DEVELOPMENT OF MATLAB-BASED DATA LOGGING SYSTEM AT SIAM PHOTON SOURCE

Prapong Klysubun and Chawalit Netsai, NSRC, Nakhon Ratchasima, Thailand

Abstract

New data logging and retrieval systems are currently under development at Siam Photon Source. The systems are written entirely with MATLAB language and utilize two MATLAB toolboxes to handle data communications. The two toolboxes are Open Process Control Toolbox, which is used to carry out communications with Programmable Logic Controllers (PLCs) via Open Process Control Data Access (OPCDA), and Data Acquisition Toolbox, which handles communications with other systems via RS-232 and IEEE-488 interconnections. The interface with the database is handled by the MATLAB Database Toolbox. These MATLAB-based logging and retrieval systems enable accelerator physicists to easily import the logged data to accelerator modeling tools for studies of the accelerator optics. Beamline researchers and users can also write their own retrieval programs to access only the data they need. In this paper we describe the concept, the current status of the systems, and the planned improvements to be carried out in the future.

INTRODUCTION

Siam Photon Source (SPS) at National Synchrotron Research Center (NSRC), Nakhon Ratchasima, Thailand is an accelerator complex optimized for the generation of synchrotron radiation. The light source consists of two 20-MeV linacs, a 1.0-GeV booster synchrotron, and an electron storage ring. The storage ring, which has recently been upgraded from 1.0 GeV to 1.2 GeV, has eight bending magnets and four straight sections for insertion devices. The beam is injected to the storage ring at 1.0 GeV and then ramped up to 1.2 GeV. Machine specifications of the SPS can be summarized as listed in Table 1. The generated synchrotron radiation is utilized for researches in a wide range of disciplines, including surface science, material science, biology, chemistry, among others. At present there are three bending magnet beamlines and three experimental stations for photoelectron spectroscopy (PES), x-ray absorption fine-structure spectroscopy (XAFS), and x-ray lithography researches.

The SPS consists of several subsystems. Most of the devices are controlled and monitored by a PC-based control system via programmable logic controllers (PLCs). The monitored values are then logged into a database for future reference and diagnosis. This database is very important in assisting machine operators in the process of identifying the sources of machine problem that occurred or might occur in the future, in order to prevent such a problem from happening again. The previous data logging scheme, however, is extremely simple and archaic, constituting of Java applets that simply record the monitored data in a comma separated value (CSV) file format, with neither search nor retrieval capability. Thus, the development of a new, robust data logging system is essential for the successful operation of the SPS.

Table 1: Summary of SPS machine specifications

Electron beam energy [GeV]	1.2
Beam current [mA]	100
Lattice	DBA
Superperiod	4
Horizontal emittance [nm·rad]	41
Coupling [%]	0.8
Circumference [m]	81.3
Number of straight sections	4
Betatron tunes ν_x, ν_y	4.75, 2.82
Synchrotron tune ν_s	2.33×10^{-3}
Natural chromaticities ξ_x, ξ_y	-9.40, -6.61
Momentum compaction	0.0170
RF frequency [MHz]	118
Harmonic number	32
RF voltage [kV]	100
RF power [kW]	10.5
Number of RF cavity	1
Energy loss per turn [keV]	65.94
Injection beam energy [GeV]	1.0
Number of beamlines	3

HISTORY OF THE DEVELOPMENT

In early 2005 the control system of the Siam Photon Source has been incorporated with a new data logging scheme based on EPICS (Experimental Physics and Industrial Control System), which is a collection of free open-source software for control applications. The main components of this data logging system are Channel Archiver and Archive Viewer. Channel Archiver is a compilation of archiving toolsets for EPICS. It connects to EPICS IOC (Input Output Controller) via Channel Access protocol to retrieve machine parameters periodically and store them in a raw data format. Archive Viewer is a data retrieval tool that allows users to browse the data, generate plots, and export the data to various file formats. While this logging and retrieval scheme is robust and has been successfully implemented at several synchrotron facilities, the insufficient number of personnel acquainted with UNIX operating system and C language makes this alternative impractical and difficult for maintenance and upgrade.

MATLAB [1] is a mathematical language that is widely used by scientists and engineers. There are a few advantages in employing MATLAB-based data logging system. One is that the logged data can be passed directly

to MATLAB-based accelerator modeling tools such as Accelerator Toolbox [2], which is regularly used by many accelerator physicists at the facility. Another advantage over EPICS-based system is that the programming is much easier, which leads to shorter development time.

DATA LOGGING SCHEME

As shown in Fig. 1, the system handles most of the data transfer from the Programmable Logic Controllers via an OPC (OLE for Process Control) server and the MATLAB OPC Toolbox. Other data that are not connected to the PLCs are logged via IEEE-488 and RS-232 communications handled by the MATLAB Data Acquisition Toolbox.

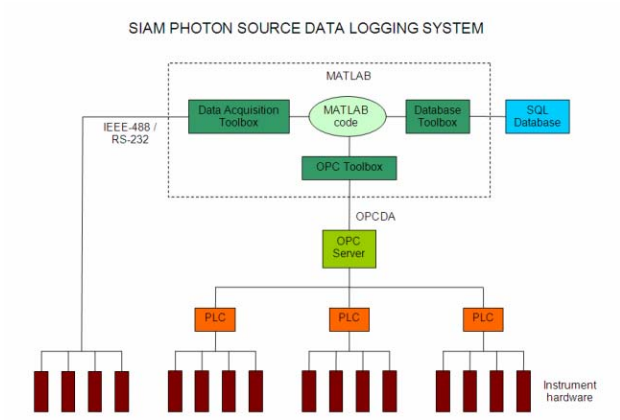

Figure 1: Schematic of the new data logging system.

There is a configuration table which serves as an index for data retrieval. Other information is also stored in this table, for instance, description of the logged parameter, upper and lower limits, interface type, etc. The logged data is stored in a separate table.

The computer used for data logging is an HP Proliant ML350 G4 with Intel Xeon 3.2 GHz/800 MHz FSB/1 MB L2 cache, 1 GB of memory, and 72 GB SCSI hard disk drive. The database chosen was the open-source database MySQL 5.0 [3]. The archiving operations are as followed. First, the system retrieves the information on the data to be logged, for e.g. PLC tag name, the logging time interval, etc., from the configuration table [Detail] in the MySQL logdb database. Then the logging process will be executed at the specified time interval. The logged data will then be written to the logged table.

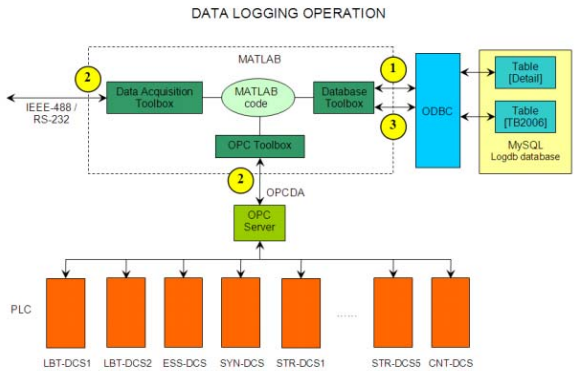

Figure 2: Detail of the logging operation.

The communication between the MATLAB Database Toolbox and the SQL database is done via an ODBC connector (MySQL connector/ODBC version 3.51 was used), while the communication between the MATLAB OPC Toolbox and the OPC server is performed via the OPC Core Components [4] (version 2.00 was used.) The OPC server used is RSLinx OPC server.

RETRIEVAL ENGINE

The retrieval engine, which is also written in MATLAB, retrieves and displays graphically the chronological record of a specified set of parameters. As mentioned earlier, the benefit of employing MATLAB-based retrieval system is that the retrieved data can be passed directly to other MATLAB-based accelerator modeling programs. For example, at the SPS, the logged BPM readings are imported to a COD correction program, which is written with MATLAB using Accelerator Toolbox, and the logged currents supplied to the magnets are imported to the accelerator model for analyses of the storage ring optics. The format of the retrieved data can be selected by the user to comply with the standard input format of other beam dynamics programs, for e.g., MAD, BETA, LATTICE, etc. The wide-spread use of MATLAB also ensures that beamline researchers can write their own programs to retrieve only the data they need.

Table 2: Format of the configuration table

ID	Tag name	Description	Sampling interval (sec)	Unit	Lower limit	Upper limit	Type of interface	Active
1	[CNT-DCS]S_BM_M.MonitoredValue	Storage ring bending magnet monitored current	10	Ampere	0	2000	OPCDA	1
2	[CNT-DCS]S_QF_M1.MonitoredValue	Storage ring QF1 quadrupole magnet monitored current	10	Ampere	0	400	OPCDA	1
3	[CNT-DCS]S_QD_M2.MonitoredValue	Storage ring QD2 quadrupole magnet monitored current	10	Ampere	0	400	OPCDA	1
…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…

Table 3: Log table

No.	Time stamp	ID	Value	Quality	Error
1	22-Dec-2005 17:26:10	1	1290.20	Good: Non-specific	(null)
2	22-Dec-2005 17:26:10	2	303.29	Good: Non-specific	(null)
3	22-Dec-2005 17:26:10	3	326.48	Good: Non-specific	(null)
…	…	…	…	…	…
…	…	…	…	…	…

SUMMARY

A new data logging system has been developed at the Siam Photon Source. The system has been written entirely with MATLAB language. By utilizing available MATLAB toolboxes the development of the logging system is simple and straightforward, leading to short development time. The open-source database MySQL was chosen so that the development cost is low. The MATLAB-based retrieval module enables the logged data to be passed directly to MATLAB-based accelerator modeling tools. The development is ongoing and several improvements are to be carried out. One is an alert system which will inform machine operators when the monitored value is approaching the limits of the allowable range. The other is an automatic snap-shot function that will automatically record all parameters when the machine experiences a problem.

REFERENCES

[1] MathWorks. Website: http://www.mathworks.com.
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[3] MySQL AB. Website: http://www.mysql.com.
[4] OPC Foundation. Website: http://www.opcfoundation.org.