A Generation Method of Presentation Slides based on Expression Styles using Slide Structure

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***Abstract*—A presentation-based communication environment can now be created in which people can use presentation slides to exchange and discuss ideas together. However, presenters need to prepare the best possible slides to enable audiences to understand the content. Although most of the slides generated by conventional methods follow a structured summary of documents (e.g., academic papers), our method attempts to generate skeletons for lecture slides with expression styles of slides are referred from textbook chapters they use specified by presenters. Our idea is to organize slide layouts from target chapters in textbooks as the expression styles of the referred slides. To achieve this, we analyze the expression styles that level positions of words presented in the referred slides by using slide structure. By arraying words from the target chapters to generate skeletons, our method can then extract the differences between tendency of word appearance in chapters and their slides are referred. Therefore, it generates skeletons by using the expression styles of the corresponding words from the target chapters arranged in slides, which are the same as the layouts of the referred slides. We also show skeletons in a presentation generated by our method with the results of an evaluation of its effectiveness.**

***Keywords*-Skeleton generation; Expression style; Slide making support; Slide structure;**

I. Introduction

With the advent of usable presentation tools such as Microsoft PowerPoint[1], Apple Keynote[2] and OpenOffice Impress[3] that can effectively create attractive presentation slides, presentations now play a socially important role to promote understanding of what presenters talk about in many fields, including business and education, among others. Many university teachers have used Web services such as SlideShare [1] and iTunes U [2] to store presentation slides they use in lectures, provides functions for browsing, sharing and reusing the slides. Prezi [3] provides a service for editing, browsing and sharing presentation data. Although useful/powerful support tools for creating slides and Web services for sharing slides are widely used, they have a problem for preparing many lecture slides to enable students to understand their content; teachers should prepare the best possible slides. In particular, lecture slides are often made from textbook chapters (after here "chapters") to determine what information should be conveyed by the teachers. It is important to focus on how to express the information that will appear in slides from chapters. In order to address this problem, we can generate skeletons serve as slide layouts that express typical words from target chapters based on their role in referred slides by considering how to convey the words to create the layouts of the referred slides from their chapters. For example, a word "vegetable" appears in the body of text in one slide entitled "Agriculture Market," which is used for explaining the topic of "Agriculture Market" related to sections entitled "Agriculture Market Analysis", "Vegetable Production" and "Vegetable Plants" are dispersively described in a chapter.

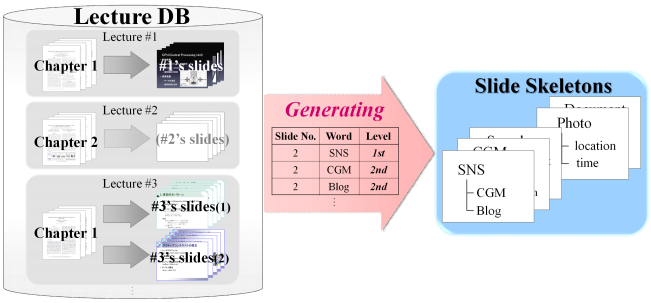


Figure 1. Conceptual diagram of skeleton generation from textbook and its lecture slides

Our approach creates an editable slide skeleton for slide-making that is able to produce a slide layout based on typical words to help presenters prepare slides easily and efficiently. In order to explore slide skeleton creation, we find that a word is expressed in different ways in slides. For instance, a word may be the title of one slide, or the same word appears in the body of text in another slide in a presentation content. We found that there are variety styles of presentation slides usually made from the same document based on the different expressions of the words. As depicted in Figure 1, when a textbook contains a number of lectures, teachers can take a target chapter to prepare slides with the generated skeletons based on expression styles of referred slides made from their chapters. In this paper, we define the expression styles that the level positions of the words are arranged in

[1]http://office.microsoft.com/powerpoint/
[2]http://www.apple.com/iwork/keynote/
[3]http://www.openoffice.org/product/impress.html

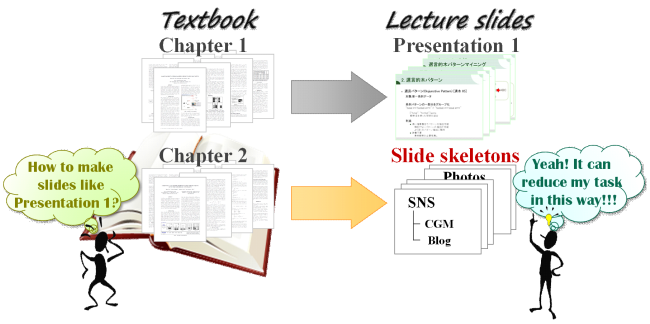


Figure 2. Skeleton generation from a target chapter using a chapter and its slides are referred

slides, based on slide structure by considering the role of the words in the slides. We derived the slide structure by focusing the level of indentation in slide text that is often used to help presenters better organize their slide content, and the document structure from chapters by focusing on their logical units.

As an example is shown in Figure 2, when the document structure that constitute Chapter 2 as a target chapter is the same as in Chapter 1, we can extract the expression styles of words in referred slides as Presentation 1 made from Chapter 1 specified by a presenter as input. We can therefore generate skeletons for slides from Chapter 2, based on the expression styles of the words in Presentation 1 by analyzing the differences between tendency of word appearance in Chapter 1 and Presentation 1 are referred.

The remainder of this paper is organized as follows. In the next section, we describe our approach and provide a brief survey of related work. Section 3 contains an explanation of document structure in a chapter and slide structure, and we determine tendency of word appearance in chapters and their slides. Section 4 describes skeleton generation for slides based on the expression styles, and Section 5 illustrate the results of an experiment conducted using a real dataset of presentation slides. Finally, Section 6 concludes this paper with suggestions for further work.

II. Our Approach and Related Work

In this section, we describe our approach for slide skeleton generation with our motivation to support slide-making. In detail, we explain our research model to exploit slide structure from presentation slides for extracting expression styles of words in slides. Then, we briefly review some related work.

A. Our Approach

In this study, the challenge is to develop an application for slide-making that is able to produce a slide layout based on typical words to help presenters prepare presentation slides easily and efficiently, while reducing their workload. We propose a method to semi-automatically generate an editable slide skeleton, which has a number of significant implications on the representation of slide structure as slide layout. We then generated skeletons consisting of the level positions (e.g., the title of a slide, the body of bullet text in a slide) of words by focusing on the role of the words in slides, based on expression styles of the words in referred slides specified by presenters, helping presenters to reduce their tasks for making slides from target chapters. Our initial motivation of this work is that the same teacher give some lectures in the same situation (e.g. students in the same knowledge level, the same scale for the number of students in a class) is often make presentation files to compose slides in the same expression. Most of this would be caused by the advance of presentation skills apply for a variety of audiences in different situations and at different levels; there are two important things, one is how to make presentation slides, the other one is how to present them. Here, we focused on how to make presentation slides, if a teacher often prepares his/her presentation slides referred to textbooks for lectures in a fixed situation. We consider that such the expression of content in slides due to convey the content made from textbook is regarded as the expression styles. In addition, expression styles in slides can be extracted from the slide structure. Therefore, we can utilize the expression styles of referred slides for the last lecture specified by the teacher, to generate slide skeletons for the next lecture.

On the basis of the motivation, the level positions of words in slides, and how the role of the words in slides, were then analyzed. We defined the slide structure based on indents in slides focusing on the title and the body of bullet text in the slides. As mentioned above, the expression styles can then be extracted by the level positions of the words in the referred slides. We also found that there were two main features particularly helpful for generating slide skeletons arraying the corresponding words from target chapters, based upon expression styles of words in referred slides by analyzing the differences between tendency of word appearance in chapters and their slides are referred: (1)When a word occurs dispersed in all sections of a chapter, it is used generally in the chapter; and when a word occurs frequently in a certain section of a textbook chapter, it is used to a specified description in the chapter. (2)When a word appears in the slide title or in lines that are less indented, it is a topic of the slide; and when a word in the body of the text in one slide, it is used for explaining the topic of the slide. These two features are particularly helpful for exploring how to convey the information in slides made from chapters by characterizing the differences between the tendency of word appearance in chapters and their associated slides.

In this paper, we supposed that when a presenter prepares presentation slides for each lecture from chapters in a textbook, he/she can take the chapters to arrange words in slides according with the same expressions of the words in

referred slides made from chapters specified by the presenter. Hence, we made a model to generate skeletons for arraying the corresponding words from the target chapter in slides based on the expression styles of the words in the referred slides, and the corresponding words from the target chapter by analyzing the differences between the tendency of word appearance in chapters and their slides are referred, in the same domain. In the experiment conducted with a real dataset, we attempt to achieve our goal to generate skeletons for slides.

B. Related Work

Most of the research related to slide-making support has focused on slide generation. Mathivanan et al. [4], Beamer et al. [5], Miyamoto et al. [6] and Yasumura et al. [7] proposed a system for generating slides from academic papers. Their method summarizes and extracts information from an academic paper by means of TF-IDF term weighting, and assigns the sentences, figures and tables in slides by identifying important phrases for bullets in order to generate slides. Shibata et al. [8] converted documents to slides representation by parsing their discourse structure and representing the resulting tree in an outline format. In our view, however, conventional methods that focus only on a structured summary of documents according to the document structure, both ignore the role played by how to express words in the slides. Our method, therefore, focuses on the role of words represented in slides, and it generates skeletons for slides based on the expression styles of words drawn from referred slides specified by presenters.

Kan [9] proposed a system called SlideSeer for the discovery, alignment, and presentation of such document and slides pairs. For alignment, in particular, this system modifies the maximum similarity in alignment in order to favor monotonic alignments, and it incorporates a classifier to handle slides that should not be aligned. Hayama et al. [10] proposed a method for aligned academic papers and slides based on Jing's method, which uses a hidden Markov model (HMM). These studies are similar to ours for analyzing information that is common to documents and their slides. Our approach, however, focuses not only on the information that is in common, but also on tendency of word appearance that differs between documents and their slides.

Kurohashi et al. [11] detected important descriptions of a word in a document where the word occurs with the highest density. Yokota et al. [12] proposed a system called Unified Presentation Slide Retrieval by Impression Search Engine (UPRISE) that can retrieve important information in slides. Their studies are similar to ours in terms of the retrieval of characteristic information in documents and slides; they focused on the important information, our method, though, considers both tendency of word appearance in documents and slides. Therefore, our goal is to analyze the differences between the tendency of word appearance in documents and their associated slides.

From the viewpoint of reusing slides, Sharmin et al. [13] and Mejova et al. [14] proposed a system for composing presentation slides from existing ones, and modifying them for specific events such as lectures and conferences. We have a common point on using existing presentation slides to making slides, however, their studies focused on how to support reuse of existing presentation slides by identifying the multiple similar versions of content. Since the problem on how to support organizing slide components has been addressed [15], Hanaue et al. [16] focused on semantic relationships among slide components and reflected a presentation strategy in the design of slides. Other approaches to presentation composition have included outline matching [17], topic clustering [18], and hierarchical organization [19]. They are similar to ours for helping presenters better organize their slide contents. Our goal is to support presenters prepare slides with semi-automatically generated slide skeletons by exploiting the expressions of words in existing slides are referred in different topics.

III. Determination of Tendency of Word Appearance

In our proposed method, we determine tendency of word appearance by calculating the dispersion and concentration of words based on the document structure in the chapter and then taking the slides structure in the slide. We define the document structure of the chapter in terms of its logical units, which consists of sections, which in turn consists of a section head and paragraphs. The content of a presentation includes a number of slides that have structured text information. We define the slide structure from slides that appear in the outline pane [4], based on the indentations in the slide. Here, we define the slide title as the 1st level. For the body of text in the slide, the first item of text is considered to be on the 2nd level, and the depth of the sub-items increases with the level of indentation (3rd level, 4th level, etc.). Objects that are outside of the text, such as figures or tables, are considered to be at the same indentation level as the text in which they are placed.

A. Determination of Tendency of Word Appearance in a Chapter

If the location in which a word appears dispersed in a chapter, the tendency of word appearance of this word is deemed dispersion in the chapter; it is called W_d. In contrast, if the location in which a word appears centered in the chapter, the tendency of word appearance of this word is deemed concentration in the chapter; it is called W_c. We explain the determination of W_d and W_c using a word b, and we calculate the degree of dispersion and concentration

[4] http://presentationsoft.about.com/od/powerpoint2007/ss/2007slidelayout_8.htm

of b in the chapter. When b is dispersed with a high degree, b is determined to be W_d; and when b is centered with a high degree, b is determined to be W_c.

$$W_d = \{b|min\Big(\frac{\sum_{v=1}^{n} dist(c_1, b_v)}{n}, ..., \frac{\sum_{v=1}^{n} dist(c_j, b_v)}{n}\Big) > \alpha\} \quad (1)$$

$$W_c = \{b|min\Big(\frac{n}{\sum_{v=1}^{n} dist(c_1, b_v)}, ..., \frac{n}{\sum_{v=1}^{n} dist(c_j, b_v)}\Big) > \alpha\} \quad (2)$$

Where b_v is the v^{th} word b, and c_j is the j^{th} section in the chapter. The function $dist$ calculates the distance between sections, that is a number indicates how many sections there are between two words. n is the number of times that b appears in a chapter. When the words appear in the same section, the distance between them in the section is 1. The minimum value of the word is extracted using the function min because there are unknown expectations. The highest degree of expectation is obtained for a position in a section with the lowest degrees of dispersion or concentration. W_d or W_c is a bag of words in the chapter, if the formula is greater than a threshold α in Eq. (1), and the tendency of word appearance of b is determined to be the dispersion in W_d; if the formula is greater than a threshold α in Eq. (2), and the the tendency of word appearance of b is determined to be the concentration in W_c.

B. Determination of Tendency of Word Appearance in Slides

If a slide has more information in terms of a given word than is contained in a prior slide in the presentation file, the tendency appearance of this word becomes upper, and it is called W_u. In contrast, if a slide has generalized information in terms of a given word than is contained in a prior slide in the presentation file, the tendency appearance of this word becomes lower, and it is called W_l. We explain the determination of W_u and W_l using a word g, which is present in both slide x and slide y. When g and the other words in slides x and y satisfy certain conditions, g is determined to be W_u or W_l.

$$K(x, g) \quad = \quad \{k_i|k_i \in x, l(x, g) < l(x, k_i)\} \quad (3)$$

Here, $K(x, g)$ is a bag of words that can be considered to provide an explanation in terms of g in slide x. $l(x, g)$ is a function that returns the level of indentation of g in slide x. When g appears frequently in slide x, $l(x, g)$ will return the lowest possible value; that is, the uppermost level at which g occurs in slide x. This because we consider that when g appears in an upper level, all the other levels in which g appears in the body of that slide are explanatory points related to a deeper occurrence of g. The word k_i is included in the levels that have a hierarchical relationship with the level of g, and k_i belongs to the bag of words $K(x, g)$ in slide x. $l(x, k_i)$ is greater than $l(x, g)$, in that k_i is a child of g in the slide structure. When k_i is not present in slide x, $K(x, g)$ will be empty. Based on the above criteria, we compute the number of words in detailed information related to g for slides x and y, and compare their numbers using the following formulas:

$$W_u \quad = \quad \{g||K(x, g)| < |K(y, g)|\} \quad (4)$$

$$W_l \quad = \quad \{g||K(x, g)| > |K(y, g)|\} \quad (5)$$

where the function $|K(x, g)|$ extracts the total number of k_i belongs to $K(x, g)$ in slide x. $K(y, g)$ is also a bag of words in slide y, and they satisfy the same conditions as $K(x, g)$ in Eqs. (4) and (5). Thus, Eqs. (4) and (5) can be used to count the number of words in $K(x, g)$ for slide x and the number of words in $K(y, g)$ for slide y. W_u or W_l is a bag of words in the slides, if the number count for slide x is lower than that for slide y in Eq. (4), the tendency of word appearance of g is determined to become upper in W_u; and if the number count for slide x is greater than that for slide y in Eq. (5), the tendency of word appearance of g is then determined to become lower in W_l.

Table I
PATTERNS IN THE DIFFERENCES OF TENDENCY OF WORD APPEARANCE

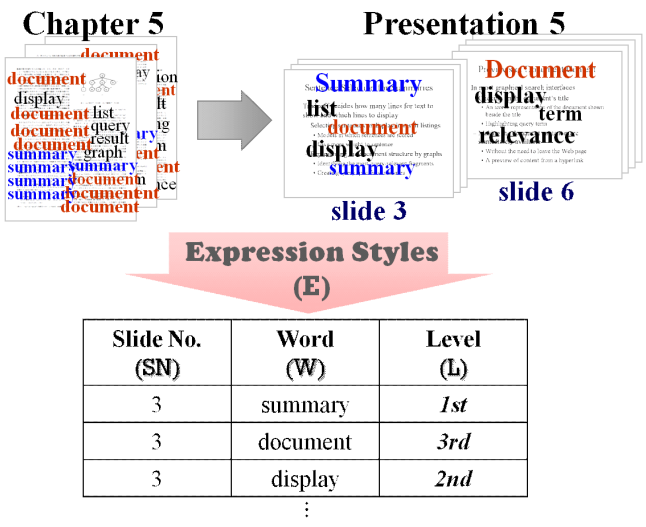
$Patterns$	Tendency of word appearance	
	in a chapter	in slides
tw_1	$dispersion$	become $upper$
tw_2	$dispersion$	become $lower$
tw_3	$concentration$	become $upper$
tw_4	$concentration$	become $lower$

C. Patterns of Tendency of Word Appearance

For the differences between the tendency of word appearance of word q in the chapter and the slides, we distinguish the following 4 patterns that are shown in Table I:

- tw_1: $q \in W_d \cap W_u$, the tendency of word appearance of q in the chapter is dispersion and the tendency of word appearance of q in the slides become upper.
- tw_2: $q \in W_d \cap W_l$, the tendency of word appearance of q in the chapter is dispersion and the tendency of word appearance of q in the slides become lower.
- tw_3: $q \in W_c \cap W_u$, the tendency of word appearance of q in the chapter is concentration and the tendency of word appearance of q in the slides become upper.
- tw_4: $q \in W_c \cap W_l$, the tendency of word appearance of q in the chapter is concentration and the tendency of word appearance of q in the slides become lower.

Based on the mentioned above, we can find what words and how the words should be described in the chapter and the slides. In addition, from the patterns of the tendency of word appearance, we can find how the words should be explained in detail or in general in slides, and whether these words appear dispersed in multiple sections, or they appear concentrated in a specified portion of the chapter. In the example shown in Figure 3, the word “document” is dispersed in all sections in Chapter 5, and “document” also is a title of slide 6 of a Presentation 5. When the tendency of word appearance of “document” is dispersion in the chapter



Slide No. (SN)	Word (W)	Level (L)
3	summary	*1st*
3	document	*3rd*
3	display	*2nd*
⋮		

Figure 3. Example of expression styles

and it becomes upper in slides as tw_1. We consider that slide 6 is concentrated the topic of " document " in detail when it summarizes the information in terms of "document" appears all sections in Chapter 5. On the other hand, when the word "summary" repeatedly appears in a certain section, slide 3 is titled "summary" of Presentation 5. When the tendency of word appearance of "summary" is concentration in the chapter and it becomes upper in slides as tw_3. We consider that slide 3 offers specialized information regarding "summary" refers to a concentrated section from Chapter 5.

IV. Skeleton Generation

A. Extraction of Expression Styles

To generate skeletons for slides, a slide layout is used, which consists of words based upon expression styles by using slide structure in presentation slides made from chapters in textbooks are referred specified by presenters. Therefore, we define the expression style E that the words W with the expression of presentation is represented by the level positions L of the words in slides SN that are shown in a table with Figure 3 as follows:

$$E = (SN, W, L) \quad (6)$$

$$W = \{q | q \in P\} \quad (7)$$

$$P = \{tw_1, tw_2, tw_3, tw_4\} \quad (8)$$

here, E can be considered as a database, and it contains 3 indexes, SN, W and L. SN denotes the slide number in a presentation. W is a bag of words that belongs to patterns P that can be considered as the words that play key roles in the slides. L denotes the level positions of the words in slides by using slides structure in slides, and P denotes the total of 4 patterns that the tendency of word appearance of the words in chapters and their slides are described in Section **??**. Therefore, we extract the expression styles to show what words in which slide and how about their expressions by using slide structure in slides.

B. Extraction Corresponding Words

We consider texts in which the chapters in a textbook have the same document structure as the sections in each chapter. When a tree of a word z belongs to a tree T_A of document structure in the referred chapter A and a tree of a word z' belongs to a tree T_B of document structure in the target chapter B are consistency, we consider that z' in B corresponds to z in A. Next, we extract z' in B by matching the partial trees of z in T_A and z' in T_B have employed a structure matching method [20]. We consider that the words in T_A and T_B that are not the common words, the structure matching method can help identify non-linguistic matches and disambiguate between seemingly identical structures in different contexts as T_A and T_B.

For each word, when there are many words in two partial trees of z in T_A and z' in T_B to be compared, the number of the partial trees are consistency to be larger. We define a set of the partial trees $PT(T_A(z))$ of z in T_A and a set of the partial trees $PT(T_B(z'))$ of z' in T_B. Based on the above criteria, we extract a pair C of z in A and z' in B as the following formula:

$$C = \{(z, z') | \frac{1}{2}\Big(\frac{sum(PT(T_A(z)), PT(T_B(z')))}{N_A} + \frac{sum(PT(T_A(z)), PT(T_B(z')))}{N_B}\Big) > \beta, z \in W\} \quad (9)$$

where the function sum extracts the total number of $PT(T_A(z))$ of z in T_A and $PT(T_B(z'))$ of z' in T_B are consistency. N_A is the number of $PT(T_A(z))$ of z in T_A, and N_B is the number of $PT(T_B(z'))$ of z' in T_B. We calculate the similarity of the trees $T_A(z)$ of z in A and $T_B(z')$ of z' in B by the above formula. If the formula is greater than a threshold β that $PT(T_A(z))$ of z and $PT(T_B(z'))$ of z' are similar, z' is determined to be the corresponding word of z. Thus, z' as candidate word for using the expression styles of z, we must extract the appropriate one by extracting the tendency of word appearance of z' in B, whether z' and z have the same tendency of word appearance. Finally, we are able to generate skeletons for layout slides by using the expression style of z' in the same expression style as z, which is performed according to Eqs. (6), (7) and (8), and the number of skeletons for slides is the same as the number of the referred slides.

C. Generation of Skeletons for Slides

Presentations consist of slides that rely on a combination of words and images to drive home a point. The way can combine these elements creates the design that layout of the slide. Layouts are crucial to making a slide understandable

and unforgettable. In this paper, we define skeletons for slides that different slide layouts to best communicate key points from texts focused on how to express key points in slides. We consider that key points as the role of words from chapters to their slides that we focused on the patterns of the tendency of word appearance in chapters and their slides can be extracted by our proposed method. Therefore, we create slide skeletons that construct different layouts to express the words following the specific rule are determined as expression styles of the words in slides are referred specified by presenter. Based upon the expression styles drawn from the referred slides made from a chapter, we can generate skeletons for slides from a target chapter in the same textbook by extracting the words in the target chapter that corresponds to the words in the referred chapter. Therefore, we can use the same expression styles of the words in the referred slides applying to the corresponding words to generate skeletons for slides from the target chapter.

For example, a presenter wants to prepare presentation slides for a lecture regarding Chapter 6 in a textbook. Our method generates skeletons for slides from Chapter 6, referring to slides in Presentation 5 from Chapter 5 (see Figure 4). In Chapter 5 the word "document" appears in all sections. Meanwhile, if "document" appears in a title of slide 6 in Presentation 5, then the expression of "document" that the level position of it in slide 6 is title (1st level). In Chapter 6 the word "query" appears in all sections that corresponds to "document" in Chapter 5. The skeleton for slide y generated from Chapter 6 shows that "query" appears in the title of slide y, which explains "query expansion" in terms of "query." Then, "query" in slide y has the same expression style as "document" in slide 6. When the author makes slides referring to the skeletons for slides, such as slide y, the information for "query" in slide y is constructed in the same way as it is for the level positions of "document" in slide 6, based upon the same expression style by arranging the words to express "query" in the title of slide y. The generated skeletons can be used to create slide layouts that construct the words according to the same roles the words play in the referred slides, and these skeletons then enable the presenter to make slides easily.

V. Evaluation

A. Implementation

Based on the method described above, we built a tool to support skeleton generation, using Microsoft Visual Studio 2010 C#. This tool has three stages: analysis, determination, and generation. In the analysis stage, we analyze the features of a slide and a chapter. The slide structure of the slide, and thus information on the indent level of words, is constructed by using Office Open XML files from PowerPoint in Microsoft Office 2007 (In our implementation, we developed a PowerPoint parser but parsers for Keynote, Open Office Impress, and so on, can also be developed. Therefore, we can also use content made by other presentation formats). The document structure of the chapter, and thus information on the logic units, is constructed by using its original LaTeX file. When the chapter is a PDF file, we should convert PDF files into XML files using pdftohtml [21]. The words in the slides are extracted by using the morphological analyzers *MeCab* [22] and SlothLib [23, 24]. In the determination stage, all express styles of words in referred slides are extracted based on the slide structure, and the patterns of the tendency of word appearance in chapters and their slides are extracted based on the document structure and the slide structure. Then, we extract the corresponding words from a target chapter based on tendency of word appearance in the target chapter and the referred chapter, by matching partial tree in the document structures of them. Thus, in the generation stage, slide skeletons are generated by arraying the corresponding words from the target chapter based on the express styles of the words in the referred slides specified by a user.

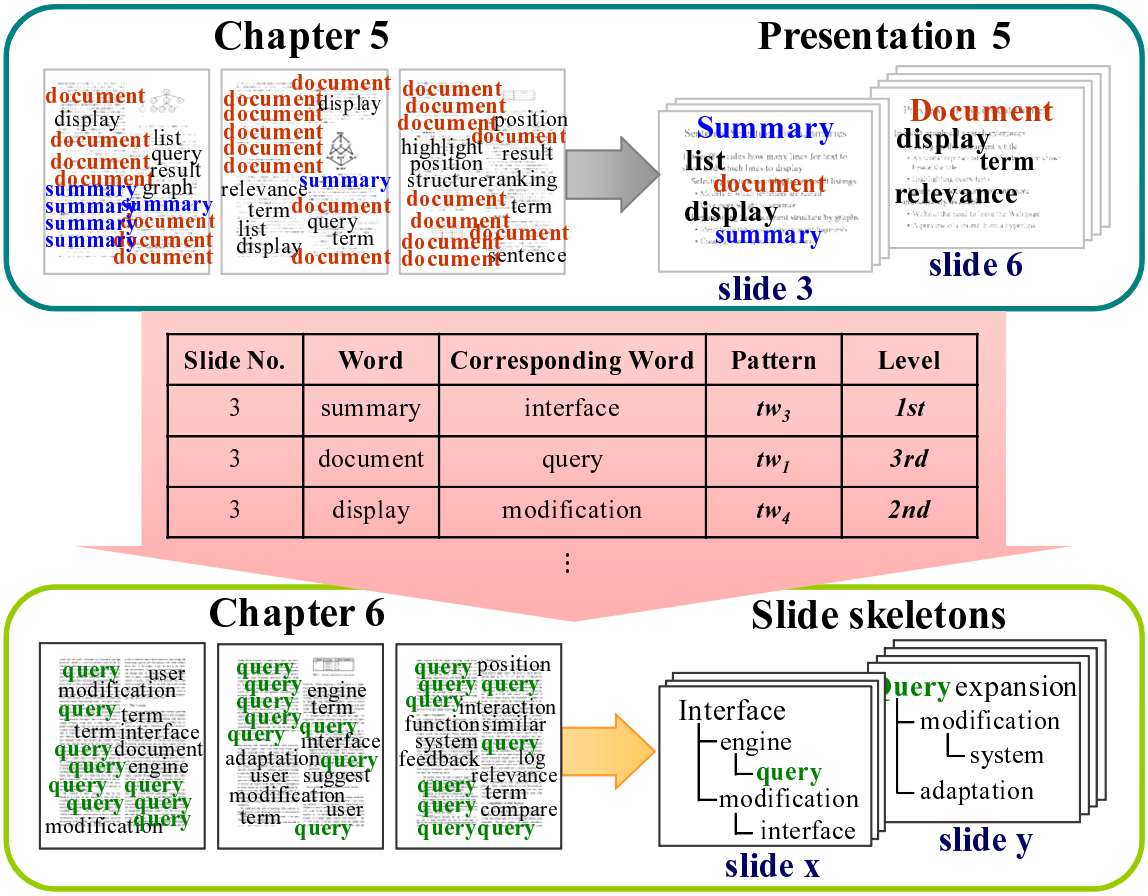
After a user selects the chapter from a textbook for preparing presentation slides, specifies a presentation file with its chapter in the same textbook from the existing data to refer. Therefore, the prototype tool has a function to generate slide skeletons as layout structures based on Office Open XML Formats in PowerPoint 2007.

B. Dataset

The aim of this evaluation was to verify whether our proposed method is useful for slide skeleton generation. We first prepared two presentation files: S_A from Chapter A and S_B from Chapter B were made by the same person, both from a textbook called Search User Interfaces [25]. Because of their single authorship, we assumed words in S_A and S_B both have the same expression styles, and A and B have the same document structure in the same textbook. Each presentation file contains 10 pieces of slides, not counting the cover slide by accident. We used A and S_A to generate skeletons from B based on our method; the slides in S_B serve as correct answers regardless of whether the level positions of the words in the slides generated from skeletons from B are correct or not.

C. Validity of Generating Skeletons

We generated 10 slide skeletons from B with the same number of slides as in S_A, and we extracted the corresponding words from B were arranged in slide skeletons based on the expression styles of the words in A. Finally, we compared the generated slide skeletons with the correct answer as S_B's slides (see Figure 5). For evaluating the generated skeletons, we have conducted two evaluation items in two aspects: (1) to measure the coverage of the extracted words in generated skeletons account for S_B. In this way, we calculated the coverage as a Recall of the words extracted in generated skeletons, that we used the extracted words only,



Slide No.	Word	Corresponding Word	Pattern	Level
3	summary	interface	tw_3	*1st*
3	document	query	tw_1	*3rd*
3	display	modification	tw_4	*2nd*

Figure 4. Example of skeleton generation

not aware of slide structure. (2) to measure the accuracy of structures in generated skeletons by comparing with S_B based on the hierarchical relationships between two words in generated skeletons. In this way, we calculated the accuracy of structures to evaluate whether the structures in generated skeletons are maintained.

In the experimental results, (1) the coverage of the extracted words in generated skeletons reached 33.8% (25/74); and (2) the accuracy of the structures in generated skeletons was 42.3% (254/25∗24). The result of (1) showed that our method can extract the corresponding words by a conventional method. However, sometimes we extracted the words were corresponded to multiple words in A, then there were a small number of the extracted words were correct. In addition, we need to consider the figure captions for determining the words in the chapters. S_A and S_B, which were written by the same person, contain a number of the words in slides, and they appear in figure captions in the chapters. This was one of the reasons why the rate of the coverage responses was low.

The result of (2) showed that our method can arrange the words in generated skeletons based on their expression styles. The rate of the accuracy for the structures in generated skeletons was low, and it was dependent upon the small number of the extracted corresponding words in (1). And our method determine the hierarchical relationships between some words in the generated skeletons were not in consistency with them in S_B. For example, a skeleton was generated from B (see Figure 6). Sentence levels containing “visualization” and “term” were the 3rd levels, and “time meaning” and “difference” were the 2nd levels in the body of a slide in S_B as correct answer. Our method, however, arrayed the corresponding words “visualization,” “time meaning,” and “difference” from B were the same level in the body of the generated skeleton, their hierarchical relationships were not the same as them in S_B’s slide.

D. Discussion

In the evaluation described in the previous subsection, we confirmed that our prototype tool generates skeletons for presentation slides that are as expressive as existing presentation slides made by a person as shown in Figure 5. In addition, our prototype tool also generates skeleton with the slide structure as shown in Figure 5. While the conventional

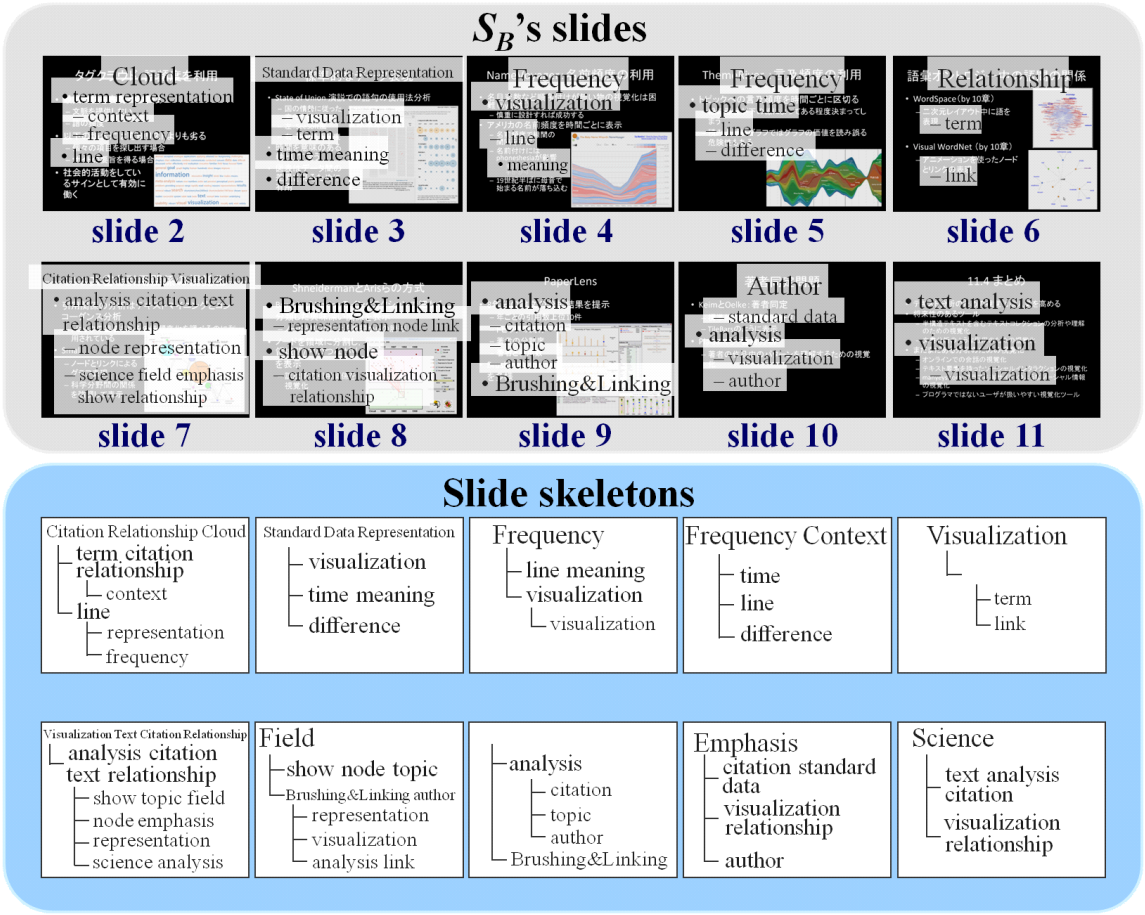


Figure 5. Generated slide skeletons compared with slides in S_B

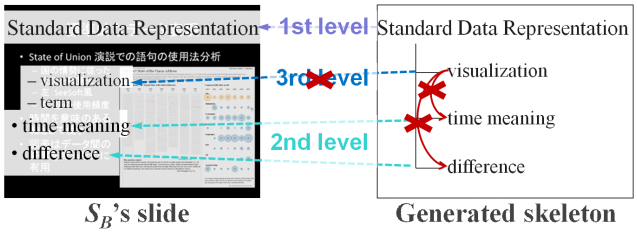


Figure 6. Inadequate generation of a skeleton

methods generate slides by summarizing content in textbook chapters with limited formats such as the document structures of the textbook chapters, our method can generate the slides with more various layout of referred slides specified freely by users do what one wants. Specifically, our prototype tool generated the skeletons with expression styles of the referred slides based on the slide structure for organizing content in the skeletons well.

Although we confirmed that our method generates skeletons with expression styles of the referred slides based in the slide structure, we have three main problems. The first problem is that the expression styles based on the slide structure are not considered visual effects in slides. At the present time, presenters often focus on visual effects that are easily understandable, and more attractive than slides with simple text. We do not currently use font or visual information, but it would not be difficult to improve our method by considering such data. Future developments to this method could also consider visual elements of figures, and the color distribution and animation occurrence in slides, as we can acquire this information by analyzing XML files from the various presentation formats.

The second problem is that the hierarchical relationships between words in the body of text in slides in our method does not cover enough semantic representation. Therefore, we need to consider semantic relationships (e.g. *compared−with*, *oppose*, etc.) between the words can be referred by the Rhetorical Structure Theory [**?**], and how to utilize them for generating skeletons. The third problem is that our skeleton-generation algorithm does not organize content in slides based on the expression styles of the phrases and

instead organize information based on the expression styles of the words. However, sometimes, especially for lecture slides from a textbook chapter, teachers often take phrases from the chapter to arrange them in slides. Determining the expression styles of the phrases may offer better support for generating skeletons.

VI. Concluding Remarks

In this paper, we have proposed a method of skeleton-generation that provides support for slide-making based on expression styles of words in referred slides specified by users. We described in detail how to the expression styles are extracted by using slide structure, and how to analyze differences between the words in textbook chapters and their slides by extracting tendency of word appearance, respectively. Our idea is to organize slide layouts from target chapters in textbooks as the expression styles of the referred slides. To generate skeletons for slides from a target chapter, we extracted the words in the target chapter that correspond to the words in referred chapter, and we then used the same expression styles of the words in the target chapter. Through our evaluation, we confirmed that some of the skeletons were successfully generated by our semi-automated prototype tool and it for making slides by referring existing slides to gain new insight in the domain of skeleton-generation that can guide the design of new making support tools.

In future work, we need to extend the definition of slide skeletons and evaluate the effectiveness of our proposed method. In order to extend the definition, we plan to improve our algorithm of skeleton generation for presentation slides from textbook chapters, to consider what context of words is change from the chapters to slides and what information in the chapters need to be described in slides. Specifically, we have to consider the expression styles of phrases, and the semantic relationships among the phrases. In addition, we have to confirm how much effort of users using our prototype tool reduces for making slides. We will conduct an experiment by participants actually use our generated skeletons for making slides to verify our method is useful or not.

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