Voice-Controlled Typesetting Robot of Alphabets for Children Learning

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Abstract

Humanoid robots are moving from the factories into our homes to imitate human actions or to do works in our daily life. Thus, the interaction between users and humanoid robots becomes more and more important in these applications. On the other hand, more and more applications of robots help people in training or education. This work has designed a voice-controlled typesetting robot of alphabet letters which can help those physically disabled to select the alphabet letters they want by voice as well as help with the learning of English letters for children. A simplified prototype of such design has been proposed in this paper. By a proper arrangement of microphone, actuators and mechanism structure, the chosen alphabet letters by voice input can be displayed by typesetting of bricks within a 3X3 grid plate via the operation of a robotic arm. Some experimental results are given to validate the satisfactory performance. Besides, 20 children between 2 and 5 years old are randomly chosen to play with this prototype and a primary conclusion is therefore summarized also shown in the proposed paper.

Keywords

Language Learning for Children; Assistant Robot; Voice-Controlled

Introduction

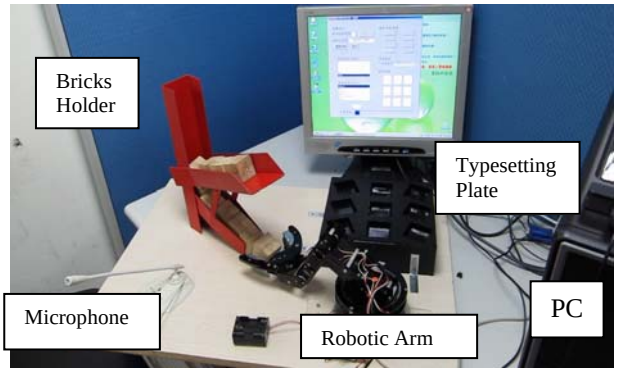
The robotic application which addresses the fundamental issues in coexistence of people and robots from psychological and philosophical aspects over interaction and communication mechanisms to architectures and technological systems is popular nowadays. [Seong and Takahashi, 2007][Shieh, etc., 2006][Taipalus and Kosuge, 2006][Hashimoto, etc., 1997] Along with gradual development of those fundamental robots which developed from basic tools to unique entities which are not only able to assist people but may also deal with situations arising in near future. Especially for helping elder people, medical applications and learning purposes, assistant robots play important roles in our daily lives. [Kim, etc., 2004][Loehr, etc., 2003] On the other hand, for children who have problems with focusing on learning but interested in motion, the proposed robotic system can help them increase their interest in alphabet's learning with typesetting the chosen English letters by bricks within a plate of 3X3 grid. Besides, speech recognition technology becomes more and more popular in the applications of robotic systems. [Xiong, etc., 2007] In order to create a learning tool for both formation recognition and pronunciation of English letters, a voice-controlled robotic system seems to be a good resolution to help children in learning foreign language with interesting. Certainly, the pronunciation of the chosen letters is also detected in the proposed system to help the children with correct pronunciation of the chosen letters. [Lee, etc., 2011] A voice controlled CD feed forward system based on microprocessor had also been developed with satisfactory performance of speech recognition. [Lee, etc., 2008] Based on such design concept, the voice-controlled typesetting robot of alphabets is therefore developed to help children with learning of English letters. Some experimental results of a prototype are shown to validate the performance of such robot. Children are interested in action and formation of the typesetting robot rather than alphabets written on paper. With the help of such design, children will have a better and interesting start in learning English.

In addition, there are many literatures about language learning with the help of technology. [Wible, etc., 2003][Hui, etc., 2008][McLoughlin and Oliver., 1998] Using computers constructs the environments for language learning. Some discussions concern about the difficulties of language learning of children and propose some methods to get better performance. [Miller, 2002][Anderson, 2011] Garrett gave a detailed description of the technology in service of language learning. Based on the above literatures, technology in service of children learning in language should be an important issue now and future. Besides, English learning in Taiwan is very important, in which

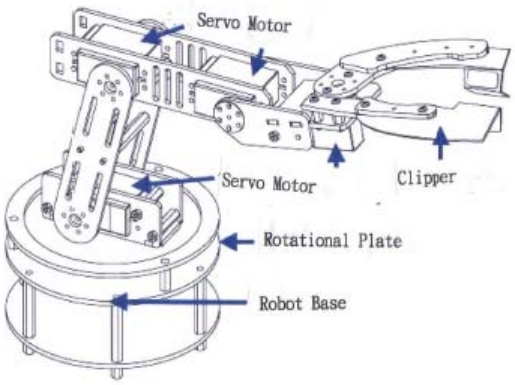
students learn English from 5 years old from pre-elementary school to high school, and after 10 to 13 years of English learning, English speaking becomes nightmare for many students. Many students are not interested in English learning since childhood. Therefore, the proposed paper hopes to increase the interesting of learning English. Begin with English letters, using typesetting bricks to form an English letter by user's voice input. Children can be attracted by the robot and focus on the formation of the English letters and furthermore learn the correct pronunciation of the chosen English letter. There are 4 English letters demonstrated in the experiment with the prototype of such design. Another experiment is conducted and shown in this paper with 20 children of age 2-5 to validate the performance of learning of English letters.

Methodology

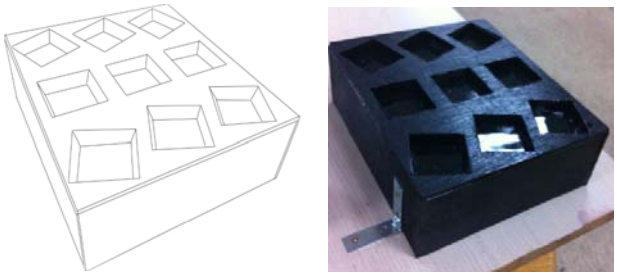
The typesetting bricks bring joy to the children in our daily lives for a long time. As mentioned previously, children are not easy to keep attention on learning for a period of time if the process is dull and plain. Therefore, a voice-controlled robot is helpful to make them devote their attention in learning. In the proposed scheme, one of the most importance teaching strategies is to increase children's interests in learning English while playing the robotic system. The worst part of learning English in Taiwan is to speak in English. Many students still cannot speak English fluently because they had a terrible learning start when they were children. Due to the ignoring of speaking English, many students are afraid of speaking English even they had learned English for over ten years. The proposed robotic system tries to let children learn English while playing and pronouncing the letters to drive the robot. During the process of learning, teachers can demonstrate the correct pronunciation and make the learning interesting but scaring. The proposed scheme tries to build a pleasant learning environment in English in the first place. Moreover, children have to give the vocal commands to drive the robot typesetting the correct. This proposed robotic system is composed of a microprocessor (SPC061A by Chirkal co.), robotic arms, some cubic bricks and a 3X3 typesetting plate and this system is operated under the voice inputs given by the user via a microphone. As shown in Fig. 1(a), the overall system of the voice-controlled typesetting robot of alphabet is composed of several parts: a robotic arm (Fig. 1(b)), the 3X3 grid typesetting plate (Fig. 1(c)), a bricks holder (Fig. 1(d)) and the controller part (PC). Fig. 1(e) shows the control board which provides the voice function and the power stage to drive the robot with a microprocessor on it. There are five motors within the robotic arm to hold up the bricks and place them into the slots on the typesetting plate.



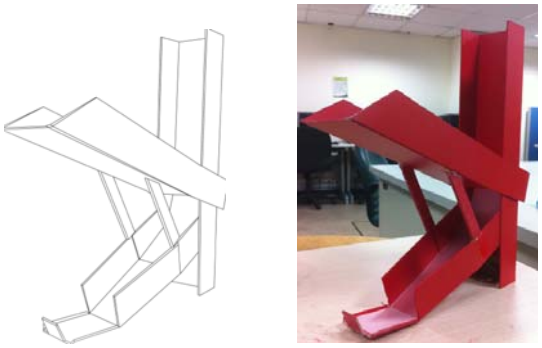
(a) PHOTO OF OVERALL SYSTEM



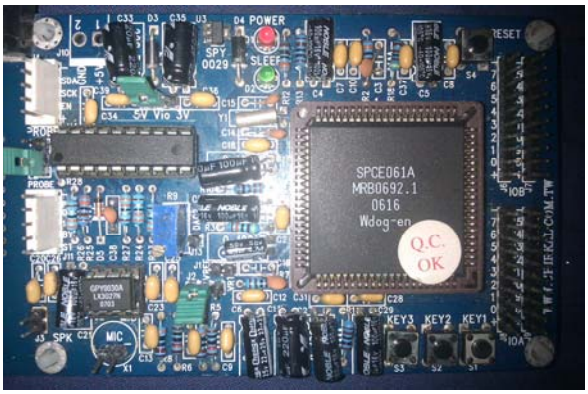
(b) SKETCH OF THE ROBOTIC ARM



(c) 3X3 GRID TYPESETTING PLATE



(d) BRICKS HOLDER



(e) CONTROL BOARD

FIG. 1 PHYSICAL STRUCTURE OF THE PROPOSED ROBOTIC SYSTEM

The sketch of control process is shown as Fig. 2 below. The following description will be helpful to explain how the mechanism works. Firstly, the voice reference should be loaded into the memory of PC by the teacher for identifying the input voice signal from the microphone by the children. Secondary, the user (child/student) gives a voice command from the microphone into the microprocessor via the A/D transformation of the control circuit mounted on the control board. Then the PC begins to identify which alphabet letter should be chosen if the pronunciation is not correct then a voice will be given as "Please try again" to encourage children to do it again and the same time, the teacher can come to the children for a correct demonstration. Lastly, after command being identified, the robot arm holds up the bricks one by one and places them in the proper locations of the typesetting pate to demonstrate the chosen alphabet letter. Children then learn not only pronunciation but also recognition of the alphabet letters.

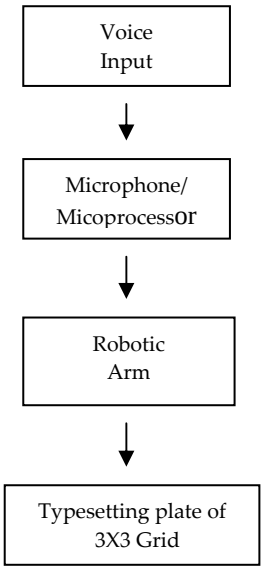


FIG.2 THE SKETCH OF THE CONTROL PROCESS

With a web-controlled interface being developed, the typesetting robot of alphabet letters system can also be driven and illustrated on screen. Fig. 3 shows the letter "I" being demonstrated both on the typesetting plate and the computer screen. With the help of three bricks, the alphabet letter "I" is displayed both on the PC screen and the typesetting plate.

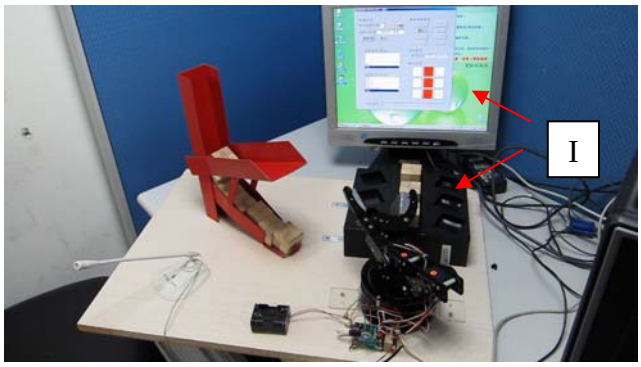


FIG. 3 THE LETTER "I" BEING SHOWN ON BOTH PLATE AND SCREEN

The prototype is equipped with a robotic arm to place the bricks on the 3X3 grid plate within the proper positions to demonstrate the chosen alphabet letter. The PC is capable of differentiating the different alphabet letters. On the other words, the PC has the ability of speech recognition. The structure of robotic arm is assembled by plastic holders and outriggers to make a wide range of working area. All the behaviours of the proposed prototype are controlled by a PC as shown in Fig. 1.

For convenience of the learning of children in Taiwan, the web page is written in Chinese. As each step being taken, the web page will show the status of the 3X3 grid of the robotic system simultaneously. Such a system provides not only a voice controlled system but also a web controlled system.

Experimental Results of the Robot

Due to the limitation of 3X3 grid typesetting plate, the experiments are conducted as followings to demonstrate the typesetting results of these letters "I", "L", "T", "H" and one return process. To make the explanation simple, the term "Letter Y" represents the alphabet letter "I", "L", "T", and "H" in the following descriptions. In the beginning, a voice command "Letter Y" is given by the user via a microphone and the voice signal is translated into electronic signal. PC receives the electronic signal of voice command and compares it with the existed voice database to recognize the input letter. After the chosen "Letter Y" being recognized, the robotic arm begins to hold up

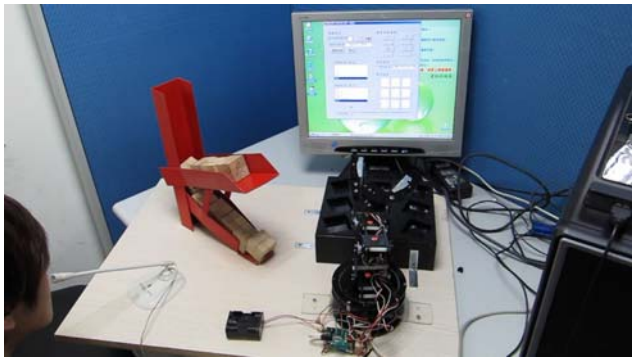
bricks and place them into the slots of the 3X3 grid typesetting plate to form the "Letter Y". Finally, the "Letter Y" is demonstrated on both computer screen and the typesetting plate. Thus, the completeness of typesetting of "Letter Y" is concluded. If the pronunciation of "Letter Y" is incorrect then the comparison with the database will fail. And, PC will answer "please repeat again" from the speaker to ask for another voice input. Unless the correct pronunciation is recognized, the robot won't take any further step but hold still.

Letter "I"

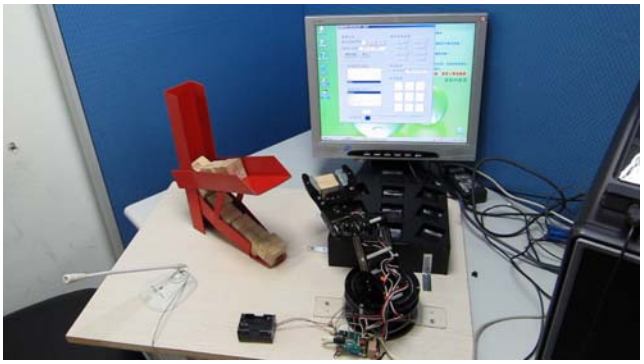
Fig. 4 shows the result of the voice controlled process of typesetting of letter "I". Fig. 4(a) shows a voice command "I" is given by the user via a microphone. PC receives the voice command and compares it with the voice database to recognize the input letter. After the chosen "I" being recognized, the robotic arm begins to hold up bricks as shown in Fig. 4(b) and place them into the slots of the 3X3 grid typesetting plate as shown in Fig. 4(c). Finally, the "I" is demonstrated on both computer screen and the typesetting plate as shown in Fig. 4(d).

Letter "L" "T" and "H"

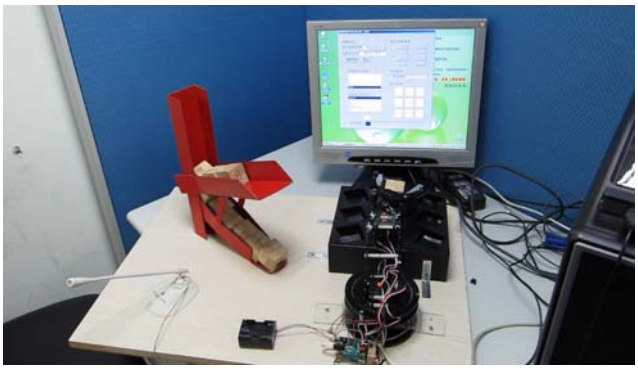
As same as Fig. 4 (d), Fig. 5 shows the final result of typesetting of letter "L". And, Fig. 6 and Fig. 7 are the experimental results of letter "T" and "H", respectively. In the processes, all the letters have the same procedure as demonstrated in Fig. 4(a) to Fig. 4(c).



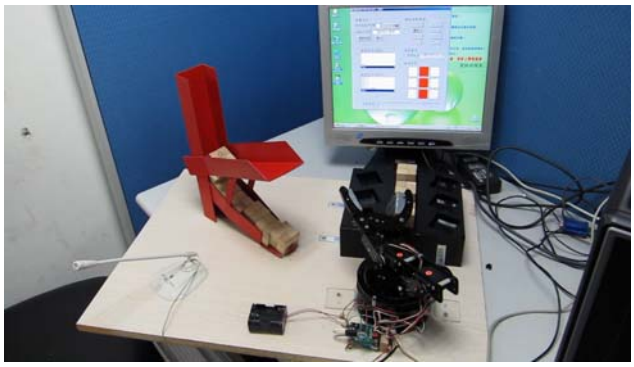
(a) INPUT OF VOICE COMMAND



(b) HOLD UP THE BRICK



(c) PLACE THE BRICK INTO SLOT



(d) THE LETTER "I" IN PLACE

FIG. 4 THE PROCESS OF TYPESETTING OF LETTER "I"

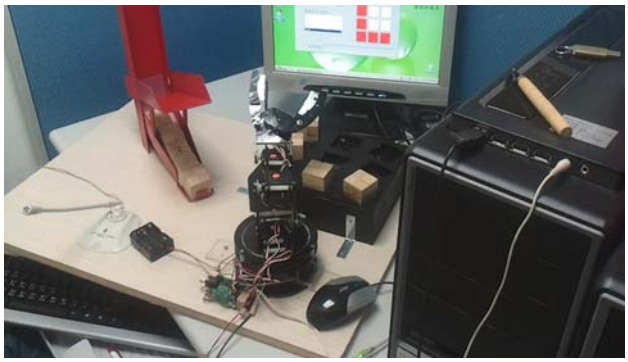


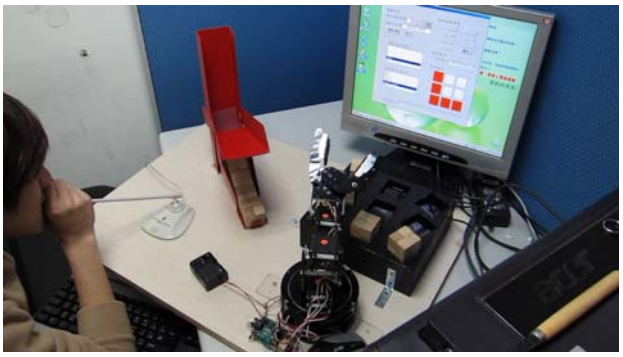
FIG. 5 THE RESULT OF TYPESETTING OF LETTER "L"

FIG. 6 THE RESULT OF TYPESETTING OF LETTER "T"

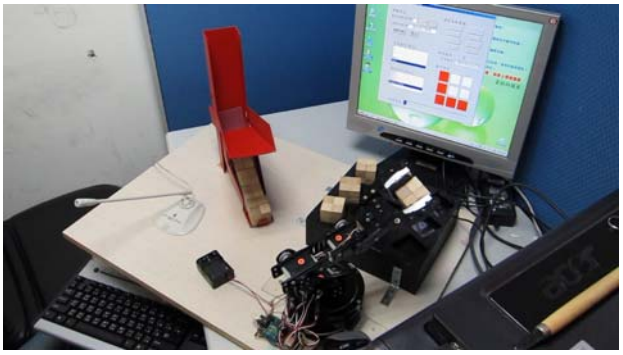
FIG. 7 THE RESULT OF TYPESETTING OF LETTER "H"

Return process - letter "L " for example

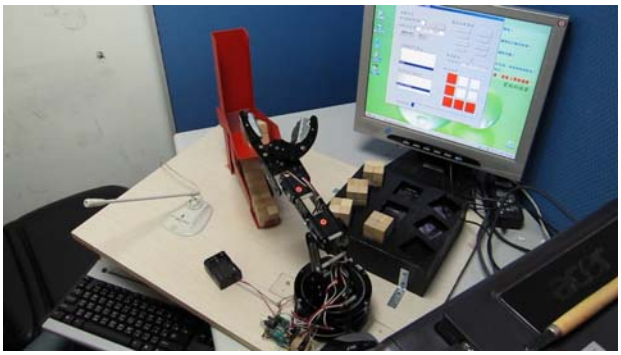
Fig. 8 shows the result of the voice controlled return process of letter "L". In Fig. 8(a), a voice command "Return" is given by the user via a microphone. PC receives the voice command and compares it with the voice database to recognize the command. After the command "Return" being confirmed, the robotic arm begins to hold up bricks on the plate as shown in Fig. 8(b) and place them back to the slot on the bricks holder one by one as shown in Fig. 8(c). Finally, the letter "L" is missing from the plate as well as the computer screen as shown in Fig. 8(d). Thus, the completeness of return process is concluded. If the pronunciation of command "Return" is incorrect then the PC will answer "please repeat again". Unless the correct command is given, the robotic arm holds still without taking any further step.



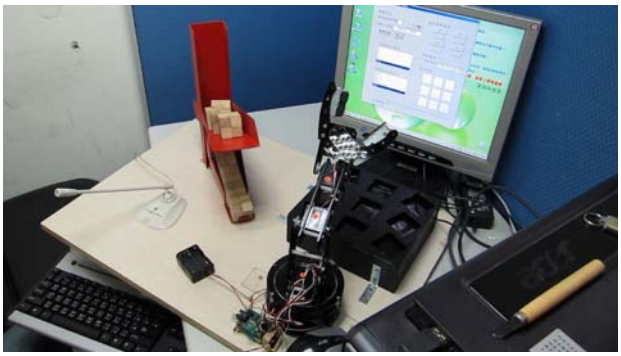
(a) INPUT OF VOICE COMMAND



(B) HOLD UP THE BRICK



(C) PLACE THE BRICK BACK TO HOLDER



(D) THE LETTER "L" IS MISSING

FIG. 8 THE RETURN PROCESS OF LETTER "L"

If the voice commands of letters are successively given without "return" in between, the control program will force the robotic arm to run "return" process in advance to avoid the collisions among bricks.

Result and Discussion

In Taiwan, children begin to learn English in 5 years old mostly. After 10 years of English learning, many of the students are afraid of speaking English. If the learning of English is more like playing, not only learning of the formation of English letters but also the pronunciation of the English letters, then the interesting and effeteness of English learning for children will be increased. In this paper, 20 participated children who are between 2 to 5 years old, including 12 boys and 8 girls, in the program, are randomly chosen in the experiment, and some of them have already learned English letters and pronunciation. Before the experiment, few demonstrations of the proposed robotic system had been deployed for them. Most of all, we wanted to make the children fell interesting in the bricks and the robotic arm. Before playing the proposed scheme, a simple card reading test was hold to record the understanding of alphabet letters of all the children. Then, after a series of playing, running and screaming, another simple test was conducted and documented

after two hours of playing the robotic system. We documented their behaviours in the experiment as shown in Table 1. There are times of success, failure and total playing for different ages listed in the table. Besides, the children are asked to evaluate the interesting grade for the system from 1 to 5, of which grade 1 means less interesting and 5means most interesting based on their own experiences.

In Table 1, it showed that children of age 2 easily failed in the experiment because of the absent mind and wrong pronunciation of this age but they showed much interesting in bricks and the motion of robotic arm. On the other hand, children of age 3 and 4 were with higher successful rate than children age of 2 and they were interesting in formation and pronunciation of English letters during the experiment. The children of age between 3 and 4 are capable of doing things with their own will. Besides, their vocal ability is much better than the children of age 2. Finally, the children of age 5 might felt the experiment boring and simple to them. Therefore, the children of age 5 were not as focused on the proposed scheme as the children of age 3 and 4 did. In brief, children of age 3 maybe the best age to begin their English learning. Because at that time they are full of energy and fell interesting in almost everything. If the learning language starts from the children age of 3, the effectiveness will be revealed. Table 2 shows the difference between boy and girl in English learning via the help of the proposed robot. In age 2 to 5, gender seems no much difference in the results of this experiment. There is no comparison with normal classroom learning of English letters in this article because the main purpose of the proposed scheme is to submit an interesting learning of English letters for children.

TABLE 1 PROFILE OF CHILDREN OF AGE 2 TO 5 IN EXPERIMENT

Age	2	3	4	5
Children no.	3	5	7	5
Success	3	20	26	12
Failure	18	10	11	4
Total	21	30	37	16
Successful rate	0.14	0.67	0.70	0.75
Playing times/child	6.7	6	5.3	3.2
Interesting Grade	4.33	4.8	4.4	3.4
Recognition of the letters after experiment	58% (7/12)	85% (17/20)	93% (26/28)	95% (19/20)

On the other hand, learning English in Taiwan is easy in reading but difficult in speaking. Many students are afraid of speaking English because of bad pronunciation. But the children of age 3 fear nothing which is another important factor to start their learning in foreign language with both formation and pronunciation of basic alphabet letters. When children first saw the proposed robotic system, they were curious about the robotic arm and bricks. During the experiment, the children of age 2 were absent minded and played with the bricks after few minutes' attention. Meanwhile, the children of age 5 showed their boring expression after twenty or thirty minutes of playing with the robotic system. In my observation, the children of age 3 and 4 paid most attention on the proposed system and showed the effective performance in learning English alphabet letters.

TABLE 2 PROFILE OF THE EXPERIMENT OF CHILDREN BETWEEN BOY AND GIRL

Age	2		3		4		5	
gender	M	F	M	F	M	F	M	F
Children no.	1	2	3	2	5	2	3	2
Success	1	2	13	7	17	9	8	4
Failure	7	11	6	4	8	3	3	1
Successful rate	0.14	0.18	0.68	0.64	0.68	0.75	0.73	0.8
Interesting Grade	5	4	4.67	5	4.4	4.5	3.6	3

Conclusions

Bringing robots as assistants into homes or education is important tasks for robot application now and future. This work has successfully developed a prototype of the voice controlled typesetting robot of alphabets which can help children with learning English letters. If the voice input of the pronunciation of the chosen English letter is correct then the physical formation of that letter will be demonstrated by typesetting bricks on a plate. The proposed scheme can increase the interest of English learning for children. And a side product is also developed in the system which is the web-controlled type of such scheme. With proper arrangement of network, the web-controlled typesetting robot can work in a long distance, which may help teachers to monitor the learning of children at home. Thus, a prototype of the bi-mode voice and web controlled typesetting robot of alphabets is therefore developed. Besides, via the

proposed scheme, an experiment of 20 children has been conducted to evaluate the performance of such design. The experimental results show that the children of age 3 are the proper age to begin to learn English letters as their first foreign language. Besides, different genders of children of age 2 to 5 seem no much difference in the results in the experiment. The proposed typesetting robot can increase the effectiveness of children in learning English alphabets. Furthermore, the proposed scheme provides an environment for children to learn English while playing.

ACKNOWLEDGMENT

This paper is partially sponsored by the project NSC 100-2221-E-147-004 of National Science Council, Taiwan. The author also thanks the co-authors in [8] for their help in experiments of the early work.

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