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234 *The Open Electrical & Electronic Engineering Journal,* **2014,** *8,* **234-239**

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Recent Patents on OPC for Central Air-Conditioning System

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Abstract: To achieve the centralized monitoring and integrated management of the central air-conditioning system, taking the characteristics of data communications and control complexity in the air-conditioning system into consideration, and combined with the OPC (OLE(Object Linking and Embedding) for Process Control) technology, an intelligent central air-conditioning supervisory system is developed and designed. In this paper, after searching the OPC technology standard, the overall structure diagram of the monitoring system is designed, and the OPC server program is also developed by using Knight OPC Server Rapid Development Toolkits. The OPC client application program and man-machine interface are exploited by KingView configuration software. The monitor and control system whose interface is opened is designed for the central air-conditioning. In the end, the experiment result proves that the system operation has good performance for temperature-controller and humidity-controller clustered controlling as well as data communications, thus, satisfying the requirements.

Keywords: Central air-conditioning, data communications, development of server and client, OPC technology.

1. INTRODUCTION

In the field of central air-conditioning, different manufacturers of air conditioning, large numbers of software and hardware equipments need to be integrated on the same module as the result of the expansion of the scale of air-conditioning production and the improvement of system complexity. In the past, in order to realize the centralized monitoring [1] of air-conditioning devices of different manufacturers and data communication between acquisition interface, plenty of time was spent on the development of a dedicated communication interface program, however, OPC [2-4] technology can effectively solve the problem.

2. OPC TECHNOLOGY

OPC, based on the Microsoft Active X, COM and DCOM (distributed component object model) [5], is a standard instruction set of access interface, properties and methods [6, 7] and it offers the communication standard between the application program upon Windows operating system and process control application.

The task of development of access interface is performed by hardware manufacturer or third party manufacturers. Using Client/Server mode, clienteles are provided to the OPC server [8]. As long as manufacturers follow the standard of opc technology, hardware and software of interconnection and interoperability can be achieved.

OPC offers a series of unified data access specification between field control equipments and application program, which, using DCOM technology, not only can be applied to computer independently, and can support communications among applications on different networks as well as different operating systems. It has characteristics of the code reuse, language independence and ease of integration. Due to the fact that OPC standardized interface functions, no matter what conditions the field devices are, the client can have unified access. As a consequence, the transparency of the software to customers is ensured.

OPC DA (data access) [9] can accomplish the real-time data communication between client and server to read and write operations. In the traditional central air-conditioning, on the basis of monitoring and control system [9], the application of OPC dynamic data read and write access mechanism can realize data sharing, centralized monitoring and improve the monitoring and control system of openness and compatibility. When each application takes the OPC interface [10] specification, the system can be connected through the OPC interface conveniently, resulting in increased efficiency of data exchange from software to hardware or software to software.

3. THE DESIGN OF OVERALL FRAMEWORK

The central air conditioning monitoring system based on OPC technology adopts three-level network structure, namely the field device control layer, the OPC server layer and the central monitoring system layer. In terms of the characteristics of the central air conditioning work, the field device control layer is divided into several independent areas, according to the geographical position. OPC server layer [11] consists

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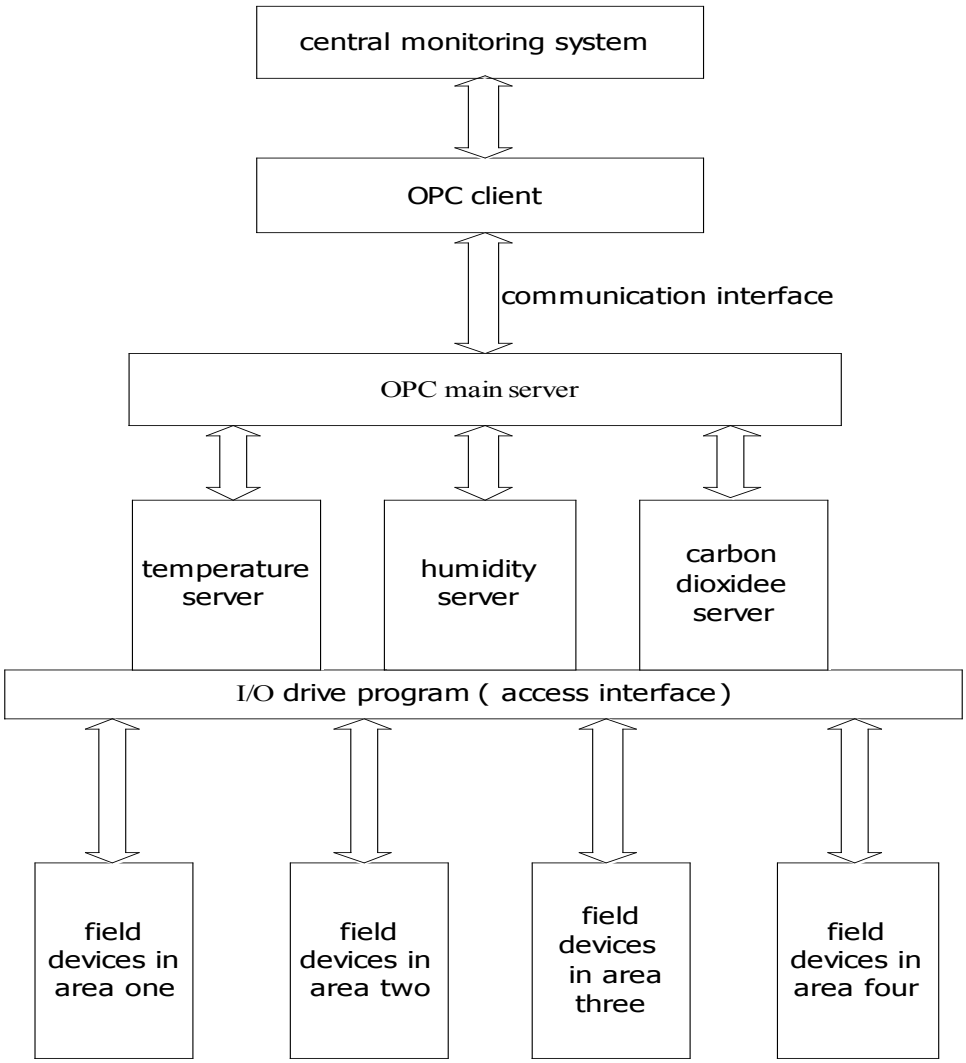

Fig. (1). The whole structure of monitoring and control system for central air-conditioning.

of the master server and sub-servers that includes temperature of the sub-server, humidity of the sub-server and carbon dioxide of the sub-server. The central monitoring system layer consists of OPC client and human-machine interface [12]. The design of monitoring and control system for the whole structure is shown as follows:

Control station cabinets in every area of the field device connect air conditioning hardware equipments through the I/O interface card Fig. (**1**).

Control cabinets adopt MIC-2000/11 that has built in power supply, and has 11 slots. ISA bus as the internal printed circuit board links the controller with I/O interface card. The field device control layer provides the OPC server layer real-time field data via OPC server access interface. Depending on the type of data quantity, OPC sub-servers are divided into temperature, humidity and carbon dioxide. Field data which is defined as the item object of main server are collected by Sub-servers that are defined as the object of main server. Server object that is the container of a group object contains information about OPC Server, and the object of group can be added and removed through it. Group object contains relevant information about group and provides logically the organizational mechanism of item objects. Item objects are associated with data objects that include three attributes: Value, Quality and Time Stamp label.

Using kingview [13] as development platform for OPC's client monitoring picture. Using Visual Basic programming language developing automation application interface achieves the communications and data link between OPC client and server.

4. OPC SERVER PROGRAMMING

There are two ways to develop OPC server: whole development and platform development. The whole development is that the user does not have to start development from the underlying, but directly call interface functions and general modules OPC foundation offers. Written application of component object model to realize automation interface or custom interface based on OPC standard to complete the development of OPC server. The platform development is through a third party software company, writing rapid development kit based on the OPC specification [14]. The user does not have to deeply understand the mechanism of component ob-

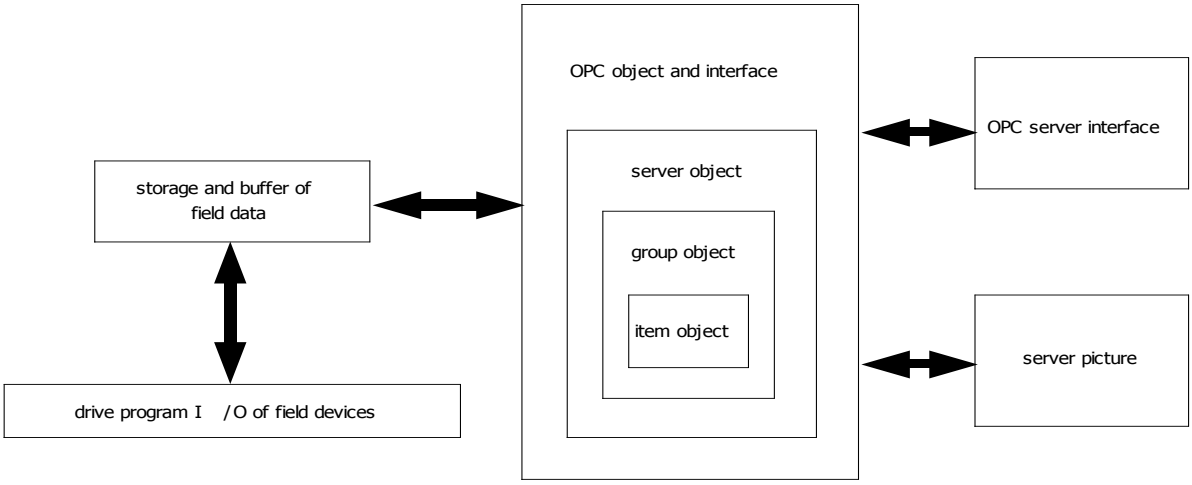

Fig. (2). The internal structure of OPC server.

ject model and interface implementation details, only need to invoke the corresponding module from the toolkit platform and utilize interface functions provided by the toolkit. Comparing two kinds of development methods, the whole development needs more workload, more difficulty and longer development cycle, but users have more initiative to develop interface according to the actual situation. On the contrary platform development has more easy operation, less workload and shorter cycle but poor flexibility. Combined with advantages and disadvantages of two ways and the complexity of the central air conditioning monitoring system, this paper adopts the model of platform development for server development of monitoring and control system. The internal structure of OPC server is shown in Fig. (**2**).

The COM (component object model) interface OPC specification defines implements dynamic link and encapsulation. Providing the definition of the callback base class, browser base class and tag base class, and gives the interface functions of building data path, access to the data and submit data. Developers conduct custom development for data submission and access only through data type derived.

Using KOSRDK toolkit to develop OPC server program, server and client of OPC need DCOM configuration. Specific development steps are as follows:

STEP 1: Dcom Configuration

Run DCOMCNFG into DCOM configuration program. Select "default properties" on the DCOM configuration chart operating interface and then select "no" on the “default authentication level". Later choose "anonymous" on the "default simulation level". Then click on the" default security mechanism", then "edit default" in the “default access permissions", "default starting permissions" and "default configuration access" respectively and then "Everyone" is added.

STEP 2: Registration/Cancellation

OPC server based on COM/DCOM technology is running on Windows operating system, information about OPC server is registered into the chart of system registry to ensure that client can be queried and connected to the server. Call the following function to complete the registration.

KOS_Register (CLSID_Svrm_strSvrNamem_strSvrDesc, strFile)

OPC server includes driver I/O module, data storage and buffer, OPC object and interface module, OPC server interface module and server interface and settings section. This article takes advantage of the third party fast kit —KOSRDK for the development of OPC server. KOSRDK using the object-oriented technology to realize

When the server is not needed or there is malfunction in the server, the registry information of OPC server in the system registry chart should be cancelled. Call the following function to complete the cancellation.

KOS_Unregister (CLSID_Svr, m_strSvrName)

STEP 3: Add the OPC Item

A data from field devices only become a tag that corresponds to the OPC item which needs to effectively become registry information in the list of registration so that it can be used by the server. Call the following function to complete addition.

HANDLE WINAPI KOS_AddItem (Cstring Name, VARI-ANT ValueWORDInitialQuality□BOOL IsWritable).

STEP 4: Read/Update OPC Item

To get the latest OPC item (the data Value, Timestamp and Quality) the data on the OPC server changes and updates at a certain cycle, periodically scanning to obtain the data. Call the following function to complete update.

BoolWINAPI KOS_UpdateItem (HANDLE ItemHandle, VARIANT Value, WORD Quality).

STEP 5: Shutting Down the Server

After the client requests to disconnect, exit the program and then delete the OPC items on the server. Call the following function to complete close.

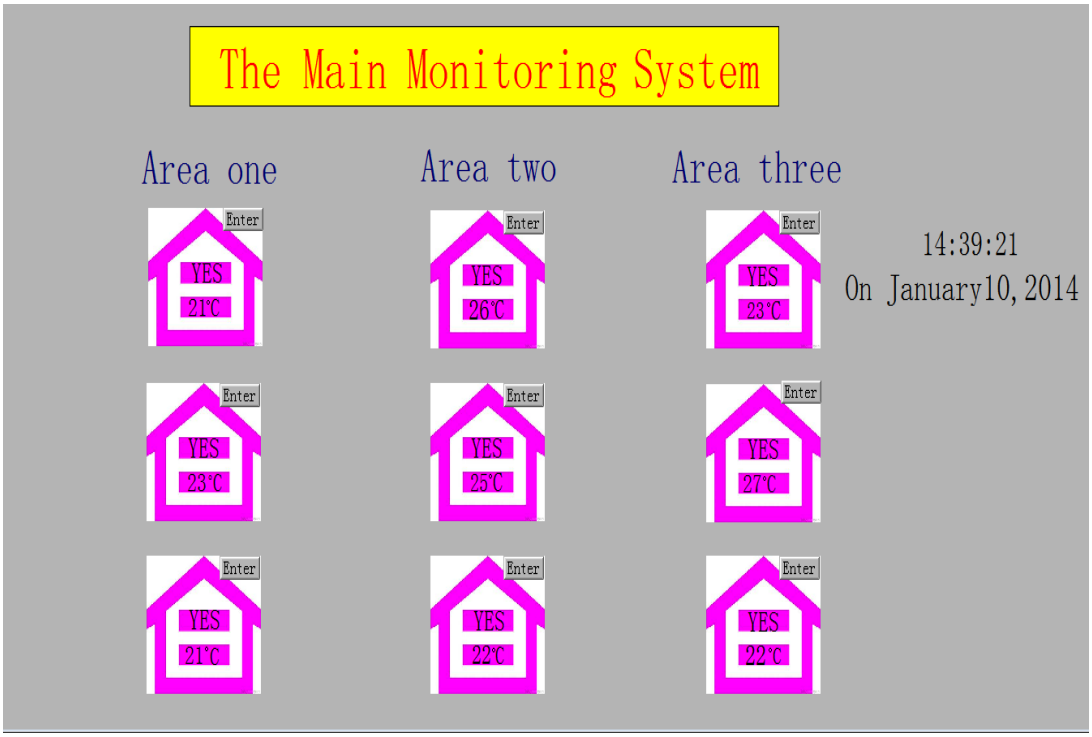

Fig. (3). The main monitoring interface for the central air conditioning system.

KOS_RemoveItem (Server)

KOS_UnInit (Server)

5. THE IMPLEMENTATION OF OPC CLIENT

The design of client layer uses kingview 6.5 version which supports OPC standard [15] and also provides reliable and efficient configuration function and network application. The interface shown on the monitoring system of the central air-conditioning is completed through the client development based on kingview. The client can access the server and display the field data from it. An administrator can easily, by monitoring the scene, observe the working state of each regional air conditioning, equipments running state and the related parameters in the service area (Fig. **3**).

In takes the following steps to complete data communication between OPC client and server.

STEP 1: Register the Opc Server to the Client

After finishing the development of the client layer of the central air conditioning, OPC server as the access object of Kingview is added to the "equipment" component, and then OPC server as a kingview equipment is used by the client, servicing to the client layer.

STEP 2: Establish Data Labels

All the data in the central air conditioning monitoring system is collectively managed by the database. In order to achieve data communication between the OPC server and client, the variable needs to be defined in the data memory of kingview to establish access interface. OPC server as the connected devices provides data to the client layer.

In this paper, the designed monitoring system adopts the master-slave structure. The main monitoring system, as shown in Fig. (**4**), has all regions represented with rooms, and can display the current inner temperature. Click "Enter" logo on right corner and enter the secondary monitoring system. As shown in the following picture, the monitoring subsystem can dynamically display returning air temperature, returning air humidity, alarm status of each area and equipment running state.

CONCLUSION

The monitoring system of multi-tier architecture is designed by analyzing the OPC specification and its core idea as well as the practical work characteristics of central air conditioning system, emphasizing, research on OPC server architecture and implementation patterns. In allusion to the "return air temperature" and "dehumidifier valve opening", the effectiveness of the central air conditioning monitoring system based on OPC technology was tested, consequently, the results showed that the monitoring system meets the requirements. With the improvement of modern information system integration, and DCOM (distributed component object model) widely used in the field of software development automation and control area, OPC technology and the shift from whole development to platform development can effectively reduce the development costs and cycles. Can satisfy the interconnection of various equipments and data sharing and finally realize the win-win situation between vendors and consumers.

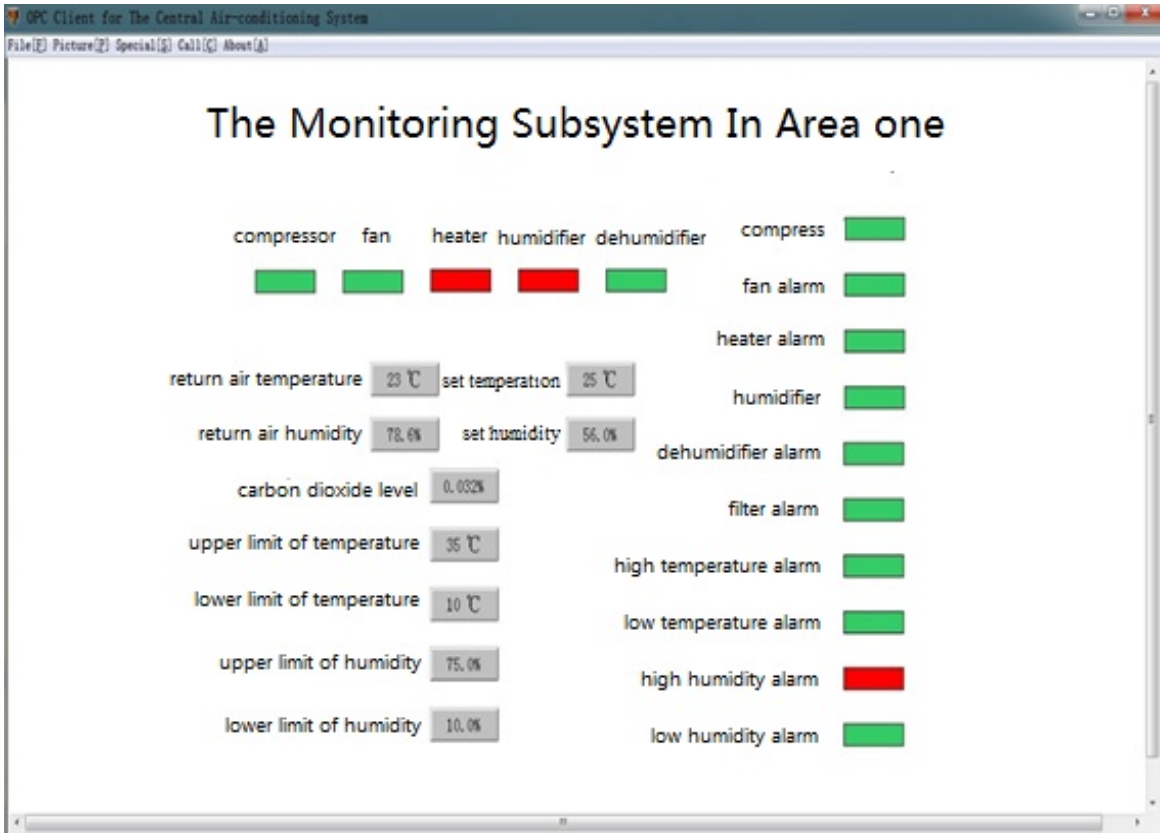

Fig. (4). The secondary monitoring interface for the central air conditioning system.

CURRENT AND FUTURE DEVELOPMENT

OPC specification is the emerging standard in the field of industrial control. OPC standard makes all communications connectivity issues become simple and plays an important role in the development of DCS full openness of monitoring system. However, OPC technology also has limitations: first, it can only be applied to the Windows platform, second only be applicable for integration in the local area network (LAN). In the future, as the new OPC XML specification improves, and with the improvement of modern information system integration and component object model (COM) and distributed component object model (DCOM) the defects of original OPC technology can be overcome. And it can also satisfy the demand for the development of intelligent building with cross-platform integration in the era of Internet of things and big data.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

We would like express our gratitude and appreciation towards University of Shenyang Jianzhu for providing research funding to our research team(No.2013-K-22).

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Received: October 29, 2012 Revised: December 02, 2012 Accepted: December 11, 2012