Рассмотрены два варианта формирования вопросов. В первом случае на Web-странице приводится вопрос и несколько вариантов ответа. Студент должен ввести номер правильного ответа. Во втором случае на Web-странице одновременно отображается несколько вопросов по одной теме и приводится совокупность ответов на все эти вопросы. Студент должен для каждого вопроса выбрать подходящий ответ. Студент передает на сервер числовой код, включающий номера вопросов и номера соответствующих им ответов. Преимущество этого подхода: на экране нет лишней информации, т.к. каждый из приведенных ответов соответствует одному из поставленных вопросов.

The application of adaptive hypermedia system for distance learning

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Abstract. В докладе рассматривается круг вопросов, связанных с применением адаптивных гипермедиа-систем в процессе дистанционного обучения. Под гипермедиа-системами в докладе подразумеваются программные системы, сочетающие в себе свойства гипертекстовых систем с элементами мультимедиа и интеллектуальных обучающих систем. Приведена структура и классификация адаптивных гипермедиа-систем, дан список требований, которым должны удовлетворять адаптивные гипермедиа-системы, ориентированные на использование при дистанционном обучении.

Introduction

The realization of distance learning technology requires creation of virtual learning environments. The virtual learning environments benefit from a strong background in educational theory. Simply reproducing conventional teaching and learning concepts in a virtual learning environment does not utilize these new technologies. In distance learning a student uses the information from the distance learning course on his own. Thus, it is important to think about useful teaching strategies to encourage a learner to learn actively and not only to read or "consume" passively the information. For this purpose, we propose to use adaptive hypermedia system (AHS), based on constructivist learning strategies. In this way it is possible to integrate problems or "real world tasks" in the curriculum of the distance learning courses, and to structure the distance learning course based on projects and their relationship to information pages. Learners can reach learning goals or can receive answers to information requests while working on these problems, which introduce, explain and show the use of the learning items.

A definition of adaptive hypermedia system

Let's make a definition of AHS. To define the hypermedia system, we need to give a definition of hypertext first.

Definition 1. A **hypertext** is a set of nodes of text which are connected by links. Each node contains some amount of information (text) and a number of links to other nodes [1].

Definition 2. A **hypermedia** is an extension of hypertext which makes use of multiple forms of media, such as text, video, audio, graphics, etc [2].

An AHS enlarges the functionality of a hypermedia system. The aim of these systems is to personalize hypermedia systems to the individual users. Thus, each user has an individual view and individual navigational possibilities for working with the hypermedia system. An AHS combines ideas from hypermedia systems and ideas from intelligent tutoring systems. It belongs to the group of user adaptive systems, which are, for example, user adaptive interfaces or user model based interfaces.

AHS use a model of the user to collect information about his knowledge, goals, experience, etc., to adapt the content and the navigational structure. Let us have a look at an example. For a user with little knowledge it might be useful to read more introductory information before going into detail. However, the same information would not be so interesting for an expert. Here, the choice of the right information at the right time is the task of the user model. To give another example, a tourist information system should consider the abilities and disabilities of its users. If a handicapped user requires the opening hours of the city hall, the system's return should also contain hints to the next parking possibility for handicapped people or to the next public transport station, information about the entrance, etc.

Adaptation of hypermedia systems is also an attempt to overcome the "lost in hyperspace problem". The user's goals and knowledge can be used for limiting the number of available links in a hypermedia system.

For a definition of AHS, we follow the proposal of P. Brusilovsky [3].

Definition 3. By **adaptive hypermedia systems** we mean all hypertext and hypermedia systems which reflect some features of the user in the user model and apply this model to adapt various visible aspects of the system to the user.

The application of AHS for distance learning

The support of adaptive methods in hypermedia systems is advantageous if there is one common system which serves many users with different goals, knowledge, and experience, and if the underlying hyperspace is relatively large [3]. In the paper we will consider an application of AHS for distance learning where the user or student has a certain learning goal (which also might be an overall learning goal). In these systems, the focus is on the knowledge of the students, which might vary enormously. The knowledge state changes during the work with the system. Thus, a correct modeling of changing knowledge, a proper updating, and the ability to make the right conclusions on base of the updated knowledge estimations are the critical part in an educational hypermedia system.

Other applications are online information systems, or, more particular, online help systems. Online information systems are, for example, electronic encyclopedias, document stores, or tourist guides. To select the right information for users with different background or knowledge, these systems also need a model of the user's knowledge. Also the context in which the user requires information from the system is important here: for a quick reference, for elaborating a presentation, or for refreshing knowledge. Online help systems take particular system environments into account, for example the location from which they have been launched (context sensitive help systems).

An AHS collects information about users. On base of these individual characteristics, it adapts its content and navigational possibilities to the particular user (see Fig. 1).

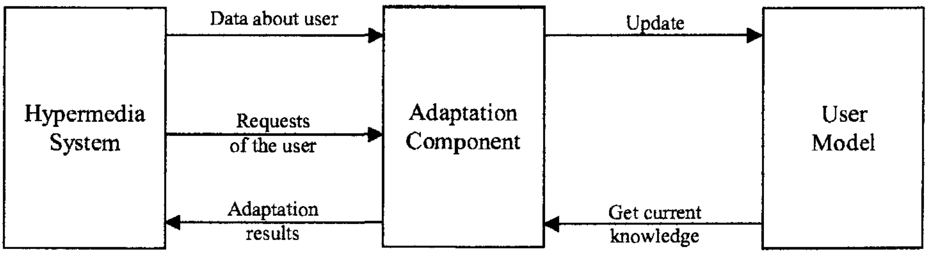

Fig. 1. Structure of an adaptive hypermedia system

A user model stores information about the individual user. We can distinguish two main types of user modeling techniques: overlay modeling and stereotype user modeling.

By overlay modeling [4], the user's state of knowledge is described as a subset of the expert's knowledge of the domain, hence the term "overlay". Student's lack of knowledge is derived by comparing it to the expert's knowledge. The critical part of overlay modeling is to find the initial knowledge estimation. The number of observations for estimating the knowledge sufficiently must be small. In addition, a student's misconceptions of some knowledge concepts can not be modeled.

A stereotype user modeling approach [5] classifies users into stereotypes. Users belonging to a certain class are assumed to have the same characteristics. Stereotype classification can be done for each adaptation feature. When using stereotype user modeling, the following problem can occur: the stereotypes might be so specialized that they become obsolete (since they consist of at most one user), or a user cannot be classified at all.

AHS need data for making assumptions about the user. Brusilovsky [3] identified five features which are taken into account by existing hypermedia systems: user's knowledge, goals, preferences, background, and experience. We claim that also the learning speed should be taken into account.

In currently existing AHS, the knowledge of the user is the most important information for adaptation. Especially in educational systems, the changing of the knowledge state of a user is a critical part for adaptation. The system always has to update its estimation about the user's knowledge, and the adaptation component has to use the actual knowledge state for making its adaptation steps.

Goals of a user depend on his current work with the hypermedia system. Using the system as a reference book requires different adaptation than a more overall learning goal. In educational hypermedia systems, we can distinguish two different types of goals. On the one hand, we have the overall learning goal which stretches over the sessions of the user with the system, on the other hand, we have the problem solving task which might vary during a session.

Users of AHS have different preferences, for example for font types, pictures or examples. These are characteristics which could not be estimated by the system without any input from the users. Systems which reflect the different kinds of preferences let their users tune these features. One can assume that preferences are not subject of rapid change.

By a user's background we mean all experiences and knowledge of a user which are not topic of the AHS itself. For example, programming experience in the language Prolog could belong to the background of a user in a hypermedia system about learning Java.

User's experience is concerned with the hypertext experience of the user. If the user has worked with a hypermedia system before, has he also worked with an AHS?

To our opinion user's learning speed is also an important user characteristic for educational hypermedia systems and should be reflected. Users with different learning preferences and different learning speed should be supported sufficiently.

So, hypermedia consists of documents which are connected by links. Thus, there are generally two aspects which can be adapted to the users: the content (content level adaptation), and the links (link level adaptation).

By adapting the content for a user, the document's content is tailored to the needs of the user, for example by hiding too specialized information or by inserting some additional explanations. According to [3], we can identify the following methods for content level adaptation:

- additional explanations – only those parts of a document are displayed to a user which fit to his knowledge or goal;
- prerequisite explanations – here the user model checks the prerequisites necessary to understand the content of the page. If the user lacks to know some prerequisites, the corresponding information is integrated in the page;
- comparative explanations – the idea of comparative explanations is to explain new topics by stressing their relations to known topics;
- explanation variants – by providing different explanations for some parts of a document, those explanations can be selected which are most suited for the user. This extends the method of prerequisite explanations;
- sorting – the different parts of a document are sorted according to their relevance for the user.

- The following techniques are used for implementing the adaptation methods [3]:
- conditional text – every kind of information about a knowledge concept is broken into text parts. For each of these text parts, the required knowledge for displaying it to the user is defined;
- stretch text – some keywords of a document can be replaced by longer descriptions if the user's actual knowledge requires that;
- page or page fragment variants – different variants of whole pages or parts of them are stored;
- frame based technique – this technique stores page and fragment variants into concept frames. Each frame has some slots which present the page or page fragments in a special order. Certain rules decide which slot is presented to the user.

Content level adaptation requires sophisticated techniques for improved presentation. The current systems using content level adaptation do so by enriching their documents with meta information about prerequisite or required knowledge, outcome, etc. The documents or fragments contained in these systems have to be written more than once in order to obtain the different explanations.

By using link level adaptation, the user's possibilities to navigate through the hypermedia system are personalized. The following methods show examples for adaptive navigation support:

- direct guidance – guide the user sequentially through the hypermedia system. The following two methods can be distinguished:
  - next best – provide a next-button to navigate through the hypertext.
  - page sequencing or trails – generate a reading sequence through the entire hypermedia system or through some part of it.
- adaptive sorting – sort the links of a document due to their relevance for the user:
  - similarity sorting, prerequisite knowledge – the "relevance" of a link to the user is based on the systems assumptions about the user. Some systems sort links depending on their similarity to the present page. Or by ordering them according to the required prerequisite knowledge.
- adaptive hiding – limit the navigational possibilities by hiding links to irrelevant information. Hiding of links can be realized by making them unavailable or invisible.
- link annotation – annotate the links to give the user hints to the content of the pages they point to. The annotation might be text, coloring, an icon, or dimming:
  - traffic light metaphor – the traffic light metaphor is the most popular method for link annotation. Here the educational state of a link is estimated by the system due to the user's actual knowledge state. The link pointing to the page is then annotated by a colored ball. A red ball in front of a link indicates that the user lacks some knowledge for understanding the pages; thus the page is not recommended for reading. A yellow ball indicates links to pages that are not recommended for reading; this recommendation is less strict than in case of a red ball. A

green ball is in front of links which lead to recommended pages. Grey balls give the hint that the content of the corresponding page is already known to the user. Variants in the coloring exist.
    - traffic lights and hiding – a mix of traffic light metaphor and adaptive hiding is also used in some systems.
- map annotation – graphical overviews or maps are adapted with some of the above mentioned methods.
- Techniques for link level adaptation are for example discussed in [3] and depend on the specific system. Here the system's assumptions about the user play an important role to decide what and how to adapt. Link level adaptation restricts the number of links and thus the number of navigational possibilities. It is useful to prevent the user from "getting lost in hyperspace". As in the case of content level adaptation, a description of the content of the documents is required for implementing the adaptation tasks.

Conclusions

It is a central requirement of a constructivist teaching approach to keep the AHS as maintainable and extendible as possible. A maintainable structure allows to integrate the students' results seamlessly and to keep the theoretical course materials up to date with minimum effort. The implementation of such a sophisticated conceptual backbone requires rigorous modeling.

We propose a conceptual modeling approach for AHS which explicitly represents all aspects of the application domain, and access to information. For integrating student projects into the AHS, we use the idea of portfolios. The students demonstrate in the portfolio which concepts they have used in their course project.

Another important requirement is the information presentation in a project-based learning approach. Since the students are supposed to work on their course projects or on smaller projects or examples contained in the AHS, they require information and background knowledge. Therefore it is a task of the AHS to select and present suitable information to a user.

Since the students are working with the AHS in the internet, the integration of useful information present in the internet into the learning material is near at hand. The AHS should serve as an up-to-date information repository. By selecting and annotating the information according to the student's goals and knowledge it should support their project work.

In addition, reading sequences must be generated. They lead the student, based on his actual knowledge, towards the requested information, including necessary prerequisites he actually lacks to know.

Since working on a larger project requires the definition of subprojects or subtasks which have to be solved first, the AHS must support goal-based learning. A user must be able to define learning goals on his own. Moreover the system must be able to generate appropriate learning goals and learning steps for the user. To reach such a (proposed or self defined) learning goal, the system should be able to find relevant projects and examples related to the goal. Therefore, selecting algorithms have to be found. They should present the most suitable projects to the user which match to his current learning goal and consider his actual knowledge.

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Высокоинтерактивный электронный учебник по курсу «Компьютерная графика»

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Abstract. The proposed textbook may be applied for various disciplines that are connected with computer graphics. Embedded in different types of lessons algorithm models have a number of parameters which can be adjusted. This enables to better understand the algorithm functioning in different situations.

Актуальным в дистанционном образовании стало внедрение мультимедийных технологий в различные учебные курсы, в частности, в графические [1-4]. В настоящее время весь накопленный опыт позволил создать электронный учебник по теоретическим основам компьютерной графики.

Графика стоит на передовом рубеже развития цифровых технологий, не говоря уже о компьютерной технике с мощной информационной всемирной паутиной Internet, где графическая информация по своему удельному весу занимает все больший сегмент. Даже в мобильном телефоне передовые модели осваивают все более высокие уровни графики, улучшая цветовое и пространственное разрешение создаваемых с помощью встроенных камер фотографических и даже видеоизображений. Это является причиной того, что базовые теоретические знания по методам и алгоритмам компьютерной графики требуются многим специалистам и занимают не последнее место в программах подготовки специалистов высших учебных заведений всего мира.