Multiple Views on Safety-Critical Automation: Aircrafts, Autonomous Vehicles, Air Traffic Management and Satellite Ground Segments Perspectives

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Abstract

This SIG focuses on the engineering of automation in interactive critical systems. Automation has already been studied in a number of (sub-) disciplines and application fields: design, human factors, psychology, (software) engineering, aviation, health care, games. One distinguishing feature of the area we are focusing on is that in the field of interactive critical systems properties such as reliability, dependability, fault-tolerance are as important as usability, user experience or overall acceptance issues.
The SIG targets at two problem areas: first the engineering of the user interaction with (partly-) autonomous systems: how to design, build and assess autonomous behavior, especially in cases where there is a need to represent on the user interface both autonomous and interactive objects. An example of such integration is the representation of an unmanned aerial vehicle (UAV) (where no direct interaction is possible), together with aircrafts (that have to be instructed by an air traffic controller to avoid the UAV). Second the design and engineering of user interaction in general for autonomous objects/systems (for example a cruise control in a car or an autopilot in an aircraft).

The goal of the SIG is to raise interest in the CHI community on the general aspects of automation and to identify a community of researchers and practitioners

Related Events at CHI by the organizers:

CHI 2004: SIG on Safety-Critical Interaction
Palanque P., Johnson C., Koornneef F., Szwillus G., Wright P. Safety-Critical Interaction: Usability in Incidents and Accidents. Ext. Abstracts CHI, ACM Press (2004), 1600-1601.

CHI 2006: SIG on Testing Interactive Software
Palanque P., Bernhaupt R., Boring R. Johnson C. Testing Interactive Software: a Challenge for Usability and Reliability. Ext. Abstracts CHI, ACM Press (2006), 1467-1468.

CHI 2011: SIG on Engineering Automation in Interactive Critical Systems
Bernhaupt, R., Boy, G. A., Feary, M., Palanque, P, Ext. Abstracts CHI, ACM Press (2011), 69_72.

CHI 2015: Workshop on Experiencing Autonomous Vehicles: Crossing the Boundaries between a Drive and a Ride.
Meschtscherjakov, A., Tscheligi, M., Szostak, D., Ratan, R., McCall, R., Politis, I., Sven Krome, S. Ext. Abstracts CHI, (CHI EA '15). ACM, New York, NY, USA, 2413-2416

interested in those increasingly prominent issues of interfaces towards (semi)-autonomous systems. The expected audience should be interested in addressing the issues of integration of mainly unconnected research domains to formulate a new joint research agenda.

Keywords
Interactive Systems Engineering; Automation; Usability; Reliability; Safety critical systems; Human Error; Acceptance; User Experience.

ACM Classification Keywords
Human safety (K.4.1); Reliability, Testing, and Fault-Tolerance (B.1.3.); User interfaces (H.5.2.).

Motivation and Background
One of the biggest challenges in the area of safety-critical systems is to automate functions within a more traditionally interactive command and control system. Projects like SESAR in Europe [www.eurocontrol.int /sesar] and NextGen in the US [www.faa.gov/nextgen/] demonstrate the efforts to introduce and promote higher levels of automation in air traffic management systems. Autonomous behavior has been studied in detail during the last 20 years [1] in a multitude of areas and disciplines but the horizon for embedding them into operational systems is not more than 10 years. These studies and early adoption of automation have not always been entirely successful as demonstrated by many studies in various application domains [3] or [4]. The SIG targets at the problem of the engineering of the user interaction with (partly-) autonomous systems: how to design and build autonomous behavior, especially in cases where there is a need to represent on the user interface both autonomous and interactive objects. For example the representation of an unmanned aerial vehicle (UAV) where no direct interaction is possible, together with aircrafts (that have to be instructed to avoid the UAV). Second the design and engineering of user interaction in general for autonomous objects/systems (for example a cruise control in a car or an autopilot in an aircraft). In addition to aeronautics we will consider automation in a variety of contexts such as Autonomous Vehicles, Satellite Ground Segments and Air Traffic Management.

Topic
In the design of user interfaces for safety-critical systems the current main challenges and goals for autonomous behavior are that the operator should identify a plan, input the plan into the system, trigger the supervisory system to execute the plan which includes some degrees of autonomy (i.e. that the supervisory system has some delegated authority), and monitor the plan execution. Work has been done and is still in progress on authority sharing [5] but also on the reliability of autonomous systems [2]. Of course, the operator being in charge of and responsible for the operations should always have the possibility of interfering with the current plan. As on the main challenges in automated driving this hand-over situations will be a main challenge towards safety, acceptance and success.
One solution to that problem is to reduce the operator's role to the one of automation overseer and thus only acting at a high (and abstract) strategic level as proposed in the various levels of automation defined in [6]. Such solution makes it very difficult (and nearly impossible) for the operator to come back to a more low (and concrete) tactical level especially in case of degradation of the automation capabilities of the

controlled system. Thus, other solutions have to be identified and designed to assess:

- How the operator will be able to identify (from the currently available information about the system) new plans or modification to current potential plans (or potential configurations),
- How the operator will be able to build new plans or configurations,
- How the operator will be able to assess the impact of a potential new plan or configuration,
- How the operator will be able to interact (both monitor and possibly interrupt) with the current configuration under "execution". This interaction aspect can be particularly complex if, in a proactive system, the configurations are executed in an autonomous way by the supervision system.

For instance, in the field of advanced driver assistance systems, studies show that the transfer of the driving task can be experienced as a loss of control and competency as well as a feeling of being at the mercy of technology [7]. On the other hand, the relief from the driving task provides a unique opportunity for new types of activities during the piloted journey, amongst them new forms of in-situ entertainment and games grounded in the contextual specificity of the automotive, mobile situation. In the field of critical systems, human in the loop for handling unexpected events for ensuring people safety is of much higher importance than operators' well-being (and human errors must be prevented [8]).

Audience

One of the goals of this SIG is to gather people interested in the field of human-computer interaction for interactive critical systems, software engineers interested in the reliability and usability of interactive systems, as well as researchers interested in the issues raised by the design of automation for these systems. We expect participants from user interface design and engineering from various application fields that have been working on problems and solutions for integrating seamlessly autonomous objects in user interfaces. The audience would be approximately 50-100 practitioners and academics interested in how to integrate mainly unconnected research work to formulate a new research agenda.

Goal, Organization, Expected Outcome

Goal of the SIG is to connect communities currently not connected: the engineering community, the automotive community and the UX community. Goal would be to identify promising research lines for this area and to identify ways of bringing such knowledge in the domain of safety critical systems. Such a research agenda will be useful in multiple application domains but also in various scientific fields ranging from safety and dependability to user experience.

SIG Organization

The activity plan for the 80-minute SIG is as follows:

- Introduction of the SIG goals and participants (10 minutes including clarification questions);
- Presentation by the organizers of issues and case studies in the various fields represented by each if the organizers (automation in civil aircrafts, automation in air traffic management, automation in satellite ground segment application, automation in advance driver assistance systems) (5 minutes per topic, total 20 minutes);

- Gathering from the audience (as well as presenting from the SIG organizers’ experience) additional issues and case studies (10 minutes);
- Interactive group discussions (one group per field, each group led by the corresponding SIG organizer). Participants will chose a field/group and participate in the identification of possible approaches to overcome the previously identified issues (15 minutes);
- Groups report back to the room as a whole (10 min)
- Advantages and limitations of the various approaches and an understanding of what the various fields, communities and application areas can contribute (10 min);
- Wrap-up and next steps (5 min).

SIG Organizers

Michael Feary is a research scientist in the Human-Systems Integration division at NASA Ames Research Center. His research focuses on the development of tools to support design and Human-Computer Interaction analysis of complex, safety critical systems.

Célia Martinie is lecturer in Computer Science at the University Toulouse 3. She is working on notations and tools for operators’ activities description and applied those contributions to the field of satellite ground segments. http://www.irit.fr/~Celia.Martinie-De-Almeida

Philippe Palanque is Professor in Computer Science at the University Toulouse 3. He is working on formal methods for engineering interactive systems and the application of such techniques to Higher Automation Levels in the field of Air Traffic Management. http://www.irit.fr/ICS/palanque

Manfred Tschiligi is professor in HCI and Usability at the University of Salzburg. He is very much involved in driving experience activities (e.g. as a national initiative on Car Interaction Safety) and has been shaping the discussion on automotive UIs, autonomous driving and human robot-interaction. https://hci.sbg.ac.at/person/tscheligi/

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