Plastic presentation of control data in Context-Awareness environment

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Abstract
The needs for re-adaptable presentations of supervision information are more necessary in the context-awareness environment whose environmental characteristics change frequently and the control data must be updated regularly into the Graphic User Interface (GUI), in order to provide efficiently to operators an accurate picture of the state of the system being supervised. The re-adaptation of GUI is necessary following each considerable changes in the context of use or in the measured data. We will suggest, in this paper, an approach that allows to generate GUI (in other word plastic GUI) capable to adapt dynamically at runtime to changeable context of use and to transform data into different scale types, while maintaining its usability, without requiring costly redesign and reimplementation.

Keywords: Supervision Systems, Scale types, Plastic GUI

1 Introduction
For supervisory control it is important that the supervised states and information are represented to the human operator then those presentations have to be updated automatically at runtime without interruptions due to a necessary adaptation of GUI. In context-awareness environment, it is necessary to consider the mobility notion of operators or users, environmental changes, and the platform migration (Mori \textit{et al.}, 2004). In order to support supervisory control activities in that environment, it is important to adapt an approach for generating graphic user interface (GUI) whose presentation components corresponding to supervisory data, in such a way that enables the operators to efficiently obtain an accurate picture of the state of the system being supervised, then the information are updated regularly. Moreover, in a case of important changes in the context of use (User, Environment, and Platform), presentation
components could be changed in order to adapt the GUI to that new context of use, simultaneously scale transformations could be required for new presentation types. In our field, we see the research work of Zhang (Zhang, 1996) who has proposed a principle for accurate and efficient presentation mapping based on the scale type of control data and the physical dimensions used to present data. However, our approach aim at generating a novel generation of GUI that can at runtime change automatically its presentation components without need to return to the design stage. Consequently, the GUI keeps its usability without requiring costly redesign and interruption time for the reimplementation. Moreover, the plastic interfaces make interaction with the computer easier, more intuitive, more flexible and more intelligently. Schilit and Theimer are among the first to have described an interactive system sensitive to the context (this system was described as Context-Aware (Schilit et al., 1994)); following work in this field, (Brown et al., 1997) has used widely range of information concerning the environment and the knowledge level of user in order to provide information and services to the user. The research presented in this article focuses on a new type of GUI that is sensitive to context of use and has the capacity to adapt dynamically to contextual changes while preserving preset ergonomic properties (Grolaux et al., 2001). At runtime, it is necessary to react dynamically to changes in context of use (Calvary et al., 2001), or also to changes in control data for the supervision field, while respecting the user interface utility and utilisability (Nielsen, 1993). Plasticity, in our case, can be seen like an adaptation of type Action/Condition-Reaction (Calvary et al., 2003); an action points to changes appearing in the context of use, a condition represents a certain state of the system or of certain control data, and a reaction indicates the procedures that can be applied automatically by the system and/or by the user, to carry out the necessary adaptation. Our research here is extending the early version of an approach to specify and generate multi-platform interfaces, proposed in our previous works (Hariri et al., 2005a, 2005b and 2006). We will describe, in this paper, the supervision notion with Context-awareness and the scale theories and scale transformations. Then we will propose a method for generating plastic GUI specified for the supervision systems in an inhomogeneous environment. In a case study, we will evaluate our contribution by applying it to an application with a view of validation. We will finish this article with presentations of the future work from this research.

2 Supervision and Context-Awareness

Mobility notion covers several aspects in the current enterprises where several profiles of nomadic users coexist; with different needs (see Fig. 1). These nomadic users can be operators on duty being able to intervene remotely, the sales engineers who need to request orders or know the inventory position. They can also be technicians in charge of the maintenance of an infrastructure or a geographically distributed installation. We distinguish two types of mobility: (1) Operator mobility where the human operator moves and performs several supervisory tasks from several fixed supervisory work stations (control room for instance) with an access to the network, but without a mobile equipment at hand, and (2) Operator-terminal mobility where the operator moves with mobile equipment at hand (ex: PDA) in certain sectors or zones inside or outside the enterprise.
The scenarios of use of the mobile devices equipped with or without wireless connection can give place to a variety of supervisory applications, for instance: (1) to acquire information of measurement and control by the operators going directly to the equipment then synchronizing their electronic message minder with a central PC and put thus up to date a centralized data base in order to optimize the follow-up of the production, (2) to allow a category of operators to access the information system of their company during a displacement (made inside or outside the company). The warehousemen provided with a PDA with integrated codes bars reader, can prepare deliveries or refer stocks by specifying job numbers. The nomadic operators provided with PDA equipped with GPS functions can thus be localized constantly thanks to the systems of localization (Location-Based-System). Some applications of such systems are quoted: to find mobile users in vicinity or a given zone, to receive the alarms based on the proximity of certain localizations and events.

![Multiple and accessible terminals in supervision systems](image)

*Figure 1. Multiple and accessible terminals in supervision systems*

A certain number of context-based systems were developed to show (1) the utility of taking into account varieties of contexts and (2) the efficiency of technologies or algorithms considering the context; see for instance (Want et al., 1992; Long et al., 1996). Interesting approaches concerned work on the field (Kortuem et al., 1999; Pascoe et al., 1998) and the assistance during displacement in tourist places (Cheverst et al., 1999; Davies et al., 1999; Long, 1996; Hariri et al., 2006). It was also shown that the concept of context is useful to various levels in connection with mobility. On the system level, it can be exploited for example for the management of resources and energy aware to the context. On the application level, the context awareness allows adaptive applications and a context based on the services. On the HCI level, the use of context can facilitate a passage of an explicit human-machine interaction to an implicit one, then towards a transparent user interface. Concerning the adaptation of the HCI to the context of use, (Keidl, 04; Pashtan, 04; Maamar, 05; Lopez-velasco, 05) highlight three dimensions of the adaptation which are: adaptation to the user (personal characteristics...), adaptation to the device (hardware and software constraints) and adaptation to the environment (localization...). However, there is little research undertaken in the supervision field that is characterized by dynamic and evolutionary contexts in which various types of nomadic actors work (see Idoughi and Kolski, 2006). We will present some ideas relating to the supervisory GUI in the following section.

3 Theory of scales

In a supervision system, we have a collection of data of the system being supervised. Some data refers to lower-order properties of the system while other data refers to
higher-order properties. Typically, the former type of data is directly sensed while the latter is a result of the transformation of data already stored in the database. Data consists of symbols or numbers that refer to the value of a property in the environment. The rule according to which symbols or numbers are assigned to some property determines the scale of the data. The concept of scales was introduced by Stevens (Stevens, 1946) who identified four types of scales. Originally, Stevens proposed the scale types (Table 1) in order to distinguish between the types of statistics that are permissible for measurements with different levels of correspondence to the properties they refer to.

<table>
<thead>
<tr>
<th>Scale type</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>Determination of equality of two instances on the scale (=).</td>
<td>(Blue, red, green)</td>
</tr>
<tr>
<td>Ordinal</td>
<td>Determination of the rank-order (greater and less) of two instances on the scale (&gt;, &lt;).</td>
<td>(Low&lt;normal&lt;high)</td>
</tr>
<tr>
<td>Interval</td>
<td>Determination of equality of differences on the scale (+, -).</td>
<td>(1,2,3..)</td>
</tr>
<tr>
<td>Ratio</td>
<td>Determination of equality of ratios on the scale (/, *).</td>
<td>(Double, three times...)</td>
</tr>
</tbody>
</table>

The different scale types form a partial order based on the sets of permissible transformations (Figure 2). The nominal scale is the weakest and the ratio scale is the strongest. For example, data about a specific property on a ratio scale contains more information than data about the same property on an ordinal scale. The former support the determination of equality of ratios and equality of differences, whereas the latter does not (Petersen et al., 2003).

![Figure 2. The partial order of scale types (Petersen et al., 2003)](image)

Note, that it is normally only possible to perform scale transformations that transform data from a stronger to a weaker scale. However, once a scale transformation has been performed it may be possible to make an inverse transformation that restores the initial stronger scale of data or in the original data stored in the system temporary database.

### 4 Method

Our approach consists to generate plastic GUI suitable for supervision systems in context-awareness environment. The solution of the dynamic adaptation of GUI that makes it possible to change the presentation of measured quantities (temperature, speed...) without need to return at the design stage. The request of GUI regeneration is occurred following an important change in the control data (environmental context), changes in the type of user tasks (user context), or also the immigration of the GUI to
another platform (platform context). Moreover, the tasks of users could be specified or modified according to the values of measured quantities; e.g. when the temperature arrived to a high level, in a nuclear power plant, thus the operator task will be passed automatically from observer to controller. In effect, we suggest, in this paper, a method that shows the relations between the environmental context and that of user while arriving at the stage of plastic GUI generation.

Firstly, data is captured from the work environment; then a group of quantities is selected by the context selection engine, in order to transferring it to the scale transformation stage, before representing them on the GUI. The scale types for the measured quantities are chosen, by the scale selection engine, according to the nature of data, the platform characteristics, and the preferred scales of the user in the case of diverse scales available for a same measured quality, the preferences of users are stored in database specified to the user context. However, during the execution of the supervision system, users could change the preferred presentations of a measured quantity then these preferences are organized under the user context, they could be used, in future, to select scale types for measured qualities. The characteristics of the target platform also could affect on the scale type selections; e.g. the preferred presentation for temperature (interval scale) is a dial instrument, but the cellular phone screen is smaller to show that presentation, in this case, the dial instrument is replaced by an ordinal display that need an ordinal scale. Note that every control data is classified, in the knowledge base of the system, with its suitable presentation components in different context.

**Figure 3 measured quantities GUI generation method**

Scale transformation stage (Petersen et al., 2006) transforms the data into the selected scale by using the scale transformation parameters defined by default (the system administrator can modify these parameters) or also theses defined last by users.
After the transformation of the measured data into suitable scale types and after the selection of the presentation components for those data; the GUI is built from the presentations components adequate to the selected scale types being suitable with the target platform characteristics, in particularly the size and color deep of screen. Finally the selected presentation components are arranged on a GUI that is distributed on the target platform.

At runtime, if a change takes place in the context of use or in control data, then the GUI is evaluated according to utilisability criteria to decide the adaptation necessity. This evaluation allows (1) knowing if the actual presentation components are still able to represent the measured data taking into account the new contextual changes, or (2) knowing if the current presentation components are still capable to represent the changed control data. If such is the case, one or more components of the GUI are detected in order to replace them with others. Then data could be returned to the scale transformation stage in order to adapt it, the data, to a scale type suitable with the new presentation component. Then the new components are shown on the GUI without an interruption for returning to the design stage; For example, Figure 4 shows two presentation components for displaying the temperature on the GUI that can contain one of these components according to the context of use. The first example (the left figure) is a simple dial instrument that shows some value of temperature, the scale starts at 0°, this should be regarded as an interval scale. The second example (the right figure) shows the same measured value but the context of platform was changed, thus the available display space is smaller for using the dial instrument. Moreover the human operator is replaced. He/she prefers to see the optimal range of temperature. Consequently, the better presentation component, for that case, is a bar-graph that shows the different ranges of temperature as defined last by the administrator and also the current value of temperature at the button of the bar. A scale transformation will be required for detect the current range of the temperature value. Therefore, the temperature value is transferred to the scale transformation stage that specifies the range by using a transformation procedure of type “interval-ordinal” while considering the scale transformation parameters that were defined by the administrator. This type of display gives the possibility to see what the desired range is, or to compare the measured value with this range.

5 Conclusion
This paper has addressed a method for generating a GUI of supervisory control systems adapted to context-awareness environment. The control data are updated on the GUI and are represented in certain type of scale. The scale type of data is determined by the presentation component, in other word, according to the context of use. A scale transformation of data implies a change in the information content of data, in order to transform the data into a scale type suitable with its own presentation components. We
saw that the advantage of applying our approach is to reduce the time recurred when a change in the presentation of control data is required following changes in context of use or in the measured data. An interesting topic for future research could be to enrich this approach using a large variety of contexts, to develop software tools supporting this approach and could build more complex supervision systems.

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7 References


