A Concept for an Introduction to Parallelization in Java: Multithreading with Programmable Robots in Minecraft

Klaus-Tycho Förster
ETH Zurich, Switzerland
foklaus@ethz.ch

Michael König
ETH Zurich, Switzerland
mikoenig@ethz.ch

Roger Wattenhofer
ETH Zurich, Switzerland
wattenhofer@ethz.ch

ABSTRACT

We explore a new concept to teach parallelization in Java to college-level students. Using a modified version of the virtual world game Minecraft, the students implement agents that interact with the world's objects in parallel, with faults leading to the removal of the agents. We perform a promising pilot study in a computer laboratory course and plan to extend our line of work in the next semesters.

CCS Concepts

•Software and its engineering → Multithreading; Virtual worlds software; •Social and professional topics → Computing education programs;

Keywords

Parallel Programming, Computing Education, Java

1. INTRODUCTION AND BACKGROUND

A tried and proven approach to treat the important and intricate topic of multiprocessor programming is to use "*concurrent* threads [to] *manipulate a set of shared* objects" [1].

Analogously, in *Minecraft*, a virtual world game centered around changing the Lego-like structured environment, agents can manipulate the world's terrain, which is shared amongst them.

We use this analogy for our programming course, extending two lines of previous work by introducing multiple agents controlled by separate threads: First, following Seymour Papert, by taking the viewpoint of the object, intricate programming tasks become easier to manage, cf. [2], and secondly, programming an agent to automatically perform tasks in Minecraft [4]. Our approach was tested in a pilot study with second year EE students.

2. SETUP AND METHODOLOGY

We use a modified version of Minecraft that allows agents to connect via a TCP connection each. More specifically, we provide a Java environment in which multiple agent programs can be run in parallel threads. This allows the agents to cooperatively manipulate the environment. The students can observe their agents' behavior using a Minecraft client. As Minecraft is easy to deploy, cf., e.g., [3], and has low hardware requirements, standard lab hardware suffices.

We assume previous Java experience, but no Minecraft experience, and allocate a four hour slot for the students. Their first task is to get familiar with the new programming setting by solving an exemplary building task with one agent. Afterwards, they have to build a larger and more complex structure, a given tower, as quickly as possible. This requires coordinating multiple threaded agents to share the workload and avoid collisions. When two agents collide they are both removed from the world, which underlines the importance of proper synchronization.

For instruction and support, we provide a page with information, and five assistants are available to answer questions.

3. STATUS AND OUTLOOK

We conducted a pilot study with two groups of 10 and 20 second year EE students, integrated into a computer laboratory course. Both groups of students were able to complete the programming tasks successfully in the allotted time and liked the Minecraft teaching approach. The students needed less assistance than expected in both groups, i.e., we can increase the group sizes. For the next iteration, we plan to formally assess the students' results and also to extend the Minecraft approach: Instead of having the students work in separate game worlds, we supply a central server for a third building task. To guarantee joint success, the students' agents will need to collaborate beyond thread synchronization on a single machine.

4. REFERENCES

[1] M. Herlihy and N. Shavit. *The Art of Multiprocessor Programming*. Morgan Kaufmann, 2008.

[2] A. Repenning, D. C. Webb, C. Brand, F. Gluck, R. Grover, S. B. Miller, H. Nickerson, and M. Song. Beyond minecraft: Facilitating computational thinking through modeling and programming in 3d. *IEEE Computer Graphics and App.*, 34(3):68–71, 2014.

[3] P. Shipman and R. Bull. Lab on a stick. In *Proc. SIGITE*, 2015.

[4] C. Zorn, C. A. Wingrave, E. Charbonneau, and J. J. L. Jr. Exploring minecraft as a conduit for increasing interest in programming. In *Proc. FDG*, 2013.

SIGITE'16 September 28 - October 01, 2016, Boston, MA, USA

ACM ISBN 978-1-4503-4452-4/16/09.

DOI: http://dx.doi.org/10.1145/2978192.2978243