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ABSTRACT

This paper presents a slide presentation software that incorporates a concept map, which explicitly shows how the various slides (and other multimedia components) presented are related to each other. Furthermore, presentations are conceived as hypermedia systems, where the presenter can navigate among slides (and the concept map) instead of the typical linear ordering of slides. This approach will alleviate the load on the audience to memorize, recognize and process perceived information. This tool can be extremely useful to enhance understanding of presented material, which is particularly valuable in the classroom environment. (Author)

Incorporating Concept Maps in a Slide Presentation Tool for the Classroom Environment

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Abstract: We present a slide presentation software that incorporates a concept map, which explicitly shows how the various slides (and other multimedia components) presented are related to each other. Furthermore, presentations are conceived as hypermedia systems, where the presenter can navigate among slides (and the concept map) instead of the typical linear ordering of slides. This approach will alleviate the load on the audience to memorize, recognize and process perceived information. This tool can be extremely useful to enhance understanding of presented material, which is particularly valuable in the classroom environment.

Introduction

Slide presentation software systems are very widely used teaching aids. Tools like *PowerPoint* have contributed enormously by making the preparation of slides efficient and convenient, and by providing numerous features that enable high quality display of slides. Nonetheless, they offer limited facilities to automatically organize the slides in a logically coherent manner. These tools typically provide a linear ordering of the slides, and the presenter usually goes forward from one slide to the next, and occasionally goes back to previous slides. This approach has its limitations, especially when the subject matter presented is complex. It is a very common experience to feel "lost" while attending a presentation because the information currently perceived (visually or orally) cannot be placed in its appropriate context. Furthermore, a complete grasp of the information being presented often necessitates considerable memorization and processing of material contained in previous slides. But the *Model Human Processor* (Card et al. 1986) describes the limits of the human mind in perception, memorization, processing, recognition, discrimination, etc.

Also, a linear ordering of slides often encourages *linear thought* (Zuhn 1995) i.e. following a sequential association of ideas, linking each concept with a single pre-requisite concept and the next logical concept, instead of the more instructive *global thought* (i.e. choosing from divergent paths of multiple linkages of concepts to reach a conclusion).

Typically the individual slides in a presentation are logically connected to each other, and the relation among slides can be represented by a network. This can be viewed a small-scale hypermedia system. The objective in this research project is to design, develop and evaluate a slide presentation tool that makes the relation of individual slides to the overall network visible throughout a presentation. That is, each slide is placed in a wider context. This will make understanding easier for the audience as well as enhance the expressive capability of the presenter.

Related Work

Computer-Human Interaction research can enormously contribute to the effective dissemination of knowledge in the classroom environment, especially when the design of hardware and software systems is

sensitive to human and psychological factors, such as capabilities and preferences of users. In (1995), Zuhn describes the use of concept maps in a hypermedia system to help teachers organize and deliver teaching material. The system encourages global thinking about concepts and skills to be learned by students. Franklin et al. (2000) show how PowerPoint can be enhanced with a speech-based interface in the context of the Intelligent Classroom Project. The use of multiple input modes (particularly visual ones) to eliminate reliance on a single constraining input mode in a classroom environment is described in (Flachsbart et al. 2000). Visualization of information, particularly in the context of hypermedia systems, is a related research area. Conventional interactive systems provide inadequate views of the information space being explored and hide most of the information, especially about the organization of the information. Many researchers have suggested graphical overviews for the users (Nielsen 1990, Zizi 1996). For example, Zizi (1996) describes *topic* and *document maps*, which provide an abstract global overview of documents and their contents. Other research on information visualization includes the Visualizer Project (Card et al. 1991), Tree Maps (Shneiderman 1992), Starfield Displays (Ahlberg et al. 1994).

Design and Implementation

The system we present consists of mainly the following: (1) a graphical representation of the network of slides, and (2) individual slides which essentially contain the material to be presented with some added information, such as hyperlinks to other slides. We use a concept map to represent the network. The nodes in the network can be slides or documents (document map) or topics (topic map). The *link*s are logical relations among nodes. These links can be represented in various ways (such as directed lines) to depict different types of relations among slides or topics. We also group nodes into *concept regions* which associate logically related slides based on proximity on a concept map. We can use scrolling facilities when there are many slides, and a hierarchy of maps when the subject matter can be more naturally presented at various levels of abstraction, thereby avoid cluttering one map with too many details. As the presentation progresses, the nodes on the concept map are updated (by changing their color, for instance) to show that they have already been presented. The concept map also contains hyperlinks to connect to individual slides.

The individual slides also have hyperlinks to the concept map and other directly related slides. Furthermore, a smaller version of the concept map (without any text) is displayed on individual slides. This scaled-down concept map is made up-to-date i.e. it reflects where we have reached in the presentation and how it is related to the slide currently been displayed. The presenter has the flexibility of moving directly from one slide to the next or via the concept map. It should be pointed out that the design of the system should be simple and intuitive, such that its *cognitive load* does not outweigh the gains in enhancing understanding. We now describe in detail the precise design choices we made for a prototype of the system that was developed.

Design of the Concept Map

Fig. 1 is a concept map of a presentation on this paper [1]. The concept map is based on a combination of the document map and topic map approaches. That is, each node in the concept map can be a slide or a topic. For instance, "Related Work" is a topic, whereas "The Organizer Project" is a slide. Nonetheless, these two types of nodes are not graphically differentiated, so as to avoid confusing the audience with too much information. The title of the presentation is also displayed at the top, which is a useful reminder of what the talk is about. The links are represented by lines of various colors and thicknesses to show various types of relations. In Fig. 1, only two types of links are shown: (1) black, uni-directional lines for parent-child relationship in a tree structure, and (2) a brown, bi-directional line to connect two slides at different parts of the tree. Other types of links can also be used, but they should be clear and intuitive or based on standard diagrammatical notations. Otherwise they should be explained to the audience.

[1] Although colors are not shown in Figures 1-4, the use of colors is essential in this system.

Concept regions group a few logically related slides/topics together and show them in a blue area (Fig. 1). A concept region is shown on single-clicking anywhere in the region (except on the boxes for nodes). Only one concept region is shown at a time. If there are too many slides to fit one screen, then we can have a multi-level concept map, where a topic node at a higher level map opens up another map. This enables display of information at different levels of abstraction. Another option is making the concept map large, which can be viewed through a scrolling facility. At the beginning of a presentation, all nodes are shown in green on the concept map, to indicate that the corresponding slides have not been *completed* yet. The presenter can open an individual slide by single-clicking on its box. If a topic box is clicked, then it connects to its leftmost, nearest descendant which is a slide. If no such slide exists, then nothing happens on the mouse click. When a slide is opened, then it is said to be *active*. On returning to the concept map after showing an active slide, the latter becomes completed. Once a node is active, it remains active as long as at least one of its descendants is active or non-completed. If all its descendants are completed, then the node becomes completed. Active slides are indicated in a yellowish color and completed ones in deep pink (Fig. 2).

If the text in a node box is not adequate to convey what it contains, then we have a longer narration on a *mouse-over* action on the box (Fig. 3). Clicking on the narration will remove the narration. The relation between particular pairs of nodes can be emphasized by a mouse-over action on the corresponding links, whereby the related nodes are highlighted (Fig. 3). In fact, a link can be further emphasized by opening a slide to illustrate the relation. We can also connect a node directly to a graphic, audio or video component. In our example presentation, we include an audio component and indicate it by an appropriate icon on the concept map.

Design of Individual Slides

Individual slides are made of four frames (Fig. 4). One central frame contains the material being presented. The three frames on the right respectively contain: (1) a smaller version of an up-to-date concept map to reflect the current status of the presentation; this map does not have any text, but shows the concept region which contains the current slide; (2) named hyperlinks to all slides connected to the current slide; as a convention, we opted for the topmost hyperlink to be the parent node (if any); (3) a hyperlink to the concept map (or maps at various hierarchical levels). The presenter can always choose to show only the information being presented (i.e. omit the last three frames) in situations where more space is required on the screen, or additional information like hyperlinks are redundant.

The slides have a default ordering. The presenter can show the next slide through one of the typical PowerPoint-like actions: single-click, PageDown or Return. Besides these options, the presenter can choose to go to any slide by doing one of the following : (1) click on a named hyperlink, (2) click on the appropriate box on the smaller version of the concept map, or (3) go via the concept map. The presenter should choose the option which will make the presentation clearer and the flow smooth and intuitive.

Implementation

The prototype was implemented in PowerPoint, using macros and modifying the Visual Basic code generated. In the current prototype, many of the functionalities have been hard-coded to suit a particular presentation. We can envision a more generic tool, where most of the features are automated and the user has the flexibility to customize the presentation by, for instance, choosing color schemes, disabling some features, choosing templates for organization of nodes on the concept map, automating the creation and maintenance of maps and slides, etc.

Extensions

There are many ways in which this prototype can be extended, and individual features can be variously implemented. Some examples of new features and variations of existing ones have already been discussed. A few more suggestions follow:

- Place *anchors* within the presented text in individual slides;
- Flexibility of organizing the contents (and sizes) of frames on individual slides;
- Explicitly distinguish among nodes, which can be topics, slides or other entities like audio, graphic or video objects; suitable graphic and auditory icons can also be used;
- Differentiating between the user actions (like mouse clicks) that the presenter wants the audience to see and those which should be hidden, and using short-cut keys for the latter;
- Different ways of showing the current status of the presentation. For instance, a node can be shown as completed as soon as any of its descendants is completed;

A good design of the system would have to be based on factors like feedback from target users, the particularities of the teaching environment (type of learning institution, subject matter, etc.), familiarity of the audience with the features, etc. One approach is to provide a wide range of features, options and templates, and let the presenter customize the system.

Evaluation

Our prototype was used for actual formal presentations in graduate classes in the Department of Computer Science at Texas A&M University. The system was evaluated through a questionnaire, which essentially queried students about the effectiveness of individual features added to PowerPoint to help understanding the presented material. More evaluation was performed informally with students and faculty of the department. The response obtained was largely positive. Over 85% of the people queried felt that the use of concept maps has a potential to facilitate learning during a presentation. Around 70% of the students who attended the formal presentations found our prototype useful. 10% felt that the system made it more confusing. The remaining 20% saw no significant benefit of our extensions to PowerPoint. We obtained many suggestions during the evaluation phase, some of which were subsequently incorporated in our design. But there were some criticisms as well; the most common ones are summarized below:

- Invoking the concept map can be obtrusive to the general flow of the presentation;
- The audience can be confused by the extra information provided; familiarity with the features is necessary;
- The smaller version of the concept map and the named hyperlinks take up too much space on individual slides;
- The presenter should fully master the tool; it is very easy to perform an incorrect action (such as clicking at the wrong spot), which can send the presentation in an unintended direction;
- The presenter may be confused when faced with too many optional actions. (This problem can be partly solved by a subtle indication of one preferred action at each stage of the presentation);
- The current status of the presentation (indicated by non-completed, completed and active nodes, using different colors) is not always obvious;

It should be noted that the proposed system focuses on the audience as the "user". As far as the presenter is concerned, it is clear that he/she has to spend more effort in the preparation of a presentation, in mastering the various features and in organizing the presentation to ensure a smooth flow and logical coherence.

The benefits of the system, as reported to us during the evaluation, are summarized in the following:

- The ability to constantly perceive the "big picture" rather than merely focus on individual slides;
- More awareness of what the presenter is really thinking about;
- Induces the presenter to organize his material more logically;
- Questions can be answered more effectively by conveniently accessing relevant slides;

- Decisions about which slides to show and which ones to pass over during a presentation can be made on-the-fly in a convenient and logical way - for instance, parts of the tree or hierarchy of nodes can be left out from the presentation, without the inconvenience of opening slides, examining them and finally deciding to skip them;
- The possibility of catching up with the talk even if you come in late or doze off for a while!

Conclusion and Future Work

We hypothesize that the slide presentation tool described in this paper has considerable potential to facilitate learning in the classroom, especially since slide presentation systems are so widely used. The key advantages of the system we propose are: (1) The ability to graphically perceive the inter-relationships among various fragments of information, and (2) the possibility of smoothly and logically navigating through the network of ideas, topics and documents.

Myriad variations and extensions of the design we have presented can be thought of. The tool will need to be customized to suit the target audience: classrooms with different types of students, and other audiences like seminars, conferences, marketing, etc. In fact, we advocate a high degree of automation and customization, so as to reduce the effort required to prepare a presentation, and to efficiently and effectively tailor the tool for different situations. As future work, we envisage the development of a fully generic, customizable prototype, and its evaluation by objectively assessing how different features (or sets of features) impact understanding (as well as ease of presentation) in various environments.

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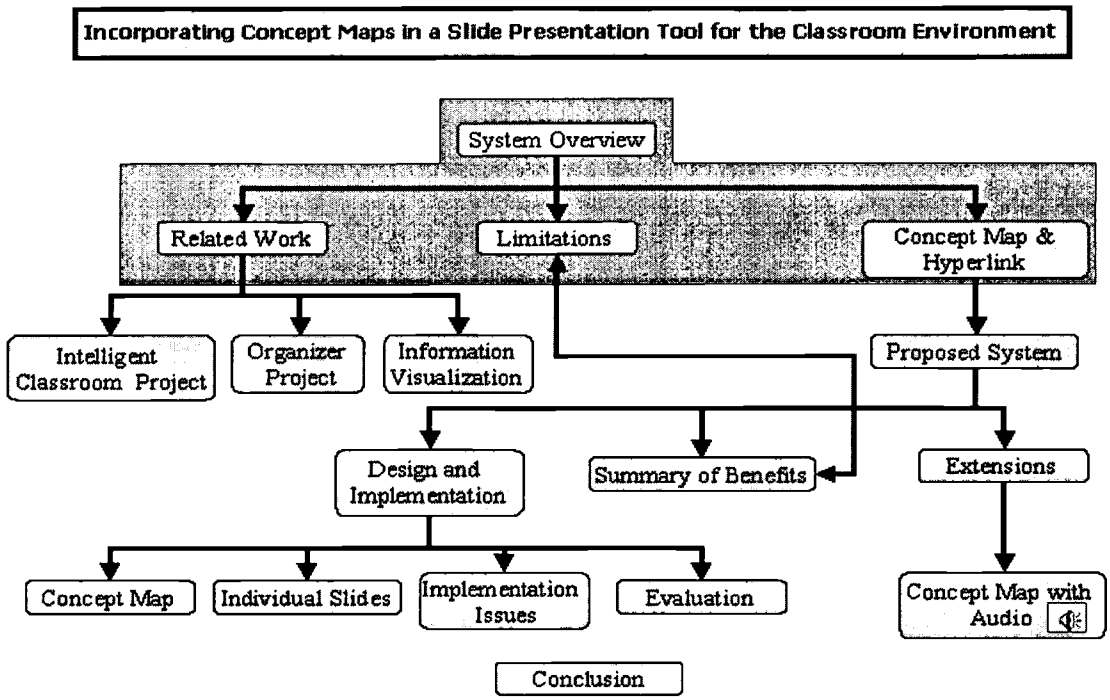

Figure 1: A concept map with a concept region grouping 4 nodes; uni-directional and bi-directional links are also shown. "System Overview" node is active; all other nodes are non-completed.

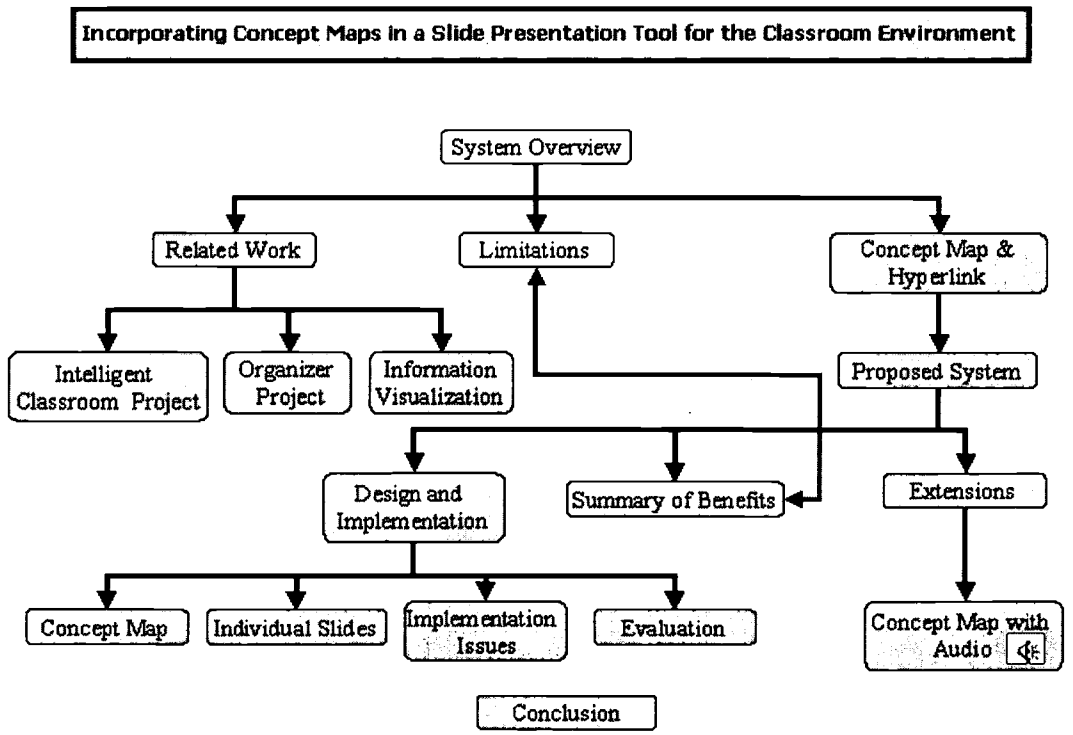

Figure 2: Different colors are used to display completed nodes (like "Related Work"), active ones (like "Limitations") and non-completed ones (like "Conclusion").

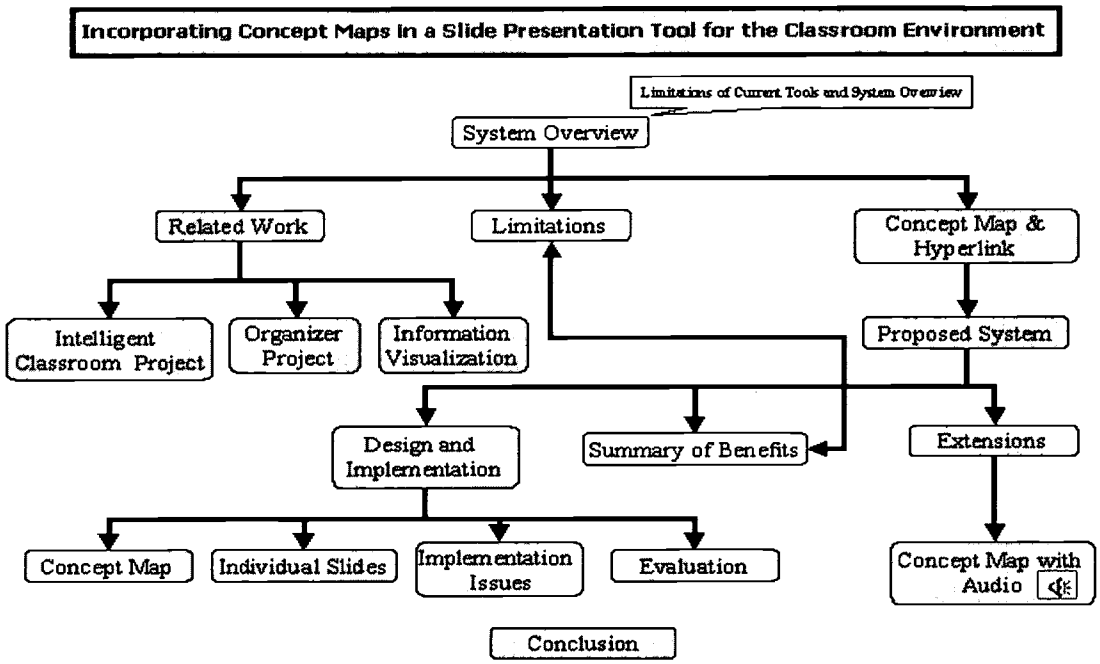

Figure 3: This concept map shows a narration and highlights two linked nodes.

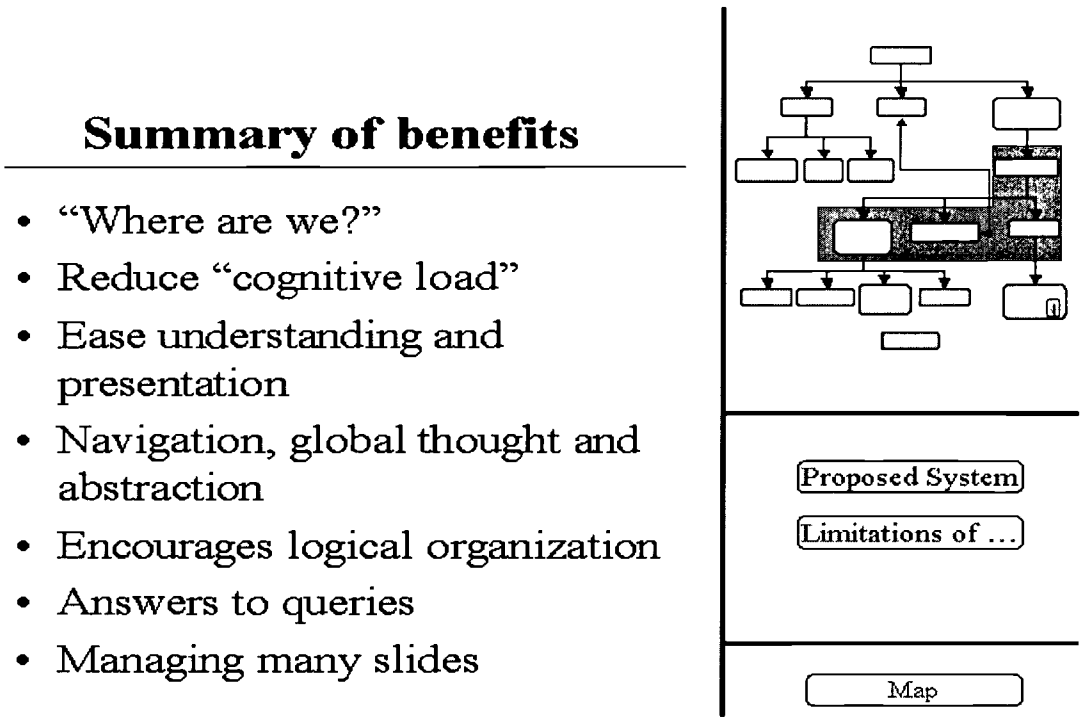

Figure 4: A typical individual slide with four frames.

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