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BandNavi: Band-Member Backtracker Based on Member History Information

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Abstract: A band-member-backtracking application called BandNavi has been developed that enables a user to discover new songs and bands by tracing musicians who have played in different bands. Previous similarity-based song recommendation systems only retrieve similar songs, but many retrieved results are not songs by musicians the user likes. By using a web-mining technique, data was collected on member history information of 3000 bands. BandNavi enables a user to discover other bands in which a musician has played. BandNavi was implemented on the iPhone, and experimental results show that 70 percent of subjects understood how to use BandNavi within five minutes, 70 percent enjoyed tracing the bands and their members' connections, and 52 percent discovered a previously unknown band that they liked.

Key words: Music recommendation, band-member, web mining technique, band network, iPhone application.

1. Introduction

We can now easily listen to and store enormous numbers of songs on MP3 players and smartphones. We can also select and buy songs very easily through online music stores. However, users may not be able to discover many songs they may like because they spend very little time choosing songs to buy even though they spend use a lot of time listening to music.

Therefore, we have developed a band-member backtracking application called BandNavi that enables a user to discover previously unknown songs or artists while listening to another song or artist. The main advantage of BandNavi is that it has the following two modes.

(1) Navigation mode

In the navigation mode, a user can discover connected artists and songs while listening to a song on a music player.

(2) Media access mode

In the media access mode, a user can listen to and buy songs discovered by using the navigation function.

BandNavi displays bands and their members by using band-lineup histories.

A musician will often have played in or with more than one band; he or she may have been a guest musician and/or have been a member of a number of bands. Therefore, relationships between musicians and bands form a complex network. We call the network formed by connecting the affiliations between bands and their members the Band Network (Fig. 1). BandNavi can display the bands and musicians that are connected to the song currently being listening to by tracing this network.

To find the networks of connections between bands and their members, we use web-mining techniques. However, there are two problems with using the networks acquired by web-mining techniques for tracing musicians' histories. The first problem is that web-mining techniques are not perfect and sometimes collect wrong information. Even information from Wikipedia has some errors, and it is very difficult to determine these errors by using web-mining techniques.

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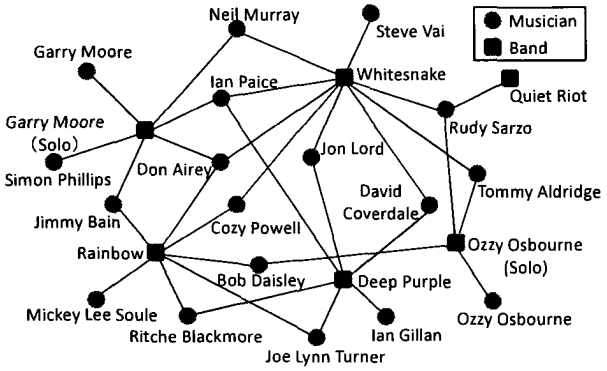

Fig. 1 Network showing connections between musicians and bands.

The wrong information obstructs the users trying to search for and find artists they like. The second problem is that it is very complicated and difficult to show all the members of a band in which many musicians have played. For example, Whitesnake has had more than thirty members in total. If the system only shows a list of Whitesnake's past and present members, it is very difficult to discover closely related bands like Deep Purple.

To solve these problems, BandNavi lists members of a band found while web mining in order of importance. Therefore, a user can discover artists closely related to his/her favorite band by tracing the connections of the more important band members.

In the experiment, we evaluated how well web mining collects the names of band members. We used 50 bands for this experiment, and 86 percent of results consist of the top five most important members of different bands. We also conducted an experiment with 17 subjects: 70 percent understood how to use BandNavi within five minutes, 70 percent s enjoyed tracing the bands and their members' connections, and 52 percent discovered a band they liked but did not know before.

This paper is organized as follows. Section 2 briefly discusses the related works. Section 3 gives an overview of BandNavi and discusses the problems in developing the system and their solutions. Section 4 explains the user inter-face of BandNavi. Section 5 describes how to find the Band Network. Section 6 explains the experimental results, and Section 7 concludes the paper.

2. Related Work

Previous music-retrieval methods that use queries such as similarity-based [1-3] searching and text-based searching [4] are useful for narrowing a large number of musical pieces, but after the list of rankings has been provided, we have to listen to songs one-by-one because no consideration has been given to finding songs one for which has an affinity from the list. Thus users spend a lot of time listening to new songs while not always discovering ones they like.

Musicream [5] makes it possible to interact with many music collections by applying a similarity-based sticking function which attaches similar musical pieces to a musical piece selected by the user. However, Musicream has the same problem as previous music-retrieval methods [1-4], because users do not always like songs that are similar to other songs they like.

On the other hand, collaborative filtering [6, 7] enables users with similar tastes to be found and recommends these similar users' favorite songs by using their song-purchase histories. However, these methods have difficulty recommending songs that are not famous, because it is difficult to collect unfamous bands' songs from song-purchase histories.

We think one way for discovering an unknown musical masterpiece is to receive recommendations from people who are knowledgeable about music, because they probably know the background information of songs. Our goal is to develop a system that extracts deep knowledge about songs by web mining that enables a user to find songs in the same way as a person who is knowledgeable about music.

The idea behind MusicRainbow [8] is similar to ours, because MusicRainbow extracts knowledge from the web. MusicRainbow displays songs circularly depending on audio-based similarity and adds words retrieved from web pages to describe each artist.

However, MusicRainbow only uses ambiguous words that explain genres or moods. Thus, the words only assist similarity-based searching.

Our system uses the abovementioned Band Network. Polyphonet [9] also acquires human networks by person collocation extraction on web pages. However, Polyphonet cannot acquire the Band Network we want because it does not tell us the actual relationships between bands though their membership histories.

To solve this problem, we assume the following:

- A musician's name often appears on a web page together with the name of the instrument that he or she plays;
- Most bands have main members and minor members, and minor members' names appear close to those of the main members on a web page.

The former assumption is for extracting a musician's name, and latter assumption is for raising the accuracy of band member name extraction.

3. BandNavi

While listening music on a music player, a user can use BandNavi to discover a song by a band that the user has never heard before by tracing the network of connections between bands and their members. When a user discovers such a band, BandNavi enables the user to listen to and buy songs through YouTube [10] and the iTunes Music Store [11].

Fig. 2 is an overview of BandNavi, which consists of a client side on an iPhone application and a server side with a database. On the client side, when a user plays a song on an iPhone, the information about the band playing the song is acquired automatically from the database on the server side that stores the connections between bands and their past and present members. The database was constructed by web mining using a pattern-matching method with Google search API (Application Program Interface) [12].

3.1 Problems in Achieving BandNavi

Here we discuss the problems in achieving BandNavi.

3.1.1 How to Display the Band Network

The network of connections between bands and their members is very complicated, because there are many kinds of band members, such as regular members, past

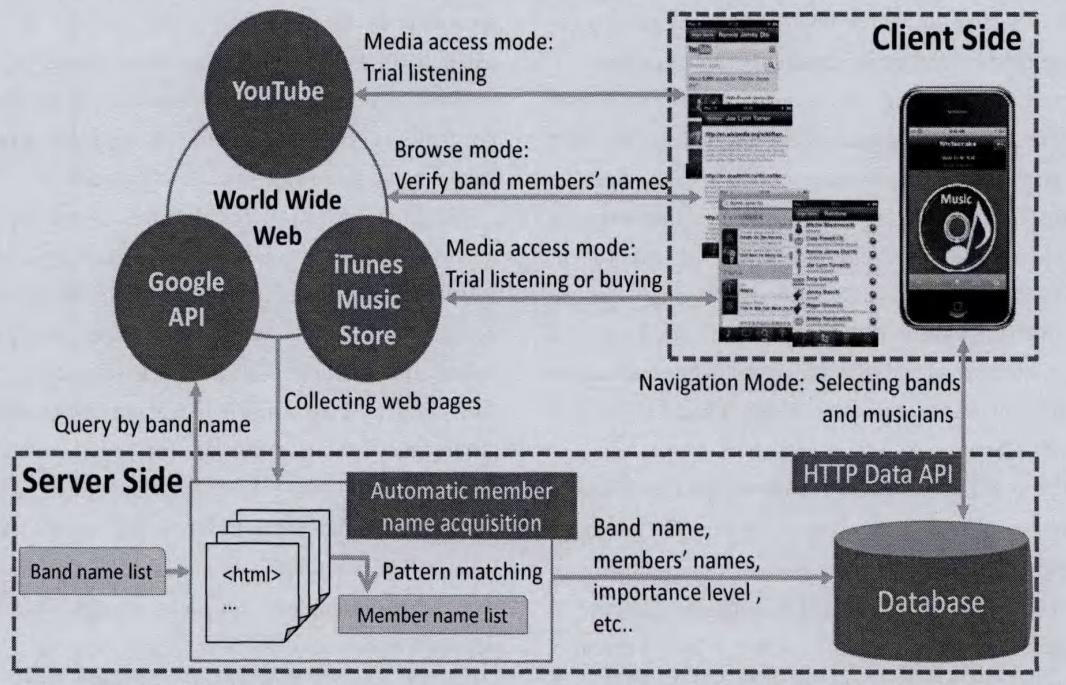

Fig. 2 Overview of BandNavi.

members, and guest and/or session musicians for recordings and/or live performances. If we display this complicated network on iPhone as a cobweb, it is very difficult to follow.

To simplify the network, we can omit the guest and session musicians that provide weak connections between bands. However, omitting these weak connections is problematic because the omitted information can be important for the user who wants know about the band more deeply.

3.1.2 How to Acquire Members' Names

Wikipedia and MusicBrainz have pages for bands that list their members' names. However, these pages are not enough, because many new or minor bands do not have pages on Wikipedia or MusicBrainz, and even when they do, most of these pages do not have the information about their members. Furthermore, guest or session musicians are not mentioned on most band pages on Wikipedia and MusicBrainz, so information for constructing the network cannot be sufficiently acquired from these pages.

3.2 Solutions for These Problems

Our solution for these problems is to introduce web mining-methods that collect the information of members' name by trawling through web pages.

3.2.1 Introduce Importance Level of Members

To solve the problem of complicated networks, we introduce an importance level for members. We calculate the importance level of each member in a band by using document frequency in the web pages when collecting band members' names using Google API. Thus BandNavi lists band members in terms of their order of importance. For example, a band member who played in the band for a long time and is often mentioned on the web pages is listed higher than a band member who is infrequently mentioned on the web pages. Therefore a user can explore the Band Network by considering the strength of relationship between bands and their past and present members.

3.2.2 Automatic Acquisition of Band Member Names

To acquire names of a band's member, we use web-mining techniques in which we first collect web pages about the band by using Google search API and then acquire the band members' names by a pattern-matching method. Because web-mining techniques sometimes collect wrong results, we also prepared a manual editing option for band member's names. Only the big fans of a particular band can use this manual editor, because they are assumed to be knowledgeable about the band. The BandNavi helps the user to editing the information of band members' names by displaying the web pages from which the band members' names was extracted by web-mining techniques.

4. User Interface

BandNavi consists of a client application on the iPhone and a server application that automatically acquires the band members' names. The BandNavi client application has three modes: navigation mode (section 4.1), media access mode (section 4.2), and browse mode (section 4.3) (Fig. 3).

4.1 Navigation Mode

In navigation mode, we can trace musicians' work by iteratively listing band members and other bands in which each member has played.

When a user plays a song using the BandNavi client application on an iPhone, the client application automatically acquires and displays members' names by communicating with the database on the server (Fig. 3a). Then, bands in which a musician has played are displayed when a user taps his/her name (Fig. 3b). Next, names of another band's members are displayed when a user taps that band's name (Fig. 3d).

The band-member list (Figs. 3a and 3d) and bands-played-in list (Fig. 3b) are ordered by importance levels. In the band-member list, each member's name has the relevant instrument(s) written

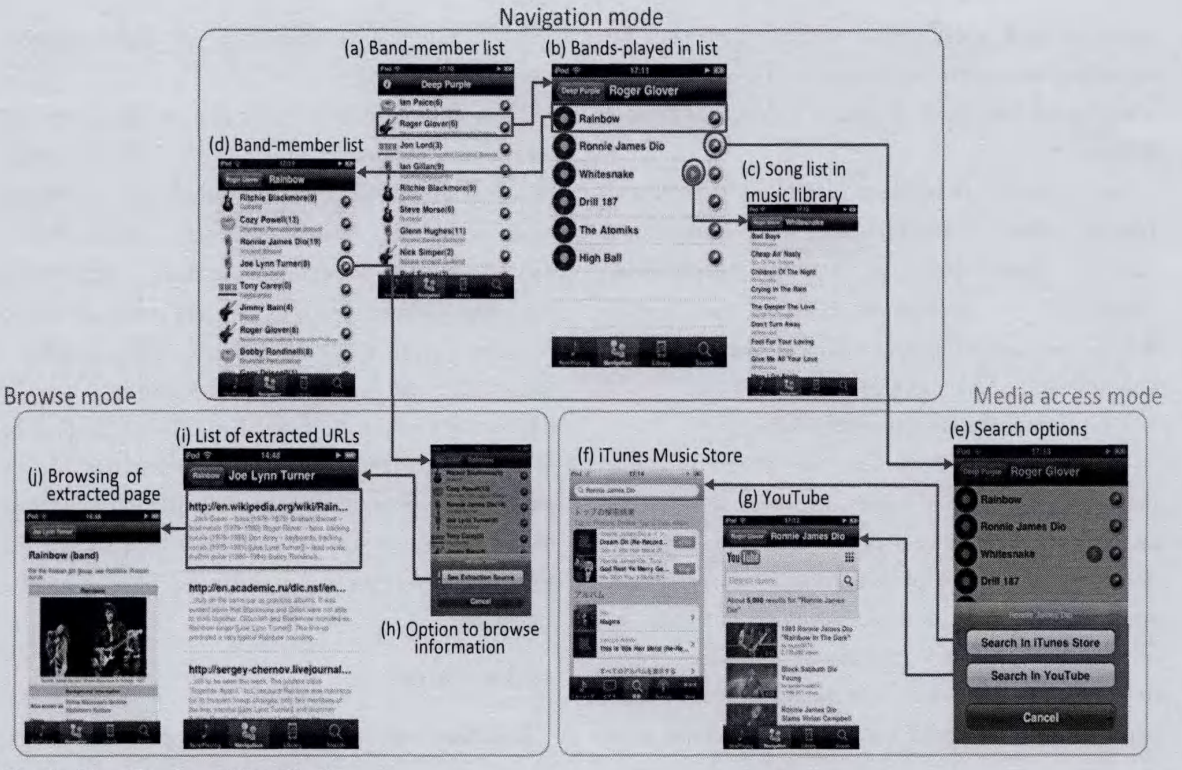

Fig. 3 User interface of BandNavi.

underneath, an icon of his/her main instrument to the left, and the number of bands in which he/she has played to the right.

The play button is displayed to the right of the band name in the band list if that band's songs are already on the user's iPhone. When the play button is tapped, the song list is displayed, and a song can be played by tapping its name (Fig. 3c). A user can look for new bands and songs again and again while listening to a song.

For example, when we played a song by Deep Purple, the member list of Deep Purple was displayed (Fig. 3a). Then, a user selected the bassist Roger Glover from the list, and the list of bands in which he has played was displayed (Fig. 3b). After that, the user selected the band Rainbow, and the member list of Rainbow was displayed (Fig. 3d).

4.2 Media Access Mode

When we push the button to the right of the band name in the navigation mode, the mode changes to the media access mode. In the media access mode, users can listen to and buy songs. When the button to the right of each band name in the band list is tapped, two kind options are displayed: "Search YouTube" and "Search iTunes Store" (Fig. 3e). BandNavi enables users to give songs a trial listening on YouTube (Fig. 3g). Users can listen to or buy any songs in which they are interested from the iTunes Store (Fig. 3f).

4.3 Browse Mode

In the browse mode, we can verify the relationship between a band and a musician by browsing the web pages from which the relationship was extracted. When tapping the button to the right of each member's name in the band-member list (Fig. 3a), BandNavi displays URLs with before and after 30 words of web pages from which the system found the relationship between the band and its musicians (Fig. 3i). When users tap the URL, they can see the web pages (Fig. 3j). They can

also correct incorrect information.

5. Automatic Acquisition of Band Members' Name

The relationships between bands and members are automatically acquired by web-mining techniques. The acquisition of members' names involves three steps: web page collection (section 5.1), musician name extraction (section 5.2), and member name filtering (section 5.3) (Fig. 4).

5.1 Web Page Collection

In the web page collection, the server application collects web pages about the band by using Google search API. When acquiring names of members of a band called B, the system acquires the top 50 web pages by sending the query {"B" + band + members}. For the preprocessing, the system removes all the html tags.

5.2 Musicians Name Extraction

In the musicians name extraction, the server application extracts musicians' names from the collected web pages by pattern matching them with the names of musical instruments, because musicians are often introduced along with their musical instruments, e.g. "Tommy Aldridge (Drums)". We use three kinds of patterns for extracting musicians' names:

A Role Musician;

B Musician (*Instrument*);

C Musician - *Instrument*.

The "*" indicates from zero to twenty characters. We use not only the names of instruments commonly used in pop and rock music such as the guitar or drums but also those of less commonly used instruments like the saxophone, trombone, or turn-tables. "Role" indicates the role played like guitarist, drummer, producer, or composer. "Musician" indicates two to four words, the first character of which is a capital letter, consisting of letters, a period {.}, a single quotation mark {'}, a double quotation mark {"}, and a hyphen {-}. To use the member name filleting, the system store tuples of the extracted musicians name, extracted patterns, URL

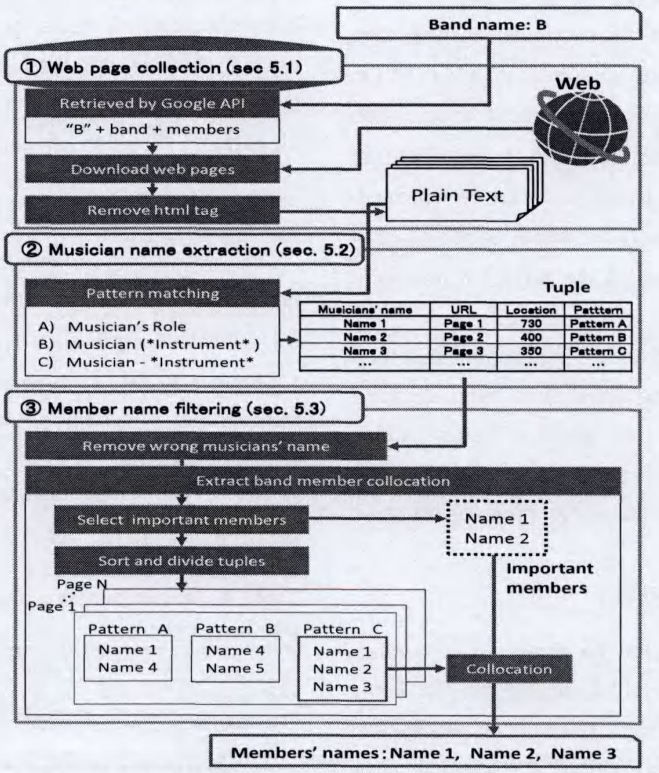

Fig. 4 Processing flow for acquiring members' names.

of extracted web page, and the location in the web page where the pattern was matched.

5.3 Member Name Filtering

In the member name filtering, the server application removes the names of musicians who have not played in the band from musicians' names extracted in section 5.2. The member name filtering consists of two steps.

(1) Remove wrong musicians name

The system removes names of musicians that have very low possibility of being band members. First, the system calculates the document frequency (DF), which indicates how many times the name appears in the collected web pages. The DF is normalized from 0 to 1. Second, the system removes the musicians' names for which DF is lower than the threshold (th).

(2) Extract band member collocation

The system extracts band member collocation to find the actual band members, because we can assume the same band members are mentioned on nearly every web page about the band.

First, the system selects the two musicians that have the highest DF as the most important members of the band. Second, the system sorts the tuples from the same web pages and then divides them into groups where the patterns for extracting musicians' names are changed. Finally, the system extracts band members that collocate in a same group as the two most important members.

In Fig. 4, Name 1 and Name 2 indicate the important members. Name 3 is extracted as a band member, because Name 3 is in the same group as Names 1 and 2. On the other side, Names 4 and 5 are removed, because Name 4 and 5 are not in the same group as Names 1 and 2.

6. Experimental Results

We input to the system the names of 354 bands classified as "heavy metal" appearing on the home pages of record companies, resulting in the system collecting 3,508 musicians' names. We selected heavy metal because the lineups of heavy metal bands often change, so few bands are isolated from other bands in the Band-Network.

6.1 Evaluation of Automatic Acquisition of Band Members' Names

We evaluated how well the system found the band members' names. This evaluation required us to prepare the correct data sets of band names and band members' names. We selected 50 bands randomly from the 354 bands and manually investigated the members' names, including those of guest or session musicians, by using official web pages and CD booklets. Then we asked someone who knows a lot about heavy metal music to verify the results manually.

We evaluated the Recall and Precision of BandNavi. Recall and Precision differ depending on the number of musicians to be investigated from top DF musician where the BandNavi shows the band-member list that is sorted by DF. Table 1 shows the results of the experiment. Both Recall and Precision are over 0.7 when we use all members for evaluation. When we use the ten members with the highest DF, Precision raises to 0.81. When we use the five members with the highest DF, Precision raises even more to 0.86.

6.2 Evaluation by a Questionnaire

We prepared questionnaires about BandNavi and posted them at the following URL: http://musicdb.iit.tsukuba. ac.jp/bandnavi.html. So far, we have received 17 responses from users. The results indicate that 70 percent of subjects understood how to use the BandNavi within five minute, 70 percent enjoyed tracing the bands' and their members' connections, and 52 percent discovered a new band

Table 1 Recall and precision for acquisition of band members' names.

	Recall	Precision
All members	0.703	0.744
Top ten DF	0.524	0.810
Top five DF	0.313	0.860

they like. However, five percent needed more than 15 minutes to understand how to use BandNavi. We plan to investigate why some people took such a long time to understand BandNavi, and we will implement changes if necessary.

7. Conclusions

We developed BandNavi, which enables a user to search for new songs and artists using an iPhone client application based on relationships between bands and band members.

The BandNavi is now available through Apple's App Store. In the experiment, we only used 357 heavy metal bands; we have since added 3000 more bands from the rock and pop genres.

We plan to extend the system so that users can find new music by using the information about the names of not only band member but also composers, arrangers, producers, or recording studios acquired by web-mining techniques.

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