Design and Implementation of Kana-Input Navigation System for Kids based on the Cyber Assistant

Hiroshi Matsuda

Information Technology Center, Nippon Institute of Technology
4-1 Gakuendai, Miyashiro-Machi, Minami-Saitama-Gun, Saitama 345-8501, Japan

and

Yoshiaki Shindo

Department of Computer and Information Engineering, Nippon Institute of Technology
4-1 Gakuendai, Miyashiro-Machi, Minami-Saitama-Gun, Saitama 345-8501, Japan

Abstract

In Japan, it has increased the opportunity for young children to experience the personal computer in elementary schools. However, in order to use computer, many domestic barriers have confronted young children (Kids) because they cannot read difficult Kanji characters and had not learnt Roman alphabet yet. As a result, they cannot input text strings by JIS Kana keyboard. In this research, we developed Kana-Input NaVigation System for kids (KINVS) based on the Cyber Assistant System (CAS). CAS is a Human-Style Software Robot based on the 3D-CG real-time animation and voice synthesis technology. KINVS enables to input Hiragana/Katakana characters by mouse operation only (with-out keyboard operation) and CAS supports them by using speaking, facial expression, body action and sound effects. KINVS displays the 3D-Stage like a classroom. In this room, Blackboard, Interactive parts to input Kana-characters, and CAS are placed. As some results of preliminary experiments, it is definitely unfit for Kids to double-click objects quickly or to move the Scrollbar by mouse dragging. So, mouse input method of KINVS are designed to use only single click and wheeler rotation. To input characters, Kids clicks or rotates the Interactive Parts. KINVS reports all in-formation by voice speaking and Kana subtitles instead of Kanji text. Furthermore, to verify the functional feature of KINVS, we measured how long Kids had taken to input long text by using KINVS.

1. Introduction

In Japan, there are some serious domestic barriers in computer education of elementary schools, especially under 4th grade student (6-10 years old, called **Kids** in this paper).
These barriers are,

(1) They can't read Alphabetic characters.
(2) They can't read difficult Kanji characters.
(3) They do not study Roman alphabet (Romaji) yet.

Because of these barriers, it's very difficult for them to type in the long text by using keyboard. Of course, there are Kana key-tops on the JIS keyboard. (Figure 1) But most of Japanese people type in by the method of Roman alphabet conversion because Kana key typing is very difficult. The layout of English keyboard (QWERTY)

Figure 1 JIS keyboard and Kana key tops

was developed by the fruits of predecessor's researches about typewriter. But layout of JIS Kana keyboard was arranged according to the order of character code (JIS code). In actuality, students in most of high schools and universities are recommended to use the Roman alphabet conversion instead of Kana-key typing. Under 4th grade students in elementary schools cannot read the alphabetic characters, dose not study Roman alphabet conversion and can not read difficult Kanji characters. Because it takes long time for Kids to type in the word by using Kana key tops, they cannot concentrate to type in continuously. As a result, they cannot enter the filename and cannot enter the Hiragana and Katakana long text. As the effects, most of themes of computer education in elementary schools are restricted to the operation of the Painting Tool or Game Software [1]. Although these barriers exist, Kids can operate the mouse. They can click the Menu Items, Buttons on the Dialog-Box unless understanding the message meaning. The reason of it may be that they can memorize the process or order of operation to get their goal. If they get a tool to type in the Hiragana and Katakana long text strings, they would be able to enter the filename, type in the retrieval word of Internet web site and send the e-Mail message. To improve this problem, we developed the *Kana-Input NaVigation System for Kids* (*KINVS*) based on the *Cyber Assistant*. *Cyber Assistant* is a Human-Style Software Robot based on the 3D-CG real-time animation and voice synthesis technology.

2. System Design of KINVS

Mouse operation may be easy for Kids. But the points at issue of *KINVS* were,

(1) Let Kids concentrate to input the long text.
(2) Let Kids know the usage of *KINVS*.
(3) Let Kids feel fun to use.
(4) Let Kids know the information message.

As a one of solution of these, we had a try to develop a **Cyber Assistant System** (**CAS**) based on the 3D-CG real-time animation and voice synthesis technology.

2.1 System Structure of *KINVS*

KINVS is a 3D-CG application, which displays the working stage just like a classroom. In this virtual classroom, **Blackboard**, some of **Interactive Parts** to enter the character, and **CAS** are placed. (Figure 2)
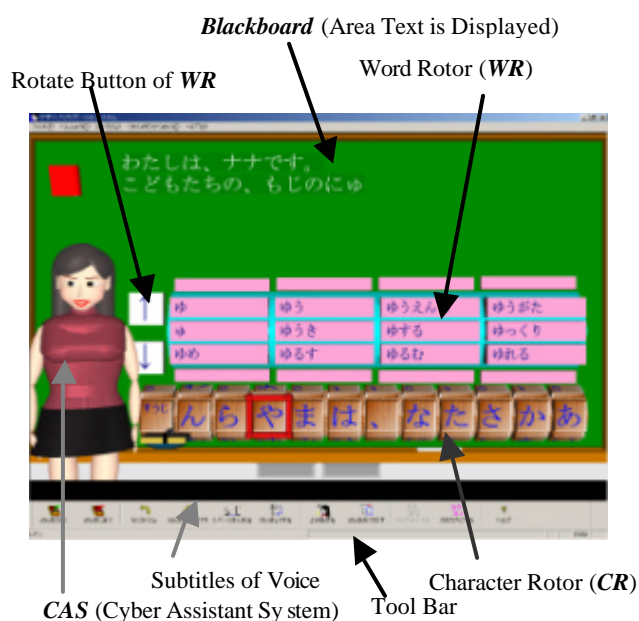

Figure 2　3D-Stage of *KINVS*

(1) Virtual Stage is a classroom in the school.
(2) **CAS** is a Human-Style Software Robot based on the 3D-CG real-time animation and voice synthesis technology.
(3) **Blackboard** is placed to display the text strings entered.
(4) Some **Interactive Parts** (Details in Section 2.3) are placed to which Kids clicks by mouse for entering the character.

The design concept of operation feelings is 3D-Game software. The reason of it is to let Kids feel fun to use, and to let them concentrate to input the long text. *CAS* responses the Kid's clicking to the *interactive parts* by voice answer and body action. *CAS* also reacts the Kid's clicking to the menu button by voice explanation. Moreover, *CAS* explains how to use *KINVS* any number

of times until Kids have understood. From this point of view, *CAS* may superior to a Human teacher.

2.2 System Structure of *CAS*

We already reported **Cyber Teaching Assistant** (**CTA**) system [3][4][5]. *CTA* is a Human-Style Software Robot based on the 3D-CG real-time animation and voice synthesis technology. *CTA* answers the student's question instead of the teacher when many questions rush to the teacher's cockpit in the computer seminar room *CAS* is developed by using the same technology. (Figure 3) The technologies of it are,
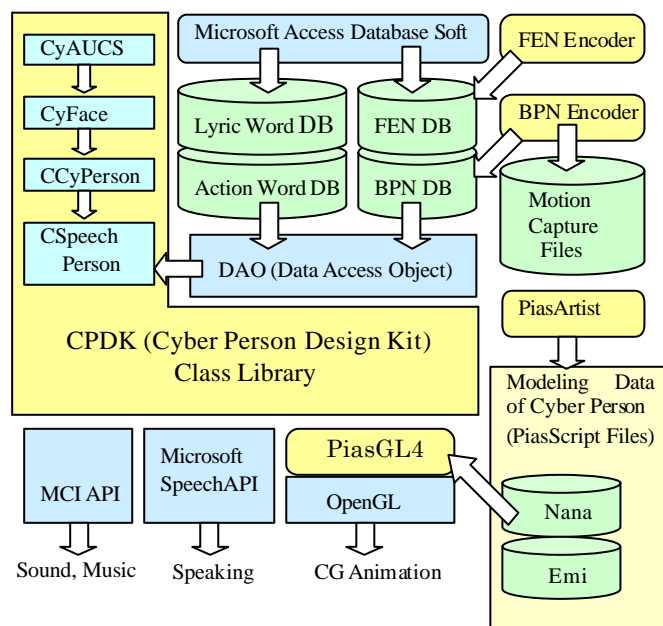

Figure 3　System Structure of CAS

(1) *CAS* uses the **OpenGL-API** for 3D real-time animation.
(2) *CAS* uses the **Microsoft Speech-API** to interface the speech synthesizer for voice speaking.
(3) *CAS* and *Stage Parts* are constructed by the 3D-CG interactive modeling tool named **PiasArtist** [6] we developed and they are saved as a Script files named **PiasScript** [6].
(4) **PiasGL4** [6] Library is the reinforcement library of OpenGL, which includes loading API of **PiasScript** file.
(5) *CAS* is implemented by the class library named **Cyber Person Design Kit** (**CPDK** [5])
(6) **CPDK** is a class library to implement the Human-Style Software Robot named **Cyber Person**.
(7) **CPDK** supports facial expression API and body action API of *Cyber Person*.
(8) **FEN Encoder** can make any facial expression of Cyber Person and save it to the **FEN database**.
(9) **BPN Encoder** can make any body action of Cyber Person and save it to the **BPN database**.

More detail information, refer bibliographies [3], [4] and [5].

2.3 *Interactive Parts* of *KINVS*

It took long time to design the **Interactive Parts** to enter the characters, which include Hiragana, Katakana, Numbers and some symbols. We developed some kinds of interactive parts and did the preliminary trial experiment. (Details in Chapter 3) The results of these experiments are,

(1) Double click was very difficult for Kids.
(2) Mouse Dragging was also difficult for Kids.
(3) List-Box with Scroll bar gave a strange feel.

But Kids gave a favorable attitude to the wheeler operation of mouse. Table 1 shows the contents of the *interactive parts*. **Character Rotor** (**CR**) includes 12 of rotated Hexagons; those surfaces include all of Kana characters, Numbers and some Symbols. Each Hexagon can be rotated independently by mouse wheeler. Kana-input method is as follows.

(1) Point the mouse pointer to the target Hexagon.
(2) Rotate the Hexagon by mouse wheeler.
(3) Click the wanted surface of Hexagon.

In this moment, clicked character is displayed on the **Blackboard** and **Word Rotor** (**WR**) is refreshed simultaneously. **WR** is a Rotated Drum and it displays 12 words those are connected with the clicked character. These words are registered in the **WR database** written by the XML format. If one of the words on *WR* (may be a wanted word) were clicked again, the character on the **Blackboard** would be replaced to the clicked word. As a reaction, *CAS* reads the entered character or word by voice speaking. At any time of operation, *CAS* reacts by voice speaking, facial expression and body action. Sometimes, the special sound effect plays to reply.

Table 1. Interactive Parts of *KINVS*

Contents	Function
Blackboard	Area on which entered text is displayed.
Character Rotor (**CR**)	12 of Rotated Hexagons.
Word Rotor (**WR**)	Rotated Drum. 12 Words are displayed.
Spacer	Insert one space.
New line	Change line on the Blackboard.
Back Spacer	Delete 1 character.
Text Eraser	Delete all text entered.
Mode Changer	Set Hiragana or Katakana mode.

2.4 Functional menu of *KINVS*

Table 2 shows the functional menu of *KINVS*. Every menu is located on the button of Tool-Bar. If button is clicked, *CAS* reacts by voice speaking to explain the function of it. **Text Reader** lets *CAS* read the whole text on the **Blackboard** to proofread the entered text. **Text Saver** saves the whole text string on the **Blackboard** to the file. Filename is assigned automatically and *CAS* informs the filename by voice speaking. This is because it's difficult for Kids to enter the filename.

Grade Changer changes the Kanji listings of **WR** database as the grade of Kids. So, Kids are able to use Kanji characters at their level. **Text Sender** is a powerful tool. It copies the whole text strings on the *Blackboard* to the Clipboard. After Kids enters the text and copies to the Clipboard by *KINVS*, they can paste it in the text area of the other application software. (For example, e-Mail software, Word processor or Internet explorer) *KINVS* can be used as a Front End Processor to another application software.

Table 2. Functional menu of *KINVS*

Button	Function
Text Reader	*CAS* reads the text by voice.
Text Saver	Save the text string entered.
Text Loader	Load the specified text file.
Grade Changer	Change the Kanji listings of **WR** as the grade of Kids.
Text Sender	Copy the text entered to the Clipboard.

2.5 The Role of *CAS*

CAS usually reacts the operation by voice speaking, facial expression and body action. Moreover *CAS* explains the usages of *KINVS*. Table 3 shows the listings of explanation. Figure 4 shows the example of the explanation of *CAS*, which is an explanation of *WR*. *CAS* explains the same explanation any number of times until Kids have understood. From this point of view, *CAS* may superior to a human teacher.

Table 3 List of explanation of CAS

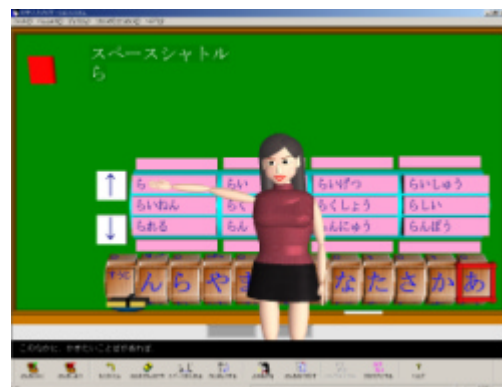| Menu	Explanation
CR	How to enter the character by *CR*
WR	How to enter the word by *WR*.
Katakana	How to change to the Katakana mode.
Hiragana	How to return to the Hiragana mode.
Read	How to read the whole text.
Backspace	How to delete one character.
Delete	How to delete whole text strings.
Save	How to save the whole text strings.
Load	How to load the text file.
Copy	How to copy the text string to the Clipboard.

Figure 4 Example of Explanation

a) 50-Hiragana Panel   b) Word List Box   c) All-Characters Rotor

Figure 5   Some kinds of *Interactive Parts*

3. Comparative Experiment

3.1 Preliminary Trial Experiment

It took long time to design the **Interactive Parts** to enter the characters, which include Hiragana, Katakana, Numbers and some Symbols. We developed some kinds of **Interactive Parts** and did the trial experiment by Kids. (3rd grade students and 4th grade students, they are 9 years old boy and 10 years old boy.) First version we developed was a 50-Hiragana Panel (Fig.5-a). This kind of input method has been used at portable computers, an automatic teller machine in Bank, book retrieval device in library in Japan or some Paint tools [2]. But as a result of experiment,

(1) It was too difficult to look for the wanted character.
(2) It tired the Kid's eyes very hard.
(3) Kids cannot concentrate to input the long text.

In this method, Kids can enter just word but cannot enter the long text. In 2nd version (Fig.5-b), we added the *Word List Box,* which is a standard list-box with scroll bar referred from word database we developed. As a result of the experiment,

(1) Double click was very difficult for Kids.
(2) Mouse dragging was also difficult for Kids.
(3) List-Box with Scroll bar gave a strange feel.

Kids also cannot enter the long text. But Kids gave a favorable attitude to the wheeler operation of mouse. Therefore, in 3rd version, we tested the All-Characters Rotor to see if it would work well (Fig.5-c). This method was,

(1) Rotate the Character Rotor by mouse wheeler.
(2) Click the candidate character or word displayed on the Blackboard.

But it did not work well, because it takes long time to look for the wanted character by rotating the *All Character Rotor.* And the distance of mouse moving to click was too long. Considering the preliminary experiments mentioned above, we decided the interface design of *KINVS*.

3.2 Comparative Experiment by using *KINVS* and JIS Kana keyboard

To verify the functional feature of *KINVS*, we did the comparative experiment by using *KINVS* and JIS Kana keyboard. Figure 6 shows the scene of experiment.
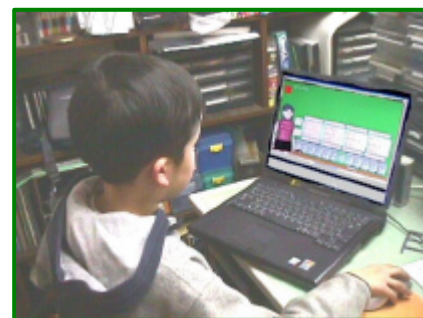

Figure 6   The scene of Experiment

Participants are three adults and 2 Kids. Kid1 is 4th grade and Kid2 is 3rd grade student of elementary school. To improve the precision of experiment, we decided to use a theme song of TV animation picture as a manuscript, because Kids already memorized the words of a song. It includes **66 characters** and it took about **45 seconds** to type in by using the Roman alphabet conversion.

Before experiment, *CAS* instructed how to use *KINVS*. Kids looked at *CAS* many times with interest. Human instructor did not instruct at all. Kids enjoyed studying how to use *KINVS* and participated this experiment with pleasure. But after 1st experiment, Kids asked some modification. According to the request, we changed the arrangement of Hexagons in *CR* and inversed the direction of rotation. Figure 7 shows the result of comparative experiment.
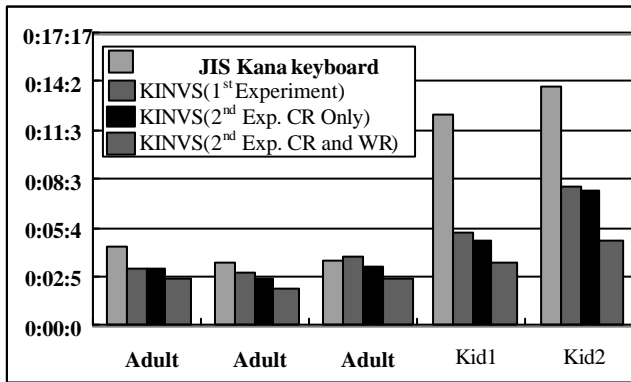
Figure 7 Result of comparative experiment.

In this experiment, participants entered the manuscript by using only *CR*, then re-entered by using both *CR* and *WR*. The current version of *WR* database includes only common nouns connected with the manuscript.
The results of this experiment are,

(1) It took long time for Kids to enter the manuscript by using JIS Kana keyboard.
(2) Kids entered the manuscript rapidly by using *CR* operation of *KINVS* within a half of input time of Kana keyboard.
(3) Kids entered the manuscript very quickly by using *CR* and *WR* operation of *KINVS*.
(4) *WR* database connected with the manuscript was very powerful function.

4.   Conclusion

We have described the summary of *KINVS* and reported the result of comparative experiment. Kids entered the manuscript rapidly by using *KINVS*. *WR* was very powerful tool. But current version of *WR* database is poor. To develop a *WR* database suitable to each children's ability is necessary as a future work. This point at issue is Japanese domestic problem. But there are many non-English native children in the world. To improve this problem, it's important to consider the *Low-Aged children to Machine* interface suitable for each native language of countries.

5.   References

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