Investigating Issues of Human-Computer Interaction for Systems-of-Systems

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Abstract. *Systems-of-Systems (SoS) are an emerging class of systems. Such systems receive stimulus from humans and from the environment to trigger the accomplishment of complex missions. Interaction among the SoS, humans, and with the environment must be investigated in order to adapt current interaction engineering methods, establishing advancements to encompass a suitable SoS Interaction. This paper presents first insights on interaction engineering for SoS. We outline the topic and briefly discuss how the SoS's inherent characteristics impact on the interaction design for SoS.*

1. Introduction

SoS are a class of software-intensive systems whose constituent parts are, themselves, pre-existing systems called constituents. Remarkable examples include swarm of robots, Smart Systems (such as Smart Cities, and Smart Buildings), Cyber-Physical SoS (CP-SoS), and Ambient Assisted Living (AAL). New modes of interaction emerge as a result of the inherent features delivered by SoS, such as the nature of the constituents, the emergent behavior, the dynamic architecture, the missions accomplishment, and the operational and managerial independence [Maier 1998]. This paper motivates the investigation and brings preliminary insights on how the nature of the SoS influences the Human-Computer Interaction (HCI) design for SoS[1]. The text is structured as follows: Section 2 reports our insights, and Section 3 the final remarks.

2. HCI for SoS

SoS have been considered the new trend of software systems due to their inherent complexity and large dimensions [Santos et al. 2014]. As such, there is a necessity of migrating the interaction design practices and methods to the software engineering of SoS. In particular, SoS' inherent characteristics directly influence how HCI must be designed. Table 1 summarizes the result of our investigation on how UI design activities are influenced by the SoS' particularities according [Maier 1998, Pérez et al. 2013]. Meilich establishes a preliminary discussion on human-SoS interaction, and predicts the paradigms

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SoS feature	HCI design
Nature of constituents	Necessity of particular HCI design for each distinct constituent, and different modes of interaction for each type of constituent
Independence of constituents	Necessity for an harmonical confluence of distinct functionalities in a same interface, for constituents' individual behavior, and for the SoS as a whole (such as, mission accomplishment)
Emergent behavior	Constituent's interaction must also fit commands or functionalities for the accomplishment of missions
Evolutionary development	Constituent's interaction also evolve along the time
Geographical distribution	Long distances require for a distributed HCI design; short distances require consistency in interaction modes
Dynamic architecture	Interactive screens which offer management services for the SoS's owner must offer functionalities to deal with the dynamic architecture
Self-management aspects	Runtime update of the SoS configuration and delivering of decision-making functionalities

Table 1. Discussion on impact of SoS' characteristics on HCI design

of human-constituent and constituent-constituent interactions. However, there is no an HCI approach or even a software engineering perspective in that study [Meilich 2007]. Santos et. al presented results that endorse the importance of interaction in SoS domain through the establishing for quality attributes for SoS, in particular, for the crisis/emergent management domain [Santos et al. 2015]. However, strategies to accomplish such quality attributes still must be proposed.

3. Final Remarks

This paper reported preliminary insights regarding Human-Computer Interaction (HCI) for SoS domain. We discussed how the inherent characteristics of SoS impact on the HCI design in SoS engineering. Further research must be conducted. Future works include the investigations of forms to integrate and carry out the classical software engineering (SE) process with the UI design process, and the integration of UI activities in SE for SoS.

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