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# Extended "2D-RIB" for Impression-Based Satisfactory Retrieval and its Evaluation

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***Abstract*—**Recently, lots of researchers are attracted to retrieving multimedia database by using some impression words and their values. Ikezoe's research is one of the representatives and uses eight pairs of opposite impression words. We had modified its retrieval interface and proposed '2D-RIB' in the previous work. The aim of the present paper is to improve his/her satisfaction level to the retrieval result in the 2D-RIB. Our method is to extend the 2D-RIB. One of our extensions is to define and introduce the following two measures: 'melody goodness' and 'general acceptance'. Another extension is three types of customization menus. The result of evaluation using a pilot system is as follows. Both of these two measures 'melody goodness' and 'general acceptance' can contribute to the improvement. Moreover, it is effective if we introduce the customization menu which enables a retrieval person to reduce the strictness level of retrieval condition in an impression pair based on his/her need.

***Keywords*—**Multimedia database, impression-based retrieval, interface, satisfaction level.

## I. Introduction

RECENTLY, lots of researchers are attracted to retrieving multimedia database by using some impression words and their values[1]-[2]. Hereafter, we call the value simply as 'impression value'. Impression-based retrieval is a kind of ambiguous retrieval[1]. The paper [3] is one of the researches on impression-based retrieval, and retrieves a music database by the combination of each value of fixed numbers of opposite impression pairs. Hereafter, this paper focuses on a music data among various multimedia data. When we simply say 'data', it means a music data.

Fig. 1 is a retrieval interface in the paper [3]. Although each term on the window is actually written in mother country language of the paper [3] authors, since the present paper is international, we write Fig. 1 in English. 'Smooth' versus 'staccato' or 'thin' versus 'thick' is opposite impression pair. Its level is represented by either value of seven levels from minus three to plus three. Retrieval operations can be carried out by specifying each value of these eight kinds of opposite impression pairs constructed from psychological analysis. Neighborhood retrieval[4] in the Salton's vector space model[5] brings us a retrieval result. Strictly, we should apply factor analysis technique[6] in order to reduce the dimension and make each axis orthogonal mutually. However, this paper mainly pays to a discussion of retrieval interface and simplifies its discussion. This approach is based on the semantic differential (SD) method[7]. It evaluates an object by some measures representing each pair with opposite meaning.

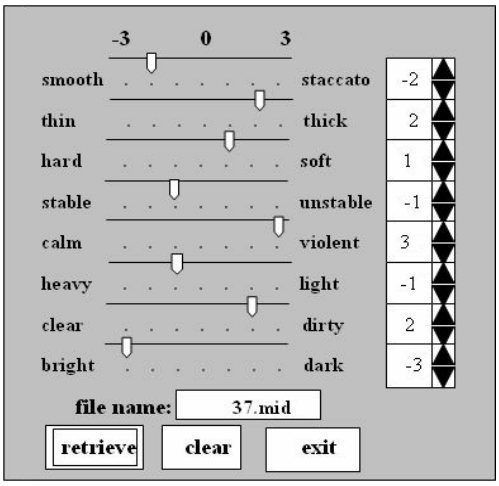


Fig. 1 Retrieval interface in the paper [3]

We had modified the Ikezoe's retrieval interface. Concretely, we had proposed an interface '2D-RIB(2D-oriented Retrieval Interface with Basic Point)'[8]-[9]. In '2D-RIB', after a retrieval person selects a single basic music, the system visually shows some other music around the basic one along relative position. He/she can select one of them fitting to his/her intention, as a retrieval result. The aim of this paper is to improve a retrieval person's satisfaction level to a retrieval result. We define and introduce two measures: one is 'melody goodness' and the other is 'general acceptance'. We also propose three types of customization menus in 2D-RIB.

The rest of this paper is organized as follows. In the next section, we describe '2D-RIB' which is a basis of this paper in detail. Section 3, the main part of this paper, extends the 2D-RIB. After we describe our pilot system in section 4, we

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carry out some evaluation experiments in section 5. Finally, in section 6, concluding remarks are described.

## II. 2D-RIB

2D-RIB is a 2D-oriented retrieval interface using a basic point. In 2D-RIB, a retrieval operation is carried out as the following Step1-5. Now, let *lev* to the number of levels for impression value, and let *par* to the number of opposite impression pairs. In the paper [3],[8]-[9],

*lev*=7 and *par*=8 (1).

*Step1: From a keyword retrieval such as title, author, and/or singer, a retrieval person selects a single music which he/she knows well, as a basic point.*

In the following Step2 and the later, he/she looks for other data fitting to his/her intention, from a relative position to the basic point such as 'brighter one' or 'more violent one'. Introduction of the concept 'basic point' brings us a standard in order to understand each place, its meaning and level in a retrieval space. In 2D-RIB, we call a single impression pair which is the most important for his/her retrieval intention, as 'main accounting impression pair'.

*Step2: He/she selects a main accounting impression pair among the par impression pairs.*

*Step3: The system shows the retrieval interface on the screen like Fig. 2.*

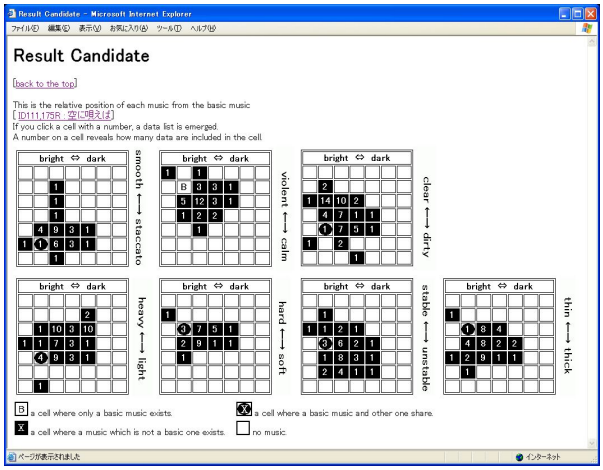



Fig. 2 Retrieval interface 2D-RIB in the paper [8]-[9]

As the same as in the Fig.1, although each term on the window in our system is actually written in our mother country language, we write Fig. 2 in English. We apply this rule to the rest of the present paper. In Fig. 2, the main accounting impression pair is 'bright' versus 'dark'. It is represented by horizontal axis in each 2D grid. The number of 2D grid is (*par*-1).

We explain the meaning of vertical axis in each 2D grid. In 2D-RIB, an impression pair which is important next to the main accounting impression pair for his/her retrieval intention, is called 'sub-accounting impression pair'. When he/she specifies a main accounting parameter uniquely, he/she has (*par*-1) cases in order to select a sub-accounting impression pair. Each 2D grid in Fig. 2 corresponds to this (*par*-1) cases.

Hereafter, we call a grid point corresponding to a single cell in Fig. 2 simply as 'cluster cell' or 'cell'. On each 2D grid in Fig. 2, a cell of 'B' or ● shows a basic point. In 2D-RIB, the rest (*par*-2) impression pairs excepting main accounting impression pair and sub-accounting one are called 'remained impression pair'. The value of each remained impression pair is limited to a neighborhood from minus one to plus one on the value of the basic point. By the means of this condition, the data he/she can relatively access from a basic point is limited.

In this way, points set in a retrieval space corresponding to each cell in 2D grid are uniquely determined. Therefore, the system can execute match retrieval per each cell, and put a ■ mark on the cell which at least a single data exists. In Fig. 2, a number on a ■ reveals how many data are included in the cell. We can see ● cell in the same figure. It exhibits that there exist a basic data and other data in the same position. The cell of ● or ■ has a link to the data list including each SMF.

*Step4: He/She clicks a single cell fitting to his/her retrieval intention in the relative position from the basic point.*

*Step5: The system returns him/her a data list included in the cell(Fig. 3).*

The table in the Fig.3 has four columns. They are identifier, artist, title, and link to its SMF. If a retrieval person clicks the most right column 'listen!', he/she can listen to the music.

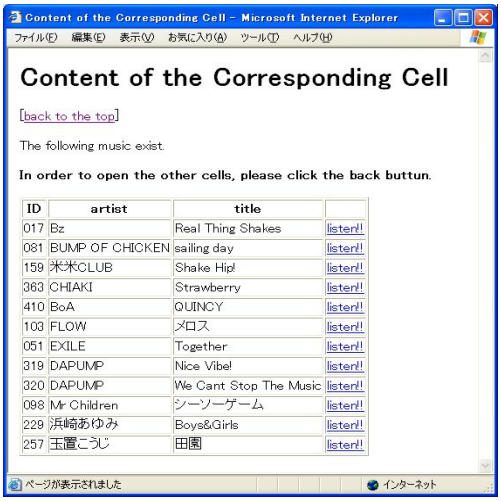



Fig. 3 Data list emerged after a retrieval person clicks a certain cell in 2D-RIB of Fig. 2

The features of 2D-RIB are as follows: he/she can obtain a data fitting to his/her retrieval intention,

- with confirming where a data exists by his/her eye,
- without contradicting to his/her retrieval intention in translation direction of an impression value from a basic point,
- without bounding to only neighborhood of a point, and
- with avoiding a redundancy that he/she obtains the same retrieval result as an immediately before retrieval trial.

Its effectiveness is clarified by the evaluation experiments in the paper [8]-[9].

However, it has a remained problem in the avoidance of a gap between a retrieval result and his/her retrieval intention. Although it is superior than the paper [3], we can not say it is sufficient. In this paper, we try to improve a satisfaction level

when he/she obtains a retrieval result using 2D-RIB.

## III. Extended 2D-RIB

### A. Introduction of Two Measures

This paper provides with an assumption that:

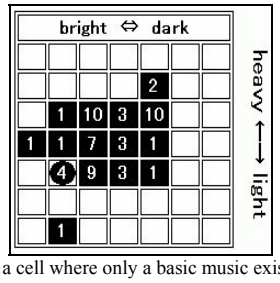
**Assumption 1:** two measures 'melody goodness' and 'general acceptance' defined bellow effectively influence a retrieval person's satisfaction level to a retrieval result.

In here, we define that 'melody goodness' is a level concerning how much a melody is good. It varies people to people and depends upon subjective favorite. We also define that 'general acceptance' is a level concerning how much audience accept a music. It is out of subjective favorite. If a music is evaluated to be accepted by large audience, its general acceptance is good. Both of two measures are determined using a median among evaluation values by some subjects. Each value is either of the following seven levels:

-3: very bad,
-2: bad,
-1: not good,
0: neutral,
+1: not bad,
+2: good, and
+3: very good.

We introduce these two measures into all music in our database. In order to verify the Assumption 1, we propose the following four methods (Method 2-5) as the introduction into 2D-RIB. In here,

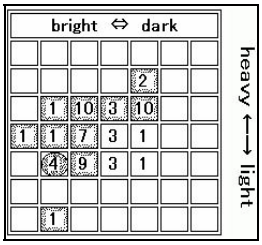
**Method 1:** means the conventional method[8]-[9] not introduced two measures. Fig. 4 shows a single grid of this method. It is just the method of Fig. 2.




**B**: a cell where only a basic music exists.
X: a cell where a music excepting a basic one exists.
circle: a cell where a basic music and other one share.

Fig. 4 Method 1: the conventional method not introduced two measures

**Method 2:** ignores general acceptance and emphasizes only the cell which includes a music whose melody goodness is larger than or equal to the threshold(+1). Fig. 5 shows a single grid of this method. In this figure, a netlike cell means emphasized one. When a retrieval person clicks a cell including music, either 'high' or 'low' is shown as the value of the most left column 'melody goodness'(Fig. 6).




**B**: a cell where only a basic music exists.
X: a cell where only music which is not a basic one and whose melody goodness is less than threshold exist.
: a cell where a music which is not a basic one and whose melody goodness is larger than or equal to threshold exists.
circle: a cell where a basic music and other one share.

Fig. 5 Method 2: treats only 'melody goodness'

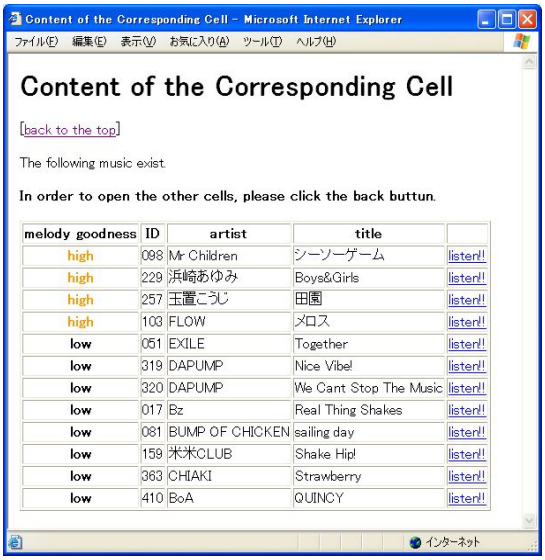



Fig. 6 Data list emerged after clicking a certain cell in Fig. 5

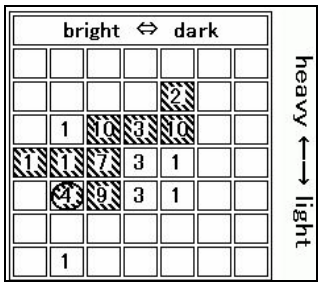
**Method 3:** ignores melody goodness and emphasizes only the cell which includes a music whose general acceptance is larger than or equal to the threshold(+1). Fig. 7 shows a single grid of this method. In this figure, an oblique line cell means emphasized one. When a retrieval person clicks a cell including music, either 'high' or 'low' is shown as the value of the most left column 'general acceptance' (Fig. 8).

**Method 4:** emphasizes only the cell which includes a music whose melody goodness and general acceptance are both larger than or equal to the threshold(+1). Fig. 9 shows a single grid of this method. In this figure, a painted cell means emphasized one. When a retrieval person clicks a cell including music, either 'both high' or 'normal' is shown as the value of the most left column 'two measures'(Fig. 10).

**Method 5:** Fig. 11 shows a single grid of this method. First, it most strongly emphasizes the cell which includes a music whose melody goodness and general acceptance are both larger than or equal to the threshold(+1). In Fig. 11, a painted cell means this category. Second, it emphasizes the cell which includes a music whose only melody goodness is

larger than or equal to the threshold(+1). In the same figure, a netlike cell means this category. Third, it emphasizes in other way the cell which includes a music whose only general acceptance is larger than or equal to the threshold(+1). In the same figure, an oblique line cell means this category. When a retrieval person clicks a cell including music, either four values of 'both high', 'melody high', 'acceptance high' or 'low' is shown as the value of the most left column 'evaluation'(Fig. 12).

We carry out some relative comparison experiments among these five methods in section V.




**B**: a cell where only a basic music exists.

X : a cell where only music which is not a basic one and whose general acceptance is less than threshold exist.

a cell where a music which is not a basic one and whose general acceptance is larger than or equal to threshold exists.

circle: a cell where a basic music and other one share.

Fig. 7 Method 3: treats only 'general acceptance'

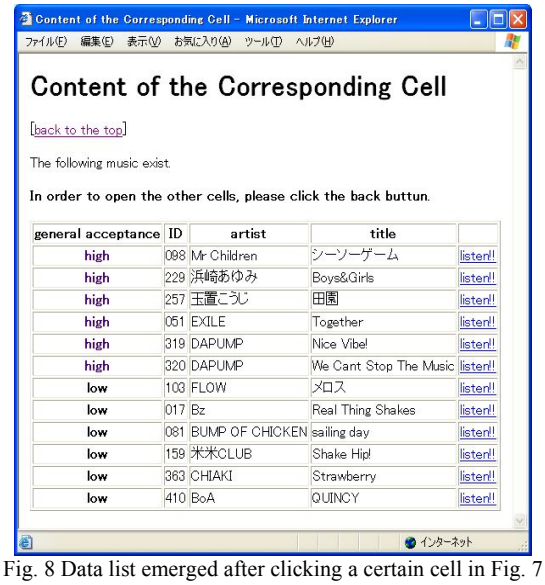
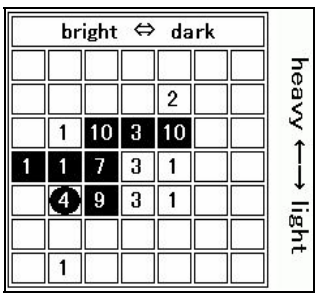



Fig. 8 Data list emerged after clicking a certain cell in Fig. 7




**B**: a cell where only a basic music exists.

X : a cell where only music which is not a basic one and whose melody goodness and/or general acceptance are less than threshold exist.

X : a cell where a music which is not a basic one and whose melody goodness and general acceptance are both larger than or equal to threshold exists.

circle: a cell where a basic music and other one share.

Fig. 9 Method 4: treats both 'melody goodness' and 'general acceptance' by two categories

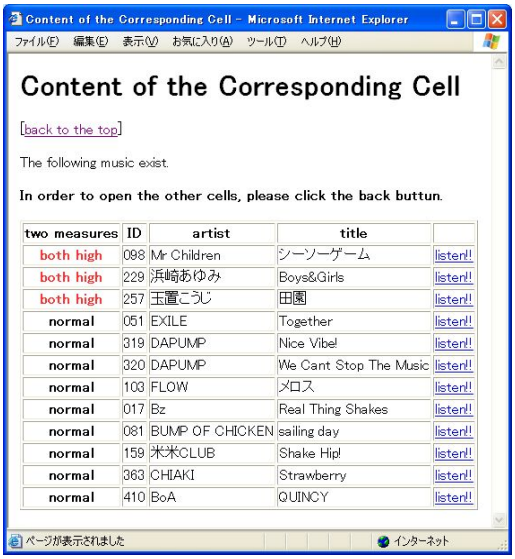
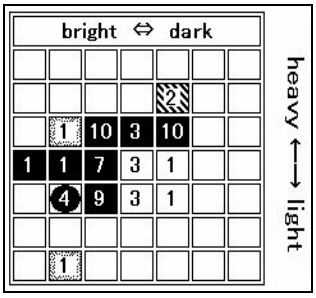



Fig. 10 data list emerged after clicking a certain cell in Fig. 9




**B**: a cell where only a basic music exists.

X : a cell where only a music which is not a basic one and whose melody goodness and general acceptance are both less than threshold exists.

X : a cell where a music which is not a basic one and whose only melody goodness is larger than or equal to threshold exists.

X : a cell where a music which is not a basic one and whose only general acceptance is larger than or equal to threshold exists.

X : a cell where a music which is not a basic one and whose melody goodness and general acceptance are both larger than or equal to threshold exists.

circle: a cell where a basic music and other one share.

Fig. 11 Method 5: treats both 'melody goodness' and 'general acceptance' by four categories

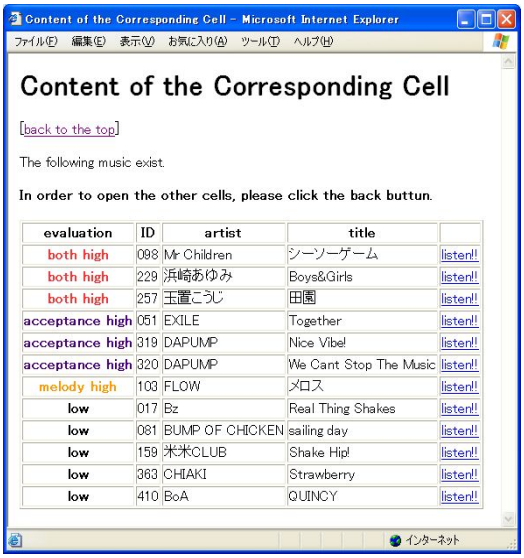



Fig. 12 Data list emerged after clicking a certain cell in Fig. 11

### *B. Three Types of Customization Menus*

This paper also proposes the following three types of customization menus in 2D-RIB.

**Customization menu 1:** to customize threshold that melody goodness or general acceptance is treated as positive(Fig. 13). As we have proposed Method 2-5 in the previous subsection, its default value is plus one.

This customization enables a retrieval person to increase or decrease the number of positive music in two measures or either of them.

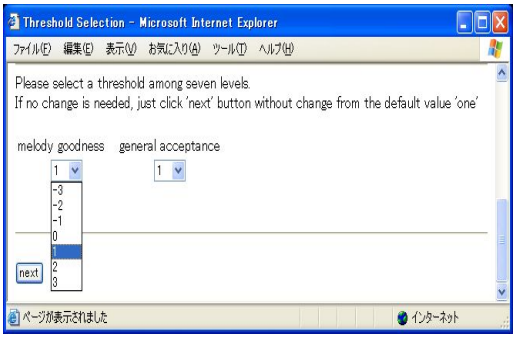



Fig. 13 Customization menu 1: threshold of positive

**Customization menu 2:** to customize a width of impression value admitted to remained impression pairs(Fig. 14). As we have explained in the previous section, its default value is from minus one to plus one.

This customization enables a retrieval person to increase the number of music as a retrieval result if the width of value in the impression pair which is not important to a retrieval is expanded.

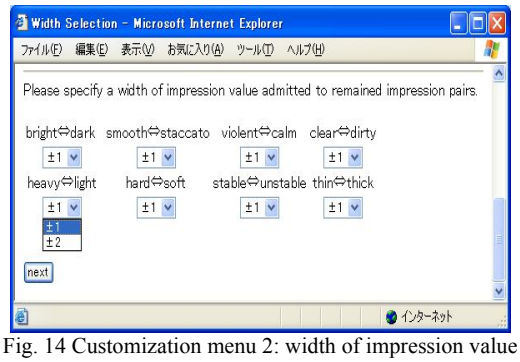



Fig. 14 Customization menu 2: width of impression value accepted to remained impression pairs

**Customization menu 3:** to retrieve with omitting a certain impression pair when a retrieval person can not understand the meaning of the pair(Fig. 15). Original 2D-RIB[8]-[9] enforces him/her to use all impression pairs even if he/she can not understand the meaning of a certain impression pair. This customization enables him/her to prevent such an impression pair from disturbing to receiving an adequate retrieval result.

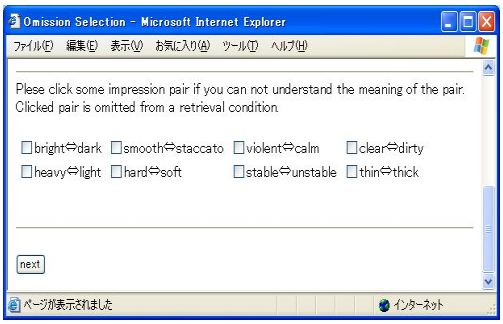



Fig. 15 Customization menu 3: omission of a certain impression pair

## IV. Pirot Systems and Music Data

### A. Implementation Environment

Table I shows our implementation environment. We adopt Microsoft Windows2000 Server as OS, and Oracle9i as DBMS(DataBase Management System). Our database is collaborated with WWW by Servlet/JSP we adopt as a programming language. We adopt Tomcat5.0 as servlet container, and Apache2 as Web server. Why we adopt Servlet/JSP is by which database can be collaborated with WWW smoothly. We use Microsoft Internet Explorer6 as our Web browser.

TABLE I
Implementation Environment

| | |
|---|---|
| OS | Microsoft Windows2000 Server |
| DBMS | Oracle9i |
| Programming language and collaboration with DB to WWW | Servlet/JSP |
| Servlet container | Tomcat5.0 |
| Web server | Apache2 |
| Web browser | Microsoft Internet Explorer6 |

### B. Music Data

Our database stores information concerning 460 popular music. Each impression value is beforehand determined by the following evaluation test. That is, we use the main part of each music, and each five subjects listen to it. The impression value of a music is derived from the median of impression values provided by five subjects.

### C. Default Setting

Both the threshold of positive melody goodness and general acceptance are plus one excepting when we use the Customization menu 1. The acceptable width on the values in remained impression pairs is one excepting when we use the Customization menu 2 or 3. It means from minus one to plus one for value of a basic data.

## V. Evaluation Experiment

### A. Evaluation of Two Measures

#### 1. Method

As in the paper [8], after a subject has determined a music image that he/she should reach, he/she evaluates how much a retrieval result satisfies the image. Concretely, we use the following two evaluation values:

**Evaluation value 1:** is provided by a satisfaction level of first two retrieval results for the determined image. It is subjective and seven levels as follows:
1: satisfied very much,
2: satisfied,
3: satisfied a little,
4: neutral,
5: not satisfied a little,
6: not satisfied, and,
7: not satisfied very much.

**Evaluation value 2:** is the number of music to which he/she listens until he/she is satisfied with a relevance between the determined image and a retrieval result. Its maximum value is ten. If ninth retrieval result does not provide satisfaction, tenth retrieval operation is stopped, and the value is ten.

These two evaluation values have the same rules: the smaller its value becomes, the better its evaluation is.

In Method 1, when the system shows a data list, it sorts according to the negative order of two measures, and it first shows the worst data. The reason is, if a data list has no column concerning the proposed two measures, it is not rare that he/she listens to the music from the top of the list. In the other methods, the system sorts according to the positive order of each measure, and it first shows the best data.

In this experiment, subjects are thirty-five students belongs to our faculty.

#### 2. Result

First, concerning Evaluation value 1, Method 5 is the best, and Method 4 follows it(Table II). Second, Method 5 is also the best in Evaluation value 2. Method 2 and 4 follow it(Table III). Table II and III show that we should introduce both the two measures rather than single introduction of them. Although Method 3 is superior than Method 2 about 2% in Table II, Method 2 is superior than Method 3 about 10% in Table III. This means that melody goodness is little bit more important than general acceptance.

TABLE II
Result in Evaluation Value 1
on Experiment of Two Measures

| | Method 1 | Method 2 | Method 3 | Method 4 | Method 5 |
|---|---|---|---|---|---|
| Mean of Evaluation Value 1 | 3.47 | 3.25 | 3.19 | 2.89 | 2.47 |
| Standard Deviation | 1.61 | 1.32 | 1.47 | 1.43 | 1.30 |

TABLE III
Result in Evaluation Value 2
on Experiment of Two Measures

| | Method 1 | Method 2 | Method 3 | Method 4 | Method 5 |
|---|---|---|---|---|---|
| Mean of Evaluation Value 2 | 5.06 | 4.42 | 4.94 | 4.53 | 3.94 |
| Standard Deviation | 2.89 | 2.37 | 3.09 | 2.89 | 2.63 |

### B. Evaluation of Three Customization Menus

#### 1. Method

We carry out our evaluation using Method 5 because it has obtained the best evaluation result in subsection *A*. It is relative comparison among total four systems. They include three types of systems which introduces either from Customization menu 1 to 3 and Method 5 itself. The definition of Evaluation value 1 and 2 is the same as in the subsection *A*.

*2. Result*

Concerning Evaluation value 1, Customization menu 3 is the best, and Customization menu 2 follows it(Table IV). On the other hand, in Evaluation value 2, Customization menu 2 is the best and Customization 3 follows it(Table V). A common feature between Customization menu 2 and 3 is to reduce a retrieval condition based on an impression pair whose importance is not high. It enables a retrieval person to obtain more appropriate retrieval result.

As the reason the evaluation of Customization menu 1 is not high, we can mention that the default value 'plus one' for the threshold is fortunately very appropriate. If we increase the threshold, we have few music whose both two measures is higher than the threshold and it is hard to obtain an appropriate music. On the other hand, if we decrease the threshold, we have too music whose both two measures is higher than the threshold and it is also hard to obtain an appropriate music.

TABLE IV
RESULT IN EVALUATION VALUE 1
ON EXPERIMENT OF THREE CUSTOMIZATION MENUS

| | Method 5 itself | Added only C* Menu 1 | Added only C* Menu 2 | Added only C* Menu 3 |
|---|---|---|---|---|
| Mean of Evaluation Value 1 | 3.44 | 3.32 | 3.00 | 2.80 |
| Standard Deviation | 1.33 | 1.18 | 1.35 | 1.38 |

C* = Customization

TABLE V
RESULT IN EVALUATION VALUE 2
ON EXPERIMENT OF THREE CUSTOMIZATION MENUS

| | Method 5 itself | Added only C* Menu 1 | Added only C* Menu 2 | Added only C* Menu 3 |
|---|---|---|---|---|
| Mean of Evaluation Value 2 | 6.08 | 6.66 | 5.00 | 5.56 |
| Standard Deviation | 2.60 | 2.80 | 2.87 | 3.23 |

C* = Customization

## VI. CONCLUDING REMARKS

In this paper, we have proposed to introduce the two measures: melody goodness and general acceptance in our impression-based music retrieval system with 2D-RIB. Its aim has been to improve satisfaction level for a retrieval result. Our evaluation experiment has shown that both the two measures are effective and the following introduction method is most appropriate. It is the method that we can say each music group in a cell of 2D-RIB is which of the following four levels:

(1) a level which includes a music whose both two measures are higher than or equal to the threshold,
(2) a level which does not reach the above (1), but includes a music whose only a single measure is higher than or equal to the threshold,
(3) a level which does not reach the above (1), but includes a music whose only another single measure different from (2) is higher than or equal to the threshold, and
(4) a level which includes only the music whose both two measures are lower than the threshold.

Furthermore in this method, we can click a cell and see the evaluation values of two measures for each music in the group. The most important knowledge from this paper is as follows. In impression-based music retrieval, in order to improve satisfaction level for a retrieval result, melody goodness and general acceptance have significant influence as well as relevance for an impression of a retrieval condition.

In this paper, we have also proposed the three types of customization menus in 2D-RIB. Its evaluation experiment has clarified that which customization menu effectively improves satisfaction level. It is effective if we introduce the customization menu which enables a retrieval person to reduce the strictness level of retrieval condition in an impression pair based on his/her need.

For future research directions, we can point out (i) extension of 2D-RIB to feature space, and (ii) application of 2D-RIB to impression-based image retrieval.

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