Computational and Mathematical Methods on Science and Engineering

Universidad Rey Juan Carlos
Madrid, Spain
20-24 septiembre-2006
Volumen I

Proceedings of the 2006 Conference on Computational and Mathematical Methods on Science and Engineering CMMSE-2006

Editor: Regino Criado
Associate Editors: Donald Estep, J. Vigo-Aguiar, Bruce Wade, M. A. Pérez-García

R. Criado, D. Estep, M. A. Pérez García, J. Vigo-Aguiar (Editors)

University Rey Juan Carlos
Madrid, Spain, September 21-25, 2006

ISBN 84-611-1090-0: 978-84-611-1090-2
Contents

✓ Artificial Neural Networks for Solving of Inverse and Direct Problems of Optical Diagnostics by Means of Incomplete Data
Victor Abrukov et al ......................................................... 1

✓ Artificial Neural Networks Using for Creation of Automation Control Systems of Boiler Unit Super Heater
Victor Abrukov et al .......................................................... 12

✓ Three-dimensional modelling of temperatures in a pin-on-disk system
N. Allat et al ................................................................. 20

✓ Scalability of Neville elimination using checkerboard partitioning ,
P. Alonso et al ............................................................... 25

✓ Wave equation, Absorbing Boundary Conditions
I. Alonso-Mallo et al ......................................................... 33

✓ Solving ODEs and DAEs: A Non Singular Jacobian Approach of the Piecewise Linearization Method
Enrique Arias et al .......................................................... 38

✓ Static elastic-gravitational deformation of a layered Earth model
Alicia Arjona et al .......................................................... 56

✓ Remarks on symmetries of 2Dquasicrystals
V.A.Artamonov et al .......................................................... 59
✓ Convergence analysis of a linearized Rubner network with modified lateral weight behavior

J A. Berzal and P. J. Zufria ................................................................. 125

✓ An Implementation of GMRES with Deflated Restarting via the shifted Arnoldi Process

R. Boojhawon and M. Bhuruth ......................................................... 133

✓ Quantum Mechanics and the Theory of Relativity

E. J. Brandas ................................................................................... 153

✓ Generalization of some properties of relations in the context of functional temporalmodal logic

Burrieza, A., P. de Guzmán, I. and Muoz-Velasco, E. ...................... 158

✓ Homogenization of nonlinear parabolic problems with varying boundary conditions on varying domains

Carmen Calvo-Jurado ................................................................. 175

✓ Verifying Real-Time Dynamical Systems from a RT-UML model

M. Emilia Cambronero et al .......................................................... 185

✓ Basins of attraction based on the iteration count of optimization problems

Javier Caso .................................................................................. 188

✓ Numerical Cliford Analysis for nonlinear time-dependent problems

Paula Cerejeiras et al ................................................................. 196

✓ Valuation of guaranteed annuity options in affine term structure models

Chi Chiu Chu and Yue Kuen Kwok ................................................ 204

✓ Application of the Moving Finite Element Method to Adsorptive Process

Maria do Carmo Coimbra .......................................................... 230

✓ Some variants of Newton's method

3
Verifying Real-Timed Dynamical Systems from a RT-UML model

María-Emilia Cambronero\textsuperscript{1}, Gregorio Díaz\textsuperscript{1} and Valentín Valero\textsuperscript{1}

\textsuperscript{1} Departamento de Sistemas Informáticos, Universidad de Castilla-La Mancha
Escuela Politécnica Superior de Albacete. 02071 - SPAIN
emails: emicp@info-ab.uclm.es, gregorio@info-ab.uclm.es, valentin@info-ab.uclm.es

Abstract

In this paper, we present the translation of RT-UML Sequence and Activity Diagrams into Timed Automata, in order to verify some properties of interest in Real-Timed dynamical systems by using model checking techniques. These RT-UML Diagrams are two of the central diagram types which are used in RT-UML for the description of dynamical system behavior. Likewise, by timed automata, we do not necessarily refer to a particular definition, analysis method or a tool, but rather to the more essential mathematical model of a discrete dynamical system with clock variables. Concretely, we use the Object Management Group's UML Profile for Schedulability, Performance, and Time, and from them, we obtain the corresponding Timed Automata systems. The purpose of this translation is to be able to validate and verify dynamical systems with time restrictions in the early design phase. The "RT-UML Profile" is used in conjunction with one commercial tool to perform validation and verification of the timing needs, this is UPPAAL tool, which is used to simulate and analyze the behavior of Real-Time Dynamical Systems described by Timed Automata.

The main motivation of this paper is presenting an algorithm to make the dynamical system verification easier, concretely for those systems with time restrictions. We present the importance of performing this verification from early phase in a methodology. For that purpose, we use RT-UML Sequence and Activity diagrams in the design phase and
we translate these diagrams into Timed Automata for performing the verification.

Firstly, we are going to explain the rules that our algorithm follows to get Timed Automata. RT- UML Diagrams can be depicted by a XMI document, and Timed Automata in UPPAAL are represented by another XML document, thus, the translation has been developed with XSLT, XML Stylesheets Language for Transformation, which is a language for transforming XML into other XML documents.

We have created XSL stylesheets, where we use XSLT instructions to extract the information from the XMI UML document, and then to generate the elements which compose the UPPAAL document, as Fig. 1 shows.

![Figure 1: Translation from RT-UML documents to XML UPPAAL files.](image)

In Fig. 2 we can see the schematic presentation of the correspondence between RT-UML Sequence diagrams and timed automata.

<table>
<thead>
<tr>
<th>Object</th>
<th>→</th>
<th>Template &amp; Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Template</td>
<td>→</td>
<td>Message^+</td>
</tr>
<tr>
<td>Message</td>
<td>→</td>
<td>State^+ &amp; Synchronization Action^+ &amp; Channel^+</td>
</tr>
<tr>
<td>RTaction tagged RTduration</td>
<td>→</td>
<td>State^+ &amp; invariant</td>
</tr>
<tr>
<td>RTclock</td>
<td>→</td>
<td>Variable (clock)</td>
</tr>
<tr>
<td>RTreset</td>
<td>→</td>
<td>reset action</td>
</tr>
<tr>
<td>RTEvent tagged RTat</td>
<td>→</td>
<td>state (urgent or committed) &amp; invariant</td>
</tr>
<tr>
<td>RTdelay</td>
<td>→</td>
<td>state &amp; invariant</td>
</tr>
<tr>
<td>Frame</td>
<td>→</td>
<td>guard &amp; Template^+</td>
</tr>
</tbody>
</table>

*Where the symbols ^+, | are BNF notation, and & is used to join information*

![Figure 2: Schematic view of the RT-UML Sequence Diagrams Translation](image)
To obtain the translation we must see how the different elements of a UML Activity Diagram description are translated into timed automata.

In Fig. 3 we can see the schematic presentation of the correspondence between RT-UML Sequence diagrams and timed automata.

<table>
<thead>
<tr>
<th>Initial Activity</th>
<th>→</th>
<th>Initial State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>→</td>
<td>Channel</td>
</tr>
<tr>
<td>Guard</td>
<td>→</td>
<td>Invariant &amp; Guard</td>
</tr>
<tr>
<td>Variables</td>
<td>→</td>
<td>Variables</td>
</tr>
<tr>
<td>Swimlane Guideline</td>
<td>→</td>
<td>Template &amp; Process</td>
</tr>
<tr>
<td>Activity</td>
<td>→</td>
<td>State</td>
</tr>
<tr>
<td>Sequence</td>
<td>→</td>
<td>Activity⁺</td>
</tr>
<tr>
<td>Concurrent Activity</td>
<td>→</td>
<td>Activity⁺</td>
</tr>
<tr>
<td>Fork</td>
<td>→</td>
<td>Synchronization Action</td>
</tr>
<tr>
<td>Join</td>
<td>→</td>
<td>Synchronization Action</td>
</tr>
<tr>
<td>Decision Point</td>
<td>→</td>
<td>Activity⁺</td>
</tr>
<tr>
<td>Merge Construct</td>
<td>→</td>
<td>Activity⁺</td>
</tr>
<tr>
<td>Clock</td>
<td>→</td>
<td>Clock Variable &amp; Guard</td>
</tr>
</tbody>
</table>

*Where the symbols †, | are BNF notation, and & is used to join information*

Figure 3: Schematic view of the RT-UML Activity diagram translation

Key words: RT-UML, Activity and Sequence diagrams, Real-time dynamical Systems, Formal Methods, Verification, Timed Automata, UP-PAAL, model checking, translation, XSLT.