JAIST Repository

https://dspace.jaist.ac.jp/

Title	Development of a Human-like e-Learning System for Students' Active Learning			
Author(s)	YOSHIDA, Kenji; MIYAZAKI, Koji; IWAMOTO, Akira; NAKAGAMI, Kayoko; Rong, Ma; NAKAYAMA, Hirotaka			
Citation				
Issue Date	2005-11			
Туре	Conference Paper			
Text version	publisher			
URL	http://hdl.handle.net/10119/3825			
Rights	2005 JAIST Press			
Description	The original publication is available at JAIST Press http://www.jaist.ac.jp/library/jaist- press/index.html, IFSR 2005 : Proceedings of the First World Congress of the International Federation for Systems Research : The New Roles of Systems Sciences For a Knowledge-based Society : Nov. 14-17, 2035, Kobe, Japan, Symposium 3, Session 2 : Intelligent Information Technology and Applications Pattern Recognitiion with Applications			



Development of a Human-like e-Learning System for Students' Active Learning

Kenji YOSHIDA¹, Koji MIYAZAKI², Akira IWAMOTO³, Kayoko NAKAGAMI⁴, Rong Ma⁵ and Hirotaka NAKAYAMA⁴

¹ Graduate School of Natural Science, Konan University 8-9-1 Okamoto Higashinadaku, Kobe 658-8501 JAPAN

² Nirvana Technology Inc.

³ The Master Of Computer Science, Illinois Institute of Technology

10 West 31st Street, Chicago, IL 60616 USA

⁴ Dept. of Information Science and Systems Engineering, Faculty of Science and Engineering,

Konan University

8-9-1 Okamoto Higashinadaku, Kobe 658-8501 JAPAN

⁵ Institute of Intelligent Information and Communications Technology (IICT), Konan University

8-9-1 Okamoto Higashinadaku, Kobe 658-8501 JAPAN

ABSTRACT

There are two types of e-Learning systems, namely, a synchronous type system and an asynchronous type system. A Synchronous type e-Learning system uses TV conference systems and it gives students a sense of reality. An asynchronous e-Learning system has merits which are free from time and place. An important element of an asynchronous e-Learning system is WBT (Web Based Training) which is used in training in companies.

Interactive communications with a teacher are important for education. However, an asynchronous, lecture type e-Learning system has some difficulty for keeping students' motivation and encouraging active learning.

In this paper, we introduce a human-like e-Learning system which provides experiment contents for active learning and which have communicative functions, such as chat.

Keywords: e-Learning, Edutainment, Automatic Answering System, Human-like System

1. Ploblems of Existing e-Learning systems

E-Learning systems are spreading over companies and universities rapidly. Synchronous type systems which use TV conference systems has a sense of reality and interactivity with the teacher. But this system has the demerit of limitation of time and place.

On the other hand, an asynchronous e-Learning system has no limitation on time and place. Students are able to have a lecture anytime or everywhere. However, there is no interaction with the teacher. The student hears lecture and there is no active learning components. Many existing asynchronous e-Learning systems manage only students' learning progress through the internet.

Therefore we suggest a human-like e-Learning system which has the ability to teach according to students' learning situation. Students are able to learn actively through experiments (Fig. 1).

Stutents access the learning site, where they learn the contents which include a page that lets student be active (through experiment and trial-and-error). The system watches the students' activity, and then the system judges the students' situation. Further contents are served based on the judgement of the system (Fig. 2).

This system serves contents according to each student. This is similar to a role-playing game. It is important for the e-Learning system to serve the contents that matches situation of each student.



Fig. 1 System Image



Fig. 2 Contents Control



Fig. 3 Contents Image

	Student's Input	Generate Pattern			
	<u>a</u> <u>b</u> <u>c</u>	Change	а	b	С
1st	$y = 1 x^2 + 2 x + 3$	1st	1	0	0
		-> Zna			
2nd	$y = [2]x^2 + [2]x + [3]$	2nd	0	1	1
	a b c	-> 3rd	Ŭ		'
3rd	$y = 2x^2 + 3x + 4$	3rd	1	1	1
	a b c	-> 4th	· .		·
4th	$y = \boxed{1} x^2 + \boxed{2} x + \boxed{3}$	4th	0	1	1
	a b c	-> 5th	Ŭ.,		· ·
5th	$y = \boxed{1} x^2 + \boxed{0} x + \boxed{0}$	Pattern	1	1	1

Fig. 4 Patterning of a Student's Experiment Data

2. How to get Student's Situation

We made the contents of high school mathematics syllabus unit "Quadrics and their graphs". The contents are a lecture and some experiments of drawing graphs. In addition, the system observes input data of students and chooses appropriate instruction contents according to

Table 1 Experiment Patterns

Pattern	Judgment
1,0,0	The student notes parameter <i>a</i> .
0,1,0	The student notes parameter b .
0,0,1	The student notes parameter c .
1,1,1	The student notes nothing.
0,0,0	The student could not operate.



Fig. 5 The screen that the system scolds the student

students' situation. (Fig. 3)

For making teaching contents according to students' situation, we patternize student's input data. For example, a student have experiments of drawing " $y = ax^2 + bx + c$ " graphs. Fig. 4 is an example of patterning of student's experimental input data. The

system judges 'All parameter changed' (Table 1). By this patterning, the system provides the next suitable content for the student.

Furthermore, we added the function to give negative feedback to the student who did not listen to our lecture (Fig. 5). Usually, teacher scolds a student who does not listen to the lecture in real class. So it is a necessary function for the system.

3. How to Communicate with Students

3.1. Automatic Answer

In our classes, we are able to answer students' question. However, it is difficult to answer questions immediately in an e-Learning system without answer models.

Therefore we prepared some template questions as follows.

- 1. How does a graph change when the parameter *a* is changed ?
- 2. How does a graph move when I change parameter *b* ?
- 3. How does a graph move when I change parameter *c* ?
- 4. Please teach me relation between the *y*-intercept and parameter *a*, *b*, *c*.
- 5. What is the relation between apex and parameter *a*, *b*, *c*?
- 6. How can I get the coordinate of apex of parabola?
- 7. Is the graph of quadratic function symmetrical?
- 8. Please tell me how to do right-left parallel translation of the graph?
- 9. Please tell me how to do up-down parallel translation of the graph?
- 10. Can you draw the graph of an side opened parabola?

A student inputs the questions (Fig. 6); the system chooses the most similar question from template (Fig. 7).

However, the judgment of the system is not always the same to the questions of the student. If the system displays a wrong answer, the student clicks the "No" button. And the system enumerates a different question (Fig. 8).

3.2. Morpheme analysis

It is necessary for the system to understand students' question correctly. It is difficult for a computer to classify Japanese sentences into words. In Japanese, a sentence does not include spaces to distribute characters. So we use the morphological analysis system 'Sen'.



Fig. 6 Input Questions



Fig. 7 Compare with Template Question



Fig. 8 Enumerate other Template Question

The template questions and students' question are separated by Sen into indexing words. The system computes the precision by using these words lists.

For example, a student asks the system "a の値を 変化させるとどうなりますか? (How does a graph change when the parameter *a* is changed?)".

The system gets primitive words list by the morpheme analysis 'Sen' (Table 2).

The system uses necessary word class and measures distance of the student's question and template questions.

Question: a の値を変化させるとどうなりますか?			
Word	Primitive	word class	
a	а	未知語(Unknown word)	
の	の	助詞-連体化 (Particle)	
値	値	名詞-一般(Noun)	
を	を	助詞-格助詞-一般(Particle)	
変化	変化	名詞₋サ変接続(Noun)	
さ	する	動詞-自立 (Verb)	
せる	せる	動詞-接尾(Verb)	
と	٤	助詞-接続助詞 (Particle)	
どう	どう	副詞-助詞類接続 (Vadverb)	
なり	なる	動詞-自立 (Verb)	
ます	ます	助動詞 (Auxiliary verb)	
か	か	助詞-副助詞 (Particle)	
?	?	記号-一般 (Symbol)	

Table 2 Morpheme analysis

3.3. Vectorization of question word

Let T_i (*i*=1, 2, 3, ..., *n*) denote template questions. Then we get the word list (*WT_i*) of T_i . And let S_j (*j*=1, 2, 3, ..., *N*) denote students' questions. Then we get the word list (*WS_i*) of T_i . For example,

- T₁: " a の値を変化させるとグラフはどのように変化しますか?"
 (How does a graph change when the parameter a is changed ?)
- $WT_1 = \{a, 値, 変化, する, グラフ\}$ ($WT_1 = \{a, value, change, do, graph\}$)
- S₁: " a の変化させるとグラフはどのように なりますか?" WS₁={a,変化,する,グラフ,なる}

We introduce the following notations:

- w_i : The word of question W
- m : Number of w
- *n* : Number of template questions
- N : Number of student question of the past
- f_{i} : Frequency of w_i in the question
- n_i : Number of questions which includes w_i

$$W = \left\{ \bigcup_{i=1}^{n} WT_i \right\} \bigcup \left\{ \bigcup_{j=1}^{N} WS_j \right\}$$
$$m = \mid W \mid$$

We define the question term vector as follows. $l_{i,j}$ is Logarithmic TF(Term Frequency) weight. g_i is probabilistic IDF (Inverse Document Frequency) weight.

> s : Term vector of student question $s = (l_{0,1}g_1, l_{0,2}g_2, \dots, l_{0,m}g_m)$

$$\begin{aligned} q_j &: \text{Term vector of template question} \\ q_j &= (l_{j,1}g_1, l_{j,2}g_2, \cdots, l_{j,m}g_m) \\ & (j = 1, 2, \dots, n) \\ l_{i,j} &= \log(1 + f_{i,j}) \\ g_i &= \log\frac{n - n_i}{n_i} \end{aligned}$$

We compute the similarity between student's question and templates by cosine measure.

- *s* : Term vector of student's question
- q_j : Term vector of template question

$$\cos\theta = \frac{\boldsymbol{s} \cdot \boldsymbol{q}_j}{\|\boldsymbol{s}\| \|\boldsymbol{q}_j\|}$$

The system selects the template question which has the maximal cosine measure.

3.4. Improvement of automatic answer

TF-IDF is often used in text mining. However, a student's question is too short to identify the template questions. Therefore we updated weight whenever a student asked the system a question.

For example, a term frequency of student question is $(f_{0,1}, f_{0,2}, \dots, f_{0,m})$

and a term frequency of selected template question is

$$(f_{j,l}, f_{j,2}, \dots f_{j,m})$$

We update weight as follows.

$$f_{j,i} = f_{j,i} + f_{0,i}$$

In this way we are able to improve value of cosine measure by updating f_{ij} . (Table 3)

Table 3 Average of cosine measure answering correctly

	No update	1 update	2update
Average of cosine measure	0.53	0.69	0.77

4. Entertainment in Education

4.1. Automatic drawing of facial expression

Edutainment is a word which combines education and entertainment. It is desirable for e-Learning systems to have a function of entertainment. Otherwise students do not stay interested in the contents.

So, we createded several characters of teachers. A student is able to choose from these teachers. But it is troublesome for us to make animation for each character.



Fig. 9 Teacher characters



Fig.10 Automatic drawing of facial expression



Fig. 11 Normal facial expression



Fig.12 Angry facial expression

Therefore we programmed an automatic drawing system using the voice data and these vowel data (Fig.10). We can reduce time required to make the contents by this function. Moreover, it is possible to change the character's facial expressions according to the contents (Fig.11, Fig.12). Emotion parameters are happiness, sadness and anger. String information is vowel (Japanese hiragana) data and the timing data.

4.2. Data for facial drawing

Facial drawing data consists of five items.

- 1. Index
- 2. Audio file name
- 3. Length of audio play time (sec)
- 4. Japanese hiragana character data
- 5. Rate for a sentence of character
 - (Short: 1 <---> 5 <---> 9 :Long)

For example, two sentences are included in a Web page. The data file is as follows.

0 ./wave/0_1.wav 5.38 にじかんすうのぐらふと、そのへいこういど うについてべんきょうしましょう 555555 5 555 5 9 55 5555 555 5 558 55555 55555
1 ./wave/0_2.wav
7.43 とくによこほうこう、えっくすじくほうこう のへいこういどうについてかんがえてみま
しよう 550 555550 & 555555 5555 5 5555555 5 555

559 555559 8 555555 5555 5 5555555 5 555 55555 55555

We comment on a calculation way of play time of character. A value r_i is relative time length of voice of vowel. of character. T is length of audio play time. A character play time t_i is computed as follows (Table 4).

$$R = \sum_{i=1}^{n} r_i$$
$$t_i = \frac{r_i T}{R}$$

The shape of a mouth of a vowel keeps for t_i second. In this way we use audio data and vowel sound synchronization file, and the system generates real time animation.

Table 4 Compute of vowel plays time

4th Item		vowel	5th Item	Play Time
に	N i	i	r_1	t_1
じ	Ji	i	r_2	t_2
か	K a	a	<i>r</i> 3	t 3
ん	N n	n	<i>r</i> ₄	t 4
す	S u	u	r_5	t 5
う	u	u	r_{6}	t 6
•	•	•	•	•
ま	M a	a	r _{n-2}	t _{n-2}
しょ	Sh o	0	<i>r</i> _{<i>n</i>-1}	t _{n-1}
う	u	u	r_n	t_n
		Total	R	Т

4.3. Merit of automatic drawing system

The automatic facial expression real time drawing system reduced our task a lot. The teacher only prepares the audio data for each explanation.

Usually, animated images are time consuming. Synchronizing the mouth drawing and the voice is complex. Besides, it is difficult for us to modify animation.

In addition, there is a system using video capture. In the case of video capture system, the teacher needs skill to edit the movie.

The automatic facial expression real-time drawing system is useful because it does not need special skill for making the contents.

5. Conclusions and Future Study Directions

The developed question and answer system cannot reply to questions which do not include the template question. In this case, the present system sends an e-mail to the teacher. We have to devise an answering system which can answer every student's question, and does not require e-mail.

On the other hand, we are able to modify the contents easily using character real-time drawing. But the system requires the contents scenario and speaker's tone data. A problem under consideration is automatic data generation from a voice.

However, we are able to make the educational contents without video capture system or any special skills. These are important things for creating educational content.

Acknowledgement: A part of this research got the private school furtherance by Japanese Ministry of Education, Culture, Sports, Science and Technology Open Research Center work (2004-2009)

REFERENCES

- M.Andoh, M.Ueno: Contents estimate for e-Learning using an eye-mark recorder, JSiSE Research Report Vol.19, pp.11-18 (2004)
- [2]. K.Nakagami, H.Nakayama: On Multi Classifivation by Fuzzy Support Vector Machines, 23th Conference of The Society of Instrument and Control Engineers in Kyusyu, pp.129 - pp.130 (2004)
- [3]. K.Nakagami, K.Yoshida, H.Nakayama: Optumal Contents Selection in E-Learning using Support Vector Machine, 37th Conference of The Society of Instrument and Control Engineers in Hokkaido, pp.111-pp.114 (2005)
- [4]. K. Yoshida, H.Nakayama: Construction of an e-Learning System Controlled by Student Input, Mem.Konan Univ., Sci&Eng. Ser., 51(2), pp.165-174 (2004)
- [5]. K. Yoshida, H. Nakayama: Auto-answering to learners' questions in an e-Learning system, Mem.Konan Univ., Sci&Eng. Ser., 52(2), pp.95-104 (2005)