PRAMANA
— journal of
physics

Vol. 63, No. 2
August 2004
pp. 455–458

Data acquisition and instrument control system for neutron spectrometers

S S NAIK, ISMAT KOTWAL, R M CHANDAK and V G GAONKAR
Solid State Physics Division, Bhabha Atomic Research Centre, Mumbai 400 085, India
E-mail: ssnaik@apsara.barc.ernet.in

Abstract. A personal computer (PC)-based data acquisition and instrument control system has been developed for neutron spectrometers in Dhruva reactor hall and Guide Tube laboratory. Efforts have been made to make the system versatile so that it can be used for controlling various neutron spectrometers using single end-on detector in step scan mode. Commercially available PC add-on cards have been used for input–output and timer-counter operations. An interface card and DC motor driver card have been developed indigenously. Software for the system has been written in Visual C++ language using MS Windows operating system. This data acquisition and instrument control system is successfully controlling four spectrometers at Dhruva reactor.

Keywords. Data acquisition; control systems.

PACS Nos 07.05.Hd; 07.05.Dz

1. Introduction

In a typical neutron scattering experiment [1], a monochromatic beam of neutrons is incident on the sample being studied and intensity of the neutrons scattered by the sample is then measured as a function of scattering angle. The data acquisition consists of counting the number of neutrons scattered at various angles normalized by either total fixed number of neutrons incident on the sample (monitor mode which automatically takes account of fluctuations in reactor power as well as change of incident neutron energy) or normalized with time (time mode). Thus the control system for the spectrometers is required to accurately move the various motors (determining the positions of the monochromator crystal, monochromator shielding drum, sample table, analyzer table and detector assembly) and acquire data from neutron detection system as a function of these angles. This paper briefly describes the personal computer (PC)-based data acquisition and instrument control system developed for the neutron spectrometers using single end-on detector in step scan mode (in contrast to the position-sensitive detector-based systems as described in ref. [2]) in Dhruva reactor hall and attached laboratory.

2. General description

The control system is designed to suit the mechanical and electrical assembly (consisting of the detector electronics, motors and encoders) of the spectrometer. The front end electronics for neutron detection consists of gas-filled neutron detector, standard high- and low-voltage power supplies, pre-amplifier, amplifier and discriminator-scaler. The angular movement of various arms/axes of the spectrometer is accomplished by worm and worm gear assembly driven by 24 V DC motor. The feedback regarding the angular position of the motor is derived from rotary optical encoder (connected to the shaft of the motor), which generates typically 100 pulses per rotation. Controlling of angular position of any axis essentially consists of counting the number of pulses delivered by the corresponding rotary optical encoder when motor is moving and then stopping the motor when desired number of pulses have been counted. In the present configuration the system can control up to six motors at a time with a typical positioning accuracy of 0.01°. The data acquisition consists of counting the voltage pulses generated by the detected neutrons.

3. Hardware

The schematic block diagram of the system is as shown in figure 1. Other than the detector electronics, motors and encoders, this system consists of PC add-on cards for input–output (I/O) and timer/counter operations, interface card and motor driver cards. Commercially available PC add-on cards are used for I/O and timer/counter operations. PCL221, a multifunction I/O card, provides 48 programmable I/O lines using two Intel-8255 integrated circuit (IC) chips. Eight lines on each IC constitute a port; hence each IC has three ports (designated as

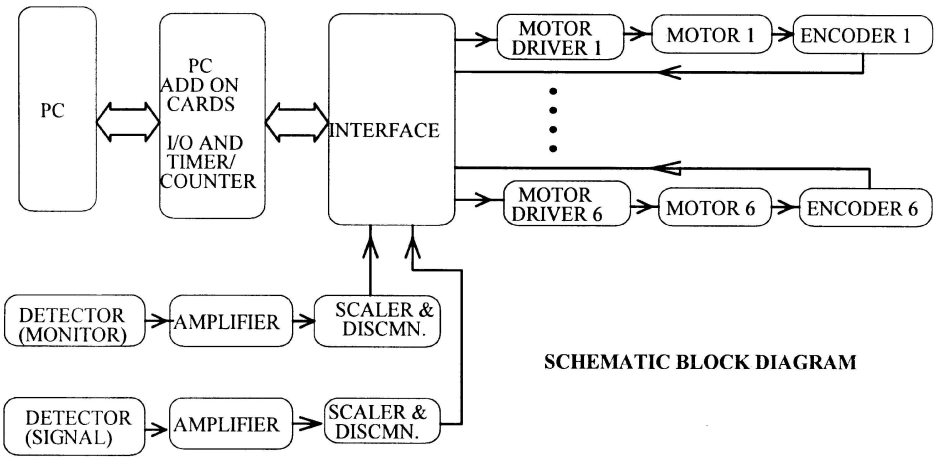

Figure 1. Schematic block diagram of data acquisition and instrument control system.

ports A, B and C). Ports A and B of both the IC's are programmed as output ports. Each output port is configured to control two motors. Port C of both the ICs is used as input port. PCL223 is a timer/counter card. It provides a total of nine counters using Intel IC 8253. Six counters are used for counting the pulses delivered by the rotary optical encoders connected to the motors and two counters are used for counting the discriminated amplified voltage pulses generated by the neutrons reaching the monitor and signal detectors.

The interface card has been developed indigenously and includes logic circuits and hardware interlocks required for motor movements and data acquisition. Further, DC motor drivers have been developed for permanent magnet type motors. These enable the switching on/off of the motors, forward/reverse and slow/fast speed operation of the motors. In this driver solid state relays are used for switching. As mentioned earlier, position feedback to the system is obtained from the rotary optical encoder. Also, mechanical limit switches are connected to the different arms of the instrument. The limit switches are employed to cut off the power supply to the motors, when required.

4. Software

General-purpose software to accomplish data acquisition and instrument control for various spectrometers has been implemented in Visual C++ in the MS Windows operating system. Programming for a typical experiment requires determining (either through computation or user input) the values of the angles for the various motors and subsequent positioning of the respective motors at those positions. In particular, for the single crystal diffractometer at Dhruva reactor, this software accepts an input file containing motor positions for various reflections. Positions for standard reflections can be inserted in the input file at the desired places.

The software controls the manner in which the motor positioning and data acquisition module interacts with the electronic hardware module described previously. A simple user-friendly active window has various experiment control (including software limits for the various motors) and data display. Experiment is conducted from Start Run-Index to Stop Run-Index as per flow chart shown in figure 2. Data are stored in files on the hard disk of the PC.

5. Conclusion

The data acquisition and instrument control system described in this paper has been installed on four spectrometers in Dhruva reactor, namely the filter detector spectrometer, single crystal diffractometer, small-angle neutron instrument and triple-axis spectrometer. The reproducibility of the settings of the motors and reliability of data acquisition as well as control through the software has been very satisfactory.

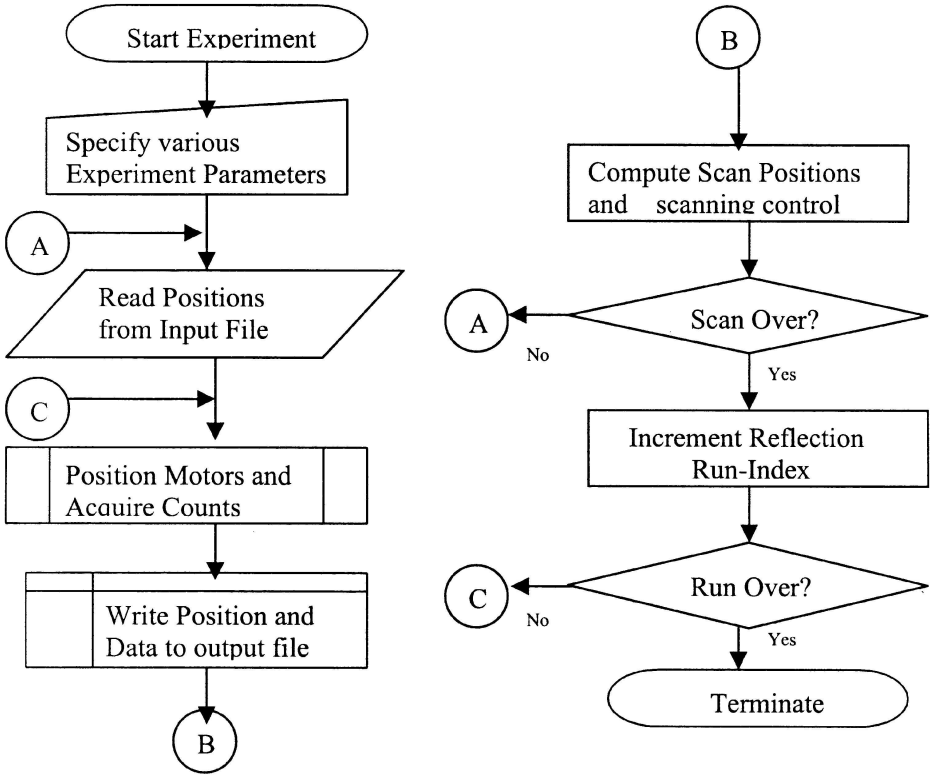

Figure 2. Flow chart of a scan.

Acknowledgement

Authors are thankful to Dr M Ramanadham and Dr S K Paranjpe for their constant support and guidance during the development of this system. Dr A K Rajarajan developed the primary version of the software. We are also thankful to Dr Mala N Rao for significantly improving the presentation of the paper.

References

[1] K R Rao, *Indian J. Pure and Appl. Phys.* **27**, 548 (1989)
[2] S K Paranjpe, *Indian J. Pure and Appl. Phys.* **27**, 578 (1989)