Tag Gon Kim (Ed.)

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Artificial Intelligence and Simulation

13th International Conference on AI, Simulation, and Planning in High Autonomy Systems, AIS 2004
Jeju Island, Korea, October 2004
Revised Selected Papers

Springer

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Lecture Notes in Artificial Intelligence 3397

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Preface

The AI, Simulation and Planning in High Autonomy Systems (AIS) 2004 Conference was held on Jeju Island, Korea, October 4–6, 2004. AIS 2004 was the thirteenth in the series of biennial conferences on AI and simulation. The conference provided the major forum for researchers, scientists and engineers to present the state-of-the-art research results in the theory and applications of AI, simulation and their fusion. We were pleased that the conference attracted a large number of high-quality research papers that were of benefit to the communities of interest.

This volume is the proceedings of AIS 2004. For the conference full-length versions of all submitted papers were refereed by the respective international program committee, each paper receiving at least two independent reviews. Careful reviews from the committee selected 77 papers out of 170 submissions for oral presentation. This volume includes the invited speakers' papers, along with the papers presented in the conference.

In addition to the scientific tracks presented, the conference featured keynote talks by two invited speakers: Bernard Zeigler (University of Arizona, USA) and Norman Foo (University of New South Wales, Australia). We were grateful to them for accepting our invitation and for their talks. We also would like to express our gratitude to all contributors, reviewers, program committee and organizing committee members who made the conference very successful. Special thanks are due to Tae-Ho Cho, the Program Committee Chair of AIS 2004 for his hard work in the various aspects of conference organization.

Finally, we would like to acknowledge partial financial support by KAIST for the conference. We also would like to acknowledge the publication support from Springer.

November 2004

Tag Gon Kim

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Continuity and Change (Activity) Are Fundamentally Related in DEVS Simulation of Continuous Systems

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Abstract. The success of DEVS methods for simulating large continuous models calls for more in-depth examination of the applicability of discrete events in modeling continuous phenomena. We present a concept of event set and an associated measure of activity that fundamentally characterize discrete representation of continuous behavior. This metric captures the underlying intuition of continuity as well as providing a direct measure of the computational work needed to represent continuity on a digital computer. We discuss several application possibilities beyond high performance simulation such as data compression, digital filtering, and soft computation. Perhaps most fundamentally we suggest the possibility of dispensing with the mysteries of traditional calculus to revolutionize the prevailing educational paradigm.

1 Introduction

Significant success has been achieved with discrete event approaches to continuous system modeling and simulation[1,2,3]. Based on quantization of the state variables, such approaches treat threshold crossings as events and advance time on the basis of predicted crossings rather than at fixed time steps [4,5,6]. The success of these methods calls for more in-depth examination of the applicability of discrete events in modeling continuous phenomena. I have previously proposed that discrete events provide the right abstraction for modeling both physical and decision-making aspects of real-world systems. Recent research has defined the concept of activity which relates to the characterization and heterogeneous distribution of events in space and time. Activity is a measure of change in system behavior – when it is divided by a quantum gives the least number of events required to simulate the behavior with that quantum size. The number of DEVS model transitions, and hence the simulation execution time, are directly related to the threshold crossings. Hence activity is characteristic of continuous behaviors that lower bounds work needed to simulate it on a digital computer. The activity measure was originally formulated in the context of ordinary and partial differential equations as the integral of the magnitudes of the state space derivatives. This paper goes deeper into the activity measure to relate it to the information content of a system behavior and to the very concept of continuity itself.

The activity, re-examined, turns out to be a measure of variation defined on finite sets of events. The value of this measure will tend to increase as we add events. But

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