Development of C-scanning LabVIEW Program for Under-Sodium Viewing in SFR

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1. Introduction

ASME Section XI Division 3 provides rules and guidelines for an in-service inspection (ISI) and testing of the components of a sodium-cooled fast reactor (SFR) [1]. For the ISI of in-vessel structures, the ASME code specifies visual examinations. As the liquid sodium is opaque to light, a conventional visual inspection is unavailable for the evaluation of the in-vessel structures under a sodium level. An ultrasonic wave should be applied for an under-sodium viewing (USV) of the in-vessel structures. Under-sodium ultrasonic sensors have been widely developed for an ISI of the reactor core and in-vessel structures of SFR [2-3]. In previous research works, the plate-type waveguide sensor technology has been developed and also the feasibility of the waveguide sensor technique has been successfully demonstrated for an ultrasonic visual inspection of in-vessel structures [4-5].

In this study, the US-MultiVIEW (Under-Sodium MultiView) C-scan image mapping program is developed to apply this waveguide sensor technology to an under-sodium inspection of in-vessel structures of SFR by using a LabVIEW (Laboratory Virtual Instrumentation Engineer's Workbench) graphical programming language. The US-MultiVIEW has the functions of a scanner motion control, a pulser/receiver control, a image mapping and a signal processing.

2. Ultrasonic C-scan System

Figure 1 shows the ultrasonic C-scan system hardware to develop the US-MultiVIEW program. The ultrasonic C-scan system is composed of a 3-axis scanner, a scanner driving module, a high power ultrasonic pulser/receiver and a signal processing module. A 3-axis scanner is to position and control the waveguide sensor by using electric step motors. A scanner driving module supplies the electric power and the moving pulse for a scanner and takes a feedback a moving distance to a motion controller. Tone burst signals are sent to the ultrasonic sensor and reflected signals are received by a high power ultrasonic pulser/receiver. A signal processing module digitalizes the received ultrasonic signals and makes a signal processing for the image mapping. The US- MultiVIEW C-scan program is developed to control the scanner, the acquisition of ultrasonic signals and the mapping of C-scan images by using LabVIEW software.

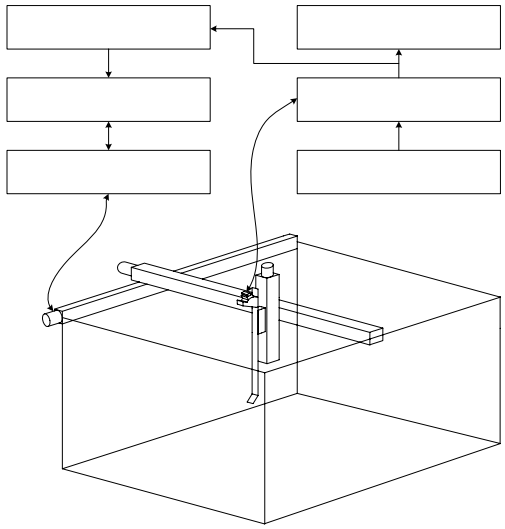

Figure 1. Experimental setup of the ultrasonic C-scan system

3. LABVIEW Programming

LabVIEW is a language developed by National Instruments for the control of instruments and a data acquisition. VI (Virtual Instrument) is for an instrument control, data acquisition and data processing [6]. A VI consists of a front panel and block diagram. The front panel is to control a VI and the block diagram is to edit a VI through a wiring of objects in the front panel. The wires connect to executable icons and describe the data flow. LabVIEW is operated by an interface of data collection cards and device controllers. A signal digitized can be processed by a digital signal processing (DSP) of LabVIEW. Also an instrument control can be operated within LabVIEW.

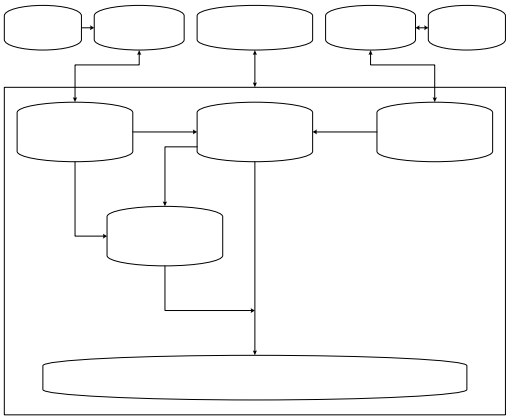

Figure 2. Data flowchart for the ultrasonic C-scan VI

Figure 2 shows the data flowchart for C-scan VI to materialize a scanner control and C-scan mapping. RF (radio frequency)/TOF (time of flight) information from the UT acquisition module and position information from the position acquisition module are combined in the A/B/C-scan/TOF processing module. DSP results are obtained from images generated in the A/B/C-scan/TOF processing module by the UT signal processing module.

Figure 3 shows a front panel of the US-MultiView composed of 6 sections. 'A-scan graph/control' section contains A-scan display, scale setting and DAQ board setting. 'Gate configuration' section is shown under 'A-scan graph/control' section. This section contains a setting such as a delay time, range, threshold and so forth for the gate. The sections for B-scan and C-scan are in the center of the display. C-scan image of the '10 won' coin is shown for the performance verification of a image mapping. This result was obtained from a commercial immersion sensor. In the 'home/set start position' section, the movement controls of the waveguide sensor assembly and the setting of the scanning range and resolution are contained. 'RAM-10000 setting' section contains the controls for a pulser/receiver such as the frequency, voltage, cycles, gain and low/high pass filter. The block diagram that corresponds to the front panel in Figure 3 is shown in Figure 4. The wires connect to icons. The wires represent the flow of data from one function block to another.

4. Conclusion

The US-MultiVIEW C-scanning program is developed to apply this waveguide sensor technology to an under-sodium viewing of in-vessel structures of SFR by using a LabVIEW graphical programming language. The US-MultiVIEW has the functions of a scanner motion control, a pulser receiver control, a image mapping and a signal processing. The performance of US-MultiVIEW was verified by a C-scanning test using a commercial immersion sensor.

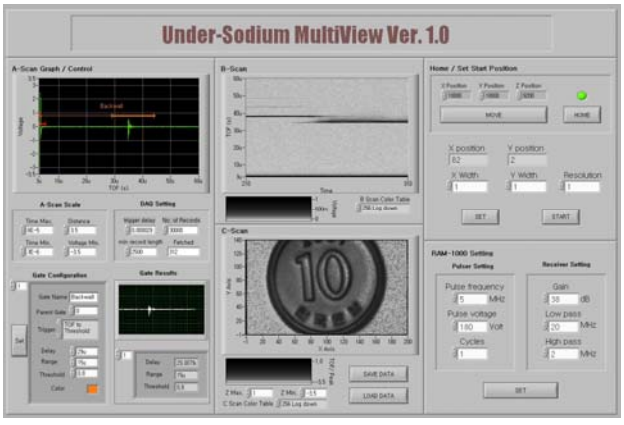

Figure 3. Front panel of US-MultiVIEW

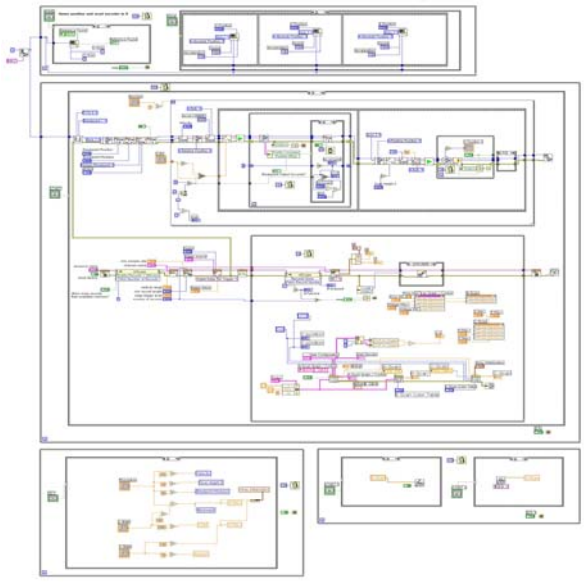

Figure 4. Block diagram of US-MultiVIEW

ACKNOWLEDGEMENT

This study was supported by the Korean Ministry of Education, Science & Technology (MEST) through its National Nuclear Technology Program.

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