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Knowledge awareness in Alarm System Database

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Abstract: Nowadays the cost of alarms inclusion in automation systems is relatively low and so the volume of information exceed the operator´s ability to carry out effective actions during operation of the process. Present in industrial processes as SCADA (Supervisory Control and Data Acquisition), alarm management systems stores data and information. Applying proper analysis, it is possible to acquire useful knowledge from the plant that can be helpful for a decision-making system. Our work focus in a context-aware ontological approach applied to an alarm system. The occurrence of certain events determines a situation allowing the system and operators to react appropriately according to the context of interest. To validate our approach a case study based on a steam turbine for electricity generation is presented, where a situation of a vibration alarm is properly inferred by our architecture.

Keywords: Context Modelling, Ontology, Semantic Rules, Alarm Management.

1. INTRODUCTION

Alarm management systems get information by processing data via computers, devices and applications. Since an alarm is easy to be inserted in a management system, the amount of available information has grown exponentially. Thus, to make a decision during a maintenance process when a problem occurs, due to huge amount of alarms, is a hard task. An alternative to this problem would be to use relevant standards that prescribe best practices for alarm management systems.

These systems must manage data from different sources, as shown in Figure 1, such as sensors and actuators, process events and handle different situations. In a desired system the unwanted situations are forecasted, and so the operators can act in advance. (Pereira and Junior (2003)).

According to (Leitão et al. (2008)), the number of alarms can make the operation unmanageable. Currently, numerous systems that manage alarm process are limited to statistical analyses and possibly none in recognizing behaviour of these systems.

According to (O'Brien et al. (2004)), alarm management is one of the most undervalued and underutilized aspects of the automation process where many plants still use the alarm management philosophy developed in the start of its construction. Once the alarm system becomes less effective, they reduce the effectiveness of the whole automation.

To increase knowledge level, an ontology can be defined along with specifications of a conceptualization with regard to a domain where relevant concepts are represent and their relationships. The ontology depicts the conceptual representation of the domain of interest. Therefore, a set of elements should be defined as a class along with related properties and can be writing in formal language (Knublauch et al. (2004)).

According to (Bernaras et al. (1996)), in power systems, the knowledge involved is very complex. The ontology allows, by means of a formal language, the representation of a semantic information and the management of abnormal situations.

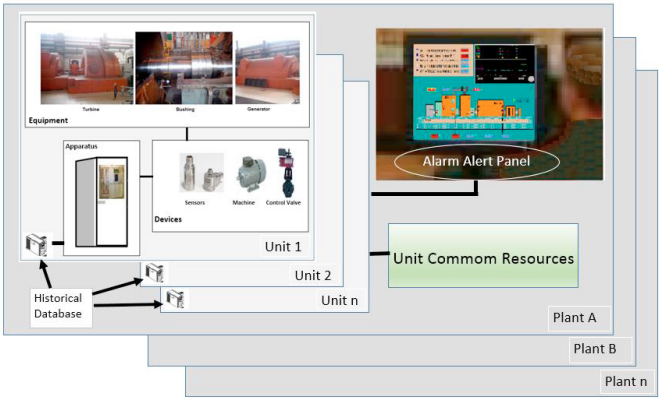

Fig. 1. Alarm system overview.

To describe context elements and their relationships an ontology-based approach is proposed. Since it provides a formal specification of the context data semantics, it is well suited for knowledge sharing.

Important contributions of this paper are the specification of the context model, rule-based filter and application on a real database of a thermal steam turbine

This paper is structured as follows. Section 2 gives a background and review of the literature. Section 3 describe

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the conceptual model developed, focusing on the characteristics that are related to the opportunities exposed in the previous section. Section 4 shows technical components and the case study. Section 5 shows situations and their dynamics factors. Finally, Section 6 draw some conclusions and give hints for a future work.

2. RELATED WORK

Events is a general change of a plant state responsible for storing and treating all changes in any situation that is occurring at a time. Alarm is a state of the plant that require attention and rises several events. For alarm system, an ontology proposes a standard representation in order to facilitate the plant analysis.

The work presented by (Matheus et al. (2005)) defines a generic ontology for a modelling situation where the goal is to define a concept of structure from which it is possible to represent a range of situations and concepts that can be reused in other domains.

The work of (Lima et al. (2008)) proposes an ontology-based proposal and correlation of alarms that enables an analysis of the system using a structured knowledge. However, their proposal could be expanded to enrich the ontology model, such as plant monitor or event.

In (Quintão and Girardi (2008)), a computerized system of an alarm management system, based on recommendation of shares, performs filtering techniques called SIGARA. Their approach does not consider context modelling to recommend actions.

According to (Machado et al. ((2013), context is a situation of an entity and situation is a high-level aggregation of data collected by sensors. Their approach shown the context of interest as a contextualized data and their relationships. A situation of interest is considered as the state of entities that represent an event. In (Machado et al. (2014)), a learning objects recommendation is structured based on context-aware rule that works in a pervasive manner.

A proactive domain in ambient assisted living is presented in (Maran et. al. (2015)). Their approach performs an integration of contextual definitions stored in a database and retrieve this information proactively applied to support sick people.

3. CONCEPTUAL MODEL DEVELOPMENT

This paper seeks to analyse and describe the behaviour of a system according to the changes occurring within it. A pattern knowledge of the context data are evaluate to determine actual situation as shown in Figure 2.

For this work, an ontology is being developed to create a standardized representation of the field (Aizpurúa et al. (2008)) of a steam turbine in a plant for electricity generation. Initially, it is defined the concept of context, which is nothing more than the environment in which the system operates. Thus, it is necessary to define the concept of a progress report represented by (Ye et al. (2011)) as the situation of the events that occur in the plant, and that are derived from the context and hypotheses about how the observed context refers to factors of interest.

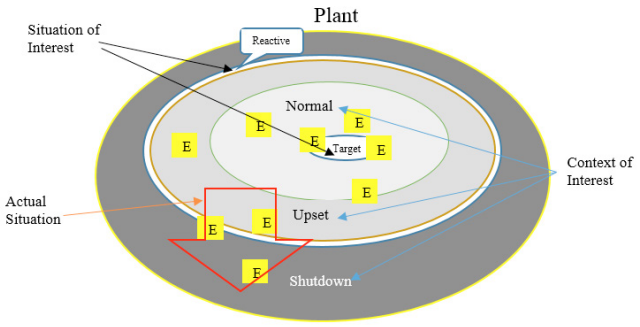

Fig. 2. Representation of event (E), plant, context and situations.

There are different approaches to model context information. The ontology-based approach are defined as a formal an explicit specification of a conceptualization. It describes the context elements that is well suited for knowledge sharing. The conceptual model presented and their main dimensions are presented in Figure 3.

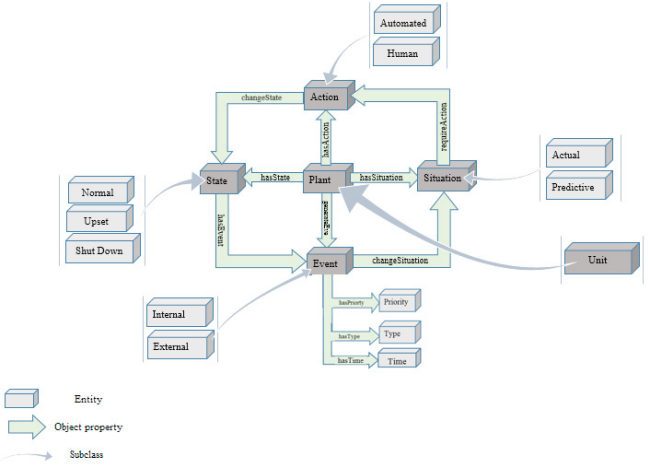

Fig. 3. Conceptual model overview.

- Plant dimension: a plant aggregates at least one or more units to realize a whole process. The unit (subclass) models the necessary information about the collection of associated equipment modules, instrumentation modules and transport channels in which one or more major process steps can be conducted.
- Action dimension: models information about actions required by a plant. It is represented through the concepts of automated and human actions.
- State dimension: it is classified in Normal, Shut-down and Upset. It represent the plant state according to (EEMUA (1999)). Normal sub-