The Programming of Robots by Haptic Means

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1 Introduction

According to the theory of constructivism, children can learn a lot not just from being taught but also through their play experiences, especially when they are designing and creating things. By playing with blocks, for example, children learn by exploration and experimentation how the physical world works [Piaget 1955]. It is also important for learners with different knowledge to collaborate in order to arrive at a shared understanding [Duffy and Jonassen 1992]. Based on these ideas, our objective has been to develop a system to program robots using the sense of touch. We believe that enabling robot programming through physical touch encourages play, learning, sharing and collaboration.

To the best of our knowledge, there is no previous example which applies robot programming through touch for children's learning. Grunwald developed a system for programming a mobile service robot by touch, which is more about demonstrating to a robot arm the intended actions for it to repeat [Grunwald et al. 2003]. Also, the system is not focused on learning and playing for children, but more for an industrial environment.

2 System overview

We present a system for the programming of robots by haptic means, which is part of the WaitLess project. WaitLess is a collaborative software programming system with the aim of simplifying programming by mashing up pieces of software submitted to the web server as shown in Fig. 1a. It allows the program that controls robot actions to be stored on the server. Using one robot each, children can program the robot actions by touching sensors, and these actions are stored on the server. In this way, a single program can be made up of different parts created by different children. We now describe the three major functionalities of our system.

The robot and its on-body sensors (Fig. 1b) connect to the server program which controls the input and output functions of the robot. Based on the input data on the sensors, the server sends output commands to control the movements of the robot. This connection is done to make it simple for children to learn by themselves, without needing to learn the overall hardware architecture. Each sensor corresponds to a single action while a program consists of one or more actions. For example, a touch on the right side of the head causes the robot to rotate its head to the right. An example of a program is a sequence of actions that lead to the robot performing a dance.

This system also allows two or more single actions to be combined and executed in parallel. The allowed combined actions are designed to be as intuitive as possible. For example, by touching the left side of the head and the right side of the body at the same time, the robot rotates its head to the left while turning its body to the right.

Furthermore, actions can be connected together in a sequence. At the start of the system, the memory state is empty. As users program the robot by touch, each action is kept in memory as an ordered list.

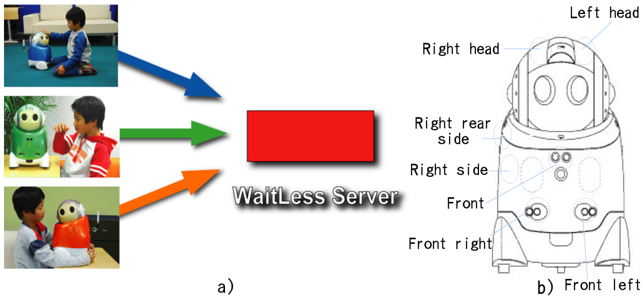

Figure 1: *a) System Overview; b) Sensors for programming of actions*

The actions are automatically 'Recorded'. The 'Play' sensor, when activated, commands the robot to perform the sequence of actions in memory. The 'Reset' sensor clears the memory. Using these sensors, children get real, physical feedback and learn how to create the ideal robot model they have in mind.

3 Advantages

Key advantages of this system include: a) Intuitive physical interaction through programming robot by touch is ideal for self learning while playing. b) Children can perform parallel programming, a concept which is difficult to implement in traditional programming. c) Remote collaboration and sharing of knowledge help children learn independently as a child's program and ideas are stored and shared on the server with other children.

4 Conclusion

Our next step would be to implement a more complex programming structure which incorporates conditional actions instead of just sequential actions, and iterative constructs, whereby children would be able to program the robot to perform a sequence of actions repeatedly.

In the future, we envision children becoming engaged in creative programming using this system, in which they will be able to program complex robot actions by playing with the robot. It will also be possible to conduct remote collaboration, with each child contributing his or her own ideas to the program controlling the robot.

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