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Paper

Music Recommendation System using Heart Rates

by

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Abstract

It is recognized that music is applicable in the field of medical. Music is expected to support a patient's mentality and medical treatment. We have studied the relationship between the heart rates and the tempo of a music piece. We assume that there is preferable tempo according to his or her heart rates and preferable music according to the preferable tempo. We propose the music search system using heart rates to find his or her favorite music. We built a model system to evaluate the correlation between heart rates and tempo of a piece. At first, we gathered some data about the relation between heart rates and music preference. We found the numerical formula from these data and implement that formula in out experimental system. Next, we executed some experiments to confirm if our system is effective to find preferable music. The result showed the heart rates could be used to find the preferable music in our case study.

Keywords: Music Search, Music Therapy, Ventricular Rate, Brain Wave

1. Introduction

Most of the current music search systems use the attributes of music, like title, singers, players and other static information. Though these systems work generally well, they are not suitable to find music according to your dynamic conditions, such as you are happy, tired or sad etc. There are no famous music search systems using the biological information of the user. We assume that there exists the relation between the listener's biological conditions and his then favorite songs. As first step, we tried to use the heart rates to find preferable music as the heart rates can be easily measured using commercial equipment.

In this paper, we propose a new music recommendation system using our assumption. We tried to confirm our idea by questionnaire and brain wave data.

Our goals are (1) to confirm the effectiveness of our idea, (2) to build the experimental system using our idea.

2. Related Works and Methodology

2.1 *Music Recommendation System*

In recent years, there are many music distribution internet sites. Users can search their desired music using the attributes of the songs in these sites.

Some of such sites have a recommendation system. It recommends some pieces of music according to the user's search history and/or his music libraries. One of the most famous systems is 'Genius' in Apple iTunes Store [1]. As Apple iTunes Store has a lot of user data, they can analyze music preferences tendencies and recommends some set of music according to their data. Most of such recommendation systems use the simple idea: 'If you like song A and most of other users who like song A like song B, you must like song B'.

With this method, as the result is led by statistical analysis, an unnatural result may be brought in some cases.

2.2 *Ventricular Rate and Music*

Music has various influences on person's psychology. If you listen to the gloomy music, you will get tired. If you listen to the bright music, you will get happy [2) 3)] . It is known that, when the walking speed matches the tempo of music, the effects of pleasure and peace of mind can be obtained [4].

In the research area of music therapy, it is known that people feel comfortable and relaxed when his heart rates and the tempo of the music he is listening synchronize [5]. Our research is to construct a new music recommendation system using the heart rates of the users and the tempo of the music.

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2.3 *Brain Wave*

A brain wave is an electrical impulse in the brain. The brain wave has divided into four types such as α wave, β wave, θ wave, and δ wave. α wave is observed when the person is relaxed, concentrated and sleeping lightly.

The brain wave shows the state of the consciousness of the person. Though it is difficult to control your consciousness, it is known that music can induce the brain wave when he needs concentration[6].

We use the brain wave, especially α wave, to check the mental condition of the users when they are listening to the music.

3. Evaluation System Design

3.1 *Search Policy*

We install the following 4 methods to search a piece of music using the heart rates in the evaluation system. These methods are used according to the objective of the search.

(1) Average Rates Method: Use the average heart rates. This is used to find the preferable music for daily life. As the heart rate changes according to your condition, this method is used to find music in your average condition.

(2) Current Rates Method: Use the current heart rates. This is used for the current situation.

(3) Specific Focused Method: Specify the other conditions, like gender, nationality or music genre before the search.

(4) BPM Recommend Method: Use recommendation system using BPM (Beat per Minute). This idea means: 'If you like the music with BPM A and most of other users who like the music with BPM A like the music with BPM B, you must like the music with BPM B'.

3.2 *Implementation of Evaluation System*

Fig.1 shows the configuration of the evaluation system.

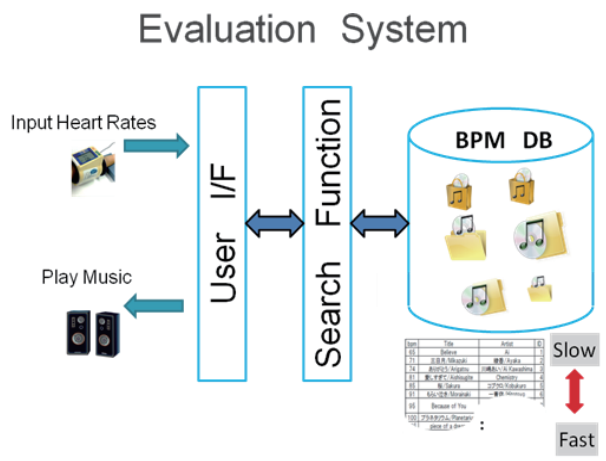

Fig. 1 System configuration of the evaluation system

The heart rates are measured using a commercial digital sphygmomanometer and the user input it to the system. The search function decides the appropriate BPM and search music in BPM database. The relation between the heart rates and BPM is described in chapter 4.

Fig.2 is the basic flow of the system.

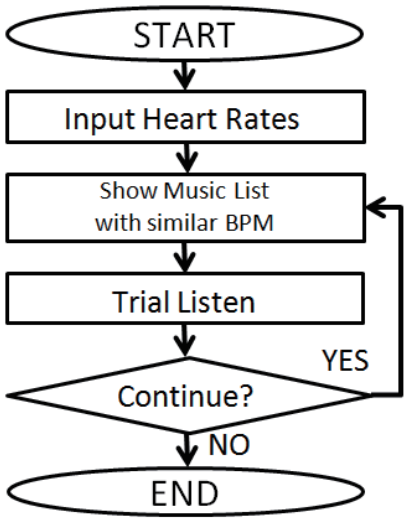

Fig. 2 Basic flow of the proposed system

3.3 *BPM Database Management*

Fig.3 shows the flow chart of the BPM database management function.

When new piece of music is added, BPM of the piece is checked and saved into the database with other static information.

When the information of the user changed, that information is saved into the database.

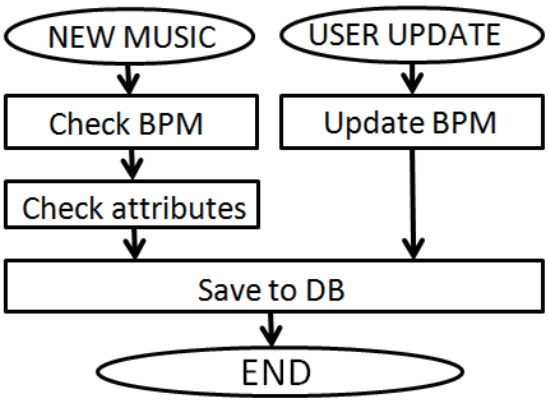

Fig. 3 Basic flow of BPM database management

3.4 *Music Search*

Fig.4 is the start screen shot of the music search function. The user is asked to input his heart rates (average or current) and his music preferences. Then the system searches the favorite pieces of music and show the result list to the user.

Fig.5 is the screen shot of the search result.

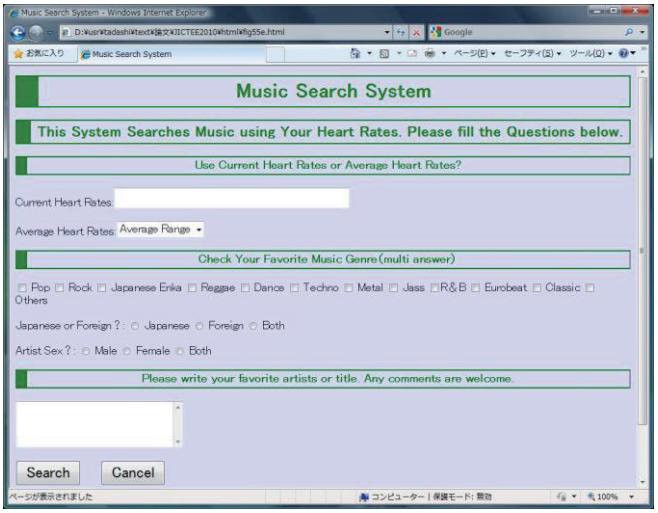

Fig. 4 Music search screen

Fig. 5 Search result screen

3.5 *Trial Listen*

After the list of music is shown, the user can select anymusic piece from the search result list. The detail information of the selected piece is displayed. The user can try to listen to that piece (Fig. 6).

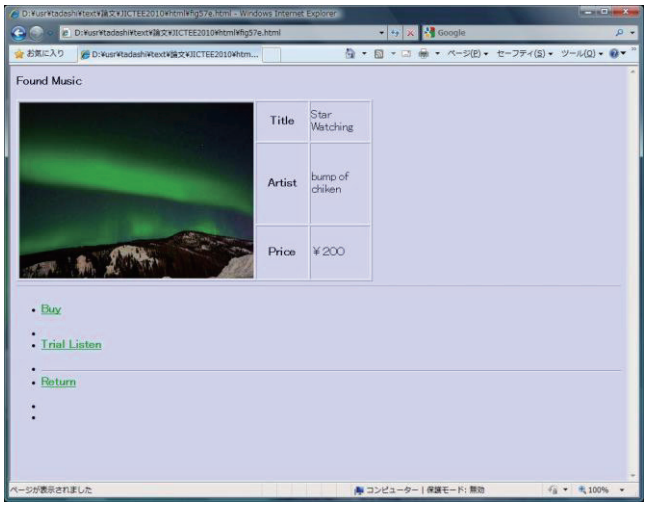

Fig. 6 Trial listen screen

3.6 *Recommendation Function*

After the user selects the one piece from the search result list, the system recommends other pieces of music with similar BPM (Fig. 7).

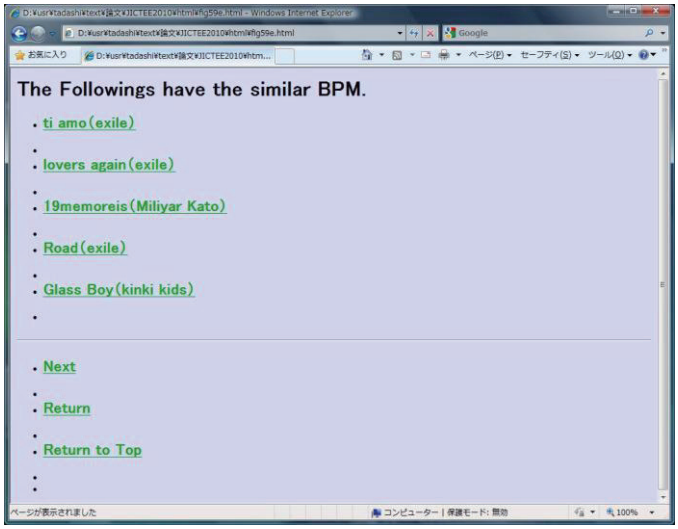

Fig. 7 Recommendation screen

4. System Evaluation and Discussion

4.1 *Preliminary Experiment*

Before we evaluate the proposed system, we started to collect data to find the relation between people's heart rates and his favorite music.

For eight subjects, we examined his heart rates and his taste of the music. As we didn't gather a lot of data, assume this was one case study.

The subjects of this experiment are men and women from the teens to 50's.

bpm	Title	Artist	ID
65	Believe	Ai	1
71	三日月/Mikazuki	綾香/Ayaka	2
74	ありがとう/Arigatou	川嶋あい/Ai Kawashima	3
81	愛しすぎて/Aishisugite	Chemistry	4
85	桜/Sakura	コブクロ/Kobukuro	5
91	もらい泣き/Morainaki	一青窈/Hitotoyo	6
95	Because of You	浜崎あゆみ /Ayumi Hamazaki	7
100	プラネタリウム/Planetarium	大塚愛/Ai Otsuka	8
105	piece of a dream	Chemistry	9
110	Sweet Impact	BoA	10
115	Million Films	コブクロ/Kobukuro	11
120	少年ハート/Shonen Heart	HOME MADE 家族 /HOME MADE Kazoku	12
124	宝島/Takara Jima	コブクロ/Kobukuro	13
130	DAN DAN 心惹かれてく /DAN DAN Kokoro Hikareteku	FIELD OF VIEW	14
135	ヒトリノ夜/Hitori No Yoru	ポルノグラフィティ /Porno Graffitti	15

Fig. 8 Music title and BPM

The followings are the explanation of the collected data.

(1) Heart Rate: Their heart rates are measured using the commercial digital sphygmomanometer just before the experiment in a calm condition. The data of blood pressure is not used in this experiment.

(2) Music BPM: We prepared 15 pieces of Japanese popular music. The BPM of each piece are measured with iBPM Counter [7]. Fig.8 shows all the music title and it's BPM.

(3) Music Preference: Each person listens to all the sample music. Then they decide if they like or dislike the music. Fig.9 shows the results. From this experiment, it was confirmed that there exists some correlation between the heart rates of a person and the tempo of his favorite pieces of music.

Examinee			A	B	C	D	E	F	G	H
Heart Rates			73	75	76	87	89	91	101	113
bpm	**Title**	**ID**								
65	Believe	1								
71	Mikazuki	2								
74	Arigatou	3	✓							
81	Aishisugite	4	✓							
85	Sakura	5	✓	✓	✓					
91	Morainaki	6	✓	✓	✓	✓				
95	Because of You	7	✓	✓	✓	✓				
100	Planetarium	8	✓	✓	✓	✓	✓			
105	PIECE OF A DREAM	9	✓	✓	✓	✓	✓			
110	Sweet Impact	10		✓	✓	✓	✓		✓	
115	Million Films	11		✓	✓	✓	✓	✓	✓	
120	Shonen Heart	12				✓	✓	✓	✓	✓
124	Takara Jima	13				✓		✓	✓	✓
130	DAN DAN Kokoro Hikareteku	14						✓	✓	✓
135	Hitori No Yoru	15						✓	✓	✓

✓ means favorite

Fig. 9 Music preference result

From this result, the relation between the heart rates and BPM is plotted on the Fig. 10. The experimental system uses this result to decide the favorite BPM ranges from the heart rates. The upper and lower boundaries of the favorite BPM range are calculated using the least squares methods from the boundary data.

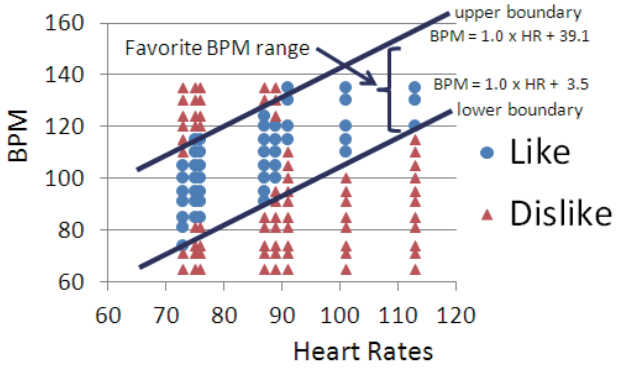

Fig.10 The relation between the heart rates and BPM

4.2 *Evaluation*

In order to evaluate our proposed system, we executed the following 2 experiments.

(1) Experiment 1

The subjects and other conditions are the same as the preliminary experiment's case. We prepared 20 pieces of Japanese popular music. This music set is different set of the preliminary experiment's case.

We executed 2 different cases.

Case 1): Recommend some music according to his favorite BPM range

Case 2): Recommend some music randomly

If possible, we should compare the case using statistical case like iTune. As we don't have enough data to implement this method, we used random case.

Each subject answers if they like a lot, like or dislike the recommended music.

Fig.11 shows the result of this experiment. When we use our system, around 60% cases out of all, the subject says he likes the recommended music a lot. This is more than twice of the number of random recommendation.

The number of 'dislike' case is 10% for our proposed system and 29% for random recommendation.

From this result, we have confirmed the effectiveness of our proposed music search system for some extent.

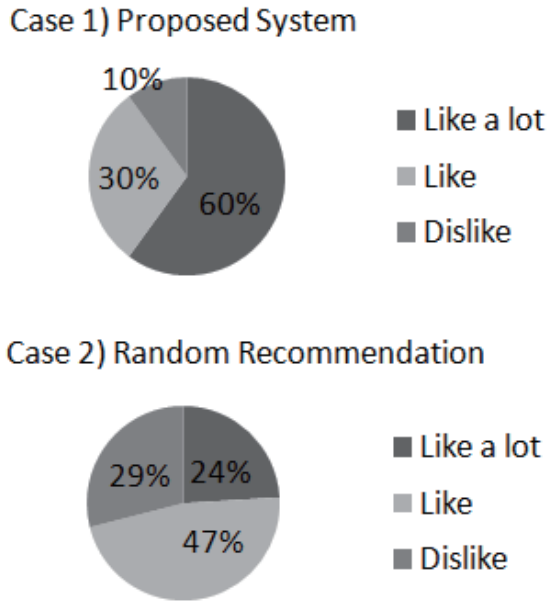

Fig. 11 Result of experiment 1

(2) Experiment 2

In order to confirm the result without the subject's assumption, we measured the brain wave of the them, especially α wave. α wave shows the person's status through 4 indices: relaxation, concentration, drowsiness and tension. Each index is expressed numerically from 0, the lowest, to 100, the highest. The experimental conditions were the same as experiment 1. The total result is shown from overall numbers. Fig.12 shows the result of this experiment.

When the subjects are listening to the favorite BPM music, their brain wave shows 'concentration'.

Mr.I (Favorite BPM: 155~195)

BPM	BRAIN WAVE
80	Low concentration, High tension
155	concentration
160	relax, concentration
175	concentration, no drowsiness
186	High concentration, no drowsiness
195	concentration

Favorite BPM

Mr.J (Favorite BPM: 121~160)

BPM	BRAIN WAVE
95	Low concentration
121	almost concentration
130	almost concentration
141	almost concentration
155	concentration
160	concentration

Favorite BPM

Fig. 12 Result of experiment 2

4.3 *Discussion*

In this paper, we propose our new music recommendation system using the heart rates and the tempo of the music piece. According to our experiment, there surely exists the relationship between heart rates and music tendency.

We also found the following observations.

(1) The effectiveness of our proposed system varies in person. It is very effective for one person, but no for another.

(2) Even if the BPM of the piece of music matches his favorite BPM range, some subjects don't like the piece because of the following reasons:

- dislike the voice
- dislike the atmosphere
- dislike the introduction sound

These reasons were got through free comments after the experiments.

4.4 *Future Works*

In this research, we use only BPM to search music and sample music set is only Japanese popular music. In order to make sure that our idea is effective in a wider area, we should extend our system to use other information, such as music genre, artist, composer etc. And we need to use a wide variety of music genre data. Also we need more subjects to confirm our idea statistically.

In order to use this system for music therapy, we may arrange the algorithm to search music according to the objective. For example, if you want to relax the patient, you may need slower music (or other conditions which is unknown now).

5. Conclusion

In the commercial music distribution site, it is expected to recommend the user his preferable music. Our proposed system can be used to find user's favorite music even if it is not famous.

Out system may not be suitable for the users who only listen to his favorite artists. We are going to expand our system to use other information. Also we have a plan to apply our system to the music therapy field.

Acknowledgment

We'd like to express my gratitude to everyone who helps our experiment in Information and Communications Technology Division of Tokai University.

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