Towards new web services based supervisory systems in complex industrial organizations: Basic principles and case study

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A B S T R A C T

Mobility, cooperation and the information access of the different human actors within a complex industrial organization are some of the concerns of web-based HMI design. In this paper we highlight the application of some key concepts of web services for the specification and design of a complex supervisory web-based HMI. Hence, a novel approach based on a service oriented architecture and web services allowing flexible and transparent interaction between the field devices and human operators currently being considered is now possible. An overall design framework is presented and discussed. A real representative case study illustrating this approach is described and discussed from the human–machine interaction point of view, as well as further work.

1. Introduction

Industrial supervisory systems are extremely demanding as regards the human–machine interface to be provided for the various actors or stakeholders involved. The relevant supervised data can be acquired from different sources and structures within the dynamic and evolving organization context as well. The current trend in industry is to integrate process supervision systems, qualified as traditional, along with new inherent functions to the underlying global information system of the organization. Thus, integrating people, process(es) and information, it can be accessed from outside the control room using web technologies [1]. This enables, for instance, members of an organization, such as operators on call, to work from remote locations, or commercial staff to send orders remotely or check the warehouse status. Moreover, this may also concern technicians in charge of the maintenance of several geographically separated IT infrastructures or installations.

Consequently, the information visualisation requires adaptations due not only to the diversity of the access devices used but also to the pertinence of the data provided on such devices [2]. So how would it be possible to provide the various human actors with rapid and efficient access, which is adequate and adapted to the various tasks they perform?

We believe that the service oriented architecture (SOA) model and its underlying web service technology offer a promising approach for the creation of new human actors' interaction models within a complex organization. Indeed, every human actor within that complex organization, whatever his/her hierarchical level or work location (inside or outside the organization), may have different needs from the underlying interactive systems. Moreover, the evolution of the global information system federating the different interoperable, integrated and heterogeneous business processes of the complex organization may also lead to newer interaction possibilities.

In Section 2, we present the main design issues of a related work on the traditional supervisory HMIs and we argue that it is possible to move towards a more global and wider type of supervision.

Section 3 presents the motivations and foundations of the service oriented approach through the basic concepts of web services which are relevant in the design of the service-based HMI development model dealt with in our proposal.

Section 4 presents our contribution which consists of a global methodological framework aiming to integrate the development of service oriented interactive applications from software engineering and HMI points of view with a business oriented vision. In this section, we highlight the first steps of the framework towards the

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HMI specification and consider the specificities of the web services as well.

Section 5 shows the feasibility of such a novel approach applied to a real case study: a sugar refinery supervisory HMI. We will illustrate the approach through a typical supervisory scenario along with preliminary HMI mock-ups. Finally we will give some elements of interest seen from the user's point of view, whilst concluding and suggesting some research perspectives.

2. Related work and new motivations

In this section, we present the main design issues taken from related work in the industrial supervision domain. Due to the newest and highest technological environment in which the supervision is evolving, newer functional and organizational issues appeared and are highlighted, leading therefore to new motivations regarding the supervisory HMI design. We recall the basic missions of traditional supervision and argue that it is possible to move towards a more global and wider supervision. We focus on the mobility and the cooperative task aspects of those motivations due to new peripheral devices and communications means and their impact on the supervision context as well.

2.1. From traditional to more global and wider supervision

The human–machine supervisory system as defined by [3], integrating various actors and stakeholders within the complex organization (including the supervision operators), has to consider the main missions of supervision representing a set of high level tasks [4]. These tasks may include: planning, transmission of orders, supervision and learning, along with alarm management, data analysis, improvement of maintenance, process optimisation, etc.

With the advent of communication means, processing functions and computing resources are made available on different work stations to different users at different locations and sites. Consequently, different business applications as well as the supervisory application cooperate with each other in order to accomplish various tasks. Therefore, the necessary information for a supervision function has become distributed. The information access and retrieval along with its processing may be carried out in different organization sites (inside or outside). Moreover, the information support has also become heterogeneous. Hence, industrial systems in general and process supervision systems in particular have become highly automated and information based technologies. All the issues raised show that the interoperable, heterogeneous and distributed environments represent the new technological environment context of supervision with a potentially increased number of actors involved as well as their need for mobility and a high degree of task cooperation [5].

In addition, thanks to new Information Technologies, various information devices (PDAs, Pocket PCs, cell phones, etc.) are already being used for many new purposes in the process industries. This results in different and new human–machine interactions, requiring not only the development of specific human–machine interfaces but also the identification of the different human actor profiles involved and their various tasks dependent on these new means.

Moreover, the current trend is to place the supervision process at the core of the complex organization, by enabling various human actors to interact with the many different automated processes (Fig. 1); it must be possible to provide them with adapted possibilities for information visualisation and access. The needs and objectives of each human actor in a web environment favour a unified view of the supervision HMI [6]. Fig. 1 shows the opening of company business processes to its partners and suppliers as well as to various (nomadic or not) human actors (within or outside the organization) in order to carry out their relevant cooperative tasks.

Consequently, considering the HMI which is almost dedicated to supervision in the control room may not be appropriate for the reasons highlighted above. Therefore, our contribution is intended to compensate for this and go further by investigating and studying the complementary aspects of the classic supervision HMI.

2.2. Availability of new technological supervision means

The supervision field covers several realities within a modern company. There are several human operator profiles (nomadic or
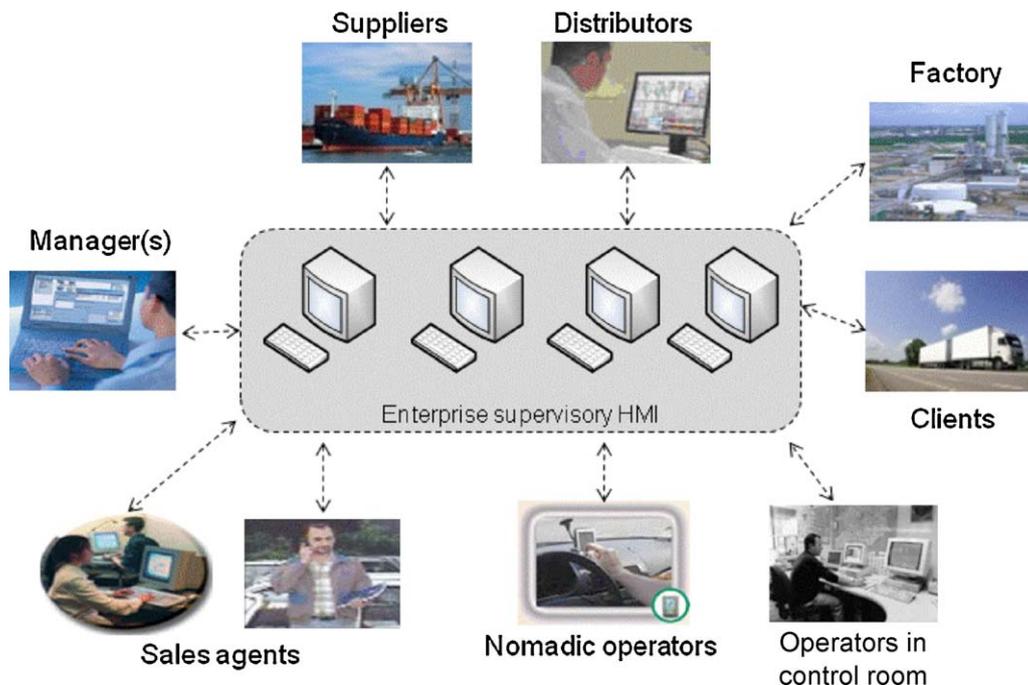

Fig. 1. The supervision core of the complex organization.