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Automatic Display of an Additional Explanation on a Keyword Written by a Lecturer for e-Learning Using a Pen Capture Tool on Whiteboard and Two Cameras

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Abstract **- "e-Leaning" system is classified by lecture time into two types, that is, "synchronous type" spent the same lecture time between the lecturer and students, and "asynchronous type" spent the different lecture time. The size of image database is huge, and there are some problems on the management of the lecture image database in "asynchronous type" e-Learning system. The one of them is that the time tag for the database management must be added manually at present, and the cost of the addition of the time tag causes a serious problem. To resolve the problem, we will use the character recognition for the characters written by the lecturer on whiteboard, and will add the recognized character as a keyword to the tag of the image database. If the database would have the keyword, we could retrieve the database by the keyword efficiently, and the student could select the interested lecture scene only in the full lecture database.**

I. INTRODUCTION

In our laboratory, the e-learning system which used both the active camera (CANON VC-C3) and pen capture tool (Virtual Ink and KOKUYO mimio) proposed. The binary image on the white board obtained from pen capture tool and the color lecture scene taken with the active camera[1] are accumulated to a mass hard disk, and lecture image database is creating from these images.

Then, the tags of the database are made by searching the word for a textbook, according to a character string on a white board. The cost of the creation is one of serious problems for the present e-Learning. Moreover, there is a problem in the management of the lesson image accumulated in large quantities. At present, the tag of database management must be added manually. By using pen capture tool, this system obtains the image on a white board and the image are changed into text data by character recognition. The recognized characters are used as a keyword for the reference of textbook.

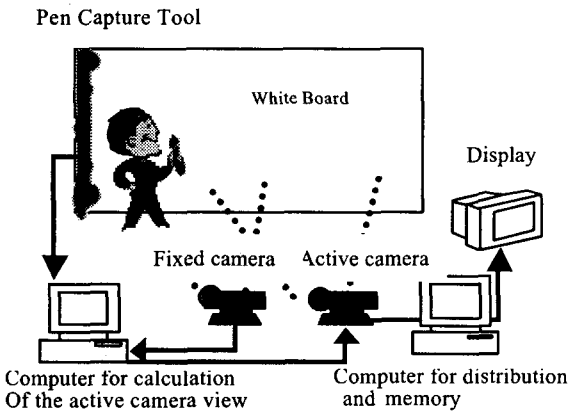

Fig.1. The e-Learning system using an active camera and pen capture tool

Generation of the link between a keyword on a textbook and a character string on white board needs a lot of cost for e-Learning. We are challenging the construction of automatic generation system for the keyword link. The automatic generation of keyword link is one of important problems for asynchronous type e-Learning[2].

In this paper, we propose a new automatic display method with an additional explanation on a keyword written by a lecturer for e-Learning. The method uses a pen capture tool on whiteboard and two cameras. The proposed display system uses the above lecture image database with the time tag, and shows three windows, that is, a moving image by the pen capture tool on whiteboard, a moving lecture scene by the active camera and a window for the recognized characters written by a lecturer on whiteboard or the additional explanation of a keyword if the student would request. We implement the above system using MS-Visual C# .NET on Windows, and we confirm the effectiveness of our method for some lectures.

II. ADDITIONAL EXPLANATION ON A KEYWORD

Our system(Fig.2) creates beforehand the keyword dictionary, which enumerated the keywords considered to be important by the lesson. The system search a keyword for full text in a textbook, and it extract the explanation of the keyword automatically. Next, character string of the image on the white board are obtained from the pen capture tool and character recognition software (Script Converter by KOKUYO). The system compares the recognized character string with the keyword dictionary, and it stretches the link to the HTML page of words-and-phrases explanation. The HTML page of a lesson image, and a lecture scene recorded on movie with the active camera are displayed side by side(Fig.3).

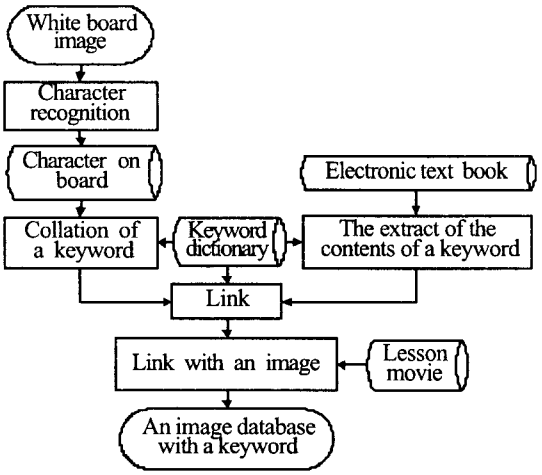

Fig.2. Generation of image database with keywords

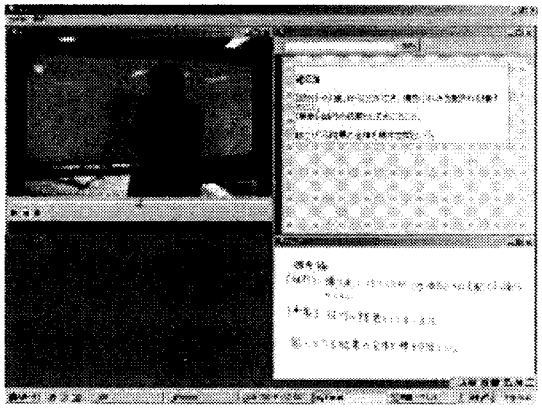

Fig.3. An example of three windows

A. Capture of a binary image on a white board

Previously an image on a white board was captured by an active camera[1]. This method has an essential problem that the character on the white board is hidden by a lecturer(Fig.4). We use a pen capture tool (mimio) to avoid this problem, presently. By forcing stylus (pen for mimio) on a white board, the switch of stylus is turned on, and mimio fires an ultrasonic wave and infrared rays, detects an ultrasonic wave and infrared rays by the sensor attached in the white board end, and detects the position of a pen by the three-point surveying method. It is taken in by the computer, and is saved as a bitmap file(Fig.5).

B. The character recognition for a white board image

In order to translate a white board image(Fig.5) into text data(Fig.6), at present, on-line character recognition soft ware(Script Converter) is used. A character string image on whiteboard(Fig. 7 upper part) is translated into a series of character code(Fig. 7 lower part).

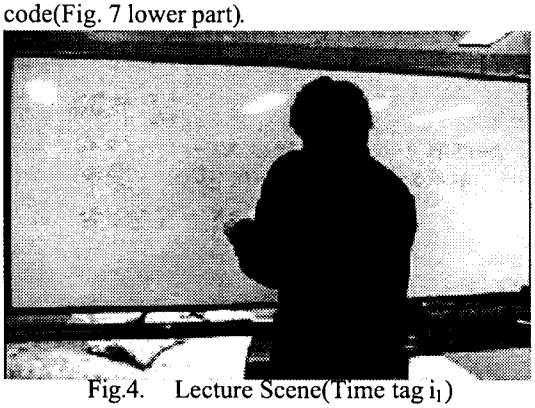

Fig.4. Lecture Scene(Time tag i_1)

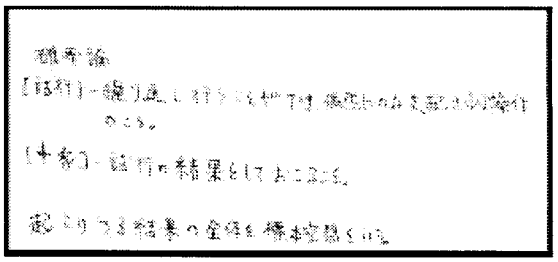

Fig. 5. White board image(Time tag j_1)

確率論

[試行]-繰り返し行うことができ、偶然にのみ支配される操作
のころ。
[事象]-試行の結果としておこること。

起こりうる結果の全体を標本空間という

Fig. 6. Characters on the white board(Time tag j_1)

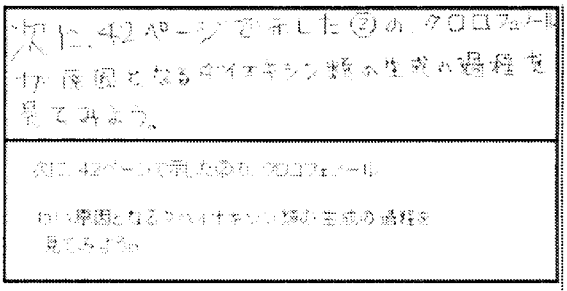

Fig.7. Character recognition (Upper part: Input image, Lower part: Output character codes)

The recognition rate has a large difference (66%-98%) by five writers. A main reason of the error recognition is the performance of the on-line character recognition software. Although a complicated character like a Chinese character has a high recognition rate, the simple characters, such as a hiragana and katakana has a low rate. Moreover, since one character "が" of Fig. 7 is recognized to be two characters"わい", it turns out that the separation of a character is imperfect(over-segmentation). Furthermore, there is a some places where the character is blurred. To avoid this problem, the writer should be used to stylus. There is a large difference in the recognition rates by the speed and correctness of a note, and the average rate of five writers became 84.9%. The improvement of the recognition rate is desired.

C. Collation of a Keyword and the Explanation in Textbook

In this system, the keyword considered to be important is beforehand registered into the dictionary keyword. If the keyword appears in the white board image, the explanation of the keyword in a textbook will be displayed. If it would be registered manually in the text, the cost of the collation of a keyword would be the problem. We are researching the automatic collation of a keyword and the explanation in a textbook. The following filter was examined as a collation method.

(1) It goes back from a keyword and the punctuation-marks + new-line which appeared first is made into a starting point.

In order to extract the explanation text showing a keyword, the starting point and the ending point of a text are needed. The starting point searched the keyword from the whole sentence data of a text, went back from the discovery position of a keyword, and made the starting point the punctuation-marks + new-line which appeared first.

を結合事象(joint event)という. ¥r¥n
数学的確率]ある試行について，標本空間の大きさ
(=全根元事象の個数)がnで，どの根元事象も同程度
に確からしく起こるとする 標本空間の中のある事象E
に対して・・・

(2) The punctuation marks which appear in the next of a keyword are made into an ending point.

数学的確率]ある試行について，標本空間の大きさ
(=全根元事象の個数)がnで，どの根元事象も同程度
に確からしく起こるとする.

(3) The punctuation-marks + new-line which appears in the next of a keyword is made into an ending point.

数学的確率]ある試行について，標本空間の大きさ
(=全根元事象の個数)がnで，どの根元事象も同程度
に確からしく起こるとする 標本空間の中のある事象E
に対して，事象Eの起こる場合の数がrであるとき，事象
Eの確率P(E)を次式のように定義する. ¥r¥n

(4) The punctuation marks which appear in the next of the keyword which appears the second time are made into an ending point.

数学的確率]ある試行について，標本空間の大きさ
(=全根元事象の個数)がnで，どの根元事象も同程度
に確からしく起こるとする 標本空間の中のある事象E
に対して，事象Eの起こる場合の数がrであるとき，事象
Eの確率P(E)を次式のように定義する.
P(E)=r/n
この確率のことを数学的確率(mathematical
probability)という.

(5) When separated [from 400 or more characters] of the keyword which appears in an eye at once, and the keyword which appears in the second time, the punctuation-marks + new-line next to the keyword which appears in an eye at once is made into an ending point.

数学的確率]ある試行について，標本空間の大きさ
(=全根元事象の個数)がnで，どの根元事象も同程度
に確からしく起こるとする 標本空間の中のある事象E
に対して，事象Eの起こる場合の数がrであるとき，事象
Eの確率P(E)を次式のように定義する.
P(E)=r/n
・数学的確率・・・

D. Attachment of time tag

Our system attaches a time tag to the lecture scene, the white board image, and the recognized character strings. A video capture board in personal computers captures the lecture scene by the active camera. The captured scene is stored with a time tag i(Fig.4). The white board image by pen capture tool is stored with a time tag j(Fig.5). The recognized characters on the white board(Fig.6) is attached the same time tag j with the white board image. On the display time of students, our system transfers the lecture scene, the white board image, and the recognized characters using the time tags synchronously(Fig.8).

E. Additional explanation on a keyword

If students requests the additional explanation on a keyword, the system will display the additional

explanation in textbook using the above mentioned collation. Fig.9 shows the recognized characters in the whiteboard, and the under lines in Fig.9 show the keyword in textbook. Fig.10 shows the additional explanation on the specified keyword by a student.

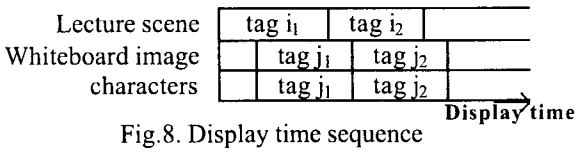

Fig.8. Display time sequence

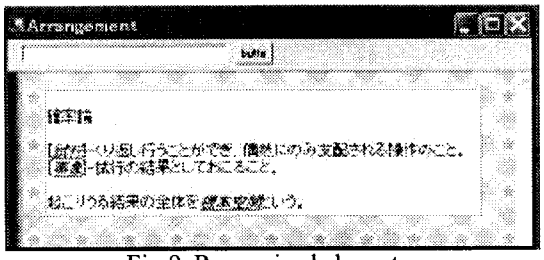

Fig.9. Recognized character

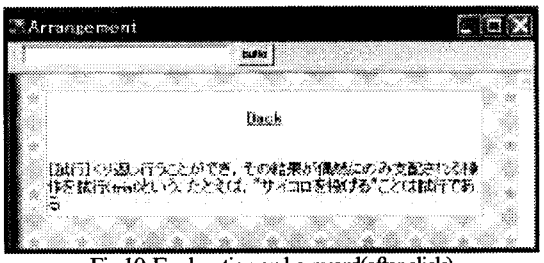

Fig.10. Explanation on keyword(after click)

III. RESULT AND DISCUSSION

The extraction rate of the explanation on 87 keywords for the Japanese textbook "Information mathematics[3]" is shown in Table I using the filter of (1)-(5).

Table I

The extraction rate of explanation

Filter	Right / Incorrect extraction	The extraction rate[%]
(1)+(2)	37/87	35.6
(1)+(3)	46/87	52.9
(1)+(4)	50/87	57.5
(1)+(5)	61/87	70.1

If the extraction of the wrong explanation of a keyword is found by a designer, he corrects the explanation manually. A target is full automatic extraction. Although the extraction method is specialized in textbook "information mathematics", the method is useful for this textbook. We are considering the other extraction rule for the other textbook. For example, some textbook includes the bold letters. The bold letters show the keywords. We are considering the bold letter extraction method.

IV. CONCLUSION

In this paper, we proposed a new automatic display method of an additional explanation on a keyword written by a lecturer for e-Learning using a pen capture tool on whiteboard and two cameras. The proposed display system uses the above lecture scene and image database with the time tag, and shows three windows, that is, the moving lecture scene by the pen capture tool on whiteboard, the moving image by the active camera and the window for the additional explanation of a keyword written by a lecturer on whiteboard if the students would request. We implemented the above system using MS-Visual C# .NET on Windows, and we confirmed the effectiveness of our method for some lectures.

The problems of extraction for the explanation are described as follows

(1) The full electronic text data of the other textbook is needed.

(2) Automatic character recognition software is desired for white board images.

(3) The dynamic index of keywords using the character on a whiteboard image is desired.

REFERENCES

[1] Shinji Tsuruoka, Toru Yamaguchi, Kenji Kato, Tomohito Yoshikawa, Tsuyoshi Shinogi, "A camera controk based on fuzzy behavior recognition of lecture for sistance, lecture", Proc. of the 10th IEEE Int. Conf. on Fuzzy Systems (FUZZ-IEEE 2001), pp.940-943,2001

[2]Dale Harris and Andy DiPaolo, "Adrancing asynchronous distance education using high speed networks", IEEE Trans. on Education, Vol.39, no.3, pp.444-449, Aug.1996.

[3]Junichiro Toriwaki, Naohiro Ishii, Shinji Tsuruoka, "Informartion mathmatics (in Japanese)", Ohm sha press, 2001