AN ALGORITHM FOR CLASSIFYING EMOTION OF SENTENCES AND A METHOD TO DIVIDE A TEXT INTO SOME SCENES BASED ON THE EMOTION OF SENTENCES

Hirotaka FUKOSHI, Futoshi SUGIMOTO and Masahide YONEYAMA

Department of Information and Computer Sciences
Toyo University
Saitama, Japan
E-mail: f_sugi@toyonet.toyo.ac.jp

ABSTRACT

In recent years, the field of synthesizing voice has been developed rapidly, and the technologies such as reading aloud an email or sound guidance of a car navigation system are used in various scenes of our life. The sound quality is monotonous like reading news. It is preferable for a text such as a novel to be read by the voice that expresses emotions wealthily. Therefore, we have been trying to develop a system reading aloud novels automatically that are expressed clear emotions comparatively such as juvenile literature. At first it is necessary to identify emotions expressed in a sentence in texts in order to make a computer read texts with an emotionally expressive voice. A method on the basis of the meaning interpretation that utilized artificial intelligence technology for a method to specify emotions of texts is thought, but it is very difficult with the current technology. Therefore, we propose a method to determine only emotion every sentence in a novel by a simpler way. This method determines the emotion of a sentence according to an emotion that words such as a verb in a Japanese verb sentence, and an adjective and an adverb in a adjective sentence, have. The emotional characteristics that these words have are prepared beforehand as a emotional words dictionary by us. The emotions used here are seven types: "joy," "sorrow," "anger," "surprise," "terror," "aversion" or "neutral."

Keywords: Reading system, Text to speech, Emotional word

1. INTRODUCTION

Technological development in synthesizing voice today has made available relatively natural-sounding synthetic voice; however, there are still unsolved problems concerning emotional expression. This research ultimately aim is to make a computer read texts with an emotionally expressive voice. Some attempts have been made over the past years to realize expressive voice as represented by the research by Iida, et al. [1], who used voice corpuses to synthesize expressive voice. However, such research assumes that text emotions are known beforehand, which actually means that an emotion of any text needs to be determined automatically when it is given. Therefore, methods such as the Hearst Method [2] divide texts into scenes, and determine emotions for all scenes. which raise problems
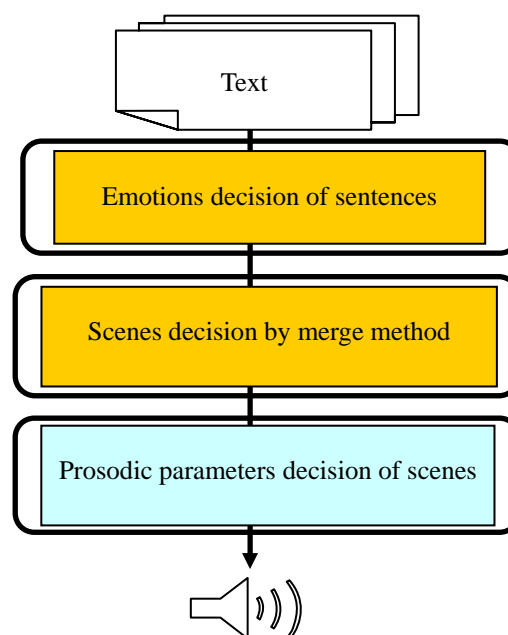

Fig.1: Outline of Emotional Reading System

that scenes are not unified with one emotion. we propose a merge method to determine emotion for each sentence and integrate adjacent sentences into it if they have an identical emotion, thus creating scenes with identical emotions. The merge method determines the emotion of a sentence according to an emotional words dictionary prepared beforehand. Logical bases differ between verb and adjective sentences to determine emotions. This paper focuses on how to determine the emotion of each sentence.

2. SYSTEM OUTLINE

Fig. 1 shows a concept of a system to read with emotionally expressive synthetic voice being developed in this research. First, the emotion of each sentence is determined according to distribution of words containing emotions of a story entered into a computer. Next, metrical parameters are determined according to determined emotions to be added to a synthetic voice, which is finally outputted as the synthetic voice.

We consider that the emotion of each sentence in a text can be determined according to images contained in words such as verbs and adverbs in verb sentences or complementary adjectives in adjective sentences. There are
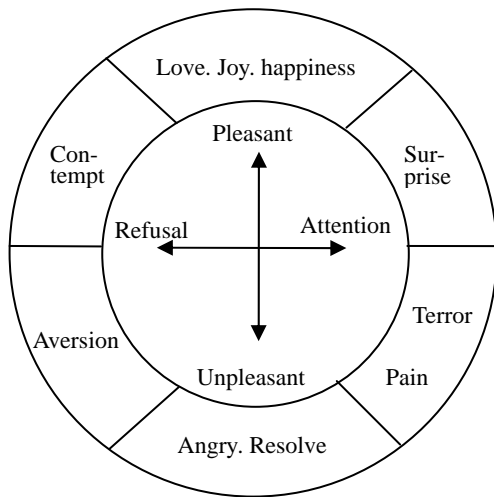
Fig.2: Schlosberg's Emotional Disk

Fig.3: Ratio of Emotions of Extended Emotional Words Dictionary of Verb

two ways to determine the emotion of each sentence from images contained in words; one is to determine emotions by combination of subjects and verbs of sentences; the other is to determine emotions by use of adjectives and adverbs or adjective nouns that show up in sentences. Here, the free morpheme analysis software "Chasen" [3] developed by Nara Institute of Science and Technology is used to determine parts of speech. Words analyzed into morphemes by "Chasen" and determined as adjectives, adverbs and verbs are checked if they are included in the emotion lexicon developed in advance; if included, emotions are determined according to the emotional words dictionary. Emotions used here are seven types: "joy," "sorrow," "anger," "surprise," "terror," "aversion" or "neutral." These emotions were chosen from Schlosberg's Emotional Disk [4] proposed in psychology as shown in Fig. 2. Thus, emotions of a story are determined sentence by sentence; the merge method is used to divide texts into
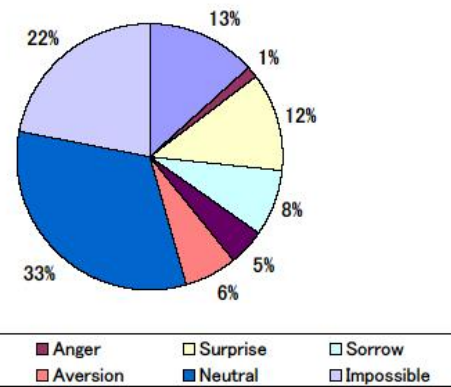
scenes after determining emotions of all sentences.

The merge method is a way to divide a text into blocks of identical emotions by emotion in each sentence, which is a type of method to divide texts into scenes, which was proposed in our research. The merge method first determines emotions sentence by sentence, and connects adjacent texts that contain identical emotions, consequently dividing them into some blocks with identical emotions. The most important point for this method is to ensure that emotions are determined sentence by sentence. Methods to determine sentence emotions are explained below.

2.1 Determining Emotions Using Subject-Verb Relationships

Emotions of verb sentences are determined from subject attributes and combinations of predicate verbs. How to determine emotions sentence by sentence in line with the

Table1: Character of Representative Words of Subject

Word	Baby	Older sister	Younger sister	Liar	Owner	Student	You
Character	Pleasant and Friendly	Subjective and Friendly	Subordinate and Friendly	Unpleasant and Hostile	Subjective	Subordinate	No Correspondence

Table2: Representative Emotional Words of Verb

Word A	Laugh					
Character	Pleasant and Friendly	Subjective and Friendly	Subordinate and Friendly	Unpleasant and Hostile	Subjective	Subordinate
Emotion	Joy	Joy	Joy	Aversion	Joy	Joy
Word B	Fight					
Character	Pleasant and Friendly	Subjective and Friendly	Subordinate and Friendly	Unpleasant・Hostile	Subjective	Subordinate
Emotion	Surprise	Surprise	Surprise	Neutral	Surprise	Surprise
Word C	Cry					
Character	Pleasant and Friendly	Subjective and Friendly	Subordinate and Friendly	Unpleasant・Hostile	Subjective	Subordinate
Emotion	Sorrow	Sorrow	Sorrow	Joy	Sorrow	Sorrow

idea above is explained below. First, morpheme analysis is conducted to find subjects and verbs in all sentences; next, all subjects and verbs found to determine emotions are checked if they exist in lexicons. These lexicons refer to the subject attribute lexicon and the verb emotion lexicon developed in advance. The subject attribute lexicon is a compilation of attributes of person-related nouns, usable as subjects and selected from IPAL [5]; in other words, this lexicon consists of two elements: nouns used as subjects and attributes of such nouns. Six types of attributes are used as subject attributes: pleasant/friendly-unpleasant/hostile, subjective-subordinate, and subjective/friendly-subordinate/friendly. These attributes were selected from the emotionally affecting attributes listed in the research by Seya, et al [6]. Examples of the subject attribute lexicon are shown in Table 1. Next, the verb emotion lexicon has a vocabulary of 1,068 verbs, excluding the 972 verbs expanded by the thesaurus [7] from the 62 verbs that had definite emotions and showed up in the randomly selected 18 stories. Emotions of these 1,068 verbs are also determined. This lexicon combines 6 types of subject attributes per verb to define which emotions sentences contain. In other words, a combination of 6 types of subject attributes per verb means a combination of (1068+972) X 6 emotional patterns to be determined. The proportion of 7 emotions including apathy in these patterns is shown in Fig. 3; examples of the verb emotion lexicon are shown in Table 2. Each verb sentence in the story is determined as one of the 7 emotions including apathy based on these dictionaries.

2.2 Determining Emotions Using Adjectives and Adverbs

Especially important parts of speech in determining emotions of all sentences including verb sentences are adjectives, adverbs and adjective nouns; therefore, the emotion of each sentence may be determined by distribution of these parts of speech. First of all, morpheme analysis is conducted on each sentence to find adjectives, adverbs and adjective nouns. Next, adjectives, adverbs and adjective nouns that are found will be checked if they exist in the emotion lexicon developed in advance. The way in which the emotion lexicon was developed is as follows: Select from the thesaurus 988 words that may contain emotions; next, have test subjects choose an emotion from the seven emotions determined on each word of the 988 words according to images; have 10 test subjects follow these operations on each word. The procedures above quantify emotions contained in the words; an attribute of one word is assumed by 10 words on average using the thesaurus; in other words, this emotion lexicon stores emotions of approximately 9,880 words. Examples of the adjective and adverb emotion lexicon are shown in Table 3. Numerical figures in the table indicate emotional intensity. If any of the adjectives, adverbs or adjective nouns contained in this emotion lexicon exists in a sentence, the emotion of this sentence may be determined according to the emotion lexicon. If more than one emotion exists in one sentence, the emotion of the sentence will be determined as the greatest emotional intensity value obtained from a total emotional intensity of each of the seven emotions. Thus, the emotion of each of the sentences containing adjectives and adverbs is determined as any of the seven emotions, including apathy.

3. RESULTS AND CONSIDERATIONS OF TEXT EMOTIONS DETERMINED

By using these two aforementioned methods, experiments were conducted to study how many sentences of emotions could be determined from actual stories. 10 stories were used in these experiments, which were randomly selected from children's literature considered relatively simple and easy to read. The length of these stories is approximately 600-3500 words and approximately 40-280 sentences.

Table3: Emotional Degrees of Representative Words of Adjective and Adverb

Word\Emotion	Neutral	Joy	Sorrow	Anger	Surprise	Terror	Aversion
thick	**0.5**	0.2	0.1	0	0	0.2	0
gorgeous	0	**1**	0	0	0	0	0
regrettable	0	0	**0.8**	0.1	0	0	0.1
annoying	0	0	0	**0.8**	0	0	0.2
rare	0.3	0	0	0	**0.7**	0	0
horrifying	0	0	0	0	0.1	**0.7**	0.2
dirty	0	0	0	0.1	0	0	**0.9**

Table4: The Result of Emotion Decision of Story's Verb Sentences

Target story's label	A	B	C	D	E	F	G	H	I	J	All
The number of all sentences	208	55	94	97	70	255	280	41	80	152	1332
The number of verb sentences	138	49	52	82	56	170	188	32	78	105	950
The number of verb sentences that could decide the emotion	37	4	7	12	10	25	52	10	11	28	196
The number of verb sentences that seem to correct emotions decision	35	3	5	11	10	18	44	7	9	21	163

Table5: The Result of Emotion Decision of Story's Sentences that Include Adjective and Adverb

Target story's label	A	B	C	D	E	F	G	H	I	J	All
The number of all sentences	208	55	94	97	70	255	280	41	80	152	1332
The number of sentences that could decide the emotion	69	32	43	49	32	123	94	21	50	72	585
The number of sentences that seem to correct emotions decision	50	21	38	43	28	84	79	18	30	55	446

Table6: The Result of Emotions Decision of Story's Sentences by Two Methods

Target story's label	A	B	C	D	E	F	G	H	I	J	All
The number of all sentences	208	55	94	97	70	255	280	41	80	152	1332
The number of sentences that could decide the emotion by two methods	92	33	48	55	40	133	132	26	56	89	704
The number of overlapped sentences that is verb sentences and sentences include adjective and adverb	14	3	2	6	2	15	14	5	5	11	77
The number of sentences that seem to correct emotions decision	72	22	42	49	36	91	110	21	36	67	546

Results and verification of sentence emotions determined are explained respectively as follows: emotions determined using subject-verb relationships, emotions determined using adjectives and adverbs and emotions determined using both.

3.1 Results and Verification of Emotions Determined Using Subject-Verb Relationships

This section refers to results and verification of emotions of actual stories classified using the method to determine emotions from combining subjects and verbs. The 10 stories mentioned in Chapter 3 were used to classify emotions. Table 4 shows the number of verb sentences in each of the 10 stories, the number of sentences classified into emotions using the lexicon, and the number of sentences of the above subjectively considered correctly classified into emotions. These results indicate that emotions of verb sentences determined were approximately 20% of all verb sentences in the entire 10 stories. Proportionately, a vocabulary of the verb emotion lexicon seems to be slightly insufficient. However, emotions of 83% of the verb sentences classified into emotions seem to be correctly determined. In other words, increasing a vocabulary of the lexicon by this method seems to allow even more sentences to be classified into emotions.

3.2 Results and Verification of Emotions Determined Using Adjectives and Adverbs

This section refers to results and verification of emotions of actual stories classified using the method to determine emotions according to distribution of adjectives, adverbs and adjective nouns. The 10 stories mentioned in Chapter 3 were used to classify emotions as in Section 3.1. Table 5 shows the number of sentences containing adjectives and adverbs in each of the 10 stories and the number of sentences of the above classified into emotions using the lexicon. Emotions of sentences determined containing adjectives and adverbs in the entire 10 stories were approximately 44% of all sentences; emotions of 76% of the sentences seem to be correctly determined. These results seem to show that emotions were somewhat satisfactorily determined. Adverb emotion words may largely have to do with some unsuccessful results in determining emotions.

3.3 Results and Verification of Emotions Using Both

This section refers to results and verification of emotions of stories determined using both methods mentioned in Sections 2.1 and 2.2. The 10 stories mentioned in Sections 3.1 and 3.2 were used to classify emotions. Results of determining emotions of each story are shown in Table 6, indicating the number of all sentences in the 10 stories, the number of emotions of sentences determined using both methods, and the number of emotions of the above sentences considered correctly determined. These results show that approximately 78% of the emotions of the sentences was successfully determined, indicating that the two methods proposed seem to have produced nearly satisfactory results of determining emotions.

4. CONCLUTIONS AND FUTURE WORKS

This paper proposes methods to determine sentence-by-sentence emotions based on emotions determined by emotion lexicons dealing with relationships between subjects and verbs, and images of words such as adjectives and adverbs. Emotions of verb sentences seem to be almost successfully determined. Yet, the proportion of the emotions of sentences determined seems to be too small at 52%. However, a vocabulary of the verb lexicon may be expanded to respond to more sentences. Emotions of sentences containing adjectives and adverbs seem to be almost successfully determined. It will be necessary to further verify our methods by conducting experiments in subjects to demonstrate whether the emotions of sentences

determined were truly correct. Also, the merge method will be verified to merge sentences adjacent to sentences of emotions determined.

5. References

[1] Akemi Iida, Campbell Nick, Yasumura Michiaki, "Design and Evaluation of Synthesized Speech with Emotion," Transactions of Information Processing Society of Japan, Vol.40, No.2, pp.479-486, 1999.

[2] Marti Hearst, "Multi-Paragraph Segmentation of Expository Text," Proceedings of the 32nd Annual Meeting of Association for Computational Linguistics, pp.9-16, 1994.

[3] http://chasen.naist.jp/hiki/ChaSen/

[4] Schlosberg H, "The Description of Facial Expressions in Terms of Two Dimensions," Journal of Experimental Psychology, No.44, pp.229-237, 1952.

[5] Information-technology Promotion Agency, "IPALexicon of the Japanese Language for computers", 1999.

[6] Masatoshi Seya, "The truth of interpersonal relationship," Baifukan, 1977.

[7] Dainippon-tosho, "The thesaurus," The National Institute for Japanese Language, 2002.