Agency Architecture for Teacher Intervention in Robotics Classes

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Abstract

Teachers working in robotics classes face a major problem: how to keep track on individual students' or even small groups' progress in a class of 30-40 students. An agency approach to this problem is based on having sensors to monitor students' interaction, robots' movements, and the construction and programming process of robots. The design can be implemented with the Lego Mindstorms set using the IPPE programming environment. The designed architecture works well for monitoring small groups, but needs further work to support teacher's intervention to an individual student's learning process.

1. Introduction

Educational robotics is successfully used for teaching in several school contexts. However, efficient usage of educational robotics requires new kinds of classroom settings. Also teachers have to change their teaching methods according to the needs of the new environment. When using educational robotics in large classroom settings, students are typically divided into groups of 3-4 students. Each group is provided with one set of educational robotics and group members work together within a given topic or project.

However, this setting is not efficient from the teaching point of view. Groups proceed differently when working with the project, and it might be difficult for the teacher to know when to intervene, with whom to intervene and how to intervene. The problem can be generalized as follows: How could the robotics environment inform the teacher what students are doing and how they are progressing?

In this article, we describe an educational robotics design which intends to help the teacher to focus his/her attention on potential problems. The concept applies agent technology to help the teacher to understand the progress of each student group. The design is based on the LeJOS programming platform for Lego Mindstorms.

This article is organized as follows: Section 2 describes the concepts lying behind the implementation of the environment: educational robotics and agency. Section 3 introduces the concept and architecture of the agent environment for educational robotics. Finally, we draw conclusions in Section 4.

2. Background and existing work

2.1. Educational robotics

The educational principles that motivate the usage of educational robotics are rooted in Jean Piaget's theories of cognitive development [2]. Seymour Papert built on these theories in his notion of constructionist learning. According to constructionist principles, the active learner is the center of the learning process. A typical educational robotics project follows an iterative cycle of building, programming, testing, and evaluation. It is typical that groups proceed differently, being in different phases of the cycle at the same time. This causes difficulty for the teacher to notice the needs for intervention. Our approach is to use educational agents to help the teacher to focus his/her attention on potential problems.

2.2. Agent technologies

There is no agreement on a unified definition for the term "agent". For some, an agent is a software piece as

long as it can travel over a network. For others, an agent represents a module that takes action on behalf of a human user. For still others, agenthood means a certain minimal level of intelligence, or the use of a specified inter-agent language, or the ability to manipulate explicit models of beliefs, desires, and intentions [4].

Educational agents can roughly be divided into two categories. One category includes pieces of software, which work invisibly within the system by autonomously dealing with delegated tasks. The other category presents to users a computer character with human characteristics that facilitate social learning. The agents in our application fall into the first category. Pedagogical agents functioning as teaching assistants like ours are frequently found in literature. One example is the teacher agent in the *I-MIND* project [3]. This teacher agent monitors the student activities and helps the teacher manage and better adapt to the class environment.

3. Applying agents in educational robotics

Unlike most current pedagogical agents which are usually applied to computerized learning environments or simulated virtual realities, the agency technologies described in this paper are used in a traditional classroom, a real physical world, in which students are working on a Lego project.

In this project, two agent modules for data collection will be implemented. One is embodied into the RCX control unit to detect what is happening to the Lego robot, by sensing and analyzing signals from motors, sensors and buttons. The other inhabits the programming environment, monitoring students' programming activities.

3.1. Implementation

The design for the agent environment is based on the *IPPE* programming tool. IPPE (Instructive Portable Programming Environment) is a tool for programming Lego Mindstorms robotics with a pseudo-like programming language near to the student's own natural language [1].

To realize the architecture described in this paper, four extensions for the IPPE environment will be developed. The *LM Agent* (Lego Mindstorms Agent) module implements agency in the robotics environment, that is Lego Mindstorms in this case. The *IPPE Agent* module implements agency in the IPPE programming environment. The *Proxy Agent* module works as a network proxy application and it receives agent data from the robot and the programming environment and delivers the data to the teacher's computer. The *Visualization Agent* module implements visualization in which decisions made by the agents are presented to the teacher. Figure 1 presents the general architecture of the environment.

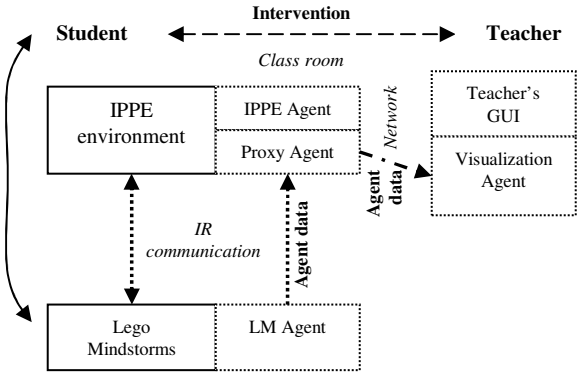

Figure 1. General architecture of the agent environment

4. Conclusion

We have introduced an agent-based architecture for the educational robotics environment that helps the teacher to intervene in small groups' work, based on the observed student-to-student interaction, robots' movements, and the group's progress in constructing and programming their robots. The design can be implemented for the Lego Mindstorms set with IPPE as the programming environment. Further research is underway to make the environment sensitive to an individual student's progress.

5. References

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