Systematic Industrial Process Analysis using OPC Technology

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Abstract

Aiming at the communication between LabVIEW and DCS, the paper presents a method of implementing remote real-time communication based on OPC (OLE for Process Control) on the Ethernet. It analyzed the principle of remote real-time communication between LabVIEW and DCS and designed a remote real-time communication test system consisting of LabVIEW, Ethernet and Honeywell HC-900 DCS. The author realized the HC-900 DCS hardware configuration, OPC server configuration, configuration variable and real-time data exchange between LabVIEW and HC-900 DCS by using NI(National Instrument) OPC server, and gave out the details of procedure and program. The test results indicate that the function of exchanging remote real-time data can be attained between LabVIEW and HC-900 DCS through OPC server, and prove that it is an effective and feasible method to realize the real-time remote communication between LabVIEW and DCS. The proposed method can be used to realize data process and advanced control in industrial to improve the process quality and control.

Introduction

OPC technology is a hardware and software interface standard using Client/Server mode based on COM (Component Object Model)/DCOM (Distributed Component Object Model), which offers a general standard mechanism for client's and server's data communication and exchange and supports the network distributional application procedure communication as well as the application procedure communication in different platforms. So OPC technology makes it easy for software and hardware from different producers to integrate and offers an effective solution for remote real-time communication between PC and process devices. LabVIEW, which is promoted by National Instruments has a formidable value computation and graphical function. It can provide some formidable and various toolboxes in many domains. We can use OPC server to gain conveniently the exterior real-time data and realize the remote real-time Communication between LabVIEW and process devices. In this paper, a concrete scheme is available
for remote real-time communication between LabVIEW and Honeywell DCS products (HC-900) based on OPC technology.

Communication Principle

OPC standard offers two kinds of industry standardization interfaces in COM module: OPC custom interface and OPC automation interface. Through the OPC interfaces, the connection of “plug and play” is formed between OPC clients and OPC server. A standard interface is provided to OPC objects by OPC Server component, at the same time, OPC objects are managed by the interface. The client creates and manages the server using API provided by COM, and accesses the server’s data objects through the interface method. OPC server described by OPC norm is made up of three levels of objects, which are the server object, the group object and
the item object. An OPC server includes an OPC server object which has all information of the server, also the OPC server object includes group object and the group object has all information of the group object and the item object. OPC object hierarchy structure is shown as Fig.1.

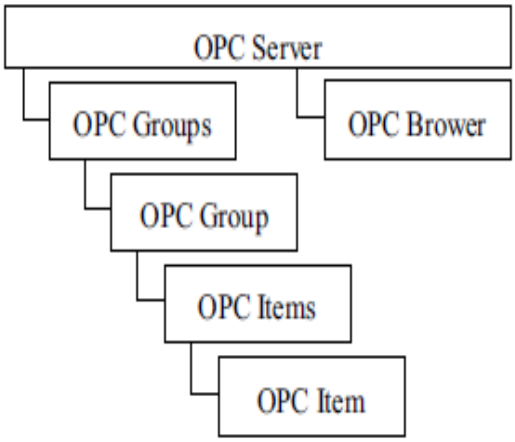

Fig.1 OPC structure object hierarchy

The NI OPC server which is a function module to expand the numerical and logical programming environment. It realizes the object-oriented hierarchy and OPC server communication method by using OPC data access standard, and provides a method to read or write OPC data through visiting the OPC server directly in the LabVIEW environment. By utilizing the OPC Toolbox, we can create the OPC customer application programming easily to realize the communication between LabVIEW and DCS and realize fast raw data analysis, measure and control, even though we don’t know the internal configuration of the OPC server.

Data access relationship between customer’s LabVIEW application programming and process devices (DCS) is shown as Fig. 2. Customer’s LabVIEW application programming visits the process devices (DCS) data through OPC interfaces, and exchanges data with OPC server object instead of visiting OPC server directly. The OPC group object provides a way of customer’s organizing data. The OPC item object is an object defined by OPC server, which is the least logic unit for reading or writing data. It can provide a connection between OPC server and process data source, that is to say, each item object connects with a signal

variable of process devices. The OPC item object provides the value, attribute, timestamp and data type of the signal variable to OPC customer, which usually points to a register of process devices. All the equipment register operations of the OPC customer are accomplished by its item object. Because the OPC item object is not a COM object and can't provide the interfaces to customer, the customer can not operate the item object directly and the access to the OPC item object should be accomplished through group object. There are three data exchange methods between OPC customer's application programming and OPC server: the synchronous way, the asynchronous way and the subscription way. The synchronous way is comparatively simple and often used when the exchange data amount is less. The asynchronous way is comparatively complicated and it can communicate with physical devices directly. The efficiency of the asynchronous way is higher when there are a large number of customers and exchange data. By using the subscription way, the OPC server will notice the OPC customer automatically when the data changes.

The paper used the asynchronous way to realize the data communication between OPC customer and OPC server.

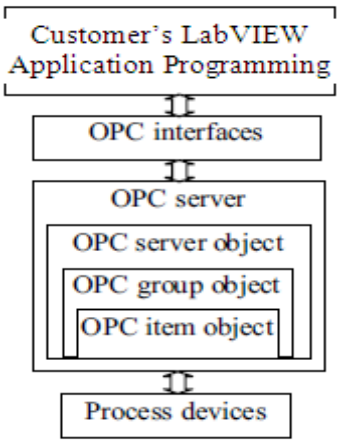

Fig.2 Data access relationship between LabVIEW application programming and process devices

Distributed Control System (DCS)

The DCS is an advanced loop and logic controller offering a modular design sized to satisfy the control and data management needs of a wide range of process equipment. When combined with the optional 1042 or 559 Operator Interfaces that are fully integrated into the controller's database, configuration and setup time is minimized. This powerful combination together with DCS performance proven control technology provides users an ideal solution for process control. Open Ethernet connectivity with Modbus TCP Protocol also allows network access using a variety of HMI/SCADA software. Easy-to-use Windows-based Control Designer software, operable over Ethernet, an RS232 port or modem connection, simplifies controller and operator interface configuration. It provides advanced monitoring functions for debug, allows run-mode configuration changes while maintaining process control, uploads the complete, annotated graphic controller and operator interface configuration, plus supplies an array of reports for enhanced documentation. The DCS

Controller provides superior PID loop control and more robust analog processing than most logic controllers without compromising logic performance. A separate, fast scan cycle executes a rich assortment of logic and calculation function blocks. Logic blocks may also execute in the same scan with analog function blocks for time critical events. These function blocks may be fully integrated into a combined analog and logic control strategy for uncompromising control performance. In this we use a Honeywell DCS (HC900), for our analysis.

The basic block diagram of DCS connection as follows:

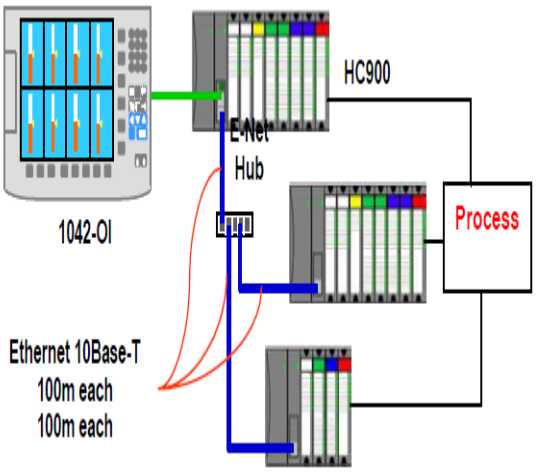

Fig3. Single Process/multiple remote I/O Racks

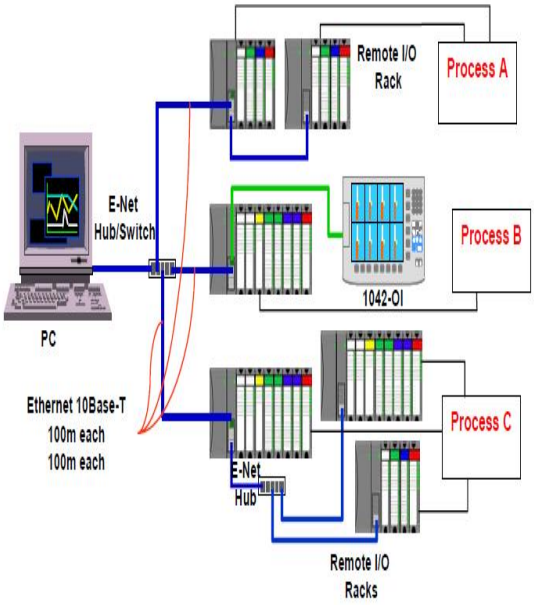

Fig4. Multiple Process/multiple Racks

Above the diagram shows the connectivity of the single and multiple process with DCS through the industrial communication protocols. Here, we are using the Intouch Wonder

ware for the over all plant monitoring system. By using this system we can change the field parameters, monitor the process and generate alarm, real time trends etc. but the major drawback is, we can't analysis the process. The DCS control the overall process as per the programming sequence create by the user.

NI OPC Servers:

The National Instruments OPC Servers provides a single consistent interface to communicate with multiple devices, saving you from learning new communication protocols or spending time understanding new applications. The combination of NI OPC Servers and LabVIEW provides a single platform for delivering high performance measurements and control to both new and existing industrial systems. NI OPC servers connect through the OPC client in LabVIEW Data logging and Supervisory Control (DSC) Module to enable you develop a fully fledged HMI/SCADA system with PLCs, PACs and smart sensors.

The OPC specifications:

- **OPC Data Access (DA)**
- OPC Alarms and Events
- OPC Batch
- OPC Data eXchange
- OPC Historical Data Access
- OPC Security
- OPC XML-DA

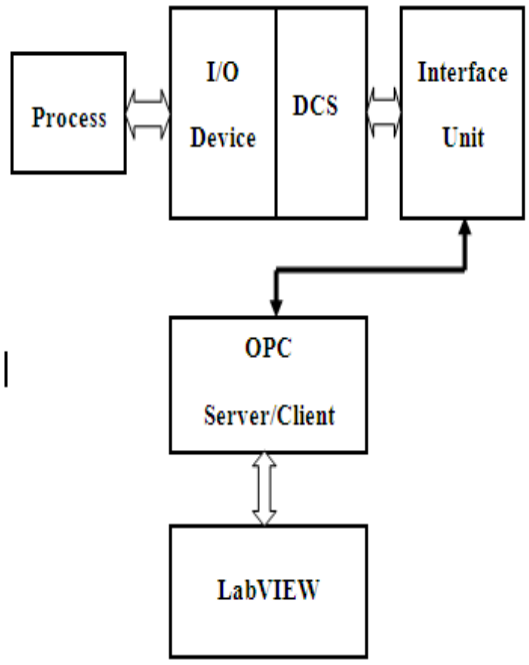

Fig.5 The composition of the remote real-time communication test system between MATLAB and PLC

Composition of Test System

The composition of the remote real-time communication test system between LabVIEW and DCS is shown as Fig.5. The systematic basic hardware items are shown as following: A PC (Personal Computer) furnished with an ordinary network card; A Honeywell HC900-C30 with Ethernet communication card (This card is supported by some protocols, such as ISO, TCP/IP and UDP, etc. RJ45 interface which is used for connecting with industry Ethernet, and through its own microprocessor. It can deal with the data communication of industry Ethernet independently, and has an only IP address preserved, also it can be put into operation directly through the network); A DI 16*DC 24V digital input module; A DO 16*DC 24V/0.5A digital output module; An AI 8*12BIT analog input module; An AO 4*16BIT analog output module; In addition, the RJ45 industrial Ethernet cable communicate the DCS and the NI OPC server and also the same cable communicate the logical program interfacing with Hybrid control designer (HC-900 software).

Benefits

One benefit of LabVIEW over other development environments is the extensive support for accessing instrumentation hardware. Drivers and abstraction layers for many different types of instruments and buses are included or are available for inclusion. These presents themselves as graphical nodes. The abstraction layers offer standard software interfaces to communicate with hardware devices. The provided driver interfaces save program development time. The sales pitch of National Instruments is, therefore, that even people with limited coding experience can write programs and deploy test solutions in a reduced time frame when compared to more conventional or competing systems. A new hardware driver topology (DAQmxBase), which consists mainly of G-coded components with only a few register calls through NI Measurement Hardware DDK (Driver Development Kit) functions, provides platform independent hardware access to numerous data acquisition and instrumentation devices. The DAQmxBase driver is available for LabVIEW on Windows, Mac OS X and Linux platforms.

Conclusion

LabVIEW OPC Toolbox offers abundant OPC tool
functions, which make the user can simply and conveniently realize the operation to the OPC objects. They can simplify the process of development and provide an effective method to realize the remote real-time communication between LabVIEW and process devices. The method about remote real-time communication between LabVIEW and process devices has its representativeness and has a high value to the study and exploitation of real-time system. Moreover, LabVIEW offers abundant control functions and provides abundant advanced control algorithms. On the basis of this paper, we can realize advanced Process Analysis of complicated industrial process based on network environment to improve control efficiency.

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