Vadim Ermolayev · Heinrich C. Mayr
Mykola Nikitchenko · Aleksander Spivakovsky
Grygoriy Zholtkevych (Eds.)

Communications in Computer and Information Science 469

Information and Communication Technologies in Education, Research, and Industrial Applications

10th International Conference, ICTERI 2014
Kherson, Ukraine, June 9–12, 2014
Revised Selected Papers

Springer

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Preface

It is our pleasure to present the proceedings of ICTERI 2014, the 10th International Conference on Information and Communication Technologies (ICT) in Education, Research, and Industrial Applications: Integration, Harmonization, and Knowledge Transfer.

The conference was planned to be held at Kherson, Ukraine, during June 9–12, 2014. But unfortunately, due to the tense situation in the country,[1] we had to cancel the face-to-face gathering of the conference participants. Based on the results of the review process, however, we were convinced that some of the submissions deserved to be published, and are of interest to the scientific community. We therefore decided to invite the authors of the best papers, to revise and extend these and to submit them for publication in this volume.

Thus, the selection was made in two phases, as the resubmitted papers were again reviewed by at least three peers based on the scientific and technical quality, anticipated reader interest, and coverage of the conference scope. Finally, the Program Committee selected the 16 most mature and interesting papers. This led to an acceptance rate of 24.2 % out of the initially 66 submitted papers.

ICTERI as a conference series is concerned with interrelated topics of the development, deployment, and use of ICT that are vibrant for both the academic and industrial communities: education, research, industrial applications, and cooperation in ICT-related aspects. The selected papers reflect that scope and are grouped into three parts: (I) Frameworks and Tools; (II) ICT in Teaching and Learning; and (III) ICT in Research and Industrial Applications.

The volume begins with the written versions of the keynote talks planned for ICTERI 2014. Vladimir Gorodetsky gives a research-oriented overview of the phenomenon of Big Data. Nick Bassiliades presents an approach and a tool to compare university rankings so that safe conclusions about their reliability are drawn; this is done by extracting data from several ranking lists and linking it to the DBpedia linked open dataset.

Part I of the volume presents the state-of-the-art formal and algorithmic frameworks aimed at enabling further ICT development and also software tools based on such formalisms. It starts with a paper contributing a novel soft computing algorithm for multiplying fuzzy sets based on the formalism of universal analytic models. The second paper deals with developing a theoretical framework for formalizing the dynamics of systems at an abstract level and taking into account the continuous nature of time. The third paper formalizes complex event processing based on pre-automata. The fourth paper analyzes the algebraic properties of nominative data and functions. Finally, the

[1] See for example http://research.un.org/en/ukraine.

fifth paper reports on a software framework that uses rewriting rules for the automated adjustment of parallel tasks in a target platform for parallel computations. These papers also indicate the applications for which the presented results may be useful.

Part II focuses on using ICT in or developing ICT for teaching and learning, and their effects on didactics. The first paper presents an original approach of using demo hardware for enabling better and deeper understanding by IT students of the inner workings of a processor. The second paper studies the challenges of learning and using the Git system for distributed version control in development projects. This study bases on the experience gained in several different kinds of computing courses, and results in a set of recommendations. The third paper surveys the practices of IT formation at Ukrainian universities and proposes, as a result, an IT competence model as a methodological core for ramping-up the IT competences of Ukrainian students. The fourth paper focuses on the proposal of a pedagogical framework for improving the efficiency in learning ICT through a collaborative approach. This framework involves school teachers and university students of pedagogy and bases on the outcomes of a series of ICT workshops that had been held with representatives of these groups. The fifth paper addresses the efficiency of an ICT-based learning environment for postgraduate students based on a set of proposed criteria. Finally, the sixth paper deals with accounting for a dominant learning style of IT students for developing more effective targeted course materials.

Part III of the volume is dedicated to the applications of ICT in research and industry. The first paper looks at how ICT may help transform Bio-Design into an industrial strength discipline. It is based on the four core hypotheses which formed the basics for the development of the MENDEL Bio-Design software platform. The second paper deals with the applications in the Airspace industry. It proposes an approach to the analysis of the verification objectives and features of on-board information and control software at development and operation lifecycle stages. The third paper proposes an evolutionary game-theoretic approach for modeling and optimizing Internet connections in telecommunications. The fourth paper proposes a model of an evolutionary stable strategy for the choice of an appropriate social behavior pattern, based on the Cournot competition formalism, for the companies on a homogeneous product market. Finally, the fifth paper analyzes the performance of the off-the-shelf plagiarism detection software and elaborates the recommendations for their effective use in electronic publications domain

This volume would not have materialized without the support of many people. First, we are very grateful to all the authors for their continuous commitment and intensive work. Second, we would like to thank the Program Committee members and additional reviewers for providing timely and thorough assessments, and also for being very cooperative in doing additional review work at short notice. Furthermore, we would like to thank all the people who contributed to the organization of ICTERI 2014.

Without their effort there would have been no substance for this volume. Last but not least we would also like to acknowledge the proactive support of our editorial assistant Olga Tatarintseva.

September 2014

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ICT in Research and Industrial Applications

Availability Assessment of Information and Control Systems with Online Software Update and Verification

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Abstract. The paper is devoted to the analysis of the verification objectives and features for information and control systems (ICS) software at the different stages of life cycle, in particular, on development and operation stages for space ICS software. Theoretic-set description of objectives, verified functions considering their criticality for space systems software and scenarios of online verification are proposed. Availability Markov chains based models are developed for different scenarios of space systems software online verification. Multi-fragment Markov models of ICS software for a serviced spacecraft is researched taking into account updating and removal of detected faults.

Keywords: Availability information and control systems · Online software verification · Markov's models · Online software updates

1 Introduction

1.1 Motivation

Successful development of aerospace industry relies on dependability and availability of information and control systems (ICS) for spacecraft (SC) as well as on quality and reliability of its hardware and software. In the first decade of the 21st century, 27 % of spacecraft failures that proved fatal or restrict their use were associated with hardware faults (6 %) and software faults (21 %) [1]. Therefore, it requires of additional measures to improve the processes of software development and maintenance, that is important task in point of view functional safety. Other aspect in this regard is to improve the quality and flexibility of software verification procedures considering the specific issues of the development and application of SC ICS.

The definition of the process of verification has no single term. For example, in [2] verification refers to the process of determining whether or not the products of a given phase of a software development process fulfill the requirements established during the previous phase.

At the same time authors of the research use the definition of the verification process taken from the standards of aerospace engineering [3–5]. In particular,

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according to the standard of European Cooperation for Space Standardization ECSS-E-ST-40C6. Space Engineering. Software [4] "verification is a process to confirm that the requirements baseline functions and performances are correctly and completely implemented in the final product".

Following a standard approach, the development of critical software is a costly process, and most of the costs are incurred not by development but its qualification trials [1, 3]. The use of software tools with the possibility of their modification allows verifying the set of non-critical software functions after the launch of a spacecraft and fixing the detected faults during the next software update. However, given the high criticality of the software, this choice must be justified by the mathematical models which take into account changing of the failure rates.

Existing models of systems with variable parameters use full-scale experiment [6], simulation methods [7], Bayesian analysis [8] and the most preferred method – apparatus of Markov's [9, 10] and semi-Markov's processes [11, 12]. In [13], a system approach is developed to the construction of multi-fragment models, but it does not provide modeling of procedures related to software updates and online verification.

The aim of this paper is to provide the theoretic-set description of the objectives, stages, scenarios of verification and models in order to assess the availability of ICS considering software faults, detected by online corrective verification during maintenance. Other one is development and analysis of availability models of ICS of manned spacecraft considering software updates. To estimate of availability function the calculation and research on multi-fragment Markov's models are performed.

1.2 Analysis of the Related Work

An overview of methods and technologies for software verification and system modeling for some critical applications considering their features is given in [3, 11, 14]. For spacecraft ICS software, the following verification methods are applied [4, 5, 15]: the testing, the method static analysis, the method of documentation analysis, the method of problem review, the method of inspection, etc.

Description of these methods is verbal and any formal procedures are not proposed in point of view online verification. Formal verification methods [16, 17], based on reporting and verifying systems specifications using special notations are severely limited in application. It is explained by complexity of the tasks and impossibility of correction and verification of software during a flight. The features related to software verification of spacecraft ICS are the following [3, 5, 18].

For some systems the complete verification functions cannot be made in full at the ground due to their specific conditions related to (a) the inability to fully simulate flight conditions and provide verification tasks to be performed onboard during take-off, orbital flight and landing; (b) the uncertainty related to both the flight conditions and target problems, the set of which may vary in its process, and (c) high complexity of testing tasks (volumes of input data which must be verified).

The required trustworthiness of verification must be ensured; otherwise the decision should be made about (a) the correction of the project in terms of scope of tasks; (b) continue the process of verification and modification to achieve acceptable risk

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