REAL-TIME MEASURING AND DATA ACQUISITION TECHNIQUES FOR NUCLEAR EMERGENCY SITUATIONS

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ABSTRACT

The paper analyses the special requirements as concerning the real-time interprocess communication and proposes a modern conception based on the last trends existing in the field of computer technology and operating systems.

The basic objective of developing new data collection techniques is to supply the user with a modular, multifunctional, highly diverse system including sensors, specific interfaces and computers, which can simultaneously gather a wide variety of information at variable speeds.

Presenting some suitable measuring and data collection techniques relative to this objective, the applications are based on the combination of subsystems created by integrating different sensors and equipments with proprietary software running on QNX, a real-time, multi-user and multitasking operating system. These subsystems can be added or subtracted, as needed, avoiding the collection of large amounts of redundant and unnecessary data.

The proposed techniques can be applied both in nuclear emergency situations and in every disaster or crisis management.

1. INTRODUCTION

The present situation in the nuclear field is characterised by a decreasing number of new plants and an increasing amount of installations and systems which have a special role in security, radiation protection and the assessment of the consequences of nuclear accidents.

The emergency management systems need rapid and accurate information in order to react promptly in time of crisis and to establish a basis for right decisions.

The rapid development, both in computer technology and in telecommunications, the evolution of fast and accurate computer codes enabling the on-line calculations improve the quality of decision-making in complex situations and assure a high efficiency.

In Section 2 we discuss the measuring and acquisition techniques in nuclear field, specific performance, trends and requirements. Section 3 gives solutions for modern techniques and their advantages. Sections 4 and 5 present applications and conclusions.

2. MEASURING AND ACQUISITION TECHNIQUES IN NUCLEAR FIELD

In the nuclear field the specific characteristics needed are: accuracy, reliability, response time, high redundancy.

The general system structure for the nuclear radiation measuring systems have developed and constantly improved, being submitted to extensive suitability tests for long-term behaviour and performance, for extreme conditions of temperature, humidity and power supply. The majority of these systems has a modular structure, handling the detector signals in the same place or in remote stations, monitoring both the neutron parameters and activity, areas and persons. All data are automatically collected, calculated and transmitted by a computerised system for automatic gathering of dose and nuclear data.

In a nuclear facility there are measurement and alarm equipments for radioactivity, both inside and outside the station, fixed installations and secondary circuits for sample assay, including: airborne radioactivity measurement systems, monitors for radioactivity in waste water, area radiation monitors, contamination monitoring systems, discrete-sample measurement systems, gamma spectroscopy systems. All these systems can send their standard signals to a central computer system based on software specific package for polling and control.

In the last years the equipments have been based on the networked-system data processing and communication electronics, consisting of one or more detector assemblies and an unique local electronic instrumentation, being adaptable to any detector application.

The analogue electronics associated with the type of detector used is mounted on the detector, forming the detector assembly, which is connected by cable to the processing instrumentation.

A new modern characteristic is the ability to stepwise upgrading and adaptation of the system to the new needs.

The random signals processing implies specific methods in order to assure a suitable accuracy correlated with a short response time.

The trends also go to hardware and software platforms which are common to all applications in measuring, monitoring, control.

The measuring and data acquisition are used for surveillance, control and safety systems. The use of the computers for measurement and control systems offers advantages, such as: large acquisition and processing capacity, large data base, flexibility, reliability, input data verifying both at the program level and at the system level. There are new computer-based techniques used for distributed control. The functional computer program runs on its own real-time operating system for controlling inputs, outputs and data acquisition, performing measurement and control algorithms, self-testing, handling off-line calibration and setpoint adjustments. For a modern measuring, control and safety system, there are some special requirements such as: integrated structure based on critical functions, computer-based control and protection system, multi-user system with a real-time simultaneously processes display, fault tolerant system, high redundancy, error detection capacity, distributed open architecture, availability and adaptability, flexibility in defining new functional requirements, on-line service, integration of information system for planning, operation and maintenance services, data access and data interchange, the ability to facilitate the running of the program with continuous self-supervision, to support in a better way process interfaces, information modelling, historical information management and data maintenance.

3. MODERN REAL-TIME MEASURING AND DATA ACQUISITION TECHNIQUES

In order to assure a fast flow of information between the remote equipments or subsystems and the support decision systems it is necessary to use a concept based on the latest computer technology. Taking into account the special needs in emergency situations created during or after a nuclear accident we must continuously update the measuring, monitoring and data acquisition techniques.

Nowadays computer technology provides commercial personal computer systems with performances such as: high speed, high storage capacity, low power, small size, extended temperature range, high reliability. It also presents compatibility with developed hardware and software. These characteristics will permit the decreasing of the data processing periods and the real-time data processing.

The real-time acquisition and data processing are known for their power to react as rapidly as possible to external tasks. The main task of a real-time system is to survey a certain number of input signals and to produce an answer or an action in a limited period, function of the external conditions.

A real-time system will be able to treat the information as soon as they are presented. The input signals coming from different sensors will be acquired and processed in the same manner, resulting more powerful and efficient systems.

We present part of the basic philosophy standing behind the conception of the measuring and data acquisition systems.

The main concepts are the following:

- local measuring and data acquisition;
- intelligent detector utilisation;
- multifunctional equipments;
- computer based measuring and data acquisition;
- QNX-based measurement and data acquisition systems;
- interprocess communication;

The measuring technique consists of the utilisation of local PC-based autonomous units which incorporate both sensors and the instrumentation and perform data processing, store and transmit the measured values and the current station situation. The local unit is also able to perform tendency evaluations in order to supervise itself.

The local measuring station is capable to perform at the same time the acquisition from different types of detectors and to measure different parameters, resulting a multifunctional equipment.

An intelligent detector consists of the detector and related electronics enclosed in one unit. The associated electronics consists of the analogue modules and the PC-based measuring

microsystem. This unit will measure dose rate, integrated dose, meteorological parameters or any kind of parameter.

A number of such local stations are placed in the area of interest, forming a local group or a measuring and data acquisition subsystem. The subsystem operates under QNX operating system, a real-time system, with integrated networking and interprocess communication. The local stations are permanently exchanging information. One of them is provided with high storage capacity, having the capability of on-line computer for data acquisition and storage, events sequences storages, detection of abnormal operating conditions and their analysis, real-time calculations of the parameters which cannot be directly measured. By means of this smart station the information are filtered on their way to the central computer.

Subsystems are created by integrating different local stations with proprietary software running on QNX. Thanks to the intrinsic modularity of the QNX operating system, these subsystems can be added or subtracted, as needed.

The proposed concept is looking to apply in distributed control of the processes. Due to the possibility of interprocess communication the following advantages will result:

- the remote processes are controlling each other by means of the evaluation of current station situation in order to avoid possible false information;
- the avoiding of collection of large amounts of redundant and unnecessary data by local data reduction;
- alarm evaluation validity;
- the increasing of the number of collected data;
- a high speed data transmission;
- the credibility of remote station is increased;
- possibility of upgrading and adaptation of the system to the new needs.

4. APPLICATIONS

The presented techniques can be applied for different types of measurement in the nuclear field as: neutron flux, radiation, pressure, temperature. They can be used for direct digital control, the process computers doing the main monitoring and regulating functions.

In order to enhance the safety of the nuclear power plants and the reliability of the structures systems, the real-time distributed control and the interprocess communication in open systems connected by a local area network with high redundancy and fault tolerance will be of major importance.

Taking into account the complexity of the surveillance activity in a nuclear power plant, the advantages relative to the operation data, the history of the operation, dosimetrical information, environmental data, nuclear fuel information, service activity and spare part information are evident.

The proposed techniques can be applied both in nuclear emergency situations, industrial pollution control and in every disaster or crisis management.

5. CONCLUSIONS

The measuring and acquisition techniques updating is a step forward in increasing the perspectives of the next units of the Cernavoda Nuclear Power Plant.

The paper aims to demonstrate that the updating of the measuring and acquisition techniques will provide higher performance and an economic and rapid way to develop monitoring systems, measuring, control and safety instrumentation.

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