Deducing a User's State of Mind from Analysis of the Pictographic Characters and Emoticons used in Mobile Phone Emails for Personal Content Delivery Services

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Abstract - *As the ubiquitous environment is taking root, there are calls for services that deliver content appropriate for the individual user's personal interests and preferences. However, it is difficult to deduce the ever-changing preferences of people who live in a complicated society. In this paper, we focus on mobile phones, whose users are growing in number and which offer many sophisticated functions besides the ability to talk. We propose a method of deducing the state of mind of the user by analyzing the pictographic characters and emoticons used in his or her emails. Moreover, we have proposed a method of selecting an appropriate piece of music based on a music type, which is represented by the "number of chords", "sound strength", and "melody pattern" in a piece of music. We have developed the algorithm to deduce the user's state of mind from an email and applied the algorithm to the selection of music, which is considered to be close related to people's feelings.*

Keywords; *content delivery service; interests and preferences; deduction of state of mind; mobile phone email; pictographic character;*

1. Introduction

As the ubiquitous society develops, the demand for personalized services is growing. For example, there is a Web mail service that analyzes the text of each email received, and delivers advertisements related to the words contained in that email [2]. As terrestrial digital broadcasting and one-segment TV services become widespread and as the memory capacity of mobile phones increases, people expect to see personalized video or music delivery services.

To provide personalized services, it is necessary to capture the preferences and dynamic state (physical/ mental/ emotional) of each user, and to determine the type of service to provide in light of the user's state so captured. There have been a variety of studies that address these needs [3][4][5]. As regards capturing the user's state, methods of determining the user's current location using GPS [4][5], and of capturing the user's state of mind by text mining have been proposed [6][7][8]. However, since text mining requires a vast computing time and vast resources, it is unfit for capturing the ever-changing state of mind of the user in real time.

By March 2008, the number of mobile phone users exceeded one hundred million and is still growing in Japan [9]. The mobile phone has evolved into a sophisticated mobile information terminal, capable of email, Web access, credit card transactions, pre-paid card functions, GPS-based navigation, functioning as a digital camera and so on, in addition to voice communication. This means that a mobile phone is a comprehensive treasure trove of the behavior and preference information of its user. In particular, more than 80% of mobile phone users use pictographic characters in order to convey a variety of emotional concepts that are difficult to express in text [10][11]. Recently, a progress has been made to standardize pictographic characters among different mobile phone providers. Mobile phone emails have the following characteristics:

- There is a strict restriction on the number of characters that can be included in each email, so most emails are short, making it relatively easy to analyze them. This means that mobile phone emails can be analyzed at low cost.
- The style of writing is relatively close to spoken language. A wide assortment of means of expression is used, such as symbols, pictographic characters, and emoticons. These make it easy for the user to write an email that directly reflects how he or she feels at the moment.

We are studying how to deliver content appropriate for the user's current state of mind by analyzing his or her interests and preferences in daily life [1]. In particular, this paper proposes a method of deducing the user's state of mind by analyzing facial

pictographic characters and emoticons contained in emails exchanged using a mobile phone. We have chosen to focus on music because user's feeling is the major factor in the selection of music. We have chosen to use the "number of chords", "sound strength", and "melody pattern" as music elements that characterize a piece of music. Based on these elements, we define the relationship between a piece of music and a user's feeling. We also propose a method of searching for an appropriate piece of music. Section 2 presents the information delivery system assumed, and the service it provides. This system and service information has been used to identify research topics. Section 3 proposes solutions for these topics. Section 4 describes the prototype system developed to evaluate the proposed algorithm, the experiments conducted and the evaluation results. It also describes the evaluation of the algorithm by having a group of students use the system, and the evaluation of the music selection method. Finally, Section 5 presents the conclusions and issues for future study.

2. Content delivery system that involves the analysis of mobile phone emails

This section describes examples of email that reveal the user's state of mind and interests, and example of use of the information content delivery service. Then, the research topics are addressed.

2.1. Emails containing pictographic characters and emoticons to express interests and state of minds

The words and pictographic characters and emoticons in emails reveal the user's interests and preferences, and the user's expressions (choice of words) and types of pictographic characters and emoticons reveal the user's current state of mind and the extent of the user's fatigue. An example of an email that reveals the current state of mind and interests is shown in Figure 1. The idea, "The Japanese team don't seem to be able to score", can be expressed in different ways, as shown by the two emails in Figure 2. Email (a) shows that the user is irritated while Email (b) shows that the user is discouraged. So, the same sentence can covey a different state of mind depending on the pictographic character used.

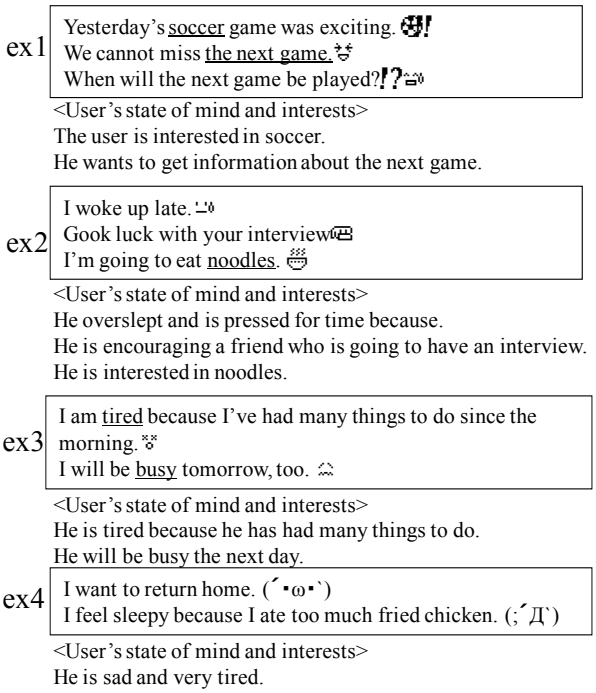
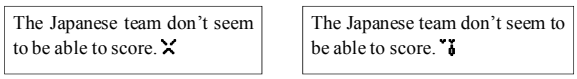


Figure 1. Examples of email that reveal the user's state of mind and interests



(a) Anger (b) Sorrow

Figure 2. The same sentence can convey a different state of mind.

2.2. Content delivery system

With this system, we aim to determine the user's interests, preferences, and the extent of his or her fatigue by consecutively analyzing emails containing pictographic characters that he or she exchanges daily with friends and family members, and to deliver content that is appropriate for his or her interests and current state of mind. An example of potential use of the service to be provided by this system is shown in Figure 3. The service proceeds as follows:

1) The user exchanges emails with friends as usual.
2) An application extracts and analyzes words, pictographic characters and emoticons contained in these emails.
3) The application determines the user's interests and current state of mind and saves that data in the mobile phone.
4) When the user wants to receive content appropriate for his or her interests and state of mind,

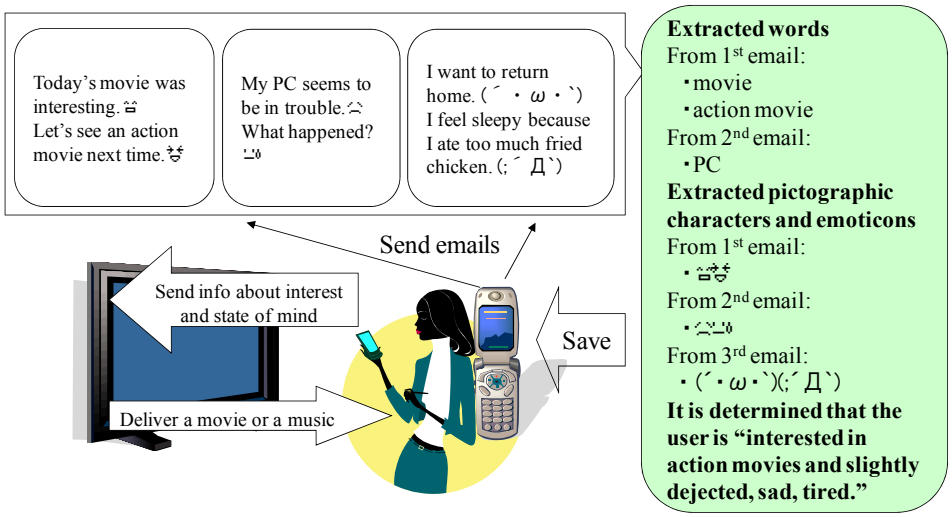


Figure 3. Example of use of the information content delivery service

the analysis result in 3) is sent to his or her TV (which relays the result to the delivery server).

5) The delivery server delivers content appropriate for the user.

2.3. Research topics

(1) Classify and characterize pictographic characters and emoticons.

In order to allow the deduction of the users' interests and state of mind from the pictographic characters and emoticons used in his or her emails, it is necessary to determine the deeper meaning that each pictographic character and emoticon conveys [12].

(2) Establish an algorithm to determine the user's interests and state of mind.

It is necessary to establish an algorithm to determine the user's interests and state of mind from the words, pictographic characters and emoticons contained in his or her email.

(3) Establish an algorithm to determine the appropriate content to be delivered.

It is necessary to establish an algorithm for selecting the content appropriate for the user, based on his or her interests, preferences and state of mind, which have been deduced from his or her email.

3. Proposed algorithms

This section describes our solutions to topics (1) (2) and (3) identified in Section 2.3.

3.1. Algorithm for determining interests and preferences

Figure 4 shows the algorithm for determining interests and preferences from words, pictographic characters and emoticons contained in an email, and for deducing the state of mind and extent of fatigue from the expressions, pictographic characters and emoticons used.

The interests and preferences are deduced from words that indicate interests, such as baseball and tennis, and pictographic characters that indicate interests, such as and , and also from past analysis results. Similarly, the state of mind and extent of fatigue are deduced from expressions used (choice of words), the percentage of pictographic characters and emoticons used in email text, and the types of pictographic characters and emoticons used. It can be assumed that a person in a poor state of mind tends to use plain or blunt expressions, that a person in a better mood tends to use pictographic character and emoticons more often, and that a person uses different types of pictographic character and emoticon depending on his or her state of mind. To confirm these assumed tendencies, we conducted a questionnaire survey with nine frequent users of email. More than half of the respondents said that they use more pictographic characters and emoticons when they are in a better mood, and almost all of them said that the pictographic characters and emoticons they choose reflect their state of mind.

We propose the algorithm for deducing the state of mind and extent of fatigue from pictographic characters and emoticons shown in Figure 4.

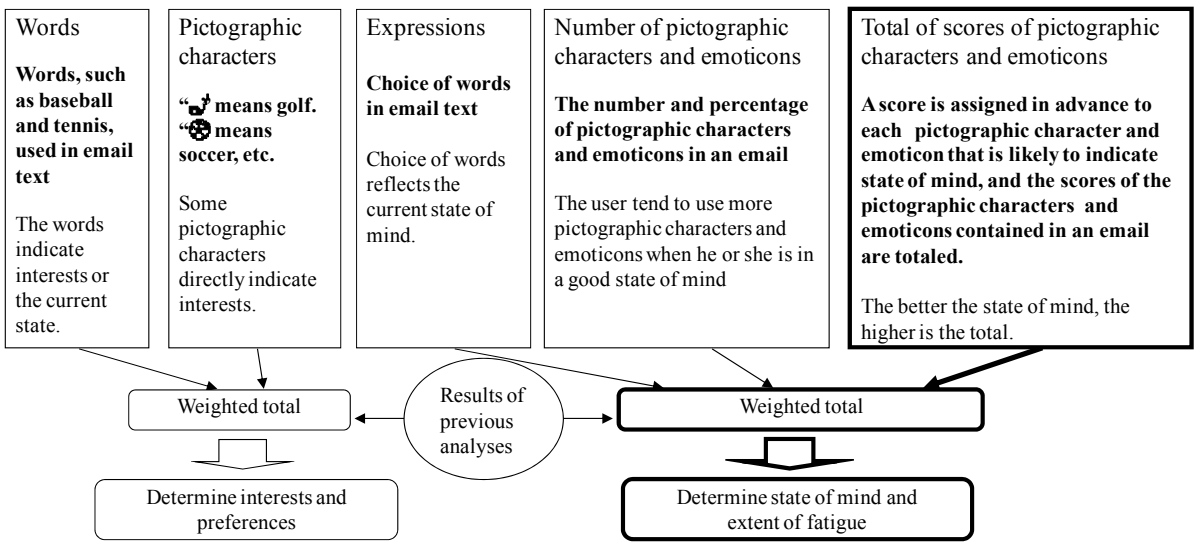


Figure 4. Algorithm for determining interests and preferences

3.2. Algorithm for deducing the state of mind from pictographic characters and emoticons

In this paper, we focus on the pictographic characters offered in NTT DoCoMo's [13] mobile phone service and emoticons, including 2-byte characters. Today, more than 200 pictographic characters and more than 1000 emoticons are used. In order to narrow down the list and select only those pictographic characters and emoticons useful for deducing the state of mind, we classified and characterized them in the following sequence of steps.

3.2.1. Selection and classification of pictographic characters and emoticons. We selected 43 pictographic characters that were found to express facial expressions and feelings. From among frequently used emoticons pre-installed in mobile phones and other emoticons, including 2-byte characters, we selected 64 emoticon that were found to indicate feelings clearly.

3.2.2. Classification of state-of-mind elements and weighting factors. We selected six state-of-mind elements: happy, angry, sad, optimistic, tired and affectionate. The newly selected element, "affectionate", is usually not relevant to the selection of an item of content, but is used only when its value is extremely high or extremely low. Since one pictographic character or emoticon can convey a variety of feelings, each is defined as a combination of vector values of several state-of-mind elements. The vector value of each element ranges from 0 to 5. For example, for one pictographic character "", a vector value 5 may be assigned to "happy", 0 to "angry", 0 to "sad", 3 to "optimistic", 0 to "tired", and 2 to "affectionate".

We conducted a questionnaire survey with 36 students (29 males and 7 females) in our university to validate our selection of the six state-of-mind elements, and to determine the vector values of each pictographic character. We asked the students to select the states of mind that are associated with each pictographic character or emoticon. The distribution of state-of-mind elements for each pictographic character is shown in Figure 5. The value of each state-of-mind vector was normalized by dividing the total votes in the survey by the number of respondents, and multiplying the result by 50. The one decimal place of this value was rounded off. A small number of respondents suggested the inclusion of "surprised" and "worried" as possible state-of-mind elements, but most claimed that the six states-of-mind elements were appropriate and sufficient for mapping the pictographic characters and emoticons. Examples of vector values for some pictographic characters are shown in Table 1.

With some pictographic characters, a few students associated states of mind that are quite different from, or even opposite to, those of other students. The differences were particularly pronounced between male and female students. However, the majority gave consistent associations between pictographic characters and emoticons and states of mind.

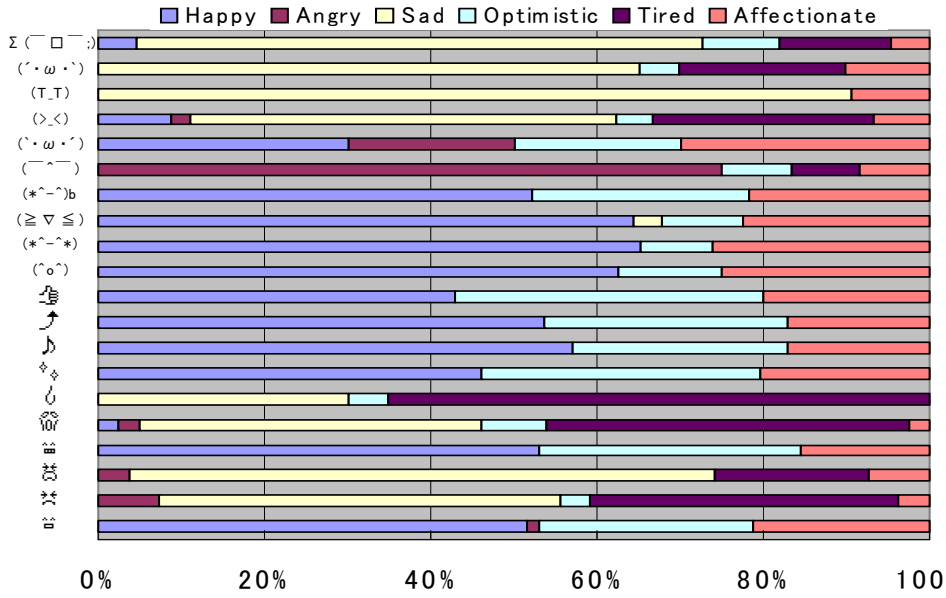


Figure 5. Result of questionnaire survey on the relationship between pictographic characters, emoticons and states of mind

Table 1. Example of state-of-mind vectors of individual value

State of mind elements / Characters	Happy	Angry	Sad	Optimistic	Tired	Affectionate
^^	5	0	0	3	0	2
<3	3	0	0	2	0	5
(^-^)	5	0	0	2	0	3
(>_<)	2	0	5	1	3	2

3.2.3. Use the regular expression for searching. In order to find emoticons efficiently, we chose to use pattern matching of character strings in an email. A new emoticon is often created by adding a character(s) to an existing emoticon. For example, the emoticon (^o^) (smiling face) is expanded to ＼(^o^)／ or v(^o^)v. If the regular expression is used, a pattern matching operation can find not only (^o^) but also ＼(^o^)／ and v(^o^)v. Since the meanings of these derivatives are not so different from the original emoticon, this search method is effective in finding emoticons that have been created by adding parts to an existing emoticon.

3.2.4. Algorithm for determining states of mind from pictographic characters and emoticons. We assume that the state of mind of a person can be expressed by a finite number of state-of-mind elements. Therefore, we express the state of mind using k-dimensional vectors.

Suppose there are m pictographic characters and emoticons in an email text, M. Then, the state-of-mind vector $\varepsilon(p_i)$ of an individual pictographic character or emoticon p_i can be expressed as:

$$\vec{\varepsilon}(p_i) = (e_{ji})_{1 \le j \le k} \qquad (p_i \in M, 1 \le i \le m)$$

Where e_{ji} indicates the intensity of the specific state-of-mind element. The state-of-mind vector that can be deduced from the pictographic characters used is defined as:

$$\vec{F}(M) = \frac{1}{m} \sum_{i=1}^{m} \omega_p \vec{\varepsilon}(p_i)$$

ω_p is a weighting factor. It reflects such factors as the ratio of the number of pictographic characters to the number of emoticons or the ratio of the number of males to the number of females.

The algorithm for calculating the state-of-mind vector F(M) is as follows. Note that the state-of-mind vector of each pictographic character or emoticon (such as the one in Table 1) is pre-registered in the database.

Step 1: Extract a pictographic character or emoticon p_i by analyzing the mail text.

Step 2: Find the state-of-mind vector values for each of m pictographic characters and emoticons p_i in the database.

Step 3: Obtain F(M) by calculating the average vector value of each state-of-mind element for m pictographic characters and emoticons.

3.3. Composition of the music database and database search method

In order to determine the music type (number of chords, sound strength, and melody pattern) that the user is likely to want to hear at present, we analyze the state-of-mind elements. We have developed an algorithm for a music search and delivery system.

We created 12 MIDI (Musical Instrument Digital Interface) files in different music categories with different chord patterns. We investigated the relationship between music types and the states of mind with 24 students. We asked them to write ○ when the music type they heard matched their state of

Table 2. Related data base of rhythm and state of mind

	Category	Key	Rhythm				State of mind					
			Chord	Ratio	Volume	Melody	Happy	Angry	Sad	Optimistic	Tired	Affectionate
Music 1	Blues	B ♭ major	B ♭ 7	6.0	Large	passing tone	2.9	-2.3	-1.7	4.4	0.2	1.0
			E ♭ 7	3.0								
			Cm7	1.5								
			F7	1.5								
			Edim	1.0								
Music 2	Bop	E ♭ major	B ♭ m7	1.0	Small	passing tone	1.7	-0.4	-1.7	0.8	-1.7	-0.4
			Cm7	1.0								
Music 3	Country	Cmajor	F	1.0	Small	auxiliary tone	-0.2	-0.4	1.7	1.0	1.9	0.6
			G	1.0								
			Em	1.0								
			Am7	1.0								
Music 4	Pops	Cmajor Fmajor	F Bb	1.0	Large	passing tone	3.1	0.0	1.3	1.7	1.0	1.7
			G C	1.0								
			Em Am	1.0								
			Am7 Dm	1.0								
Music 5	Classic	D ♭ major	D#m	7.0	Small	passing tone	1.0	0.0	-2.0	4.0	2.0	3.0
			C#	2.0								
			B	5.0								
			D#sus4	4.0								
			G#m	1.0								
			C#sus4	1.0								
Music 6	R&B	Cmajor7	CM7	1.0	Large	auxiliary tone	2.7	-1.7	-0.8	2.3	-0.2	1.0
			C6	1.0								
			Dm7	1.0								
			Dm6	1.0								
Music 7	Rock	Cmajor7	FM7	1.0	Small	auxiliary tone	0.8	-1.3	1.3	1.0	0.6	0.8
			G	1.0								
			Em	1.0								
			G9	1.0								
Music 8	Latin	Cmajor7	CM7	2.0	Small	auxiliary tone	1.7	-1.7	-1.9	3.3	-0.4	0.2
			Dm7	1.0								
			D ♭ M7	1.0								
Music 9	Jazz samba	Emajor	D	1.0	Large	passing tone	2.9	-1.3	-0.4	1.5	-1.0	0.6
			E	1.0								
			F#m	0.8								
			G#m(♭ 5)	0.5								
			A	2.8								
			Bm	1.8								
			A#aug	1.0								
Music 10	Ballad	Cmajor	A7sus4	2.5	Small	auxiliary tone	-0.6	-0.4	2.5	0.4	2.5	1.7
			D9	1.5								
Music 11	Techno	Aminor	DM7	1.0	Large	auxiliary tone	-0.6	-0.6	0.4	0.2	-0.4	-0.6
			E6	1.0								
Music 12	Rock	Dmajor	D	5.0	Large	auxiliary tone	-3.0	1.0	2.0	-1.0	2.0	0.0
			G	4.0								
			A	2.0								
			Bm	1.0								

mind, × when they did not match, and nothing (space) when neither of them was true. If ○, 1 is added to the value. If ×, 1 is subtracted from it. If nothing, no operation was made. The state-of-mind value was calculated by dividing the total by the number of people, and multiplying it by 5. The results for each music type are shown in Table 2.

We created music metadata that consists of music title, category, key, chord, and state-of-mind elements. Music type data was extracted from each MIDI file. The state-of-mind data was obtained by searching the basic element database. The process of deriving state-of-mind element data from a MIDI file (MU_i) is as follows.

Step 1: Extract the number of chords, volume, and melody pattern from the MIDI (MU_i) file.

Step 2: Compare these with data in the basic element database (Table 2), and determine the music type that best matches the extracted data.

Step 3: Obtain the state of mind element values from the matched music type, and register them as the state of mind values of MU_i.

Step 4: Repeat steps 1 to 3 for MU_0 to MU_j. Build a music database for each of MU_0 to MU_j.

Step 5: Compare the user's actual feeling data with the feeling element data in the music database, and determine that music that best match each other.

4. Development of a prototype system and evaluation

This section describes our prototype system to evaluate the proposed methods and the experimental results also.

4.1. Prototype evaluation system

We implemented the state-of-mind deducing algorithm and the state-of-mind element database for the proposed pictographic characters and emoticons on a PC. In order to collect sample mails and evaluate the algorithm, we built a website with an input form written in JavaScript. The form enabled the user to input his or her personal information, such as name, gender, age, and the prefecture in which he or she had been brought up, as well as mail sentences and his or her subjective feeling values. We used a set of "i-pictographic characters [14]" for the input of pictographic characters, and a piece of free software called "Emoticon Helper Mini [15]" for the input of emoticons. The prototype software was written in Perl. The state-of-mind database was built using MySQL. We registered the state-of-mind elements and scores of 43 pictographic characters and 64 emoticons in the database. Figure 6 shows the configuration of the prototype system. The system operates as follows.

Step 1: The user inputs an email that contains pictographic characters and emoticons using the input form. The user also inputs his or her subjectivity values.

Step 2: Extract pictographic characters and emoticons that express user's feelings from the email text.

Step 3: Access the MySQL database to extract the score of each state-of-mind element of the pictographic characters and emoticons.

Step 4: Calculate the state-of-mind element score, and deduce the state of mind. Identify the three strongest emotions in each state of mind.

Step 5: Save the email text and the deduction result in text form.

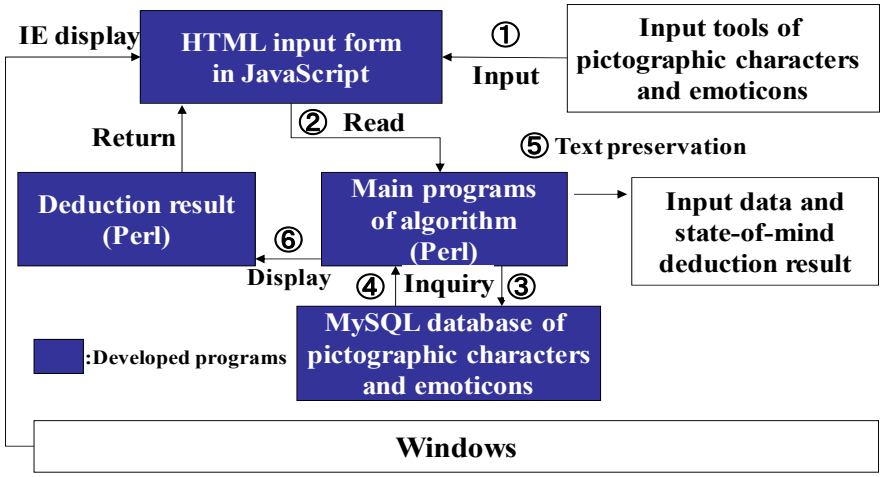


Figure 6. Block diagram of the system and programs developed

Step 6: Display the extracted pictographic characters and emoticons, the user's subjectivity feeling value, and the state-of-mind deduction result.

4.2. Evaluation

We collected one sample mail from each of 64 students (43 males and 21 females) by using a prototype system. We calculated the state-of-mind value of each person and compared it with each person's subjective feeling value. Using this result, we excluded the item of data with the highest state-of-mind value and the item of data with the lowest value, leaving 62 items of data for evaluation.

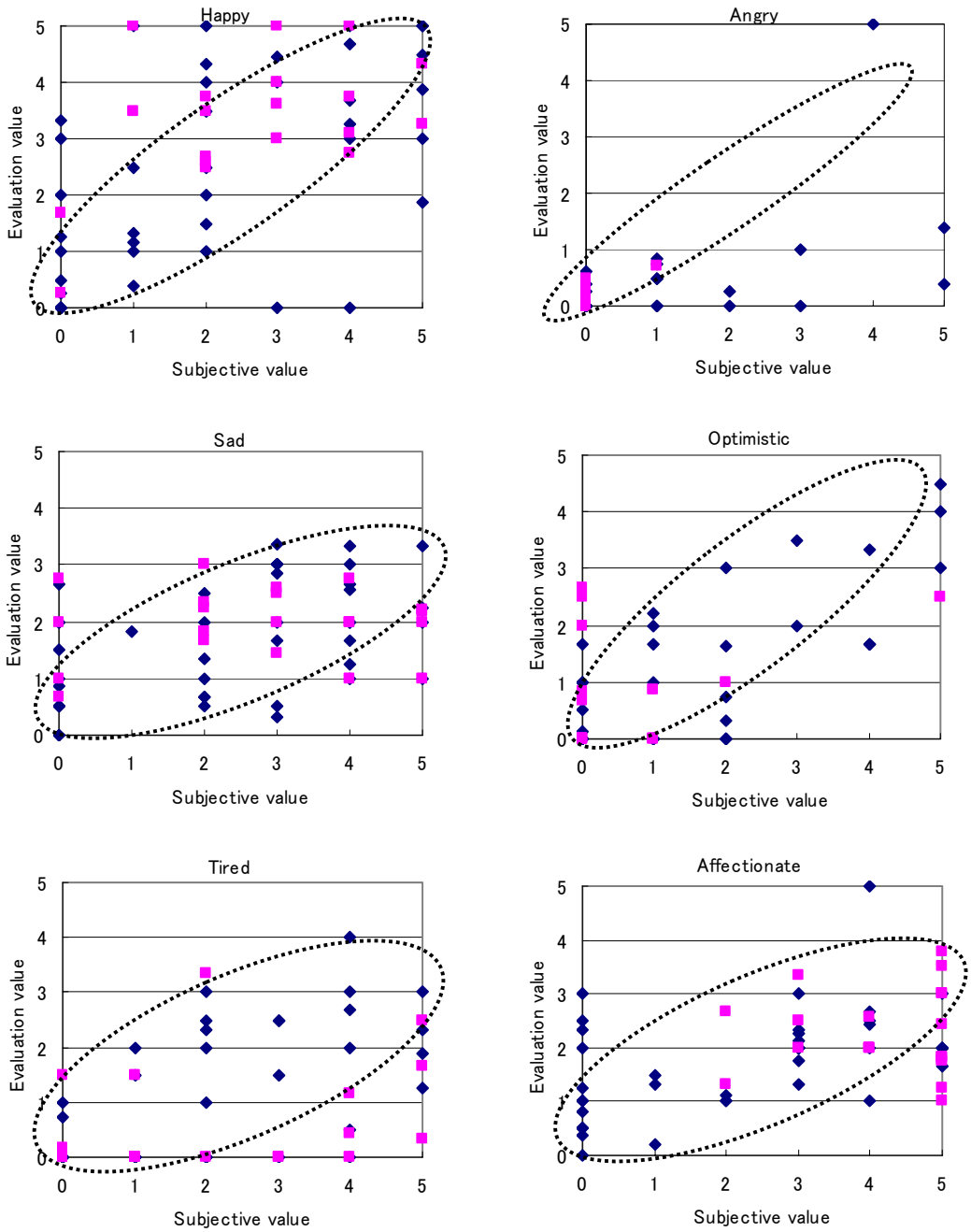


Figure 7. Correlation between the subjective value and the evaluation value (Note : ◆Male ■Female)

The correlation between the calculated state-of-mind value and the subjective self-declared feeling value for each state-of-mind element is shown in Figure 7. The correlation for “angry” was the highest (the correlation coefficient = 0.66), and that for “affectionate” the lowest (the correlation coefficient = 0.34). The correlation coefficients for “happy”, “sad”, “optimistic” and “tired” were 0.53, 0.65, 0.35 and 0.49, respectively. The average was 0.5. These results were more or less what we had expected. The definitions of "optimistic" and "affectionate" were vague and differed between genders and between individuals. The definitions of these states of mind made by the students may have been different from what we had in mind, and this fact would explain the low correlation for “anger” and “affectionate”. Overall, the correlation coefficients of the female students were lower than those of male students. This is probably because there were more male students than female students among our subjects.

Figure 8 shows the statistics of the correlation between subjective feeling values and calculated values of all state-of-mind elements. The average correlation coefficient value for males and females were 0.63 and 0.57, respectively, and the overall average was 0.61, which is sufficiently high.

We evaluated whether an appropriate item of music can be selected from the state-of-mind values by referring to the music database. We selected three students (two males and one female) who recorded a h igh correlation value. Specifically, w e compared the strong state of mind obtained from the deduction result with data in the database shown in Table 2, and selected three pieces of music. We checked whether the pieces of music selected matched their feelings. We asked each student to write ◎ if the first piece matched their feeling, ○ if the second piece matched their feeling, △ if the third piece matched their feeling, and × if none of the three pieces matched their feeling. The results are shown in Table 3.

The piece number in Table 3 correspond to the piece number in Table 2. The piece encircled by ○ is the one that matched the subject’s feeling. The state-of-mind element to which the woman gave the highest value was "affectionate." However, since that value

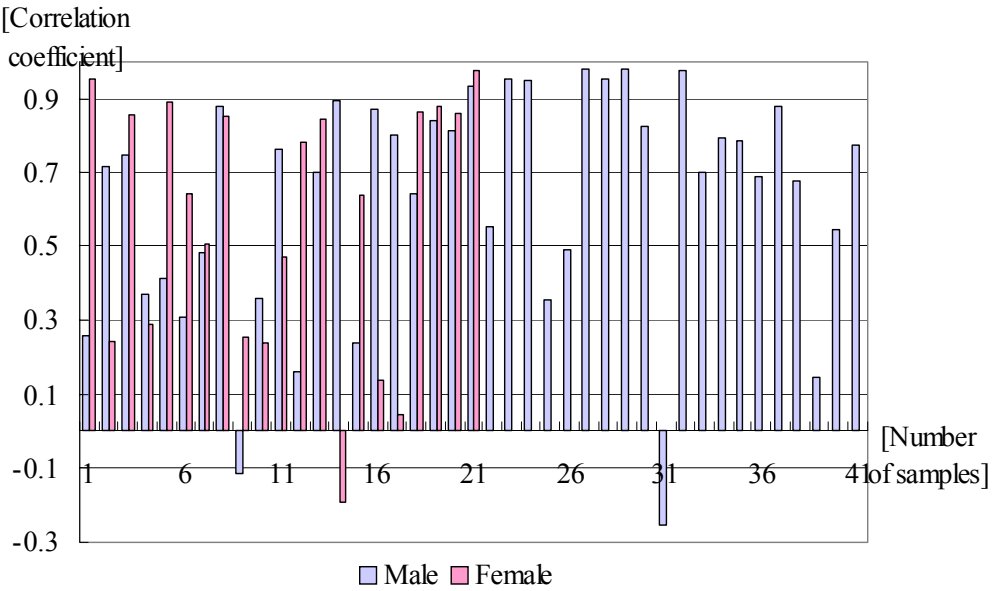


Figure 8. Statistical graph of individual correlation value

Table 3. Evaluation of music recommendation method

Items / Gender	Strong state-of-mind element presumed			Individual's correlation coefficient	Selected piece of music	Evaluation
	First element	Second element	Third element			
Male 1	Sad	Tired	Angry	0.705	3,12,⑩	△
Male 2	Sad	Tired	Happy	0.828	⑩	◎
Female	Affectionate	Happy	Optimistic	0.975	4,1,⑨	△

was not pronounced, we selected pieces mostly from "happy" and "optimistic". We found that at least one of the three pieces selected matched the subject's mood. Some answered that the second or the third piece best suited his or her mood. We find that the evaluation result was relatively good.

5. Conclusion and future work

We have proposed an algorithm for deducing the user's state of mind from the pictographic characters and emoticons contained in emails, and evaluated its feasibility. We have studied the state-of-mind elements associated with pictographic characters and emoticons, and their weighting factors, and have introduced specific values for the weighting factors. We have studied the algorithms for extracting pictographic characters and emoticons from an email, and for deducing the user's state of mind from the state-of-mind elements of the extracted pictographic characters and emoticons. We have developed a program that implements this algorithm, and a prototype evaluation system. Using this system, we have verified the effectiveness of the proposed algorithms.

We have also presented an algorithm for extracting the number of chords, volume and melody from a piece of music. We have identified the relationship between the user's state of mind and the music type he or she is likely to want to hear, and evaluated the relationship.

Future issues include the method of sending the obtained state-of-mind information to the delivery server, and the method of sending the appropriate content from the delivery server to the user. It is necessary to study how to automate the processes for determining and providing content appropriate for the user based on the obtained state-of-mind information. To sum up, future issues include the following:

- Algorithm for deducing user's state of mind from multiple emails that the user has sent in the last few hours in order to take the immediate trend of the user's state of mind into consideration.
- Algorithm for searching for and analyzing more types of emoticons and detailed parts of emoticons, such has eyes, mouth, cheek and hand.
- How to deduce changes in the user's state of mind as the exchange of emails progresses.
- How to automate the processes for determining and providing content appropriate for the user, based on the obtained state-of-mind information.
- Algorithm for deducing more detailed state-of-mind data instead of a simply state-of-mind element value calculated by the system, in order to achieve a stronger linkage with the service of content delivery.

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