A New Methodology for Massive Alarm Management System in Electrical Power Administration

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INTRODUCTION

Based on the EEMUA 191 Standard, an operator in a control room has the capacity to effectively handle an average of 1 alarm each 10 minutes. However, there are control rooms that register about two thousand alarms per day. In critical cases, as in electrical power dispatch control centers, that amount could reach more than forty thousand alarms per day. This amount is much larger than the average that one operator can manage effectively and efficiently. Although there are several commercial products designed to attend the alarm administration problem, the technical literature does not present a methodology that integrates all the entities and their domains that are involved in the alarm administration process. Work has been conducted to attempt solving the alarm administration problem; however, they have failed because of the necessity of integrating the methodologies with entities and their domains (Andow, 2005). Different approaches have looked into Alarm Management (Broadhead and Earnshaw 1998) and publications have presented a general compendium for Artificial Intelligence and Neural Network Applications in Power Systems (Wong, 1993), Parallel computing (Huang, et al., 2006) and Dynamics Simulation (Manzoni, et al., 1999). Another special applications with Expert Systems and Knowledge-Based Systems are presented in (Leon, et al., 1995) and (Vásquez, et al., 1996). Others applications using Artificial Intelligence Techniques for Complex Problem Solving are shown in (Luger and Stubblefield, 2005).

INTEGRATION METHODOLOGY

The Integration Schema is shown in figure # 1. The figure has been divided in two sections. On the upper section, the figure presents the integration methodology. On the other hand, the lower section of the figure presents the validation methodology.

The first step in the process is to determine in which group the alarm avalanche is located. There are three possibilities: Auxiliary Equipment (AUX), Sub-Station (SE-230), and Generation (GEN). The selection criterion relies on both the apparition and repetitiveness times.

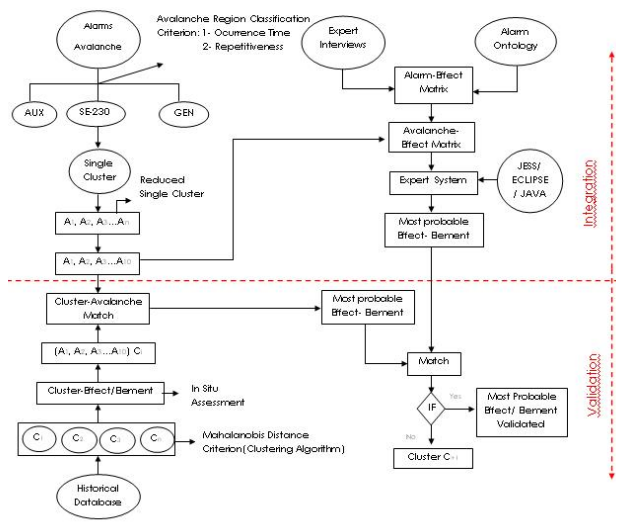

Figure 1: Integration Methodology

To determine the location of the alarm avalanche region, two assumption are made. First of all, the alarms occurrence time and the region repetitiveness. This information comes from the SCADA system.

Once the selection of the alarm avalanche region is done, the alarm avalanche is treated like a single cluster and after that it is reduced under the hypothesis that the first alarms from the avalanche contain the Alarm Root Cause (ARC). This group of alarms or Alarm-Avalanche-Cluster conforms an Avalanche-Mask which together with the Alarm-Effect Matrix produces the Avalanche-Effect Matrix (AEM) as is shown in fig. # 1. The whole knowledge within the AEM is used to build the Expert System with the help of a JESS, which is an Expert System Shell. JESS contains an Inference Machine that has been developed in a JAVA platform. In addition, ECLIPSE as JAVA editor was also used as another program tool. From the Expert System developed, both the Most Probable Effect/Element and the ARC are obtained.

VALIDATION METHODOLOGY

With respect to the treatment of the historical database, a distance-based cluster analysis has been implemented (Mahalanobis Distance). In machine learning, clustering is an example of unsupervised learning. Unlike classification, clustering and unsupervised learning do not rely on predefined classes and class-labeled training examples. In order to validate the results from the Methodology, i.e., The Effect/Element Failed and the ARC, a match between the Avalanche-Mask and the Clusters-Mask from the Historical Database must take place. When the match took place, automatically, the failed Effect/Element obtained from the Expert System should pass or agree with the failed Effect/Element from the Historical Clusters (see fig.1).

RESULTS

In order to start the process and finding the Alarm-Root-Cause it is necessary to have an Alarm Database (Alarm Avalanche or Avalanche-Cluster) and another Database containing the Clusters from the Historical Database and the Failure Type and Failed Element associated to each Cluster, i.e., each cluster can be defined or matched with a specific failure determined by an expert. This assignment is done In Situ, with contributions from Operators, Users and with information from historical files. If the final match is successful, then the results from the methodology are validated. In this research case, from 100 tests, 95% of the tested Alarm-Avalanche was successful, i.e., Both Alarm-Mask (Avalanche and Historical) matched.

FURTHER WORKS

First of all, it is good to say, that the methodology is looking for the Alarm-Root-Cause, and not for the Event-Cause. It means that the most important region to analyze is the SE-230, because is associated with the higher probability of occurrence. Naturally, most of these alarms could be a consequence of a failure at the GEN or AUX region. However, the goal is to know which alarm is the root-cause in the SE-230 region. As further work all the regions can be studied, i.e., AUX and GEN. On the other hand, a dynamic cycle can be implemented when the final match is not validated and also the historical database can be increased.

CONCLUSIONS

This research effort helps users or operators to make decisions. When the alarms avalanche appears, there is an instrument to know with a very high probability which of these Alarms is the Alarm-Root-Cause and their effects and failed elements. This Methodology is a combination of Data Mining techniques, Artificial Intelligence and Ontological methods. This combination of various techniques makes of this approach a breakthrough in this matter, since this methodology attempts to involve all the domains of the Power Alarm Management.

REFERENCES

Andow P., (2005). "Alarms and Abnormal Situation Management": *Experience from the Process Industries*.

Broadhead, N., and Earnshaw, J. K., (1998). IEE. Optimization of the size well b alarm list displays.

Huang, Q., Qin, K., and Wang, W., (2006). "IEEE Proceedings of the International Symposium on Parallel Computing in Electrical Engineering (PARELEC'06)". *A Software Architecture based on Multi Agent and Grid Computing for Electric Power Systems Applications.*

León, C., Casado, J.B., Gonzalo, F., and Luque, J., (1995). "Sistema Experto para la Gestión de Fallos para una Red de Radioenlaces. Tesis Doctoral". *Departamento de Tecnología Electrónica, Facultad de Informática y Estadística*, Universidad de Sevilla , España.

Luger, GF., and Stubblefield, W.A., (2005). Artificial Intelligence: Structures and Strategies for Complex Problem Solving. Addison-Wesley, 5th Edition

Manzoni, A., Silva, A.S., and Decker, I.C., (1999). "Power Systems Dynamics Simulation Using Object-Oriented Programming". *IEEE Transactions on Power Systems*. Vol. 14, No. 1, pp. 249-255.

Vásquez, E., Chacón, O.L., and Altuve, H.J., (1996). IEEE. An online Knowledge-Base System for Fault Section Diagnosis in Control Centres. Nuevo León, México, pp232-236.

Wong, K., (1993). Artificial Intelligence and Neural Network Applications in Power Systems._IEE 2nd International Conference on Advances in Power System Control., Hong Kong. pp. 37-46.