Summer Pedagogical School

Hybrid Systems: A Formal Paradigm for Safety Critical Embedded Systems

22-23-24 September 2004
University of Patras, GREECE

A summer school within the auspices of project "*Distributed Control and Stochastic Analysis of Hybrid Systems Supporting Safety Critical Real-Time Systems Design*" (**HYBRIDGE**[1], IST-2001-32460)

Scope

The main purpose of the school is to introduce students, in a pedagogical manner, to the fundamentals of Hybrid Systems from the perspective of safety critical embedded systems and specifically to the Air Traffic Management paradigm covered in the HYBRIDGE project.

Hybrid systems are systems that combine continuous dynamics with discrete/logic components. From a theoretical point of view, the study of this class of systems is particularly challenging because they exhibit the complexities that arise from the interaction of discrete-event systems, such as finite automata, Petri nets, and continuous dynamics, governed, for example, by differential equations. For the expressive power hybrid systems possess (they can model physical systems at different levels of abstraction) and the interesting theoretical problems they pose, these systems have been subject of a great deal of attention in the past few years both from academic and industrial communities.

The course illustrates the importance of hybrid systems in engineering. Hybrid models for control problems in different application domains will be presented first; then, verification techniques will be described with particular emphasis on formal methods. Classical control problem topics such as reachability, controllability, stabilizability, observability, and observer design will be analyzed in the context of hybrid systems. Finally, hybrid stochastic systems will be introduced as a mean to model and evaluate advanced air traffic operations against the very good accident risk levels of current air traffic management.

Target audience

The school is primarily targeted to graduate / postgraduate students as well as other researchers and control engineers working in industry and willing to enrich their technical background. The material covered at the school will expose the participants to the state of the art in the area of hybrid systems as well as point to open research problems in the area of hybrid system control and modeling.

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[1] Funded by the European Commission within the 5th Framework http://www.nlr.nl/public/hosted-sites/hybridge/

Instructors:

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- **De Santis, Elena** – University of L'Aquila (I)
- **Di Benedetto, Maria D.** – University of L'Aquila (I)
- **Kyriakopoulos, Kostas** – National Techn. Univ. of Athens (GR)
- **Lygeros, John** –University of Patras (GR)
- **Pappas, George** – University of Pennsylvania (USA)
- **Prandini, Maria** - University of Brescia (I)
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Provisional Schedule:

Wed 22nd : 12:30 – 18:00
- Introduction to Hybrid Systems
- Hybrid Modeling & Verification

Thu 23rd :09:00 – 13:00, 15:00 – 18:00
- Verification of Hybrid Systems
- Structural Properties
- Stabilizability & observability
- Hybrid observer design

Fri 24th : 09:00 – 14:00
- Accident Risk Modeling
- Applications

Further Information : http://www.csl.mech.ntua.gr/hsps

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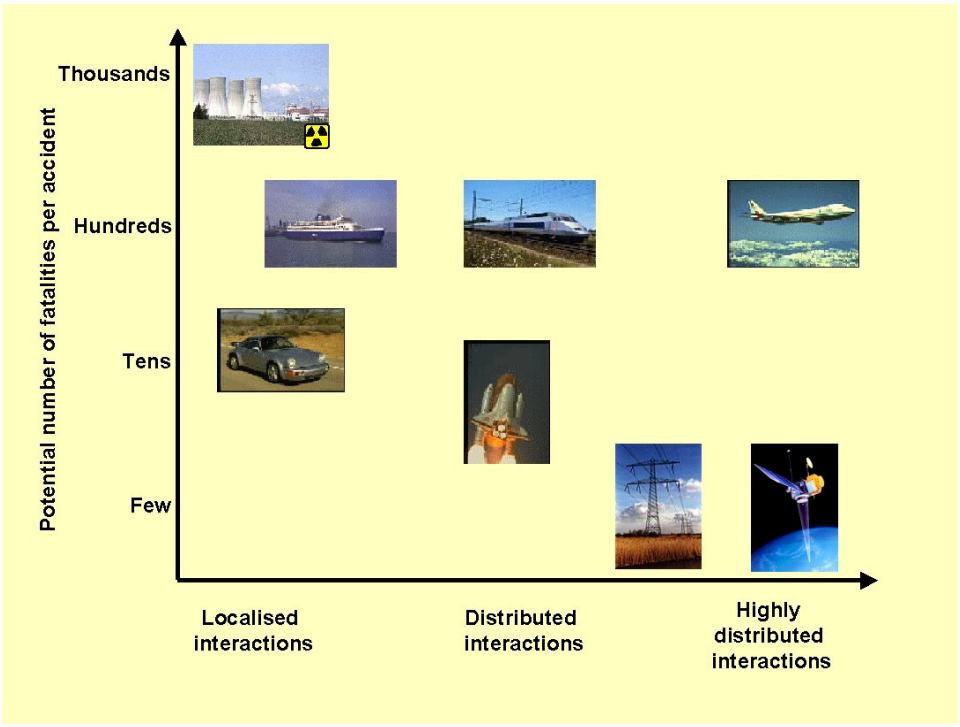
The HYBRIDGE Project

The management and control of large complex real-time systems undergoes a natural trend of becoming more and more distributed while at the same time the safety criticality of these systems for human society tends to increase. However good the control design for these systems will be, humans are the only ones carrying responsibility for the operational safety. This implies that control system designs for safety critical operations have to be embedded within sound safety management systems such that the level of safety stays under the control of humans.



HYBRIDGE aims at developing the methodologies to accomplish this and to demonstrate their use in support of advanced air traffic management design. In addition to direct application to air traffic management, these contributions form the nucleus for further research and development into a complex, uncertain system theory, and into application of this theory to distributed control of other real time complex systems such as communication, computer and power networks.