COMMERCIAL APPLICATIONS OF LARGE ACCELERATOR CONTROL SYSTEMS PRODUCTS

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INTRODUCTION

A wide range of hardware and software components designed for control systems of accelerators and physics experiments can be directly, or after some modification, implemented for commercial purposes. Among them, of greater and lesser significance, are:

- control of small particle accelerators and microwave equipment for use in medical, industrial and ecological applications - lithotrypsy, irradiation sterilization, irradiation therapy, customs inspection of cargoes, facilities for dental medicine, wood drying, etc.
- re-use of an accelerator control system for environmental monitoring
- applications of fiber optic technology in devices such as turbine expanders or any other rotating shaft vibration meters, other fiber optic sensors, fiber optic networks and applications in radiation environments
- precise DC/AC high current meters and control systems for electrical energy consumption
- bubble chamber film analysis system for a land survey

A few results of such implementations are presented.

CRYOGENIC TURBINE EXPANDER PROTECTION SYSTEM

The system is designed as part of a liquid helium plant control system; it is intended to protect a turbine expander from vibration damage. It is based on fiber-optic sensors; it calculates a turbine expander rotation frequency and those of radial and axial vibrations as well. It also generates alarm signals and remembers parameter values at the moment of alarm generation. The system includes a rotation frequency sensor, an axial and two radial vibration sensors and a microprocessor unit with digital display. It can be supplied with a Fourier analysis submodule and communications through a serial port. As to accuracy, its vibration amplitude error does not exceed 1 μm. This device can also be used for protection of turbine expanders in air splitting machines, for gas mixture rectification at cryogenic temperatures in metallurgy and the chemical and food industries and for diagnostics of moving part vibration parameters of devices such as turbines and compressors.

UNDERGROUND PIPELINE INSULATION DIAGNOSTIC EQUIPMENT

Oil and gas pipelines are usually covered with an organic insulation layer and are protected from corrosion by an electrostatic potential. In case of damage to the insulation, rust quickly destroys a pipe wall. Normally, insulation monitoring is performed with the help of a sinusoidal waveform generator connected to a pipe and with observation via a portable voltmeter. However more effective location of damaged insulation can be performed with a generator providing a set of frequencies and readout with a narrow band voltmeter. Working frequencies used have been : 3.75, 7.5, 18.75, 187.5 and 937.5 Hz. The device can also locate and measure the depths of pipes. Both the generator and voltmeter are coupled to the pipe in such a manner as to avoid interference from the DC potential which is always present. The measurement data, which are accumulated in the voltmeter during a field measurement run, can be loaded into a PC for analysis. The results can be predictive of possible future failures.

PORTABLE HELIUM LEAKAGE DETECTOR

The device is an indicator of changing surrounding gas content. It indicates appearance in the air of gases in which the sound velocity differs significantly from that in air. Such gases are: hydrogen (sound velocity is 4 times greater), helium (3), methane (1.33), and ammonia (1.28). It is also able to detect the presence of vapors of alcohol, gasoline, acetone and perfume. With a sensitivity for helium at a level of 0.05%, it can be used for indication of gas leakage in a kitchen or coal mine or for fire protection

CUSTOMS INSPECTION

A customs inspection device (RK-300) for sea containers enables one to take an image of the cargo in both horizontal and vertical projections using radiographic techniques based on the linear electron accelerator. The main characteristics are:

source of irradiation	8 MeV Linac
photodetectors of imaging system	1024
contrast dynamic range-	14 bit
space resolution	1 mm
cargo size	2.5 X 2.5 X 12 m.

A PC-based on-line data processing system allows control of the inspection procedures with different imaging approaches (zooming, gray level modification, masking, etc.).

STERILIZATION

The STEROS irradiation device is used for sterilization of medical products and food. It is based on an 8 MeV linear electron accelerator which can be transported. A PC-based control system enables one to monitor all the necessary parameters and to provide complete support for the process.

URAT-P2 LITHOTRIPTER

The URAT- P2 kidney stone disintegration device (lithotripter) is based on a shock wave generator with a pulsed electro-hydraulic discharger and ellipsoidal reflector \ as a focusing system. The variations of the shock wave parameters are envisaged as having a high efficacy of disintegration of the stones. Provision is made for 3-D X-ray examination control as well as ultrasonic imaging. All the data processing and control are done with a microprocessor- and PC-based control system.

ENVIRONMENT MONITORING SYSTEM

For one year the MRTI software team has worked with its dedicated accelerator control system on problems of software portability, object-oriented programming and expert systems. The experience gained was applied to solving some environmental problems in agriculture. There are problems ranging from monitoring individual detector locations, the networking of the monitors all over the Russia and collecting and processing data to those of data analysis and data reduction to aid the government in making decisions for operative controls and for long-term planning. There are, along with the normal technical tasks (sensors, monitoring stations, distributed control, networking, etc.), many problems to be solved together with the agricultural institutes: modeling of environmental processes (pollutant migration and transformation, structuring of regions, solving environmental boundary problems, etc.), developing multilevel expert systems for decision making, joining the heterogeneous databases existing in the communication ministry, etc. Now that the Technical Project has begun and we understand the size of the problem, we shall seek solutions in collaboration with the experts from the different sciences: agriculture, environment, physics, biology and so on.

COMPUTER BLOOD TESTING

There is a very interesting task for the use of hi-tech computing in medicine - complex blood testing and analysis. To estimate the objective condition of a patient it is proposed to use different groups of blood sample parameters measured simultaneously to monitor functional capabilities and form prognoses. A special type of expert system and database will be utilized within this project.

CONCLUSION

Over the years the control community has developed broad scientific knowledge which could be successfully implemented for commercial purposes. Joint efforts in the various fields could demonstrate our ability to return the money spent on Fundamental Science.