

How to read a novel

– Analysis using wavelet transform –

Noriko Morohoshi^{a,*}, Hisashi Endo^b, Yoshifuru Saito^b and Kiyoshi Horii^a

^aShirayuri College, 1-25 Midorigaoka, Chofu-shi, 182-8525, Tokyo, Japan

^bGraduate School of Engineering, Hosei University, 3-7-2 Kajino, Koganei, 184-8584 Tokyo, Japan

Abstract. When reading a novel by EKUNI Kaori, reader's world in the brain has been clarified by means of the discrete wavelet analysis. According to the analysis, reader's world in the brain has been classified into two layers. One is the world in the book and the other is the existing real world. Major target of this paper is to visualize the transition states between two layers. As a result of our analysis, it has been revealed that the wavelet multi-resolution analysis has made it possible to visualize the transition states as well as to clarify the composing methodology of the novel.

1. Introduction

When reading books, we often get wrapped up in the world spreading in the books. However, we do not always have the same consciousness as we find in the book world. We are sometimes confused between the real and virtual book worlds. Also there are some worlds, which are called layers in this paper, in the story. Reader's world in a brain while a novel reading can be classified into major worlds. One is the world in the novel and the other is the reader's existing real world. The further classified into two layers, i.e., the main-character's world in his/her brain of novel and the world-surrounding main-character's real world. This means that the brain while reading novels is forced to switch from the world in the book to real one or vice versa [1,2].

Principal purpose of this paper is to visualize such the switching transition states by means of the multi-resolution analysis of discrete wavelet transform [3].

Most of the novels are composed of two major layers, i.e., main-character's world in the brain and his/her real world. As a concrete example, we apply our approach to a novel by EKUNI Kaori. As a result, we have succeeded in visualizing the switching transition states by means of the wavelet multi-resolution. Thus, this paper suggests a new great possibility of the mathematical scientific approach to the literature analysis.

2. Method of analysis

Rakka-suru Yugata (Twilight is falling down by EKUNI Kaori, 1996: this is *I*-novel about young lady named Rika and her love romance.) [4] has been selected for a practical example to verify our new

*Corresponding author: Noriko Morohoshi, Shirayuri College, 1-25 Midorigaoka, Chofu-shi, 182-8525, Tokyo, Japan. Tel.: +81 3 3326 7604; Fax: +81 3 3326 7604; E-mail: morohosi@sepia.ocn.ne.jp.

Table 1
Evaluation reference

Evaluation	Meanings	Standards for classification
1	<i>I</i> 's inward world (<i>I</i> 's inner speech)	<i>I</i> 's direct speech without “”
2	<i>I</i> 's inward world contacting with other characters	Indirect speech
3	Real world in the story	Direct speech
4	Real world (scene) in the story	Description

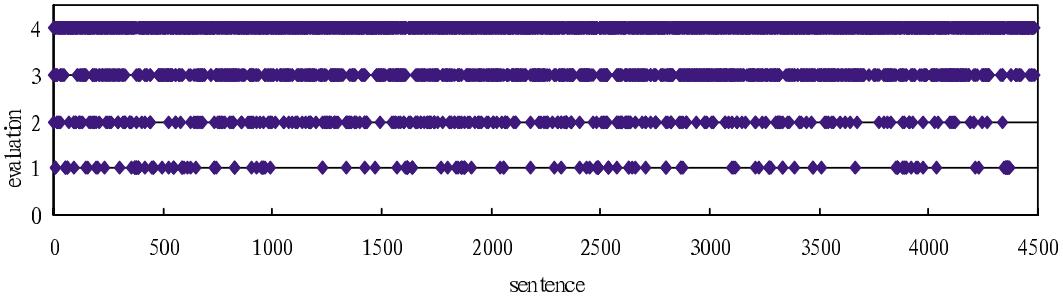


Fig. 1. The layers in *Rakka-suru Yugata*.

approach. In order to apply the discrete wavelet analysis, it is essential to set up the object vectors, which are composed of the numeric values. We count the frequency of evaluation points listed in Table 1 in each of the sentences. A part of the direct speech is counted as one sentence if it is concluded any number of sentences.

Each sentence reflects on the layer in the story directly. Figure 1 shows the data evaluation results through the entire story. By considering the results in Fig. 1, numbers of interactions inside the reader's mind can be observed while reading the book. Usually the reader is on the description (evaluated level 4), which consists of the real world in the story. In addition, there are many parts of direct speech (evaluated level 3) in this book. These two layers are forming the real world in the story. Any reader who reads these parts easily accepts the real world in this book. On the other hand, while reading the heroin's inner speech (evaluated level 1), the reader does not exist in the real world in the story. The reader identifies with the heroin thereby; her inward thought is not concerned with the real world in the story. Furthermore, when reading the second level's sentence, the reader has already complicatedly mixed the real world and heroin's inner world, because indirect speech contains *I*'s expectation.

To extract the transition of reader's mind as well as what the text intend, the wavelet multi-resolution analysis is applied to the evaluated data vectors, $S_i, i = 1, 2, 3, 4$, shown in Fig. 1, because the wavelet multi-resolution analysis classifies the evaluated data into the low to high levels variations. This enable us to visualize the transition of the reader's mind as well as what the text intend from average to local differences.

The vectors, $S_i, i = 1, 2, 3, 4$, are composed of binary (0 or 1) elements. If an evaluation reference applies to a sentence, then the element is 1. Otherwise, it becomes 0. In the present analysis, the evaluation references are assumed to be independent each other. This means that the wavelet transform can be applied to $S_i, i = 1, 2, 3, 4$ independently. When the wavelet analysis is carried out, the number of elements in vector S_i , has to compose of the power of 2 elements. So that, after adding zero elements to $S_i, i = 1, 2, 3, 4$, the wavelet transform is carried out, as given by

$$S_{i'} = WS_i, \quad i = 1, 2, 3, 4. \quad (1)$$

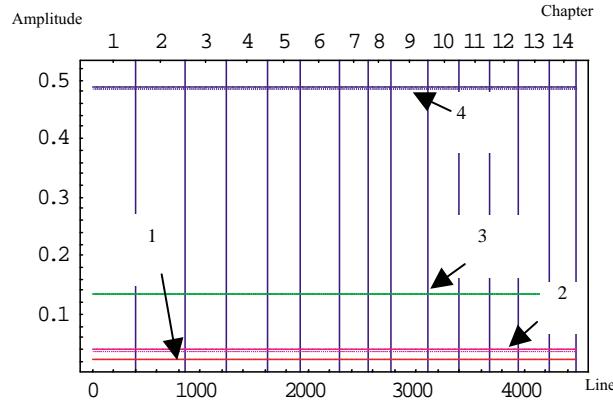


Fig. 2. Level 0 of multi-resolution analysis.

Where S_i , $i = 1, 2, 3, 4$ are the wavelet spectrum to the respective evaluations. Moreover, W in Eq. (1) denotes a wavelet transform matrix. S_i , $i = 1, 2, 3, 4$ can be divided into some levels for the nature of orthogonal wavelet transform viz,

$$S_i = W^T \sum_j [S_i]^j, \quad i = 1, 2, 3, 4, \quad (2)$$

where j refers to a level of the wavelet multi-resolution analysis.

The level of the wavelet multi-resolution analysis makes it possible to visualize the transition states of reader's mind from average to local viewpoints.

3. Results and discussions

Figure 2 shows the result of level 0 of wavelet multi-resolution. It is able to divide this story into the story line and the author's characteristic techniques. In Fig. 2, the story line has been extracted as evaluation 4, which means the most of the real book world. In addition, evaluation 3, which means the direct speech, has extracted as the secondary factor in this story. Evaluation 3 and 4 are based on character's everyday life. Thereby, these are considered as the main factors in *Rakka-suru Yugata*. In contrast, evaluations 1 and 2 seem to be minor in Fig. 2. These minor factors may provide the opportunities to transfer to the real world. These are the characteristic techniques of this author.

Figure 3 shows the results of level 5 of multi-resolution analysis. When reading books, two aspects of the world have been experienced. One is our real world and the other the story world. Also there are the other some layers in the story. Reading books is like crossing between the two real and story worlds.

Paradoxically, the reader is a mediator who connects the two worlds. The reader can exist in the two worlds simultaneously. Reading is not a one-dimensional work. Reading is also switching transition states between two layers.

At first, evaluation 1 varies characteristically along with the story spreading. Also, evaluation 3 is increased step by step from chapter 2 to 3. Further, evaluation 4 repeats the similar steps as evaluation 3 from chapter 4 to 6. This means that the reader is invited in the book world gradually in the first half of this story. Also in chapter 7, evaluation 1 is increased again as shown in Fig. 3 (a). The book world is established until chapter 7, so the evaluation 1 works to transfer the real to story worlds effectively.

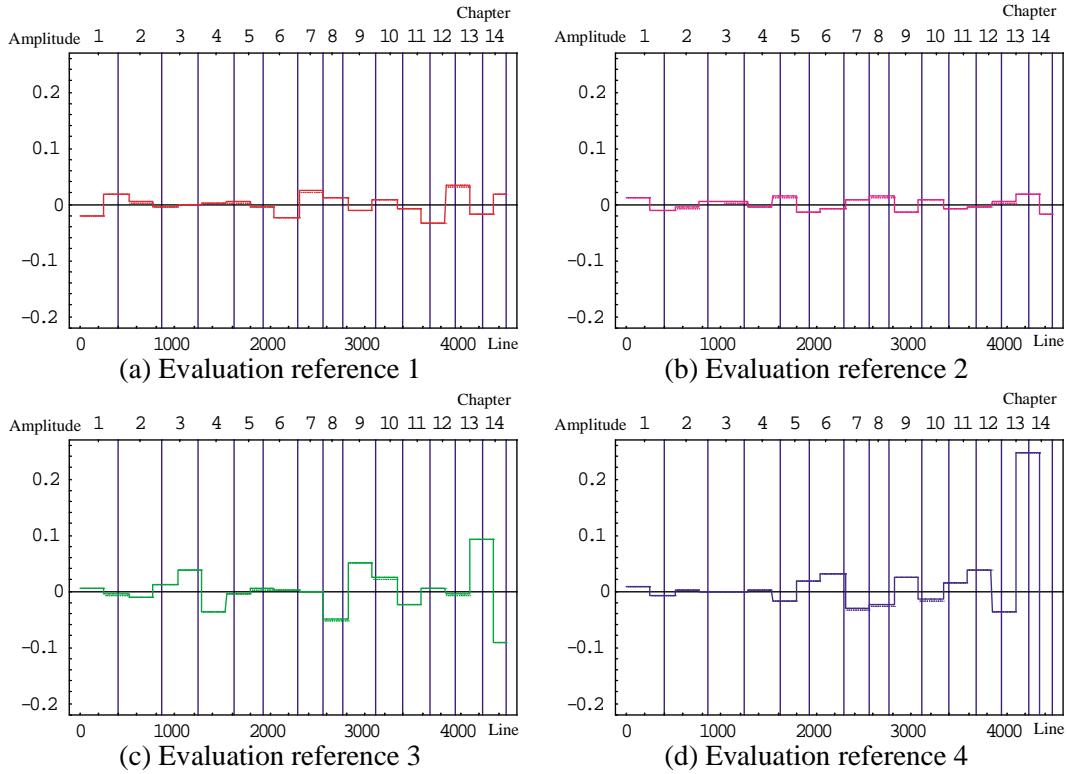


Fig. 3. Level 5 of multi-resolution analysis.

At this very moment, the reader finds the two worlds combined. The level 5 of wavelets shows that the story is constructed not only by the story line but also the expressions, which are not related to the plot.

In Fig. 4, we can see the same features as the results of level 5. The chapter 7 contains the evaluation 1 and 4 for the most of the part. These results are reflected on the story and heroin's changings. Comparison the evaluations 1 and 4 with 2 and 3 seems to move constantly. The evaluations 2 and 3 show characters' voices in the evaluation references. This may mean that the conversation pushes forward with this story.

4. Conclusions

Using multi-resolution of wavelet transform, the dynamism of reading clarified by this paper is as follows:

- A) It becomes possible to extract the story line and author's characteristic techniques.
- B) Description and conversation are the main factor in *Rakka-suru Yuhgata*.
- C) The book world is established in the first half of this story connects the book and real worlds.
- D) The expressions that are not related to the plot are also important factors to establish the book world.
- E) The story is pushed forward not only in the description but also in the conversation.

Thus, to extract the patterns showing how to switch the layers in the story reveals us answers concerning with the reading process. Also, the wavelet analysis is one of the best useful tools for visualizing the

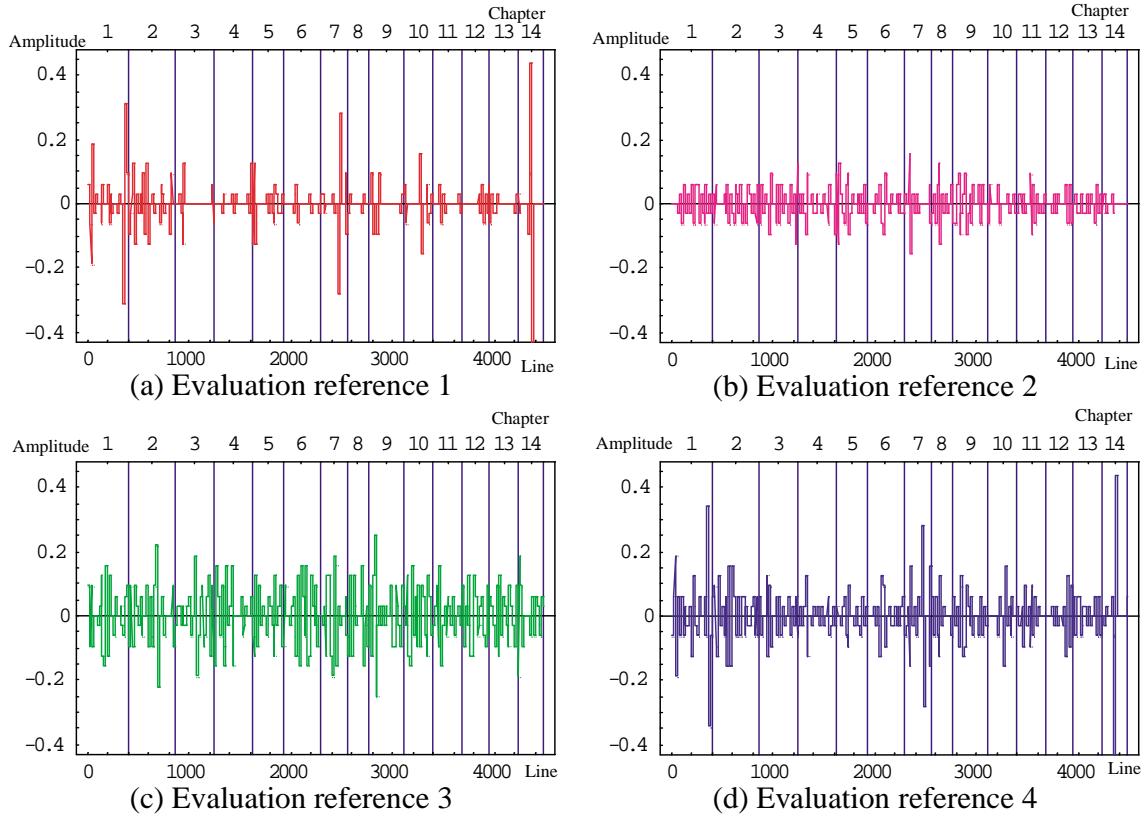


Fig. 4. Level 9 of multi-resolution analysis.

implicit knowledge in the novel. It may be promised that this provides a clear advantage to the literature study.

References

- [1] N. Morohoshi et al., Visualization of Inward Fluctuation between the Book and Real Worlds in the Reading -Tacit Knowledge Analysis using Wavelet Transform, *Journal of the Visualization Society of Japan* **21** (Suppl.) (2001), 235–238.
- [2] Patent: Analysis Method and Its System for the Style of Literary Books, JP 10-102673A.
- [3] Y. Saito, *Introduction to Wavelets Transform with Mathematica*, Asaka, 1998.
- [4] K. Ekuni, *Rakka-suru Yugata*, Kadokawa, 1996.