doi:10.1017/S1431927618012916
Microsc. Microanal. 24 (Suppl 2), 2018

Information-tagged Data-acquisition System for On-the-fly Scanning

Chien-Yu Lee[1*], Gung-Chian Yin[1], Bo-Yi Chen[1], Huang-Yeh Chen[1], Bi-Hsuan Lin[1], Shao-Chin Tseng[1], Shi-Hung Chang[1], Xiao-Yun Li[1] and Mau-Tsu Tang[1]

[1.] National Synchrotron Radiation Research Center
* Corresponding author, lee.cy@nsrrc.org.tw

This scanning system is an innovative project to handle a high-speed, multiple-variable input interface that can be used on any analogue driving and scanning system to perform stage movement and to transmit, continuously and synchronously, the data upward to a control computer. This data-acquisition system has been first installed at nanoprobe endstation 23A [1,2] of Taiwan Photon Source (TPS).

The scanning system, designed in house, uses 1-Gbit ethernet as an interface for control and data transmission. The scanning system includes a four-channel digital-to-analogue converter (DAC) to generate an analogue wave form that is used to drive the voltage-control stages. A four-channel analogue-to-digital converter (ADC) converts the analogue signal into the system, which is usable for an ion chamber or any other analogue signal input. There are up to ten channels in the interferometer interface and two parallel interfaces, which serve to connect laser interferometers and quantum detectors. There are up to 30 pairs of high-speed differential input and output (IO), which are used for high-speed, low-impedance signals such as a photomultiplier tube (PMT) or a high-speed quantum detector. Two small-form-factor pluggable (SFP) transceivers and four pairs of high-speed gigabit transceivers are reserved for high-speed gigabit usage. The highly flexible ability of this system allows more than 60 extensible IO that could be readily used for multipurpose data input and output.

In X-ray-excited optical luminescence (XEOL) [3,4] and X-ray fluorescence (XRF) experiments, the DAC drives the sample stage. The hardware of the scanning system continually packs the PMT counts for data from the XEOL and the silicon drift detector (SDD) for XRF into an ethernet packet, then sends the data back to the computer. Similarly, in an experiment to record X-ray absorption spectra (XAS), the computer software controls the energy change; the hardware of the scanning system continually packs sampling data of the ion chamber into an ethernet packet, then sends it back to the computer.

Figure 1(a) reveals the packet data format and the method for image reconstruction. These system-acquired data are separated and packed into ethernet packets of two kinds: one is an analogue data packet (ADP); the other is a SDD Data Packet (SDP). The ADP includes a four-channel ADC and single PMT data; the SDP includes four-channel SDD data. Each piece of data is tagged with two pieces of information -- position and time. These two tags are important for consistent data reconstruction and timing analysis. In particular, for image reconstruction as shown in figure 1(b), the position tag decides the pixel position of the image and is more important for auto-stitching with adjacent images.

The control software for this scanning system is separated into two segments as shown in figure 2(a) -- a server and client software application interface (API). The server API controls the scanning system and the data storage; the client API handles the user control -- it could prevent fault control, check and filter out the out-of-range control, then send the correct command back to the server. These two separate control API have the advantage to separate the job and the responsibility. The client API provides a method to set the privilege for a particular user. The server API focuses on high-speed data processing and avoids interruption due to a user's improper operation.

This high-speed information-tagged data-acquisition mechanism is the heart of a scanning system that is steady and reliable, and enters service for the user at end station TPS 23A.

References

[1] G.-C. Yin *et al*, AIP Conference Proceedings, 1696 (2016) 020026.
[2] G.-C. Yin *et al*, Proc. SPIE 9592, X-Ray Nanoimaging: Instruments and Methods II, 959204
[3] B.-H. Lin *et al*, Applied Physics Letters 109, 192104 (2016)
[4] B.-H. Lin et al, Optics express 26, 2731-2739 (2018).

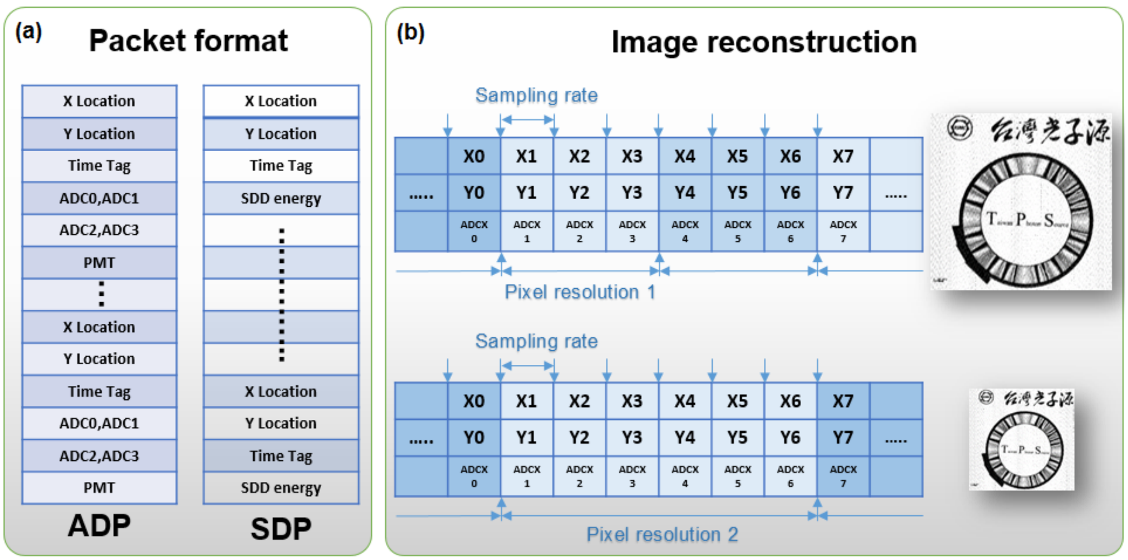

Figure. 1. Packet format and image reconstruction. (a) Data packets of two kinds -- ADC packet (ADP) and SDD packet (SDP). (b) The size of reconstructed image depends on the selected pixel resolution. The pixel value is accomplished through accumulating and averaging data in a period of time that is decided according to the selected resolution.

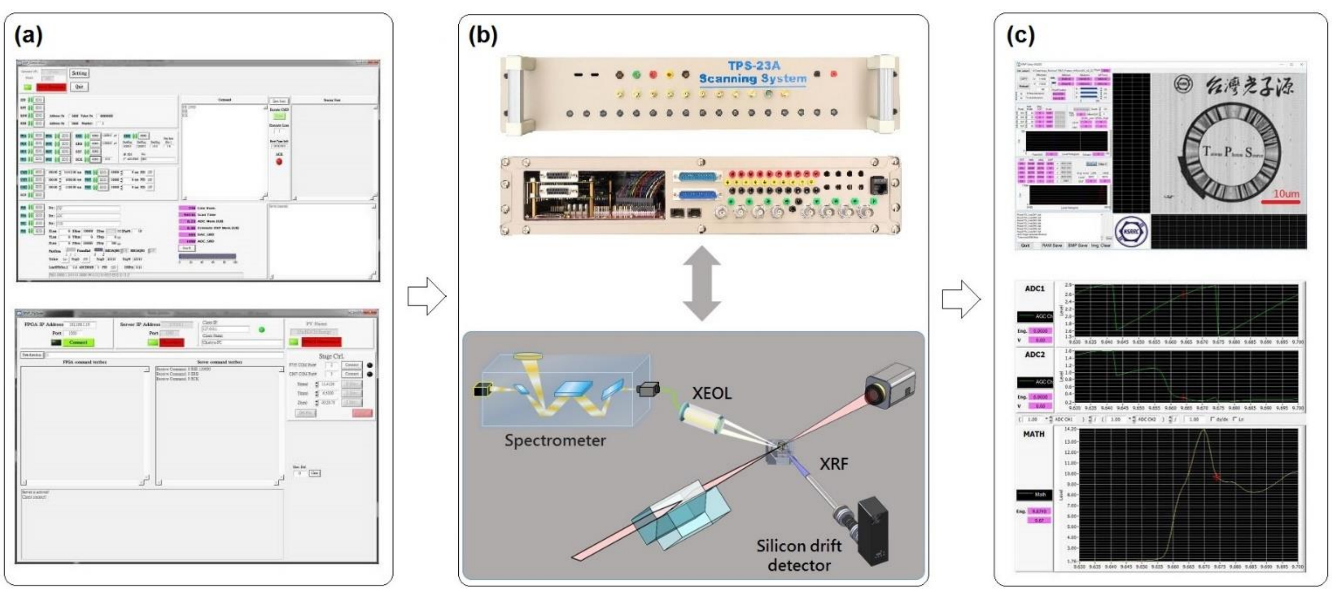

Figure. 2. Software API and system control implementation. (a) Server/client structure API used to handle the entire system control. (b) On-the-fly scanning system. (c) Back-end analysis tool, which is used for analysis of the XEOL, XRF and XAS.

https://doi.org/10.1017/S1431927618012916 Published online by Cambridge University Press