A New Development on Measurement and Control Software of SANS BATAN Spectrometer (SMARTer) in Serpong, Indonesia

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Abstract. In 2005, the main computer for data acquisition and control system of Small-angle Neutron Scattering (SANS) BATAN Spectrometer (SMARTer) was replaced since it halted to operate the spectrometer. According to this replacement, the new software for data acquisition and control system has been developed in-house. Visual Basic programming language is used in developing the software. In the last two years, many developments have been made both in the hardware and also the software to conduct the experiment is more effective and efficient. Lately, the previous motor controller card (ISA Card) was replaced with the programmable motor controller card (PCI Card) for driving one motor of position sensitive detector (PSD), eight motors of four collimators, and six motors of six pinhole discs. This new control system software makes all motors can be moved simultaneously, then it reduces significantly the consuming time of setting up the instrument before running the experiment. Along with that development, the new data acquisition software under MS Windows operating system is also developed to drive a beam stopper in X-Y directions as well as to read the equipment status such as position of the collimators and PSD, to acquire neutron counts on monitor and PSD detectors, and also to manage 12 samples position automatically. A timer object which is set in one second to read the equipment status via serial port of the computer (RS232C), and general purpose interface board (GPIB) for reading the total counts of each pixel of the PSD from histogram memory was used in this new software. The experiment result displayed in real time on the main window, and the data is saved in the special format for further data reduction and analysis. The new software has been implemented and performed for experiment using a preset count or preset time mode for absolute scattering intensity method.

Keywords: neutron, neutron scattering, neutron spectrometer, data acquisition, control system
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INTRODUCTION

One of the National Nuclear Energy Agency of Indonesia (BATAN) neutron beam instruments for materials science research and biology is a small angle neutron scattering (SANS) spectrometer. The new software for data acquisition and control system has been developed in-house according to a replacement of the main computer for data acquisition and control system of the spectrometer started at 2006[1-3]. Seeing as the number of SANS experiment and the research interest using SMARTer significantly increased, the applicable conditions and performance of instruments as well as experimental methods has been expanded[4]. However, with the previous system, the experimental setup is very time consuming since the devices could not be controlled simultaneously. In the last two years, many developments have been made both in the hardware and also the software to conduct the experiment runs effectively and efficiently. The new software reduces SANS user intervention since the experiment can be run automatically for 12 samples. This paper presents some developments of the measurement and control system software.

SANS BATAN SPECTROMETER

Figure 1 shows the SANS spectrometer located in the neutron guide hall of the neutron scattering laboratory (NSL). This spectrometer consists of an 18 m long tube of collimation system and another 18 m long tube

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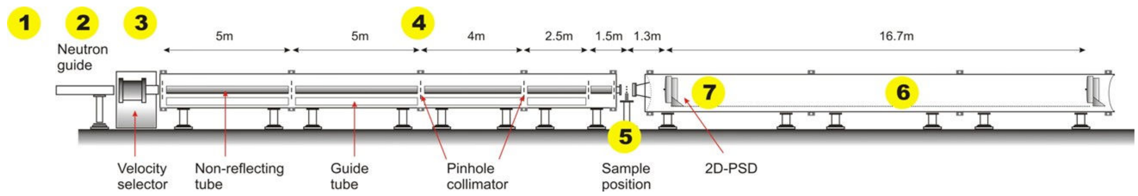


A Schematic drawing of 36 meter SANS spectrometer: 1. Neutron source, RSG-GAS; 2. Neutron guide; 3 Velocity selector; 4. Collimation system; 5. Sample table position; 6. Flight tube;
7. A 2-dimensional position sensitive detector (2D-PSD)

FIGURE 1. The 36 meter SANS BATAN spectrometer (SMARTer).

accommodating a 128x128 ^{3}He 2D position sensitive detector (2D-PSD). The detector can be moved continuously from 1.3 m to 18 m away from sample position and can also be shifted in lateral direction for 0.1 m from the centre beam.

The collimation system comprises of four sections of movable guide-tubes and one section of fixed non-reflecting tube. Collimation is determined by adjustable apertures or pinholes at discrete distances of 1.5, 4, 8, 13, and 18 m from the sample position. Variation of collimation length and sample-to-detector distance (SDD) is fully computer controlled.

The SMARTer Hardware

The control system of the spectrometer has been developed to drive all devices simultaneously. The previous motor controller card (ISA Card) was replaced with the programmable motor controller (PMC) card through Peripheral Component Interconnect (PCI) interface card for driving in total 15 motors, i.e. one motor of position sensitive detector (PSD), 8 motors of four collimators, and 6 motors of six pinhole discs. The comparison between the previous system and the modified system is shown in figure 2. In figure 2a, the ISA Card which is made in-house does not have a programmable IC, so that it sends pulses directly from the software. Consequently it cannot control all motor simultaneously. The beam stopper control system was removed from the previous system and installed in the new modified system in order to maintain the beam stopper while the pre-experiment is running, figure2b.

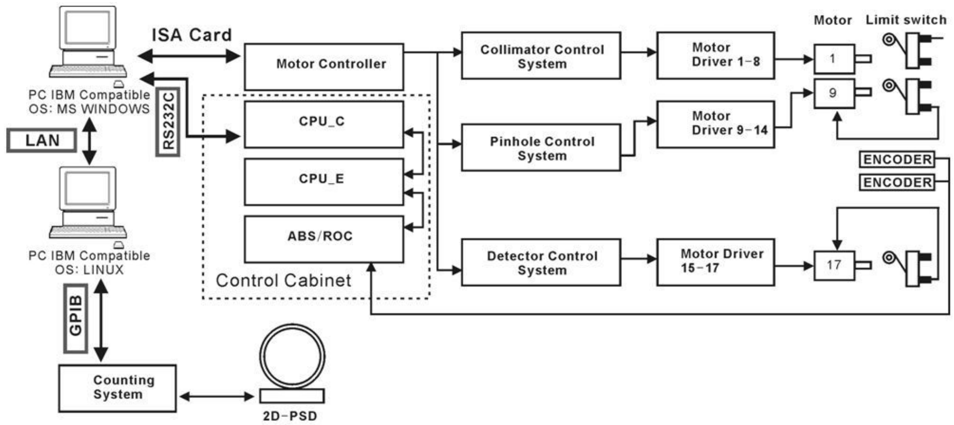
Each controller card maintains 8 axes that can be controlled independently. Two stepper motors and two absolute encoders were mounted at the edge of each collimator to control the collimator in horizontal condition, while one absolute encoder was mounted to read position of the PSD. The encoder was not installed at the pinhole disc drive system, but a limit switch was mounted as home position of each pinhole disc. The pinhole disc has 8 configurations, i.e. open, close, and holes with the diameter of 30mm, 20mm, 15mm, 10mm, 7mm, and 5mm, where can be set according to the experiment.

A sample changer which accommodates 12 sample holders has been developed in order to run the experiment automatically for maximum 12 samples. The limit switch is mounted at the home position of the sample changer. A personal computer for data acquisition manages the sample changer drive system using a serial port, as well as a beam stopper drive system using 4 axis PMC card. A selector for serial port is mounted between controlling device and data acquisition computers in order to read the encoders while the software is running. All encoder position is read by the computer using serial port (RS232C).

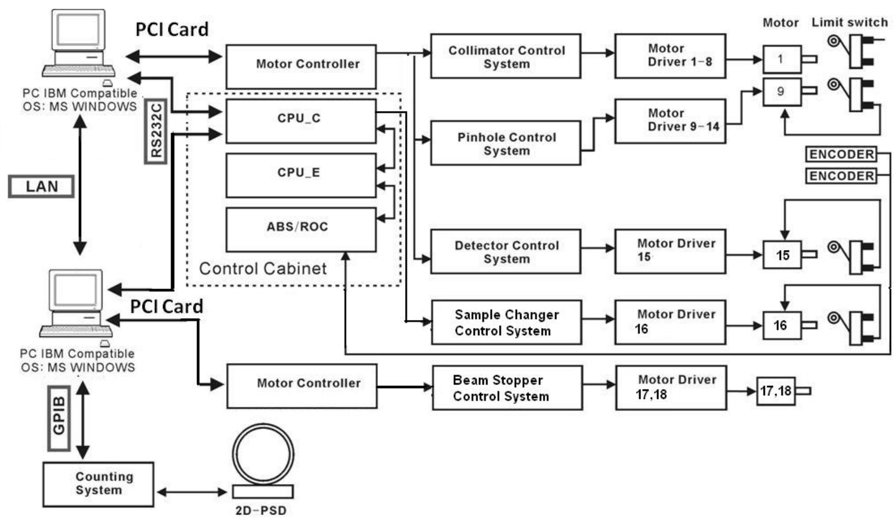
The SMARTer Software

Due to the replacement of the motor controllers, the software for data acquisition and controlling all devices has also to be developed. However, in order to keep the users can operate the software easily, the windows of the BATAN-SANS spectrometer control system software has not been modified [1,5]. The modification is only in the source code that makes all devices can be controlled simultaneously. The software for data acquisition [2] is also modified in order to run experiment with automatic sample changer. Visual Basic programming language is used in developing this software. The window of BATAN-SANS spectrometer data acquisition software is shown in figure 3.

The equipment status of the spectrometer is displayed in real-time on main window of the software. Only beam stopper (X and Y direction) that can be controlled by the data acquisition software in order to set the beam center on the PSD before running experiment. There are three sample changer type can be chosen for experiment in the input parameters window, as well as two experimental modes (preset time and preset count) in the main window. Since the sample changer accommodates maximum 12 samples



(a) The previous system, from 2006 to 2009[1]



(b) The modified system, from 2009-2012

FIGURE 2. The previous and the modified system.

holders, and the sample will be automatically changed without operator intervention during the experiment, therefore the software conducts the experiment runs effectively and efficiently. These are the advantages of the new software compared with the previous software. The experimental data is displayed in real-time in two-dimensional pattern with 16 colors scale, then can be saved in two different format data for further data analysis..

The flowchart of the software is shown in figure 4. In the first step, the new modified control software initializes the PMC card, reads the data log file which contains the information of the last setting configuration of the devices, and reset the controller. In the previous software, it gave the user a preference for repositioning the setting configuration of the six pinholes and the beam stopper. This action embedded at the initial step of the previous software for confirming those device positions since unexpected stop (emergency stop, power failure, etc.) might be occurred during the movement and caused some errors at the software[1]. In spite of that, in the new modified software, this function is deleted, then the user still can move the six pinholes to the home position after the software is loaded. The next step is, reading the pulses that transferred directly from 13 encoders (8 at the four-sections of the collimator, 1 at the 2D-PSD and 4 at the beam narrower systems). Those pulses converted into the position of the collimators, 2D-PSD, as well as beam narrower, is written to PMC card and then displayed in the main window. A timer object has been used to read all the encoders and motor positions for every second that updates the SANS device status in the window. Finally, the software is ready to control each device by clicking the appropriate button.

In figure 4a, on the collimator control, there are three inputs for positioning the collimator, i.e. collimator number, neutron guide or non-reflecting tubes, and in the PSD control there is one input, i.e. detector position, for positioning the PSD. For the pinhole control, since no encoder is mounted in the system, a datum button has been created in order to move the pinhole to the home position with a limit switch as reference, and to correct the pinhole position. According to the moving command, the software sends the moving function to PMC card, and makes a loop to check the device position whether it reached the target position or not. This loop will not make the software stall, since each device has timer object independently. All of the moving results are saved in the file for the last status configuration of the SANS devices, as well as the usage data log.

Meanwhile in figure 4b, the new modified data acquisition software starts with initializing the PMC card, reading the data log file which contains the information of the last setting configuration of the devices, and resetting the controller, such as the new modified control software. After writing the position of collimator, pinhole, detector, beam stopper, and sample changer to the controller, the software counts the neutron in 10 seconds for calculating the rate of incoming neutrons. This count rates will be used by user to approximate the consuming time of SANS experiment before setup the preset time/count of the experiment. The next step is displaying main monitor of the software. In this window, there is a control button to drive the beam stopper in two directions, and the sample changer. For the data acquisition, the first step input the experimental parameter that contains of experimental setting, and sample changer parameters. Then, the software moves the sample holder to the center of the neutron beam, and starts the data acquisition. The experiment data is temporary stored in two banks of histogram memory alternately, so that the software take the data for every 10 seconds, save the data to the selected format, and then display the data to the main monitor in two dimensional pattern.

CONCLUSION

The new development software for measurement and control has been made, implemented and then tested for handling the all motor devices of the SANS BATAN spectrometer simultaneously, and it works well. This software has an open possibility to be developed easily to accommodate any other new devices or additional setup, such as stop flow cell system, etc for in-situ and real time experiment.

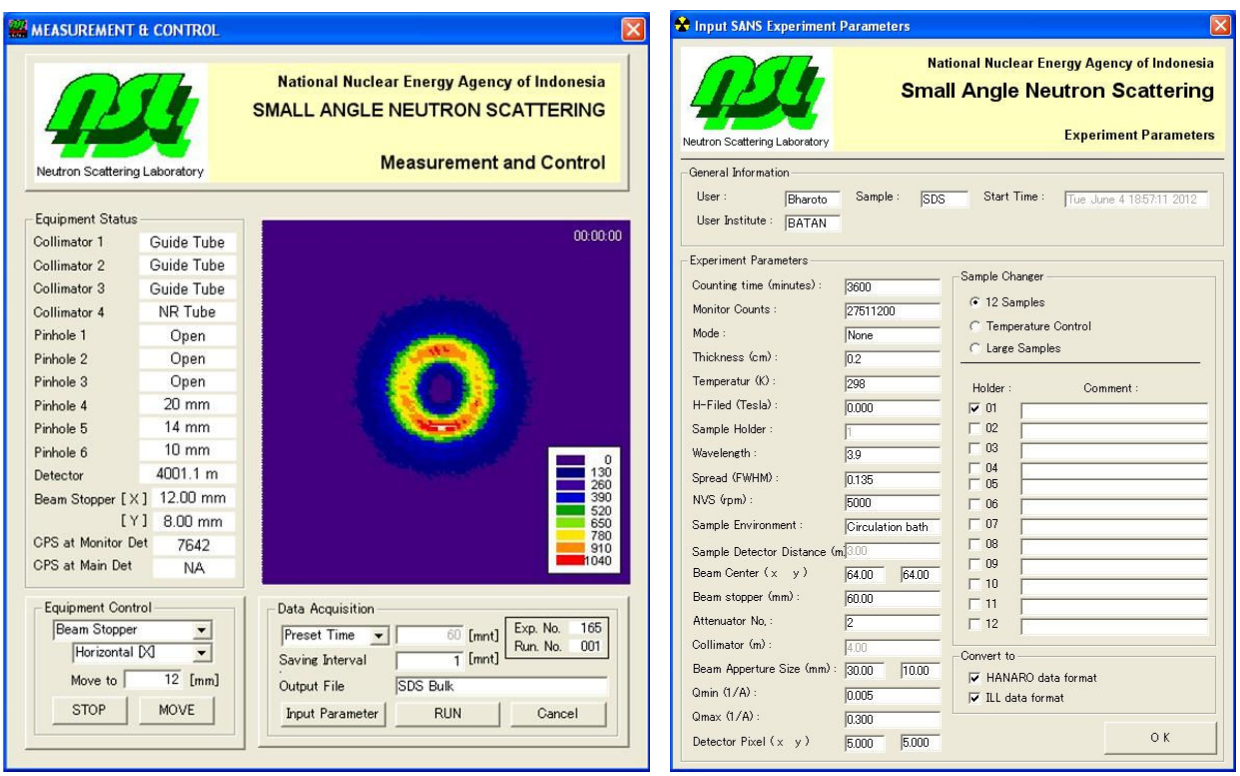
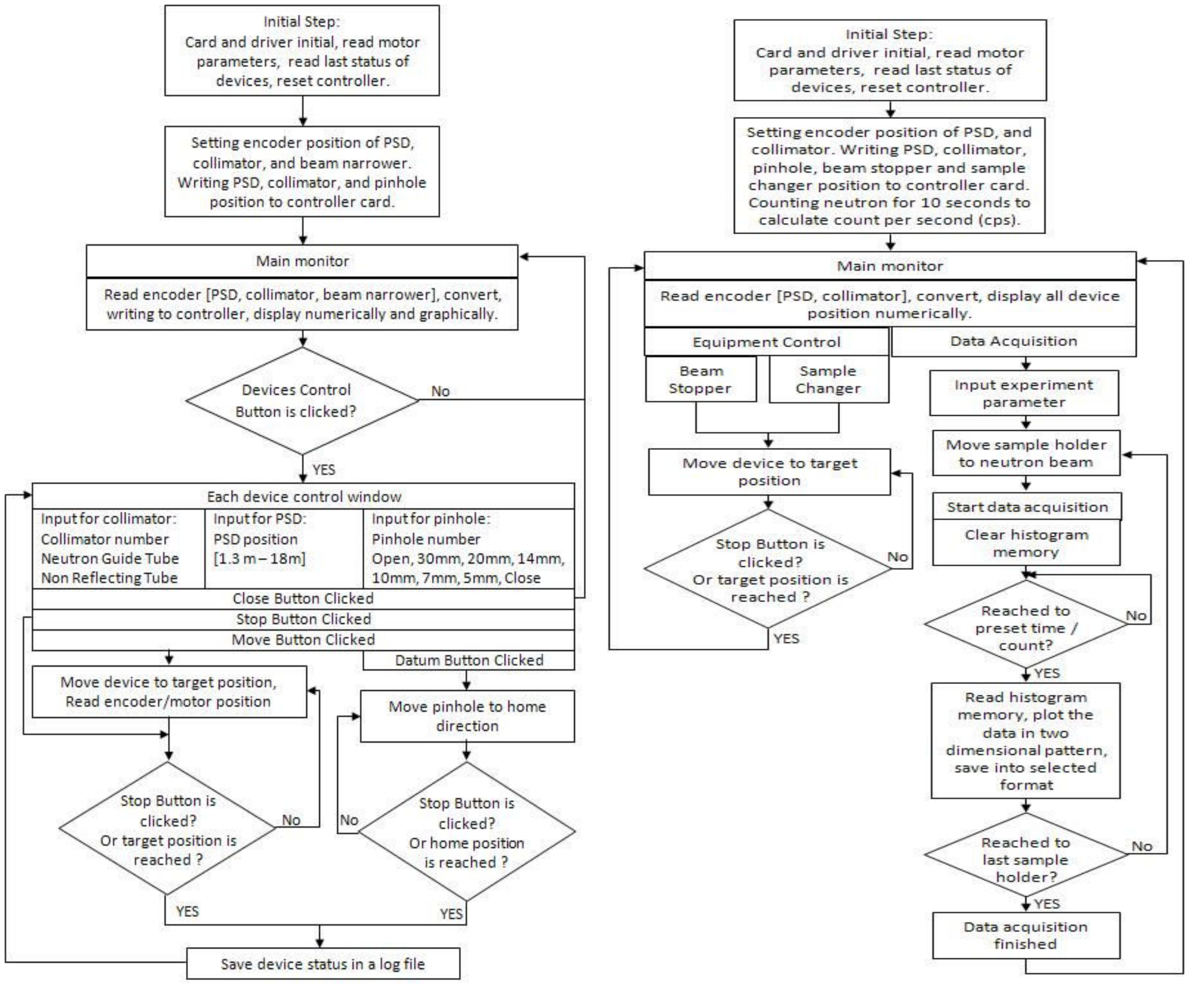


FIGURE 3. The SMARTer Measurement and Control Software at Data Acquisition.



(a) Flowchart of the new control software (b) Flowchart of the new data acquisition software

FIGURE 4. Flowchart of the SMARTer Measurement and Control Software.

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