated generation. It is entails medium costs and it can be reflected by the meaning of a song.

5. INTERACTIVE HISTORY PLAYER

Interactive History Player visualizes the history of VOCALOID songs. Figure 8 portrays a screen shot of Interactive History Player. It displays groups of songs published during the specified period in chronological order, giving the user a full perspective on the trends and transitions in published song groups over time. Each song is represented as a “bubble” (a colored circle). New song bubbles appear in accordance with their respective published dates and congregate in an animation (Fig. 8-(A)). The color of each bubble corresponds to the VOCALOID character, whereas the sizes of the bubbles indicate play counts. On the left side of the screen, the bar chart presents a summation of play counts of bubbles in the same VOCALOID characters.

The interface exhibits growth in the music content cre-

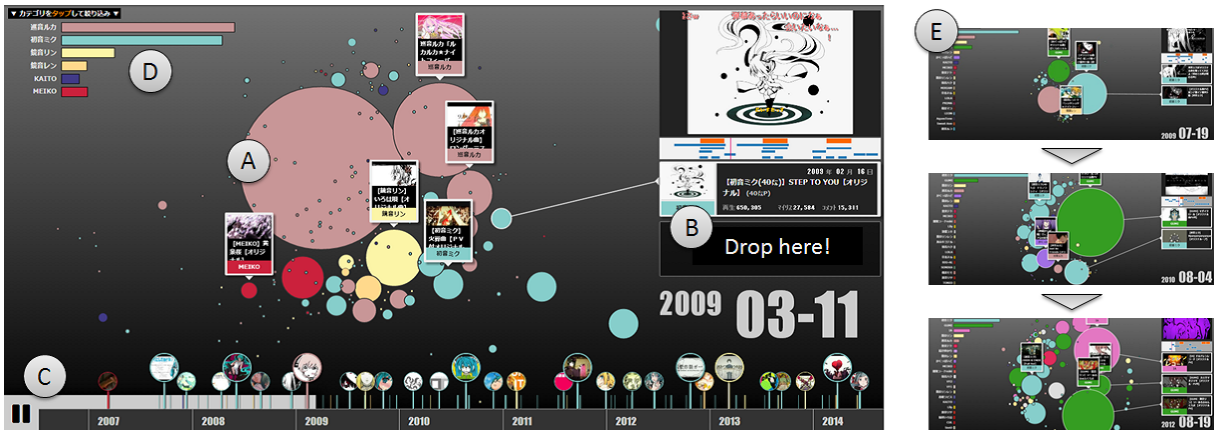

Figure 8. Screenshot of the "Interactive History Player" in Songrium. It visualizes the history of VOCALOID songs. (A) A bubble represents the music content. Its size denotes the play counts; its color shows the VOCALOID character. When users click a bubble, its thumbnail and metadata are shown. (B) Users drag and drop a bubble; then the song is added to the playlist. (C) The timeline displays the current time and popular content in each period. When users click on the timeline, it jumps to the clicked period. (D) The bar chart shows the summation of play counts of bubbles with the same color. (E) It displays groups of songs published during the specified period in chronological order, automatically.

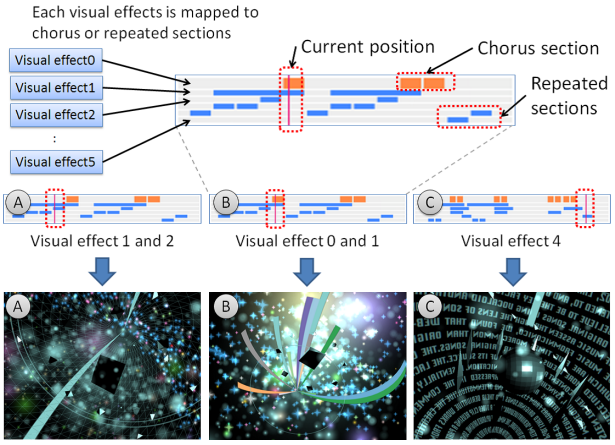

Figure 7. Examples of pair of visual effects and repeated sections. Each visual effect is mapped to a chorus section or one repeated section. In the left panel, the current time is repeated for sections 1 and 2. Then users can see a mix of visual effects 1 and 2. Each visual effect will be started at the beginning of the repeated section.

Figure 9. Songrium3D on the live stage of Hatsune Miku. Animation generated by Songrium3D is shown in the gate-shaped LED display.

ation community, arranged by published date, in an animated display. It plays songs for which the play count is high in the period automatically. Consequently, this feature enables users to experience a group of songs in one continuous movie, providing a clear, intuitive picture of how trends on video-sharing services behave.

Users can play songs with drag-and-drop operations if users become curious about some songs (Fig. 8-(B)). Additionally, they can change the current time (we called this function "time warp"), and filter songs by VOCALOID characters solely by mouse operation (Fig. 8-(C)(D)). Furthermore, Songrium enables users to play back the chorus part using SmartMusicKIOSK. This trial listening environment makes it easy to ascertain what kinds of songs were being published at each time. These interactive functions help users to browse music contents in a growth community.

The Interactive History Player has two different versions: "Singing derivative works" version and "Dancing derivative works" version. They display derivative works with the same interface. The bubble colors correspond to their original songs. A bar chart shows a trend of original songs for derivative works.

6. EXPERIENCES WITH SONGRIUM

6.1 Songrium on the Web

Users can use all functions of Songrium and can watch the latest music contents every day merely using the web browser. The Songrium web crawler checks updated mu-

Figure 10. Demonstration of Interactive History Player at a public event. The left panel shows the demo system. As shown in the right panel, participants are using our service with touch panel display. The wall-hanging big-screen shows the Interactive History Player screen that is operated by participants. At the venue, many waiting persons and passersby watched it.

sic video clips related to VOCALOID on Niconico automatically on a daily basis. The user interface of Songrium is implemented using HTML5, SVG, JavaScript, the JavaScript library D3.js, threeJS, and the embedded video player of the Niconico service.

The Songrium service was released to the public at http://songrium.jp on August 7, 2012. In addition to the web service, the Songrium extension for Google's Chrome browser was released on February 28, 2013. As of April 2015, 128,044 original songs and 564,623 derivative works had been registered in Songrium. More than 147,000 users have visited our web site. Of them, more than 2,500 users have installed the browser extension.

6.2 Songrium3D on the live stage

Animation of Songrium3D was used as a back-screen movie on the live stage of Hatsune Miku in the "SNOW MIKU 2015 LIVE!" held four times in February 7–8, 2015. It was hosted by Crypton Future Media Inc. for a total number of audiences of about 7,000.

Figure 9 shows the live performance with Songrium3D. The centerpiece is a figure of Hatsune Miku on the DILAD screen and the movie generated by Songrium3D shown over her head. At the bottom, one can see the many light sticks swung by audience members. The live show used the prerecorded singing voice and prerecorded dancing animations of Hatsune Miku. Only the backup band performed live on-stage.

We produced a prerecorded animation of Songrium3D to avert problems deriving from internet connections or real-time rendering. We captured screenshots of Songrium3D in 29.97 fps and combined them to produce a single movie. A movie of the live performance[3] and the animation of Songrium3D for the live[4] are available on the internet.

[3] https://youtu.be/GOano9x9cBY
[4] https://youtu.be/71o8jit1c4I

6.3 Interactive History Player in public events

The Interactive History Player has been used at three big public events, *Niconico Chokaigi 3*[5] , *Niconico Chokaigi 2015*[6] and *Magical Mirai 2014 in Osaka*[7] . The first two were public events for Niconico hosted by Niwango, Inc. Chokaigi 3 was held April 26–27, 2014, for 124,966 attendees. Similarly, Chokaigi 2015 was held April 25–26, 2015. The total number of attendees was 151,115, up 20% over the prior year. The last one was a public event for Hatsune Miku hosted by Crypton Future Media, Inc. It was held in August 30, 2014 for a total number of attendees of about 11,000.

Figure 10 presents an image showing the demo system in Niconico Chokaigi 2015. Many people enjoyed using the Interactive History Player and watched videos nostalgically. At first, many people were passively browsing contents using the system; then they sought their own memorial contents or period using filtering and the time warp function. Some users talked about their favored old contents with friends while using our service.

7. RELATED WORK

Songrium, at its core, is a music browsing assistance service. Most previous research into interactive music browsing has emphasized visualization to explore musical collections. A particular visualization technique is often attempted to lay out a music collection in a two-dimensional plane [8–10] and three-dimensional plane [11–14]. Our Music Star Map (see Section 3.3) and Songrium3D (see Section 4) are particular examples of this. Interactive interfaces are also important for user experiences; [15] assists a user in discovering songs. [16] assists a user in finding artists. In contrast to the advances in interactive music browsing described above, Songrium visualizes not only original songs, but also their derivate works and respective histories, facilitating the effortless browsing of web-native music content. Furthermore, we apply our visualization methods to huge and dynamic volumes of music contents and release them as a web application.

Music recommendation [17–19] is an automated method giving users the opportunity to encounter unfamiliar but potentially interesting songs. Similarly, automatic playlist generation [20–23] can provide such opportunities for users. Songrium also assists such user activities by visualizing large amounts of user-generated music content. However, Celma and Cano report that the collaborative filtering approach, which is a typical recommendation method, is prone to popularity bias [24], meaning that a tendency by which "The rich get richer" is reinforced by music recommendations. It is unsuitable for browsing assistance with large amounts of user-generated music contents. Kamalzadeh reports that 50% of active listeners would like to choose songs one after another [25]. Furthermore, only 9% use online recommendations and 10% use shuffle when listening to a collection, which indicates that

[5] http://www.chokaigi.jp/2014/abroadEnglish.html
[6] http://www.chokaigi.jp/2015/abroadEnglish.html
[7] http://magicalmirai.com/2014/index_en.html

active listeners enjoy not only listening to songs but also choosing songs. Regarding this point, visualizing large amounts of user-generated music content can provide an excellent experience for active listeners, having a complementary relation with music recommendation.

8. CONCLUSIONS

As described in this paper, we proposed two new interfaces of a music browsing assistance service called *Songrium*, which visualizes *VOCALOID* music including original songs and their derivative works on the video sharing site *Niconico*. Our target music content is *web-native music*: music content that was born, listened to, and distributed over the web. Songrium provides various visualization tools to assist users in grasping the relations among web-native music. Particularly, this paper features *Songrium3D*, which portrays to a user all web-native music content in a community and *Interactive History Player*, and which presents a history of related web-native music contents.

As goals for future work, we will continue to run the Songrium service and improve it based on user feedback. Herein, we described only VOCALOID music, but web-native music is available from many other sources, which we hope to exploit in the near future.

Acknowledgments

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