Computer learning system for pre-school-age children based on a haptized model railway

Haruo NOMA[*] **Hirokazu SASAMOTO**[‡] **Yuichi ITOH**[‡]
Yoshifumi KITAMURA[‡] **Fumio KISHINO**[‡] **Nobuji TETSUTANI**[*]

[*]*ATR Media Information Science Laboratories, Kyoto, Japan*
{noma, tetsutani}@atr.co.jp
[‡]*Graduate School of Information Science and Technology, Osaka Univ.*
{sasamoto,itoh,kitamura,kishino}@ist.osaka-u.ac.jp

Abstract

This research is aimed to develop a new methodology and its supporting technologies for pre-school-age children to learn about computation and programming through hands-on playing experience with toys. It allows children to acquire the concept and the knowledge of computation and programming by playing with model railway toy. The final aim of the research is to establish a ladder rung toward great scientist and engineer development through education in the pre-school-age.

1. Introduction

The best way to learn abstract knowledge in the initial phase is to compare it with some concrete illustrations. For example, we start acquiring literacy by using a picture storybook. (Fig.1) Children notice the correspondence between the picture and the shape of the characters beside it first, and acquire literacy step by step. In this research, we aim to develop a new methodology and its supporting technologies for pre-school-age children to learn about computation and programming using the same step.

We will develop a model railway toy like system as picture storybooks for computation and programming. Each action of the model railway system is to be designed to correspond one-to-one to a computation step of a program. Children can code, run and debug a program by constructing, manipulating and otherwise handling the actual model railway toy. The most important point of the system is that the sense of computer is completely hidden from children. Children simply play with a toy, a set of real objects, with their own hands, and need never to interact with a computer, nor to write program codes in symbolic languages. We call this projection from a computer to real toy "haptization."

Using our method, we expect even pre-school-age children to acquire experimental knowledge of how a computer works and how to program it by playing without using a keyboard and mouse, and without learning an abstract programming method.

2. The 1st idea

Today's widely used computer systems are designed based on the von Neumann-type computer. This kind of computer carries out stored programs step by step. Similarly, trains travel on a track according to a pre-defined timetable and traffic control system. This indicates that a computer process can be compared to the operation of a train. We focused on this formal relatedness, and designed a model railway toy so that its actions correspond to the actions of a computer or program one-to-one. The user can arrange layouts that is corresponded to some basic programming exercises, such as sorting, mathematics, maximin, search and so on. However, from the point of children's view, the most important point is that these exercise should look just a toy train action on the layout as shown in Fig.2, and the children should be able to contract layouts as they wont at will.

For example, the layout in Fig. 3 represents the structure of a sorting exercises. Here, the position of the train with its dump cars represents a program counter, the variables

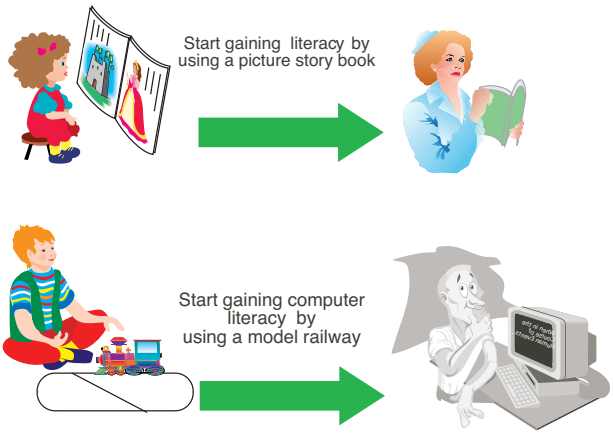

Fig.1 Gaining literacy for reading and programming

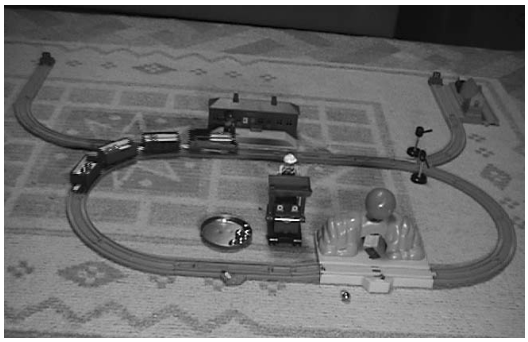

Fig.2 Concept image of the system using a toy

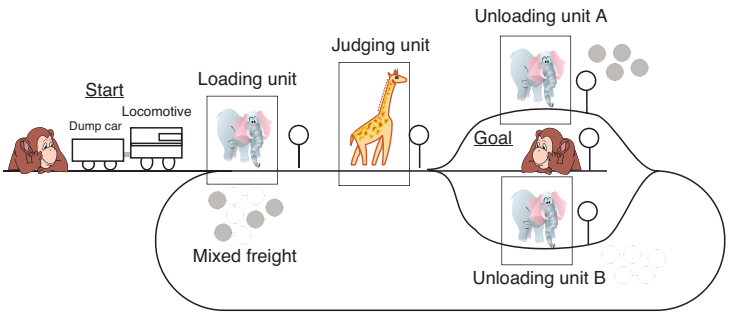

Fig.3 The layout for sorting game

represent the dump cars, the variable value represents number of freight pieces in the dump cars. The monkey point units are start and end point of the program. The giraffe unit at the point represents a conditional jump, and the operations for variables represent loading and unloading freight to and from the dump cars at elephant units.

When children play with the layout, they first order the monkey unit to starts the train. The train goes to the first elephant units, then the elephant loads one freight in the dump car. At the next point, the giraffe check color of the freight and change his point. If there is a freight at the dump car, the train goes any unloading unit and elephants pick it up. The train repeat this process until it carries all freight.

In a classroom, a teacher gives an instruction such as, “Let's sort out the stuck of freight by the animals and train!", and the children make the layout as they like using their own hands. After they build their handiwork, they run a train and watch the process of the layout. They may step into the process holding the train in their hands. They can also modify the number of piece of freight in a dump car manually. These operations represent functions of a debugger in real computer. In every phase, they use their own hands directly to interact with the layout, and, in other words, they can code and debug the program though the layout. Therefore, we call this projection process from a computer to a model railway “haptization.” That is to say, the children handle haptized computer programming pieces directly. From the point of the view of the children, they just play with the model railway and try to solve the puzzles that their teacher gives them. They may play with the toy for hours without a dull moment. We expect that the children will acquire ability to think strategically and pick up knowledge about computer programming through their own experiences. When they learn programming method in a more sophisticated and functional, but more abstract, programming environment in the future, this experimental knowledge will help them.

3. Related research

Some learning method using model railways has been studied. McCormick gave a real-time systems course using a model railway layout [1]. Students were asked to build a large computer-controlled layout and they learned how to control a real-time system. Tosten applied a model railway in an AI & OS course [2]. The layout were used to display the status of the process, that showed deadlock, hang-up and so on.

These studies use the same analogy, they, however, stopped at using the layout to demonstrate conditions of the software, and to display a status of the software. In our proposal, the layout of the model train will be the program structure itself, and the its action itself will show an execution result. This means that the children will acquire experimental knowledge in computers and in the concept of programming as the operation of the toy.

4. Conclusion

Every child in every country loves playing with model railways. So, the proposed methodology for learning will be highly effective in supporting the development of computation-oriented minds through education in pre-school-age. Children who enjoy playing with model railway toys can acquire the ability of strategic thinking through playing, which must be very useful when they grow up and begin writing programs in conventional, but more abstract, programming languages. Now, we are designing the toy and making the trial system, workbook, and learning course syllabus using the system.

Acknowledgment

This research was conducted as part of "Research on interaction media for the high-speed & intelligent networking." with funding from the Telecommunications Advancement Organization of Japan.

References

[1] J. McCORMICK, “Using a Model Railroad to Teach Digital Process Control”, 19th SIGCSE Technical Symposium on Computer Science Education, Vol. 20, No. 1, pp. 304-308, 1988, http://www.cs.uni.edu/~mccormic/RealTime/

[2] R. TOSTEN, “Using A Model Railroad System in an Artificial Intelligence and Operating System Course”, ACM SIGCSE Bulletin, 25(1), pp. 30-32, 1993