A Humanoid Robot as a Teaching assistant for primary education

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***Abstract*—In this paper, we propose an IDML tools which can provide teachers a humanoid robot to help them for engaging teaching activities in a classroom. Teachers can use this humanoid robot as a teaching assistant for providing an interactive learning experience to students. In order to evaluate the teaching efficacy of humanoid robot, we conducted a trial experiment in the primary education. Formative evaluations of the experiments not only proved that the humanoid robot can promote students' learning interest, but also found that humanoid robots have potential benefits for primary education and the possibility of robot-aided education in the classroom.**

Keywords-humanoid robot; primary education; robot-aided education; teaching assistant.

I. Introduction

In recent years, a new wave of robot research has enabled the development of humanoid robots which interact with their users in a natural manner through physical body and actions. They are expected to play increasing roles in many fields of interaction, such as entertainment, education, security, rescue, elderly care, guiding and so on [1]. Humanoid robots are a new type of robot whose have a physical body to attract humans' attention and interact with them in socially meaningful ways [2, 3]. A number of research asserted that actions of a humanoid robot give strong impression to users [4-6]. When the robot raises his hand, it will attract users' attention to focus on the robot. Furthermore, several researchers and companies have strived to develop robots as partners for people, such as Honda's ASIMO [7], Sony's AIBO [8] and Kismet [9]. They provided the opportunities for users to touch and communicate with pet robots or humanoid robots. In other words, humanoid robots could be regarded as successful social actors.

Furthermore, more and more studies begin to apply humanoid robots to support teaching and learning in a classroom. Such robots are called teaching assistant robots in educational environments. Few of research use teaching assistant robots to be instructional tools to help teachers for designing learning activities and presenting materials. For example, Seymour Papert [10] found that children can learn from designing and assembling their own humanoid robots. Martyn Cooper and his colleagues [11] asserted that teaching assistant robots can capture the imagination of many younger people, so such tools are regarded as useful aids to teach mathematics and physics course. Chin-Wei Chang and his colleagues [6] indicated that the robot can create an interactive and engaging learning experience, thus it can attract students' attention and help them to develop problem-solving abilities. Most of such research suggests that teaching assistant robots could support teaching and enhance learners' enjoyment and engagement.

In this paper, we propose an IDML tools which can provide teachers a humanoid robot to help them for engaging teaching activities in a classroom. The humanoid robot called Bioloid which is a hobbyist and educational robot kit produced by the Korean robot manufacturer Robotis. We use this robot as a teaching assistant for providing an interactive learning experience to students. The IDML tools can be installed on a PC to support teachers' to edit instructional materials, and further directed students to learn these materials and interact with the teaching assistant. The goal of this paper is to explore potential benefits of using humanoid robots for primary education and the possibility of robot-aided education in the classroom. The evaluation results also are gathered and analyzed from students' questionnaires.

The remaining sessions of this paper are organized as follows. In the session 2, we introduce the structure of IDML tools. In order to demonstrate the satisfaction level of the humanoid robot, the experimental evaluation is given in session 3 as demonstrations. Lastly, session 4 gives the conclusion and future works of this paper.

II. The IDML Tools

The IDML tools include an IDML-based authoring tool and an IDML-based learning system with the humanoid robot respectively. Fig. 1 shows the structure of IDML tools.

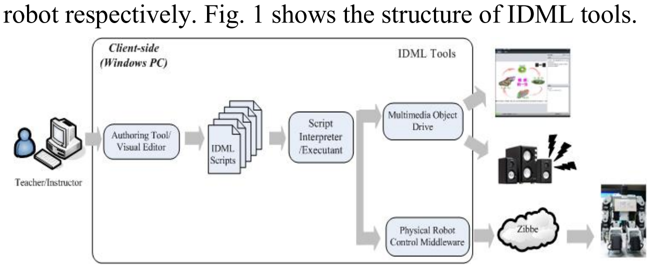

Figure 1. The structure of IDML tools.

978-0-7695-4449-6/11 $26.00 © 2011 IEEE
DOI 10.1109/ICGEC.2011.13

A teacher should design and author subject matter in multimedia content and pedagogical agency. The IDML-based authoring tool provides a visual editor for a teacher to design material contents by selecting and deploying the source multimedia objects (e.g., images, video/audio files, etc.) from his expertise domain knowledge. The teacher can also script a humanoid robot by configuring its behaviors, motion patterns, as well as speech. Then, the authoring tool produces a teaching material documented in IDML-based curriculum scripts: Lesson Script, Segment Script, and Tutor Script [12]. Each part of IDML-based curriculum scripts is executed by the script interpreter for translating into IDML commands included multimedia object play commands and physical robot control commands. The IDML commands are sent from the script executant, and then present multimedia materials by invoking the corresponding multimedia object players and control the humanoid robot by invoking the physical robot control middleware.

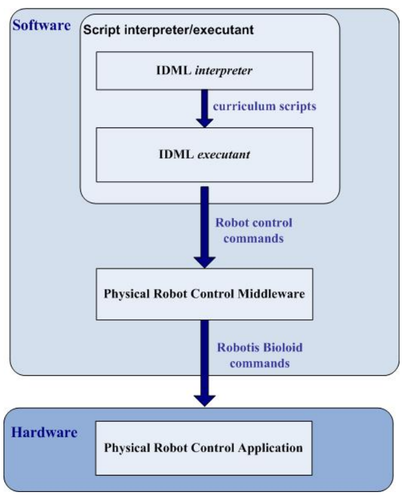

Figure 2. Physical robot control middleware diagram.

It is worth to be mentioned, we have developed the physical robot control middleware to control the Robotis Bioloid via a Zibble connection. When the middleware receives physical robot control commands, it will translate these commands to Robotis Bioloid commands which are sent through Zibble connection to the physical robot. In other words, the physical robot control middleware is used to control the humanoid robot at the hardware environment. Fig. 2 diagrams the physical robot control middleware to translate IDML-based curriculum scripts into Robotis Bioloid commands.

A. IDML-Based Authoring Tool

The IDML-based authoring tool provides a visual editor allowing teachers to create, delete, and modify IDML-based curriculum scripts. The basic functions, such as ‘Create’, ‘Open’, and ‘Save’, are deployed on a panel shown in fig. 3. Teachers are able to create a new material or modify an existing humanoid robot’s action by using this authoring tool. All of the operations can be undertaken simply by mouse-clicks and key strokes.

Figure 3. The IDML-based authoring tool.

Fig. 3 shows the user interface of the IDML-based authoring tool. There are three main sections: *Lesson Management*, *Segment Setting*, and *Tutor Setting* [12]. When a teacher creates a new curriculum by using the authoring tool, a lesson script will first be generated. In the *Lesson Management* section, there is a canvas to display the current lesson structure in a graph consisting of segments. Teachers can add or delete segments, and then the lesson structure can be repainted immediately. As a teacher selects a segment, the *Segment Setting* section is thus started. Teachers can use several source assets regarding a common subject to describe the selected segment. For example, he can select an existing multimedia file (e.g., images) to present the theme of the segment. The *Tutor Setting* section provides a form for teachers to maintain the humanoid robot in the current segment. It allows adding or removing a humanoid robot’s action in the current segment. The current presence sequence of a humanoid robot is also displayed.

Figure 4. The behavior editor of physical robot.

In [13], they asserted that users may feel boring with repeated movements of the humanoid robot. Thus, in order to enhance the diversity of behaviors, we also provided a behavior editor of physical robot for teachers to create custom-made actions. Fig. 4 shows the user interface of the behavior editor. The editor is able to combine the available activities of physical robot to form a new action module for satisfying teachers' personalized requirements. For example, if the teacher wants the humanoid robot to lift its arm with a walk-forward action at the same time, he can use the behavior editor to make both actions work simultaneously.

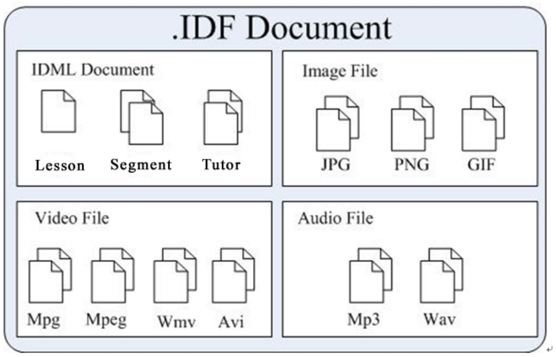

Figure 5. The IDF document structure.

When the teacher finishes his editing work, the IDML-based authoring tool will encapsulate all files including IDML-based curriculum scripts, image, video and audio into an IDF (IDML Data Files) document. Fig. 5 shows the structure of IDF document. IDML-based learning system will load and implement the IDF document which is assigned by the teacher to present teaching content for students.

B. IDML-Based Learning System With Humanoid Robot

The IDML-based learning system not only presents multimedia teaching materials, but also provides the humanoid robot to be the teaching assistant to support teachers to show teaching contents. Fig. 6 shows the main page of the IDML-based learning system with the humanoid robot.

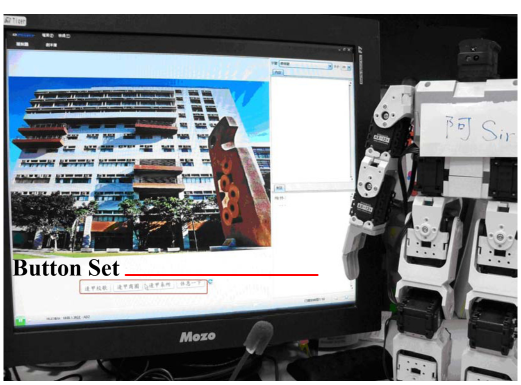

Figure 6. The IDML-based learning system with humanoid robot.

In this learning system, students can read the teaching content on the screen and also accept advice from the humanoid robot. The humanoid robot is stand on the desk near the screen. Different from multimedia materials in computers, the humanoid robot exists in the real world. The *Button Set* section deploys a set of buttons which were specified by the teacher. The student can interact with the humanoid robot through pacing control by buttons.

III. EXPERIMENTATION AND RESULTS

In this experimentation, we carried out a pilot evaluation to investigate the possibility of IDML-based learning system with the humanoid robot in a classroom. Fig. 7 shows a teacher instructed students to interact with the humanoid robot in a classroom.

Figure 7. The teacher instructed students in interacting with the robot.

All students filled the questionnaire to verify their attitudes toward the humanoid robot in the classroom. We want to know the influence of applying a humanoid robot in a computer-assisted learning environment. In table 1, we list 10 questions in the questionnaire to show some thought of students.

TABLE I. RESULTS OF APPLYING THE ROBOT IN A CAL ENVIRONMENT

Questions	Mean(SD)
Q01. You are satisfied with having the physical robot in your learning.	4.79(0.62)
Q02. The physical robot helps you to understand more about the "Science and Technology" course.	4.82(0.54)
Q03. The physical robot makes me more like this class.	4.86(0.35)
Q04. I think the physical robot's motion is very funny.	4.76(0.62)
Q05. The physical robot resembles a friend of yours and helps you to learn the content of materials.	4.71(0.71)
Q06. When the physical robot cheers me, I will feel very happy.	4.86(0.52)
Q07. You feel relaxed while learning with the physical robot compared with a human teacher.	4.79(0.49)
Q08. The physical robot performs with the teacher very well.	4.82(0.47)
Q09. Compare to other multimedia materials, I more like the physical robot in class.	4.93(0.37)
Q10. I wish the physical robot will appear in next class.	5.00(0.00)
The overall average score.	4.83(0.47)

Table 1 shows that the overall average score is 4.83, indicating that the majority of the students are highly satisfied with integrating the humanoid robot in the proposed computer-assisted learning system. All mean values of the questions are higher than or equal to 4.00, which means that the students hold affirmative opinions.

IV. CONCLUSION AND FUTURE WORKS

In this paper, we developed an IDML tools which can provide teachers a humanoid robot to help them for engaging teaching activities in a classroom. Our IDML tools provides not only the IDML-based authoring tool for teachers to generate teaching materials and arrange the humanoid robot's actions, but also the IDML-based learning system for students to interact with the humanoid robot and involve in learning activities. Then, we have finished empirical evaluations through questionnaire method to understand students' attitudes toward the humanoid robot. The result of questionnaires revealed that over 90% students prefer to use our learning system to engage in learning activities. Especially for the humanoid robot, it gives a better impression for students and grabs the main focus of students' attention. All students wish that the humanoid robot is able to appear in class next time.

However, our experiment is conducted to Taiwan elementary schools, thus the evaluation results only explain that the IDML tools has a teaching efficacy for elementary education. In the future, we want to extend our application to different educations, such as high school education and college education, etc. We hope to cooperate with the teachers and students with different background, and further to investigate the teaching efficacy of the IDML tools. In addition, Robotis Bioloid is too small to be used in a classroom which has more than 25 students. It also not has enough senses to receive all interactive messages from students or teachers. With the development of robotics, it is possible to have a cheap and more suitable robot to perform in the classroom.

V. ACKNOWLEDGMENTS

This work is partly supported by the National Science Council, Taiwan under the Contract No. NSC-97-2221-E-468-005 and NSC-99-2221-E-468-006.

REFERENCES

[1] Yoshitaka Nishimura, Kazutaka Kushida, Hiroshi Dohi and Mitsuru Ishizuka, "Development of multimodal presentation markup language MPML-HR for humanoid robots and its psychological evaluation," International Journal of Humanoid Robotics, Vol. 4(1), pp. 1-20, March 2007.

[2] Takayuki Kanda, Takayuki Hirano, Daniel Eaton and Hiroshi Ishiguro., "Interactive Robots as Social Partners and Peer Tutors for Children: A Field Trial," Human-Computer Interaction, Vol. 19(1), pp. 61-84, June 2004.

[3] Liang-Yi Li, Chih-Wei Chang and Gwo-Dong Chen, "Researches on Using Robots in Education," In Proceedings of 4th International Conference on E-Learning and Games, Edutainment pp. 479-482, Banff, Canada, August 2009.

[4] Eun Kyoung Lee, Young Jun Lee, "A Pilot Study of Intelligent Robot Aided Education," In Proceedings of 16th International Conference on Computers in Education, pp. 595-596, Taipei, Taiwan, September 2008.

[5] YunYoung Hur and Jeonghye Han, "Analysis on Children's Tolerance to Weak Recognition of Storytelling Robots," Journal of Convergence Information Technology, Vol. 4, No. 3, pp. 103-109, September 2009.

[6] Chih-Wei Chang, Jih-Hsien Lee, Po-Yao Chao and Gwo-Dong Chen, "Exploring the possibility of using humanoid robots as instructional tools for teaching a second language in primary school," Educational Technology & Society (IFETS), Vol. 13(2), pp. 13–24, January 2010.

[7] Kazuo Hirai, Masato Hirose, Yuji Haikawa and Toru Takenaka, "The development of the Honda humanoid robot," In Proceedings of the IEEE International Conference on Robotics and Automation, New York: IEEE, May 1998.

[8] Masahiro Fujita, "AIBO: Towards the era of digital creatures," International Journal of Robotics Research, Vol. 20, pp. 781-794, July 2001.

[9] Cynthia Breazeal and Brian Scassellati, "A context-dependent attention system for a social robot," In Proceedings of International Joint Conference on Artificial Intelligence., CA: Kaufmann, San Francisco, 1999.

[10] Seymour Papert, "The Children's Machine," Basic Books, New York. 1993.

[11] Martyn Cooper, David Keating, William Harwin and Kerstin Dautenhahn, "Robots in the Classroom-Tools for Accessible Education," IOS Press, Christian Buhler and Harry Knops, 1999.

[12] Kai-Yi Chin, Yen-Lin Chen, Jong-Shin Chen, Zeng-Wei Hong and Jim-Min Lin, "Exploring the efficiency of multimedia with an animated agent in Web-based learning systems," IEICE on Transactions on Information and Systems, Vol. E94-D, No.4, March 2011.

[13] Xing Shusong and Zhou Huanyun, "Behavior enhanced instant messaging using desktop robots," In Proceedings of IEEE Conference on Robotics, Automation and Mechatronics, pp. 988 - 993, September 2008.