Smart Learning System using Contents Adaption Method

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Abstract

The rapid progress of IT technologies promoted the foundation to offer users 'Any Time, Any Where, Any Service', and mobile wireless internet services. Cellular phone is evolving to the form of smart phone. In the future visual telephone service or DMB service use is on the rise. Furthermore, it can become representative terminal of smart learning. Increasing content is available on the Internet, and there is a growing need for mobile access. Users can access Internet contents through various devices and networks. Today's mobile world is composed of various networks and devices with different characteristics. Progressive learners want to access and utilize services and information content using all available devices. This smart learning environment can help to increase interest in learning English and develop one's ability. To solve these problems and produce a superior system, we propose an Intelligent Tutoring System (ITS) for learning English that uses multi-modal technology. By overcoming mobile environment limitations and using appropriate mobile contents and content negotiation; and adaptation strategies, the proposed system provides an effective learning method based on ITS-supported teacher's role.

Keywords: Smart Learning, Contents Adaption, Tool of Teaching and Learning, Science of Education, Project-based Learning

1. Introduction

Today's Web applications are designed for use on a wide range of target devices, which can range from smart phones to Web browsers in PC environments. Users can access Internet contents through various devices (*e.g.*, PCs, smart phones, Cellular phones) and networks (*e.g.*, GSM, CDMA, WiFi, WiBro, WLAN). These devices have enhanced capabilities that support various content formats and hardware characteristics. The emerging availability of mobile services offers great new possibilities and challenges for services and its users. Users can access service categories that offer new possibilities and are accessed and used in ways different from traditional services. Service providers creating value-added mobile services face increased effort during development as they must adapt services to new devices and modalities. Content adaptation is necessary when a mobile client requests a Web document from a Web server. Web documents are commonly designed for desktop computers with fast network connections. Thus, considerable processing and reorganization of the document may be necessary [1, 2].

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English learning that involves multimedia content can increase learner interest and assist in developing the communication ability [3]. Use of computers to teach English in a conventional educational environment promotes motivation and effective learning for students. Related research has investigated Web-based ITS applications that are useful in various learning contexts. Results indicate that a structured Web-based ITS using a three-tier system can reduce expenses related to system design and development. This structure can also provide load balancing and reduce risk when many students are using the system simultaneously [4, 5].

In content adaptation approaches, CASHE adapted Internet contents among users for various devices taking into account contextual constraints and the different environments' limitations under consideration [6]. The adaptation proxy is adapting Web documents to mobile devices so users can more easily view and navigate them. The adaptation proxy can perform media adaptation [7, 8]. Also, server-side adaptation provides the Web content author maximum control over content delivery for mobile devices [9, 10].

According to these researches, the need to accommodate a variety of potential learning devices such as cellular phones, personal data assistants, and notebooks also complicate the design of a useful system. But, few studies have focused on learning or educational methods involving mobile devices [11-13].

To solve these problems while retaining the advantages of Web-based learning, this paper introduces an Intelligent Tutoring System (ITS) for learning English. Its design and implementation were based on an intelligent tutoring system to provide content suitable for specific student levels in a multi-modal education platform that supports various communication environments and devices.

2. Review of Pertinent Literature

2.1. Intelligent Tutoring System (ITS)

Changing teaching methods to use Computer Assisted Instruction (CAI) systems is a difficult task. But, because ITS is based on artificial intelligence (AI), it supports an adaptable and dynamic learning environment that can overcome the limitations of CAI [14]. Figure 1 is a general schematic diagram of ITS.
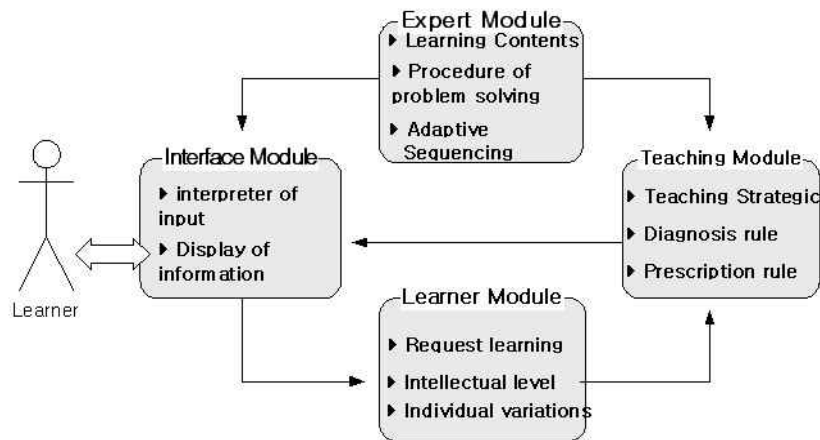

Figure 1. Framework of General Intelligent Tutoring System

Generally, ITS consists of: an interface module, a learner module, a teaching module, and an expert module. The expert module builds and applies a knowledge base obtained through pertinent professional advice. It also manages information about suitable learning objectives, material, and specific instruction conditions [15]. The learner module consists of a learner model and a diagnostic processor. The learner model illustrates the current state of a student's knowledge, while the diagnostic processor infers the learner model. A diagnostic function applies statistics or probability theory to diagnose a student's level of knowledge and classifies it into one of several grades [14].

The teaching module decides what, when, and how to teach given the student's learning status [15]. The interface module provides an interface through which student and system can interact; the interface module must offer a friendly and appropriate interface and respond to student interactions.

2.2. The 300-Certification Program for English Conversation

The 300-Certification program for English conversation is currently used in Korean primary schools. The teaching material consists of 300 English sentences organized into groups according to the school grade in which they should be learned (Korean grades 3– 6 correspond to K3–K6 in the United States). Sentences are incorporated in 23 dialogues for grade 3, 15 dialogues for grade 4, 34 dialogues for grade 5, and 26 dialogues for grade 6.

The program's spiral structure results in increased knowledge with each grade level. To distinguish learning ability, I analyzed the 300-Certification program for English conversation and elementary school English curriculum that used a systematic instruction design [16, 17]. Table 1 illustrates the results.

Table 1. List of Communication Functions

Domain	Lower function
Friendship activity	Greeting and Introduction, Thanks, Pay Attention, Praise, Congratulation, Admiration, Promise, Pray, Advice on food, Response
Realistic information exchange	Realistic information, Truth confirmation, Truth description, Experience, Plan, Comparison
Intellectual attitude expression	Agreement and disagreement, Suggestion, Invitation, Proposal, Possibility, Impossibility, Convince, Permission, Direction, Prohibition, Opinion expression
Expression of Emotion	Like, Dislike, Joy, Anger, Sorrow, Pleasure, Want, Compassion
Expression of Moral attitude	Apology, Excuse
Persuasion and Advice	Request, warning
Problem solving	Street guidance, Marketing, Ask again, Call

2.3. Reconstruction of 300-Certification Program for English Conversation

As described above, the 300-Certification program for English conversation is currently used in Korean primary schools; the teaching material consists of 300 sentences organized into groups. To distinguish learning ability, listening functions are evaluated based on multimedia content and include: discernment of sound characters,

stress and intonation, retention of learned contents, *etc*. Based on a systematic instruction design [16, 17], 300-Certification program contents can be classified into a scheme using four types of items for general evaluation, illustrated in Table 2.

Table 2. Types of Items and Forms

Types	Example
A	Listen, and Choose a suitable Picture
B	Listen, and Choose a Correct Answer
C	Listen, and Choosing a missing statement
D	Listen, and Choosing a including statement

3. System Design

3.1. System Architecture

The ITS core consists of an inference engine that chooses materials appropriate for each student and monitors the student's learning progress. The communications module supports the Internet and intranets, wireless LAN for PDA, and CDMA for cellular phones. Students are presented with learning content and materials via computer, cellular phone, or PDA; the presentation interface also permits telecommunication, shown in Figure 2.
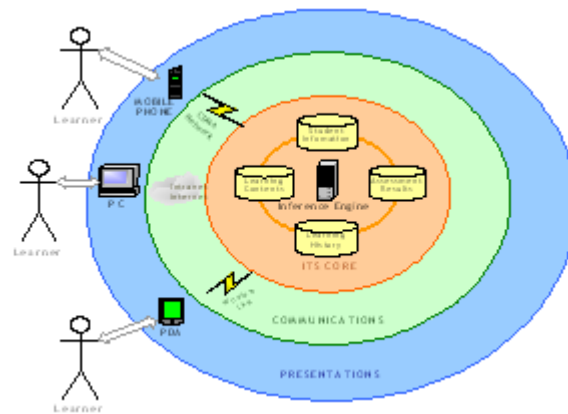

Figure 2. System Architecture of Intelligent Tutoring System based on Smart Learning

While a server side waits on a user's connection, if a user logs in, the server creates thread into a socket communication module. Created socket communication module takes complete charge in communicating with a client's socket communication module to exchange data. Course manager module performs arithmetic per user request. This paper proposes a system consisting of an expression section that presents learning materials to the student--an ITS core for data processing and management.

3.2. Content Negotiation and Adaptation

Content negotiation and adaptation strategies were implemented within the server-based architecture, shown in Figure 3. The network used in this architecture is based on three types of infrastructure: CDMA, 802.11 wireless LAN, and a wired network. Three kinds of devices can be used to access content: a cellular phone using CDMA, a personal data assistant running under Windows CE and connected through the wireless network, and a desktop computer using the wired connection.
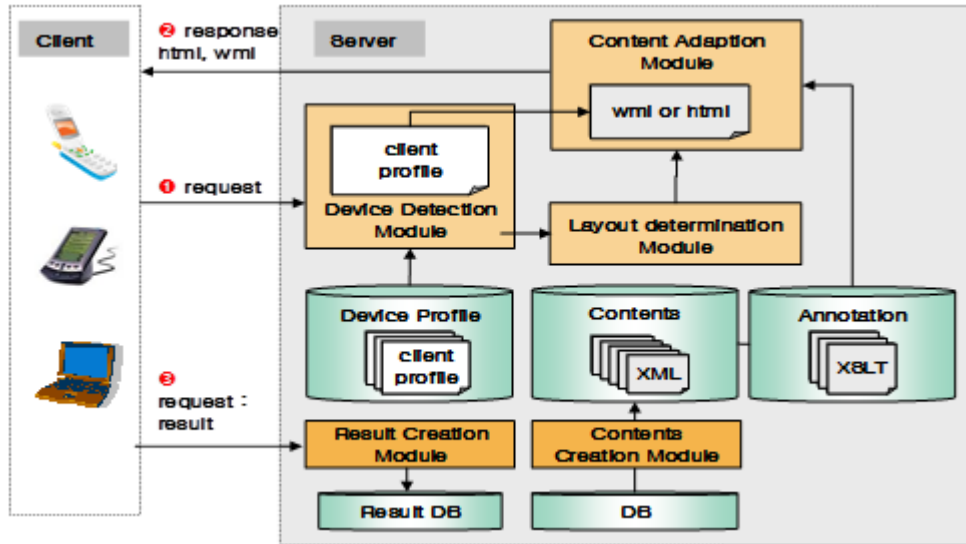

Figure 3. Multi-modal Architecture

Figure 4 shows the device detection process. The device-detection module samples User-Agent information from the user's request header and compares device configuration information with extraction information; the device selected is saved in a device-setting file. The device-detection module analyzes and uses device information stored in the existing user ID; because the database manages this device-setting file, additions or upgrades are easily achieved.
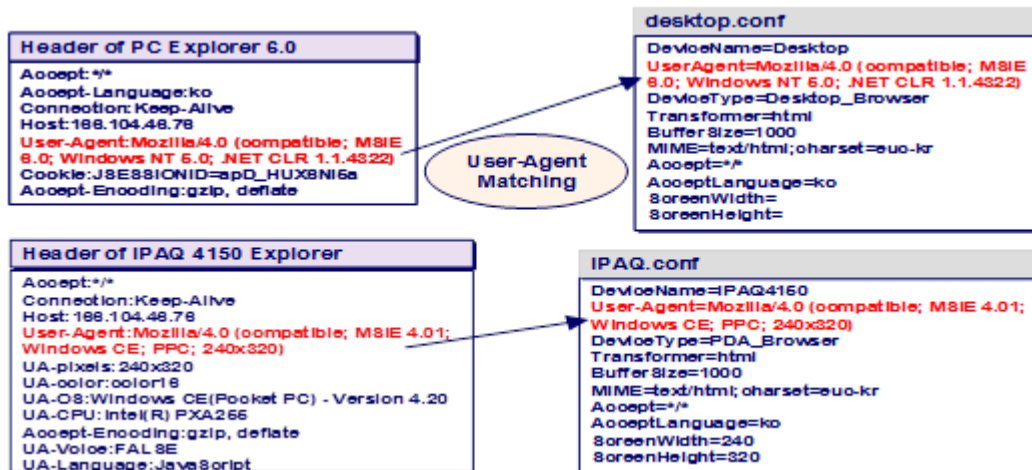

Figure 4. Device Detection through User-Agent Matching

Proposed ITS needs some kind of user interface structure-studying menu, evaluation menu, review menu. According to the each item type, evaluation menu need more content adaptation algorithm. Content adaptation algorithms are shown in Figure 5.
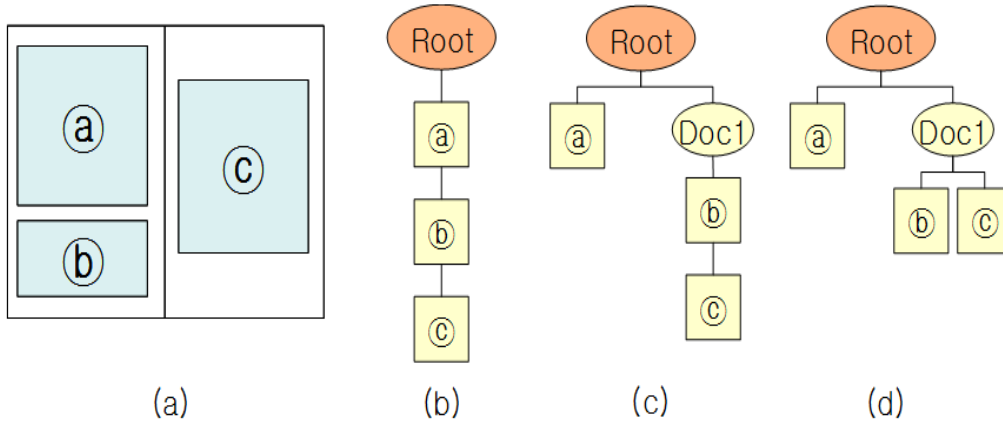
In deed it was a success.

Figure 5. Contents Adaptation Algorithm

(a) is an original Web page, (b) is the decomposed document created by the adaptation rules no. 1, the preferred segmentation point is <frame> tag. (c) is perceivable unit structure after segmentation - image and text. The preferred segmentation point is <img> tag by the adaptation rules no. 2. User can use next page button to move the image or text, and interacts to system by text selection. (d) is structure that user can input digit or character about text information through the separation of image and text. Table 3 shows the application of content adaptation algorithm.

Table 3. Application of Content Adaptation Algorithm

Menu ⟍ Device	Studying	Item Type A	Item Type B	Item Type C	Item Type D	Review
Smartphone	(b)	(c)	(b)	(b)	(b)	(b)
Cell Phone	(b)	(c)	(d)	(b)	(b)	(b)

Most content adaptation module use (b) method and apply scroll. However, in case of Item Type A, content adaptation module use (c) method, because user select suitable picture. In the case of cellular phone, the screen size is smaller in order to improve efficiency of input using (d) method in Item Type B case because there is difficulty to answer input.

4. System Implementation

4.1. Implementation Environment

The propose system was implemented within environments described in Table 4.

Table 4. Implementation Environment

	H/W	S/W
Server	Intel Xeon 3.2 GHz Dual CPU 3072MB RAM	Windows 2003 Server with IIS MS SQL-2000, ASP.NET, C#
PC Client	Intel Pentium4 3.0GHz 1024MB RAM (Minimum)	Windows 98 (Minimum) Internet Explorer 6.0 (Minimum)
Smartphone Client	64MB RAM 320*240 Screen (Minimum)	Pocket PC 2003 Internet Explorer (Minimum)
Cellular Phone Client	1MB Heap Memory 128*120 Screen	Openwave v7 simulator

34.2. Implementation Results

Figure 6 shows the results of Smartphone interface implementation. Smartphone interfaces interact like PC interfaces, using annotation and content adaptation modules in Web browsers.

Figure 6. Results of Smartphone Interface Implementation

5. System Evaluation

Evaluations of the system's adaptation features showed that most Web pages will be usable through the adaptation proxy. Figure 7 show the result of content adaptation process.
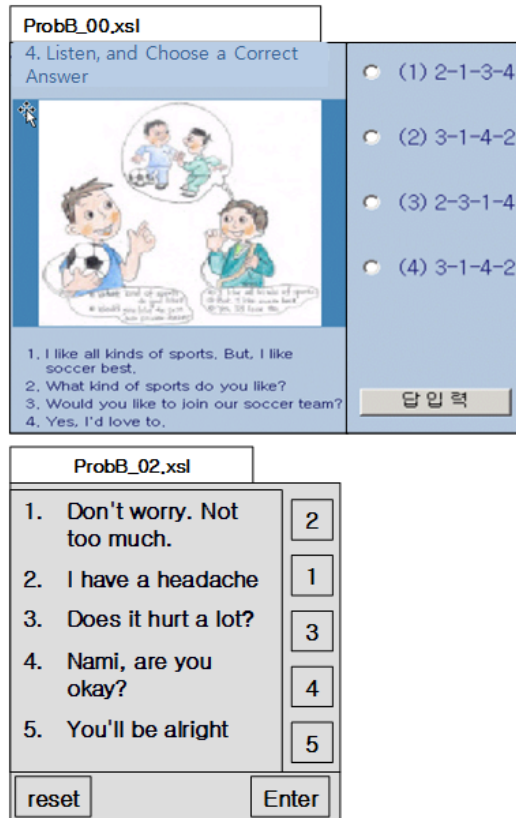
Figure 7. Results of Content Adaptation by PC, Smartphone, Cell Phone

A content adaptation process can be applied to each case. For Smartphone interface, all content adaptation applied to Rule No. 1 except type of item A. Type of item A applied to Rule No. 2. For phone interface, Studying menu, type of item C and D applied to Rule No. 1, type of item A applied to Rule No. 2, type of item B applied to Rule No. 3.

To evaluate proposed ITS, result that compare and analyze with connected system - *e.g.*, CASHE [6], Adaptation proxy [7] - is shown Table 5.

Table 5. Quantitive Analysis of each System

Feature Systems	Learning	Evaluation	Adaptation Rule	Device Negotiation
CASHE	△	×	×	○
Adaptation proxy	△	×	○	×
ITSUC	○	○	△	○

If the case used CASHE or Adaptation proxy method in Studying menu, the text and image information could be controlled. However, usability of audio contents is not easy. The proposed ITS shows performance of the most suitable in image, text, audio.

Also, there is an advantage using this over other research methods because there is a present module to fit in special quality of device from part that evaluate. The proposed ITS

does not consist automatically content adaptation, but interacts according to an adaptation rule that is decided through device detection.

6. Conclusion

Existing Web-based education systems focus on providing study materials without considering devices or networks. This paper proposed an intelligent tutoring system to provide materials appropriate for specific student levels via a ubiquitous computing education platform that supports various communication environments and devices.

This study designed and implemented a system that can conduct education appropriate to a learner using a mobile environment and can produce learning feedback. Results indicate it is possible to create a multi-modal and device-independent mobile service that uses less effort to develop compared to approaches based on traditional tutoring systems.

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