AN EXPERT SYSTEM APPROACH FOR WARNING MESSAGES FILTERING IN A POWER INFORMATICS PROCESS SYSTEM

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Abstract. *An Artificial Intelligence application was built for the FTDEE Suceava-The Energy Transport and Distribution Local Authority - in order to increase the reliability of the Remote Control Power Stations Supervising System. The proposed approach is an expert system based on a rule set established by the process analysts of the FRE Suceava and able to infer with chronological knowledge.*

Introduction

The system of process computers implemented at the Suceava Energy Transport and Distribution Local Authority for the supervising and the remote control of the power distribution network is structured to respect the existing configuration of the electrical lines graph. The main server is installed at the Central Dispatching Center in the town of Suceava, the local acquisition and processing computers are installed in each of the 34 substations composing the local energy distribution system. The task of each local computer is to supervise, 24 hours a day, 365 days a year, the signals from the primary commutation apparatus and from the protection relays, and to transmit them to the dispatching center.

Each event in a substation is signaled by the local computers to the dispathching center via a messages transmitted in a codified form. After reception, the messages are decoded and processed by the main computer at the dispatching center. Every decoded message is stored in historical file for later analysis. Sometimes messages are produced by equipment or computer interfaces malfunctions. The dispatcher has to discern between these false messages and the good ones [1]. Therefore, the high number of the false alarms make this task very difficult. The solution is an expert system based on a knowledge base for filtering the messages generated by the equipment in the power stations.

The Expert System Approach

The problem was to achieve an expert system for the synthesis and high level filtering of the warning messages produced in an electrical substation at a certain moment [2]. The specific difficulty for this system was arise by the temporal knowledge processing. We present an example of rules involving time and message arrival synchronization

RULE 10. After one ***close-open-close*** sequence, only the first ***close*** message remains for an odd number, or all the sequence will be rejected if the messages are in even number and appear in less then 5 seconds.

The designed Expert System was a deterministic one, the logical fundamentals for the correct solutions provided by the inference engine are states by the principles modus tolens and ponens:

$$\text{if } A \rightarrow B \text{ and } B \text{ then } B$$

$$\text{if } A \rightarrow B \text{ and not } B \text{ then not } A$$

the lates being used in the intelligent interrogation of the Facts Base. The preferred solution was to associate to each rule a time active horizon which may differs be different from a

rule to another and sliding list for the values of the facts involved. The main steps done by the inference engine are the following: states at the starting point the chronological limits been fixed by a first level rule, continues with a depth traversal of the tree representing the rules system in order to determine which warning message is the consequence of the other warning messages. If no rule may be applied the message is copied into the final list. A second parsing is dedicated to the determination of interest sequence in final list.

The designed software works on a data structure as presented in [3]. It can be observed (figure 1) that the rules are codified by lists where the hypothesis and conclusions are pointing to other lists of premises and actions. At their turn the latest are pointing to the Facts List for consulting or modifying.

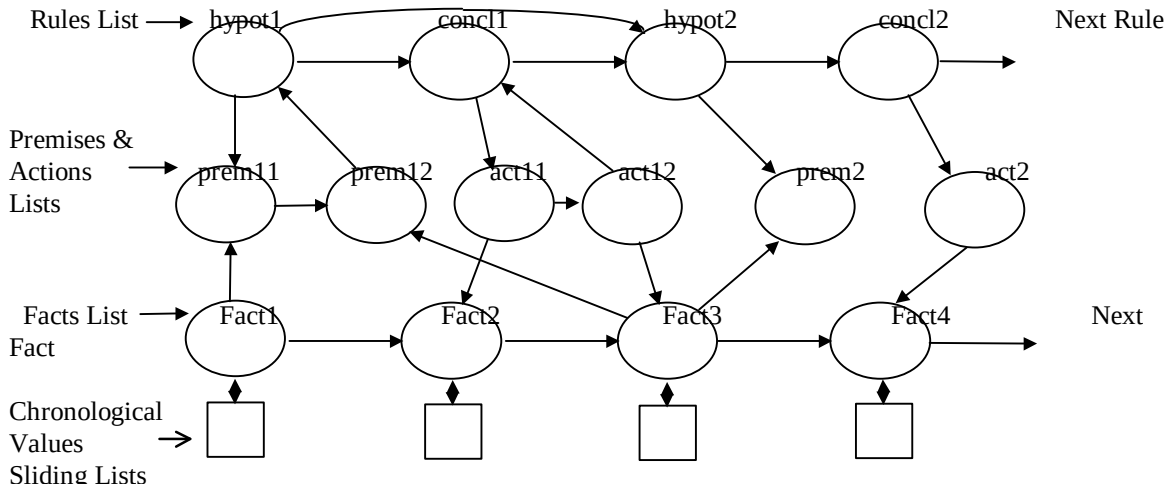

Figure 1

The acquisition system feed continuously with values the facts. The data are introducedafter the arrival of each message. The messages format is as follows:

<time>_<cell>_<message-code>_<equipment>

where:

<time> is the local time when the event took place, **<cell>** and **<equipment>** codify the component unit of the power station where the event occurred, **<message-code>** is the code of the event, describing the event in a numeric form. The decoded data are stored in the Sliding List assigned to every fact. For synchronization reasons the inference engine states the value of each fact in respect with the rule and time of inference.

It must underlined that the inference process is more complicate in this expert system due to this dynamical feature. Depending on the arrival of messages at the central point, and depending the time of the event producing, there arise situations when an expertise done a minute ago must be actualized after 1 minute because a later message contains a crucial information.

The Software Package *Sinteza*

It was achieved a software product based on windows technology that has facilities for the specific implementation by the power experts (figure 2) in order to interface friendly the application with the existing system for the supervising and remote control of the substations. The object oriented approach offers an useful method to manipulate the knowledge involved by this application.

Another components serve to the dispatcher information an provide different windows with the original message list, the filtered messages, synthesis and explanations of the decisions done by the expert system (figure 3).

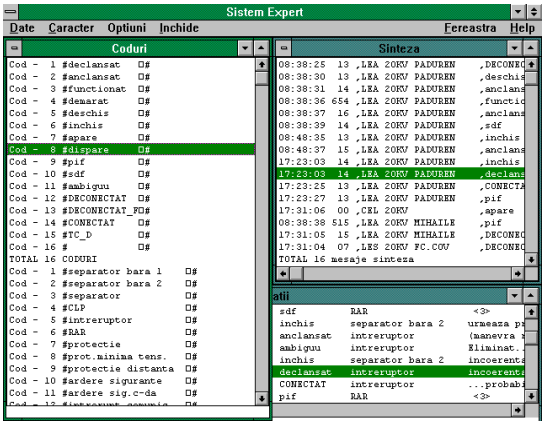

Figure 2

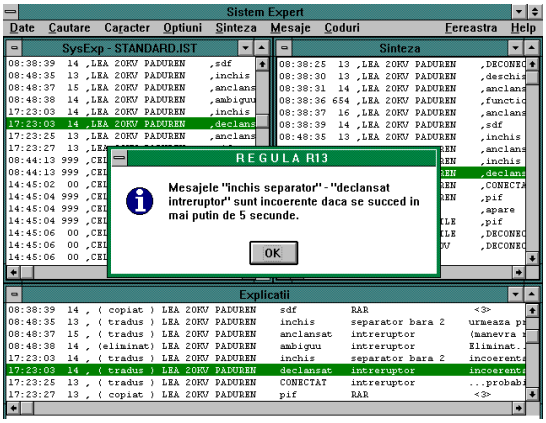

Figure 3

Due the interactions between the information presented in two or three windows if it clicks on a message from one window, specials cursors are displayed in the others windows on the corresponding message. A double click on a message from the explanations window commands a displaying of a small window containing the rule (in natural language) that was applied for that message (figure 3).

Conclusions

For solving the problem a program named *Sinteza* was developed. The achieved software represents an useful expert system for high level messages filtering. The utility of this program consists in the fast and reliable analysis of the events.

The competence area of the experimented software version is placed at the electric substation level. The further rules implementation will expand the expertise area to the others levels of the supervised electric network.

The implementation in a specific network is facilitated by friendly user interface. The experimentation revealed that the system may increase the quality of the dispatcher decisions.

Another way of the system developing is represented by the treatment of incomplete information [4] and automatic classifiers for decision.

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