Development of a Computer Program for Nuclear Measuring and Monitoring System in the PyRoprocess Integrated Inactive Demonstration (PRIDE)

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1. Introduction

PyRoprocess Integrated Inactive Demonstration (PRIDE) has been built to produce and optimize the essential design data of Engineering Scale Pyroprocess Facility (ESPF) by making the same scale with the ESPF. The difference between the ESPF and the PRIDE is that the ESPF processes spent fuel, and the PRIDE processes natural uranium. For this reason, enhanced safeguards are not required in the PRIDE such as in the ESPF, but it is necessary to develop the enhanced safeguards system considering the ESPF because the PRIDE is the facility to verify the pyro technology.

In this study, we developed a computer program of nuclear measuring and monitoring system based on pre-conceptual design of the safeguards system in the PRIDE.

2. Hardware Configuration

For developing this system, we selected the safeguards equipment and process monitoring sensor that will be installed in the PRIDE. These selected equipments are an electronic scale, each one neutron and gamma detector, three cameras, each two temperature, volt and current sensor. The composition of the nuclear measuring and monitoring system is shown in Figure 1. Various sensors and detectors are controlled by one computer. The Computer is equipped with a video board, counter board, DAQ card, and serial board. Video card is connected to the camera. Counter board is connected to the neutron detector and gamma detector. DAQ card is connected to voltage, current, temperature sensors. Serial board is connected to the scales.

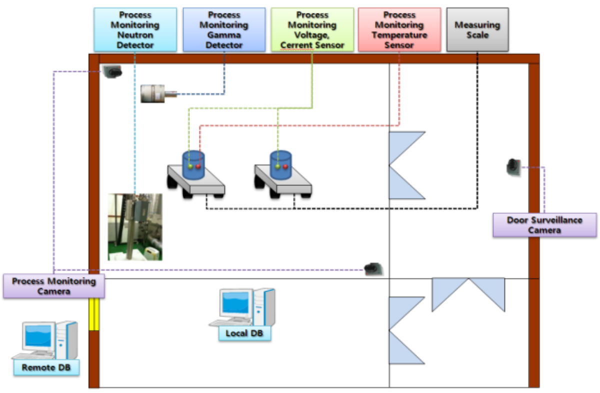

Fig. 1. The composition of the nuclear measuring and monitoring system.

3. Program Configuration

This program was developed based on Windows XP, the application is the MS VC ++ 2003, the database is MySQL, and e-mail application is Microsoft outlook.

The program consists of 20 CPP files and 22 header files. Each of these files has been modularized by function. In the header files, variables and classes, and structures are declared. Functions are created in CPP files that has same name with the header file by using these variables, classes and structures. These variables, classes, structures and functions are called from the 'PyrosrcView.cpp' file that is the main source file according to regular algorithms. The flowchart of the program is shown in Figure 2.

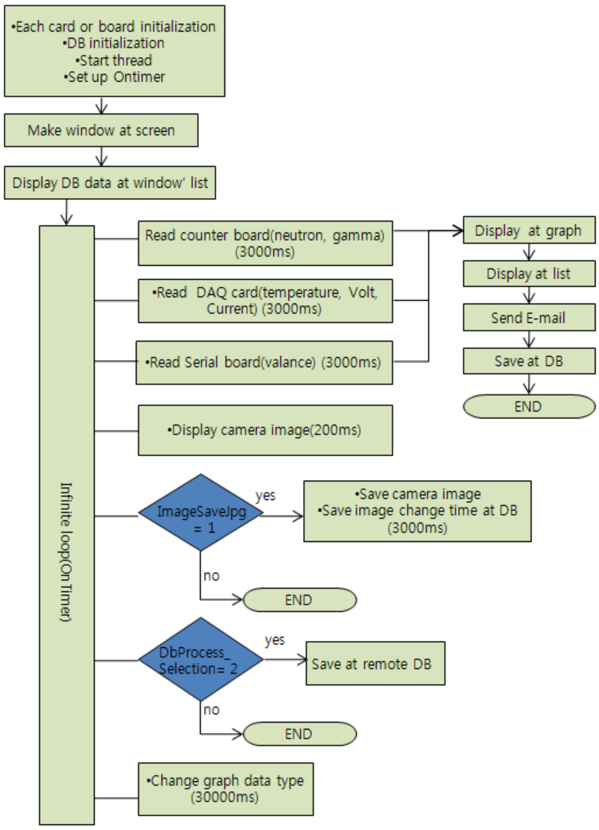

Fig. 2. The flowchart of the program

4. Data Acquisition and Process

The data acquisition and process of the program can be divided into the data acquisition, data display, data storage, alarm system. The composition of the data acquisition and process is shown in Figure 3.

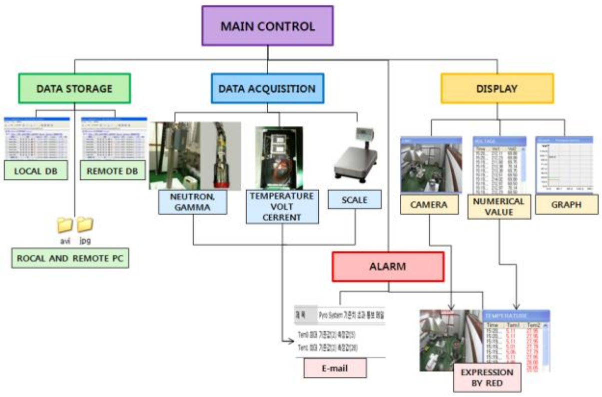

Fig. 3. Program configuration.

4.1. Data acquisition

The seven kinds of data are a neutron, gamma, weight, voltage, current, temperature and camera's image data. Neutron, gamma, and weight data are acquired to increase the reliability of the amount of nuclear material during transport and to accurately identify changes in the amount of nuclear material. Current, voltage, and temperature data are acquired to determine the status of connection and operation of equipments and facilities. Image data is acquired to monitor nuclear materials and to identify warning signs.

4.2. Data display

The data obtained from each sensor can be seen through facility manager's computer screen. Acquired image data will be displayed on the screen in real time. So the facility manager can watch the condition of the facilities and transport and storage of nuclear materials. Neutron, gamma, weight, voltage, current and temperature data is displayed on the screen by the numerical figure every 3 seconds. In addition, these data will be shown through a graph. Facilities manager's computer screen is shown in Figure 4.

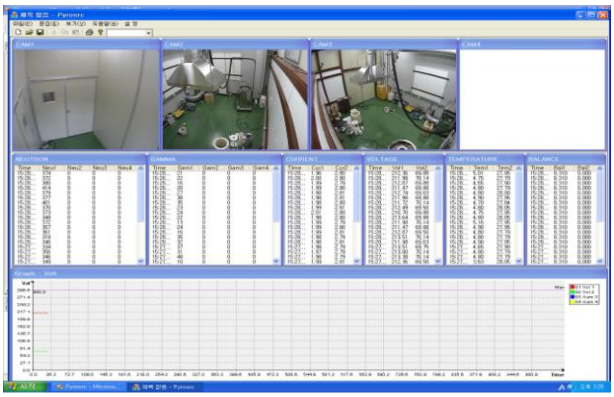

Fig. 4. Program execution screen.

4.3. Data storage

The neutron, gamma, weight, voltage, current and temperature data is stored on the database every 3000ms. In the case of the image data, by comparing the previous image and the current image, if those images are different, then the time at the point of different images is stored in the database, and the data is stored equally in the database of the remote computer. Thus availability of data storage can be improved, and we can easily review the data.

In addition, by comparing the previous image and the current image, if the current image and previous images are different, video files and image files are created. These files are stored on the computer's memory.

4.4. Alarm systems

The system has two types of alarm system. The first type is the way that the dates are displayed on the screen in real time. If the current image and previous images are different, the different portions represent by the red box. In the case of neutron, gamma, weight, voltage, current and temperature data, normally, these data are displayed as black numbers. But if the data exceeds the threshold, then the data is displayed as red numbers. In the case of graph, threshold line is marked, so whether the data has exceeded the threshold or not can be checked.

The second type is notified by email. If the data exceeds the threshold, the program automatically sends an E-mail that includes the contents about exceeded the data type, value and time.

5. Conclusions

In this study, we developed the computer program for the nuclear measuring and monitoring system. Based on pre-conceptual design of the safeguards system in the PRIDE, we choose the safeguards each device and sensor. From this equipment, we gained the data and we can management this data through this program.

In the future, if we find the way to increase the gamma and neutron detection distances and reflect the characteristics of safeguards each device and sensor in the program, then this program is expected to improve the safety and the security, and ensure the reliability for the amount of nuclear material during transporting and processing nuclear materials in the PRIDE.

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