Implementation and Evaluation of Classroom AI in PRINTEPS

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Abstract—PRINTEPS (Practical INTElligent aPplicationS) is a total intelligent application development platform that integrates 5 types of sub systems (knowledge-based reasoning, speech dialog, image sensing, manipulation and machine learning). This paper shows how PRINTEPS has been applied to classroom AI where multiple people and robots cooperate.

I. INTRODUCTION

Currently, we are promoting the study of PRINTEPS (PRactical INTElligent aPplicationS), a platform for developing total intelligent applications for cooperation between humans and machines, by only reconfiguring the software modules related to knowledge-based reasoning, speech dialog understanding, image sensing, and manipulation [1]. This paper describes the availability of PRINTEPS for classroom AI, where multiple people and machines (robots) cooperate, and explains how PRINTEPS has been applied to the actual educational environment in elementary schools.

II. MULTI-ROBOT SYSTEM THAT COOPERATES WITH TEACHERS AND STUDENTS

A. System outline

Figure 1 shows the outline of the teacher and robot cooperation system proposed in this paper. This system is mainly based on cooperation channels between the actors. The workflow of each actor is decided according to these channels. Our classes have three main purposes: development of students’ interest, imparting knowledge, and progress checking.

B. Robot used in the study

We used the following three robots in our study.

• NAO\(^1\):
Communication robot of Aldebaran, which is capable of speaking and understanding speech and can be controlled with a touch sensor, and plays the role of the teacher’s assistant

• Sota\(^2\):
Communication robot of Vstone, which has a camera to capture images, and plays the role of the students’ supporter, who is allocated by each test group

• Jaco2\(^3\):
Robot arm of Kinova, which grips and moves an object. (NAO and Sota cannot perform such operations.)

The role of each robot corresponds to one of the three purposes mentioned earlier: NAO takes charge of imparting knowledge, Sota takes charge of progress checking, and Jaco2 takes charge of the development of students’ interest.

C. Cooperation channel

The cooperation channels are paths for multiple robots and human actors, such as a teacher and students, to cooperate with each other. Lower left of Figure 1 shows the outline of the cooperation channels. We first researched how the teacher developed students’ interest and imparted knowledge in the normal classes, and designed the cooperation channels. We defined the following channel design elements for each actor:

• Cooperation partner
• Contents
• Media
• Main purpose of cooperation
• Purpose of Cooperation

The main purposes of cooperation include management of flows to promote workflows, in addition to the development of students’ interest, imparting knowledge, and progress checking.


\(^2\)Sota, http://www.vstone.co.jp/products/sota/

D. Workflow

Each of the five actors had a workflow. Among the cooperation channels mentioned in section II-C, we used the channel that aims at managing the teaching flow to associate with each actor, for generating the workflow for the entire class. Figure 2 shows the workflow for the introductory part of the class we conducted in our case study.

![Workflow sample](image)

Fig. 2. Workflow sample

III. EXPERIMENT AND EVALUATION

For the case study, we selected an experiment to find the regularity of leverage balance in the unit “Principle of leverage” in the scientific programs for sixth graders of elementary schools. To evaluate the system we proposed in this study, we conducted a class for the sixth graders of Keio Yochisha Elementary School, where a teacher, students, and multiple robots cooperated with this system. We reported our conclusions based on the experimental result, questionnaires given to the students after the class, and an interview with the teacher.

A. Case study

1) Preparation for experiment: First, we designed the cooperation channels mentioned in section II-C according to our empirical rules, and decided the specification after the interview with the teacher.

We also had a meeting with the teacher eight times to design a class scenario mentioned in section III-A2. In the meetings, we operated the robots to show their actual motions based on a rough scenario that we prepared, and asked the teacher to consider the scenario. We had to reconfigure our scenario based on the feedback we received in the previous meeting, and then the robots were re-programed.

2) Class flow: The experiment to find the regularity of the leverage balance in this case study had the following flow. Note that some details are skipped.

   1) Introductory part of the class
      We started the class with a dialogue between NAO and the teacher. Jaco2 cut some carrots, since cut carrots were necessary in this step.

   2) Explanation of the experiment
      NAO explained the procedure of the experiment, and Jaco2 demonstrated it actually.

   3) Experiment for leverage balance Sota helped the procedure and checked the students’ progress.

   4) Checking answers and summary
      NAO explained the result of the experiment.

   5) Application of the experiment
      NAO explained the application cases.

   6) Summary of the class
      NAO explained the summary.

B. Evaluation of the class

We gave questionnaires to the students and interviewed them along with the teacher after the class, and evaluated our case study based on the results as follows.

1) Evaluation of development of students’ interest
   The highest number of students answered that the motion of the arm of the robot Jaco2 to cut the carrots and attach the weights was the most impressive item. Accordingly, we consider that the cooperation channel successfully developed the students’ interest as designed.

2) Evaluation of imparting knowledge
   In response to the question on the most important item about the class, more than two-third of the students gave their answers as “conditions of the leverage balance”, which was the most important theme to be understood in this case study class. Further, the teacher told that he could convey the important points to the students equally well or better than in the normal classes. Therefore, we consider that the cooperation channel imparted the knowledge sufficiently.

IV. CONCLUSION

In this study, to improve the educational effects in an environment where multiple people and robots cooperatively conducted scientific experiments in the elementary school program, we set up a system that focuses on the cooperation channels between the actors, and conducted an experiment with students and a teacher from a class.

As a result, we used cooperation channels that were designed for the effective development of students’ interest, imparting knowledge, and progress checking. Since we designed the cooperation channels in advance, we could use them for each target or purpose, such as development of students’ interest while adding and preparing a new teaching theme, and decide the method of cooperation between the actors in the class in a simple manner. Moreover, PRINTEPS makes preparation of the workflow easier, makes the repair time of the teaching workflow shorter, and allows simpler operation of the PDCA cycle.

REFERENCES