LabVIEW-Based Data Communication in LAMOST Telescope

Lingzhe Xu
[1]National Astronomical Observatories /Nanjing Institute of Astronomical Optics & Technology
Chinese Academy of Sciences Nanjing, China
[2] Key Laboratory of Astronomical Optics & Technology, Nanjing Institute of Astronomical Optics & Technology, Chinese Academy of Sciences, Nanjing 210042, China

Abstract: The Large sky Area Multi-Object fiber Spectroscopic Telescope (LAMOST), one of the National large scientific and engineering projects, successfully passed the National inspection and acceptance test in 2008. Ever since then the giant astronomical telescope has become the world's most powerful survey instrument of its kind with nominal scan rate of 4000 celestial objects simultaneously per observation. This amazing output rate absolutely requires a means of efficient data acquisition, accessing and publication with enormous volume of local and remote data. The dataflow is running on networks of hierarchical levels within various kinds of components of the LAMOST control system. The paper briefly describes about LAMOST control system as a start, and further evolves into discussion on the data communication based on LabVIEW virtual instrument technology with an illustration of accessing a rain-and-dew sensor using a serial port. Also the paper presents the mechanism of DataSocket interface connected to the LabVIEW in LAMOST remote monitoring and control.

Keywords-component; LAMOST; LabVIEW; serial port communication; DataSocket; remote control

I. INTRODUCTION

LAMOST telescope is one of National large scientific and engineering projects completed a couple of years ago. Since the end of 2011 the telescope has started its pilot survey of the sky at the nominal rate of 4000 [1] celestial objects per observation, This is 5.5 times that of American SDSS (Sloan Digital Sky Survey) telescope, thus has set a new world record in the number of stars scanned at a shot. LAMOST, the largest astronomical optical telescope in China with 4meter-class [1] effective aperture has now stood tall and upright at Xinglong Station of the National Astronomical Observatories (NAO). LAMOST identifies an independent innovation and outcome of painstaking research and development carried out by Chinese astronomical community, which also is a big event in the world astronomical society. With perspective of a technical development in control system the telescope is a comprehensive optical-electromechanical integration with powerful multi-functions that coordinates and monitors various kinds of numerous electromechanical components and devices. All these electromechanical elements are either individually or collectively distributed on the corresponding hierarchical network nodes working harmoniously as a whole. The completed network is hierarchically divided into a number of levels. Subordinated to the Telescope Control System (TCS) and situated one level down are several sub-systems such as Azimuth-Elevation Mount Control (AEMC), Focal Plane Control (FPC), Active Optics Control (AOC), Guider Tracking Control (GTC),Environmental Condition Monitor & Control.[2] (ECMC) and so on. Each one of the 5 sub-systems at first level communicates basically through the supervisor TCS, while they interacts each other directly if real time is critical. Furthermore each first level sub-system has its own sub-component at one level further down in the hierarchical network infrastructure. From the description above it is absolutely needed for the designers to search for an efficient integrated programming platform with rich communicating tools and GUI (Graphical User Interface) resources for sophisticated programming yet with relatively less time consuming. Here is where the LabVIEW comes in. LabVIEW is an amazingly intuitive program created by NI (National Instruments). It enables the programmer to code using a graphics-based programming language. As a result, lines upon lines of text-based code with hard-to-remember syntax are no longer needed. All needed is just to drag the functions onto the screen and wire them together. Also, LabVIEW is equipped with many easy-to-use functions such as numerical analysis, digital signal processing and drive ability that take care of the dirty low-level work of configuring the computer hardware to establish communication between the computer and the instrument. It is also notable that programmable instruments are easy to be coded on LabVIEW platform and ready to start. So that LabVIEW-program is recognized as a virtual instruments program.

The paper briefly outlines about the LAMOST control system with its hierarchy network and the reason for choosing LabVIEW programming platform as mentioned above. The paper focus down on the data communication as below based on LabVIEW virtual instrument technology with an illustration of accessing a rain-and-dew sensor using a serial port. Also the paper elaborates about DataSocket interface connected to the LabVIEW in LAMOST remote monitoring and control.

 978-1-4673-0199-2/12/$31.00 ©2012 IEEE

II. DATA ACQUISITION SCHEME USING RAIN-AND-DEW SENSOR IN LAMOST

As its name implies the rain-and-dew sensor is a switching element and sensitive to dewdrops and raindrops so able to protect telescope mirrors from blemish. The data acquisition application based on LabVIEW is illustrated below.

A. Configuration of Rrain-and-Dew Sensor Data Acquisition

In LAMOST telescope, the Schmidt corrector mirror MA and primary mirror MB are assembled and installed in dome-A and chamber-B respectively. During routine observation the dome-A is required to open for the telescope to scan the sky. In order to protect MA mirror and the azimuth-elevation mount inside the dome-A from exposure to dewdrops or raindrops it is highly helpful to put a rain-and-dew sensor locally at the site. The sensor senses all the time the variation of dew point and humidity so as to predict what is about to happen. The TCS responds to the rain-warning signal and shuts down the telescope and closes up the dome-A in a programmatic way.

Technical requirements presented to the LAMOST telescope control system are comprehensive. Many control modes in a single master-slave .configuration can hardly meet the requirements. Therefore control technology based on network communication is adopted. This is done through bus-architecture connecting varies kinds of facilities and equipments as a whole to ensure the entire system working securely and reliably. At present time, in the industry area the field-bus architecture RS485 is utilized most frequently. RS485 bus can be categorized into serial communication bus architecture with balanced transmitting and differential receiving so has the ability to suppress common mode interference. RS485 bus transceiver features high sensibility and is able to monitor a weak signal as low as 200mv, which benefits the signal recovery in the location of 1 km away, suitable for long distance data acquisition. Another important feature for RS485 is two-wire serial interface, which forms a communication loop so as to reduce greatly the number of signal wires for multi-terminal connection and simplifies the networking topology. The RS485 bus has finally been employed [3] in LAMOST network layout. The figure 1 shows the network topology structure for distributed rain-and-dew sensors monitored and controlled by a master PC.

B. Programming of Rrain-and-Dew Sensor Data Acquisition

The rain-and-dew sensor data acquisition as a whole could be divided into three parts: the serial port data acquisition, the data validation and the data conversion & display all illustrated respectively below.

- The serial port data acquisition: (1) Initialize the serial port with LabVIEW serial port initialization function. (2) Set the port number, data bit, stop bit and the baud rate. (3) Once the configuration of the serial port is set it is then possible to use serial port read-function to get the BCC (Block Check Character) from the port's buffer. The slave PC program in loop writes the data at certain rate into the buffer so that the read-out data from the buffer is updated.

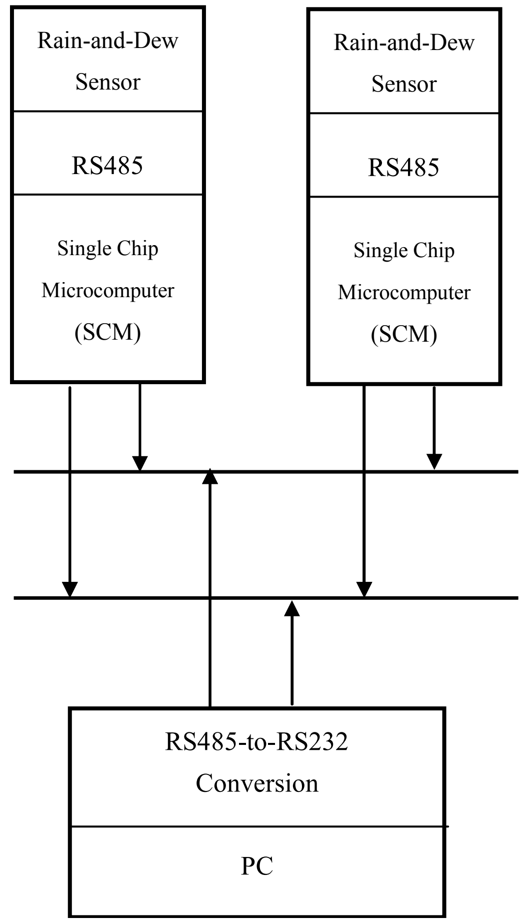

Figure1. Network of distributed rain-and-dew sensors.

- Data validation: Get BCC from the read-out data, and compare this BCC with the BCC delivered by the slave PC so as to conduct data validation.
- Data conversion & display: Convert the acquisition data and get the rain-and-dew information accordingly. Once the data value in the information exceeds predetermined value the system gives out a warning signal.

The program flowchart for rain-and-dew sensor is shown in figure 2.

III. LAMOST REMOTE CONTROL TECHNOLOGY BASED ON DATASOCKET COMMUNICATION

LAMOST telescope is required to be remotely manipulated. This remote control mode has been realized thanks to contemporary network technology. LAN (Local Area Network) and internet both can be categorized into this group. DataSocket is actually an interface technology that can be seamlessly applied based on TCP/IP standard in many popular kinds of network for remote data communication. DataSocket function is included in LabVIEW. In the control system of LAMOST telescope the DataSocket technology is widely used for data communication among TCS and its sub-systems as long as they support TCP/IP standard.

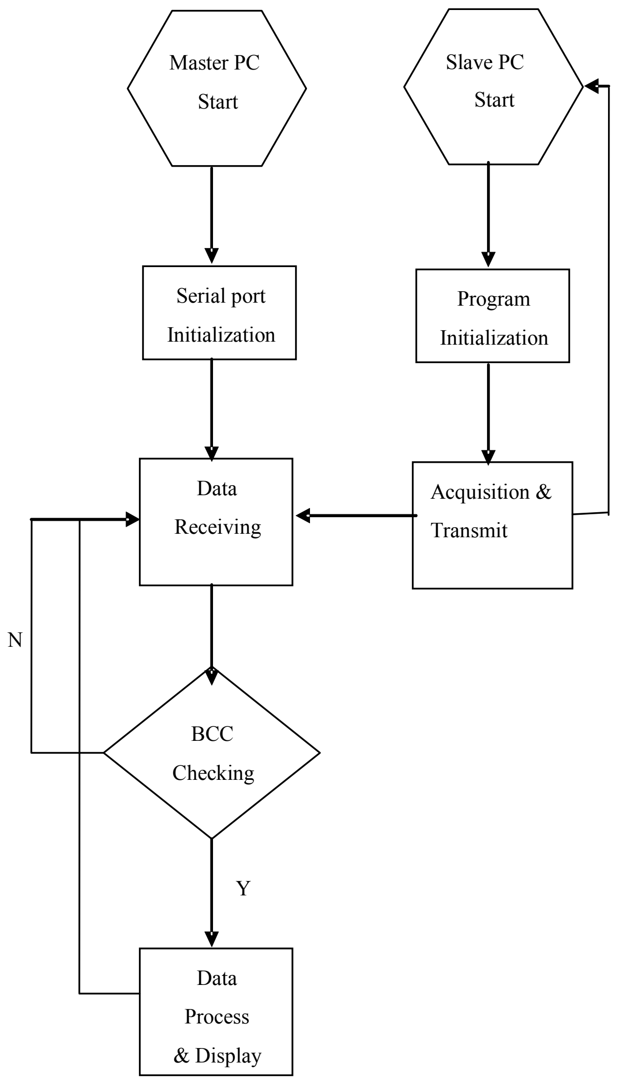

Figure2. The Program Flowchart for Rain-and-Dew Sensor

A. A Brief Introduction to DataSocket Technology

DataSocket is a TCP/IP based communication technology released by NI, which is oriented to online measurement and high speed data communication in a network. The software package is included in LabVIEW. DataSocket for LabVIEW simplifies live data exchange between different applications [4] on one computer or between computers connected through a network, including the Internet, so as to benefits a remote control.

Just as a WWW browser the data source and data destination in DataSocket application are defined by URL (Uniform Resource Locator).These data sources can be one of a few file formats such as DSTP (DataSocket Transfer Protocol), OPC (OLE for Process Control) or FTP (File Transfer Protocol), Thereinto, DSTP is a protocol specifically for data read and write in DataSocket applications. In DataSocket transfer DSTP is mainly used for connectivity between data source and data destination [5].

DataSocket package is made up of three parts: DataSocketServerManager, DataSocket Server and DataSocket API. The major function of DataSocketServerManager is for setting up the user function, user privilege, and configuration for DataSocket Server. The major function of DataSocket Server is to provide a solution for network communication. The user created by DataSocketServerManager then can make communication according to their privilege. DataSocket API provides a standard programming interface, which can be applied in a number of programming environments such as VB, VC, LabVIEW, etc.

DataSocket-based technology can be utilized not only for network measuring devices in c/s (client/server) mode, but also for Web-based network virtual instruments with ActiveX technology. All the data acquisition and process with Web-based network virtual instruments are collected in the server. The client-end only needs a browser. The interface for remote control in LAMOST telescope is realized just in the way stated above.

B. Structure of the Web-based Network Virtual Instrument

The structure of Web-based network virtual instrument is shown in figure 3. VXI、DAQ、PXI and so on are some of system bus interface hardware connected into Ethernet or Internet via a PC in the network. The virtual instrument sends acquired data to the server, with further process the data are published using HTTP standard protocol on the Internet. The client accesses the remote server through a browser.

C. The Realization of Remote Control

In the LAMOST remote control system an ActiveX-control is created under VB programming environment by means of DataSocket sever. The ActiveX-control communicates with GUI widgets. When the client accesses the server the ActiveX-control automatically creates an Internet package. The IE (Internet Explorer) is then able to identify and establish the Internet package. This way provides a possibility to dynamically accomplish the data display and the data interchange. Because both VB and LabVIEW support the DataSocket protocol, the communication between ActiveX-control and local widgets is achievable through DSTP (Data Space Transfer Protocol). At the same time the read-write function reads the status of each instrument and sends out the instruction.

IV. CONCLUSION

The paper presents data communication in LAMOST control application using LabVIEW-based virtual instrument network incorporated with serial port interface and DataSocket technology in a hierarchical network. These two data communication modes have now typically adopted in network control for data acquisition and publication. However, it is supposed for the first time to be implemented in the remote control design for monitor-and-control system of large astronomical telescopes in China.

This work is supported by NSFC(no. 10903018).

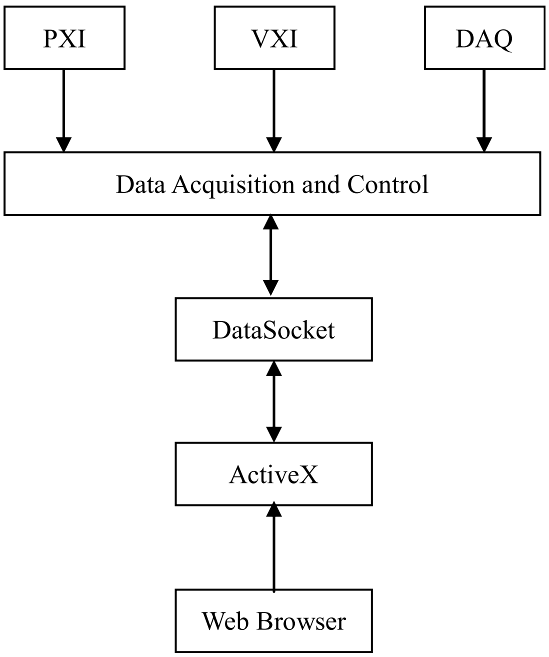

Figure3 Structure of the Web-based Virtual Instrument

REFERENCES

[1] Su Hongjun and Cui Xiangqun, “Proceedings of symposium on new technologies for astronomical telescopes and instruments,” Technical Committee on Astronomical Instruments of Chinese Astronomical Society. Lushan, pp. 79, 1997.

[2] Xu Lingzhe, “M&C System Integration for LAMOST Telescope,” Chinese Journal of Scientific Instrument. Beijing, vol. 29(4), pp. 747-750, 2008.

[3] Xu Jianwei, Xu Guoqing, and Kang Jinsong, “A Study of Monitor Systems for Distributed Power Supply,” Journal of MECHATRONICS. Shanghai, vol. 2, pp. 59-61, 2008.

[4] Lei Xiaoyong et.al, “The Realization of Remote Test System for Equipment Based on DataSocket Technique,” Instrumentation Technology. Shanghai Academy of Sciences. Shanghai, vol. 2, pp. 24-28, 2008.

[5] Chen Xiaoqiu and Xu Xiaohua, “Networklized measuring & control system based on DataSocket technique,” ELECTRONIC INSTRUMENTATION CUSTOMERS. Tianjin Instrument Group. Tianjin, vol. 2, pp. 263, 2008.