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Remote Data Acquisition System at the Dairy Farm Based on Datasocket Technology

Xiaojing Huo, Wendi Wang, Jinguo Zhang, Hui Wang and Shuxia Liu
College of Mechanical and Electrical Engineering, Agriculture University of Hebei, Hebei, Baoding, 071001, China

Abstract: In dairy cow breeding industry, the successful real-time remote monitoring of cow body parameters or environmental information leads to know well the nutrition status, healthy condition, oestrus and productive performance of the cattle in time. The objective of this research is to develop a real-time remote data acquisition system with C/S(client/server) structure based on virtual instrument technique. The Internet communication function was realized using LabWindows/CVI 8.5 DataSocket library. With the DataSocket technique the cowshed ambient temperature, the humidity as well as dairy cows' activity amount, milk yield, body temperature and milk conductivity were measured and remote transmitted. Then test experiments were done by taking the body temperature, milk yield and milk conductivity for measurement parameters. The results showed that the system worked safely with high data transmission speed and friendly user interface in practical operation.

Key words: Datasocket, virtual instruments, labWindows/CVI, remote data acquisition, dairy farm

INTRODUCTION

The cow feeding industry is developing from the traditional extensive management to the precision feeding management in China (Li, 2007; Liberati and Zappavigna, 2009). Using the sensors and computer to automatic obtain the various individual parameters and environmental data at the dairy farm can help milk farmers to have the careful understanding to herd's overall condition, such as cow oestrus time, physiological state of health and so on (Eigenberg *et al*., 2008; Yanxin *et al*., 2010; Xiong *et al*., 2005). Thus has the potential to improve efficiencies and maximize economic benefits in the dairy industry.

With the development of the Internet and the cow feeding of intensive, open and extensible dairy farm remote data acquisition system which has the functions of network data sharing, data publishing and remote monitoring is the trend of the times (Xiong *et al*., 2005). This study developed a dairy farm remote data acquisition system based on C/S model that has being the most widespread information exchange platform of Internet because of the advantage of easy and effective (Samer *et al*., 2011). The virtual instrument development platform LabWindows/CVI 8.5 was used to design the system software. With the DataSocket technique the cowshed ambient temperature, the humidity as well as dairy cow's activity amount, milk yield, body temperature and milk conductivity were real-time measured and remote transmitted (Cai *et al*., 2013).

SYSTEM STRUCTURE AND OPERATIONAL PRINCIPLE

The system mainly consists of sensors, single-chip microcomputer, wireless transceiver module, data acquisition board, computer, network card, exchange, etc. (Grimaldi and Sergio, 2009). According to the function of structure, it is divided into measurement node, data analysis and processing node (on the local server) and remote client node, so that the remote monitoring system based on Internet or Intranet for dairy cow farm is composed as shown in Fig. 1.

Information acquisition module, which is distributed in everywhere of dairy farm, consists of ATmega32 single-chip microcomputer and sensors (Chang *et al*., 2006; Croitorum *et al*., 2010). It converts the physical variables obtained from cow house and individual cattle, such as environmental temperature, humidity, harmful gas concentration, cow body temperature, milk yield, activity, feed intake and so on, into the digital signals. These information are transmitted to data receiver, which is fixed in cowshed and milking parlor and connected with on-site computer through RS-232 bus or USB-6259 data acquisition board, by wireless transmit-receive chip nRF24E1 (Tedin *et al*., 2013). Then, the computer analyzes

Corresponding Author: Xiaojing Huo, College of Mechanical and Electrical Engineering, Agriculture University of Hebei, Hebei, Baoding, 071001, China

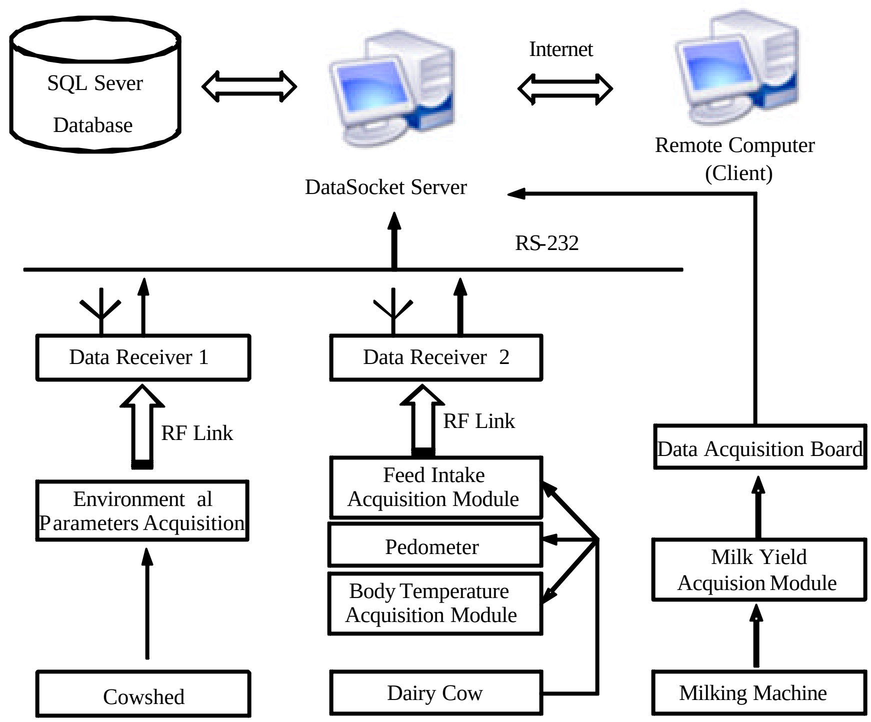

Fig. 1: Hardware structure of remote data acquisition system at the dairy farm

and processes those signals, displays the measured parameters, makes warning if any abnormal signal occurred and saves those data into the SQL Server 2000 database. The Data Socket server is also installed on the on-site computer in order to transmit the live data to the remote multiple clients and realize the remote monitoring and management of dairy farm.

SOFTWARE DEVELOPMENT FOR REMOTE DATA ACQUISITION SYSTEM

The whole system software of dairy cow farm takes the monitoring system running on the work field server as the core, it not only communicates with single-chip microcomputer or interfaces with data acquisition board to acquire the live data but also broadcasts the data on network by DataSocket technology (Chen *et al*., 2012; Zhang and Xie, 2013). Aiming at the requirements of comprehensive management to such situation as dairy cow nutrition, illness and production performance for dairy farm, this system mainly has 5 modules included user management, dairy cow card, milk yield management, oestrus detection, health report and so forth. The system has so many functions as parameters setting, data acquisition, state monitoring, alarming, data processing and analyzing and network communication.

Data acquisition module: The monitoring modules such as thermometers and pedometers worn on the dairy cow gather the body temperature, activity amount signals and so on and store the signals in the memory. When a host computer that the DataSocket server is on asking for the measuring data, the monitoring module will send the wireless signals to the data-receiver fixed in the cowshed or milking hall. Then the monitoring server obtains the field information from the data-receiver through the RS-232 bus. Milk yield and conductivity are acquired by the DAQ board USB-6259 manufactured by National Instruments Corp. (NI, U.S.A).

The communication relationship between the host computer and multi monitoring modules is one-to-many. To read the cow individual information accurately and avoid the communication conflict, we assigned the only code number for each data acquisition module in the system. For example, the code of thermometers all begins by the Letter “T” as well as pedometers code all begins by “P”, followed by 4 digit numbers. We can use the *Cow Card* module of the upper computer software to realize the assignment of thermometers and pedometers for each dairy cow. Therefore the cow ID will be bound with the code numbers of those monitoring modules in the SQL Server 2000 database.

Take cow body temperature acquisition as the example, data read flow chart is shown in Fig. 2. The

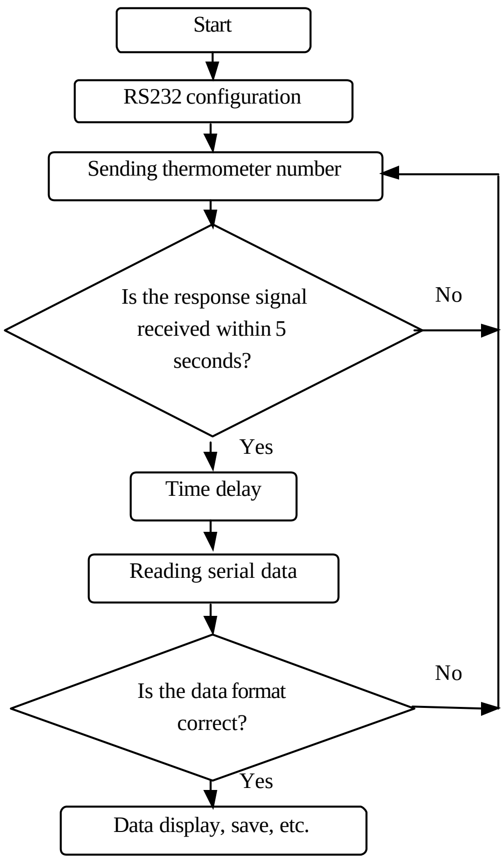

Fig. 2: Data acquisition flowchart of cow body temperature on the measurement server

communication mode is receiver polling and sender replying.

After serial port configuration, the monitoring server sends out the code number of monitoring module, like "T0001", as the data request handshake signal. The data receiver then broadcasts this information in some range. All acquisition units in the scope of the communication receive and check the signal whether it is the local machine code or not. If it is, still send back 'T0001' as the answering signal to the receiver; if it is not, then does not respond. The upper computer can read data from the serial port if it receives the correct answering signal within 5 seconds; if no response, then continue to ask.

To acquire data, the software must communicate with I/O interface of the bottom layer hardware. LabWindows/CVI provides the RS232 library and DAQmx library, which we can use with serial interface devices and NI data acquisition devices to develop instrumentation, acquisition and control applications. Using the Open/Close class function, Input/Output class function, Control class function, Status class function and *Serial Events Callbacks* class function of the RS232 library, we can send and receive commands to and from a device via a serial port easily. In DAQmx, the data acquisition is basically completed by calling those functions by the following steps (Xiong *et al*., 2005):

- DAQmxCreateTask( ); Creates a task
- DAQmxCreateAIVoltageChan( ); Creates channel(s) to measure voltage and adds the channel(s) to the task you specify with taskHandle
- DAQmxCfgSampClkTiming ( ); Sets the source of the Sample Clock, the rate of the Sample Clock and the number of samples to acquire or generate
- DAQmxStartTask ( ); Transitions the task from the committed state to the running state, which begins measurement or generation
- DAQmxReadAnalogF64( ); Reads multiple floating-point samples from a task that contains one or more analog input channels
- DAQmxStopTask ( ); Stops the task
- DAQmxClearTask ( ); Clears the task

Data remote transmission module

Datasocket technology: DataSocket, a new programming technology based on industry-standard TCP/IP, simplifies live data exchange between different applications on one computer or between computers connected via a network. Although, a variety of different technologies exist today to share data between applications, such as TCP/IP and DDE, most of these tools are not targeted for live data transfer (National Instruments, 2013). DataSocket implements an easy-to-use, high-performance programming interface designed for sharing and publishing live data in measurement and automation applications.

DataSocket consists of two pieces-the DataSocket API and the DataSocket Server (National Instruments, 2013). The DataSocket API presents a single interface for communicating with multiple data types from multiple languages. DataSocket Server simplifies Internet communication by managing TCP/IP programming.

To connect to a data source location, a URL (Uniform Resource Locator) need to be specified. Like URLs we use in a Web browser, the data source locator can point to different types of data sources depending on the prefix. The prefix is called the URL scheme. DataSocket recognizes several existing schemes, including http (hypertext transfer protocol), ftp (file transfer protocol), file (local files) and OPC (OLE for Process Control). The DataSocket also has a new scheme, dstp (DataSocket transfer protocol), for sharing live data through DataSocket Servers.

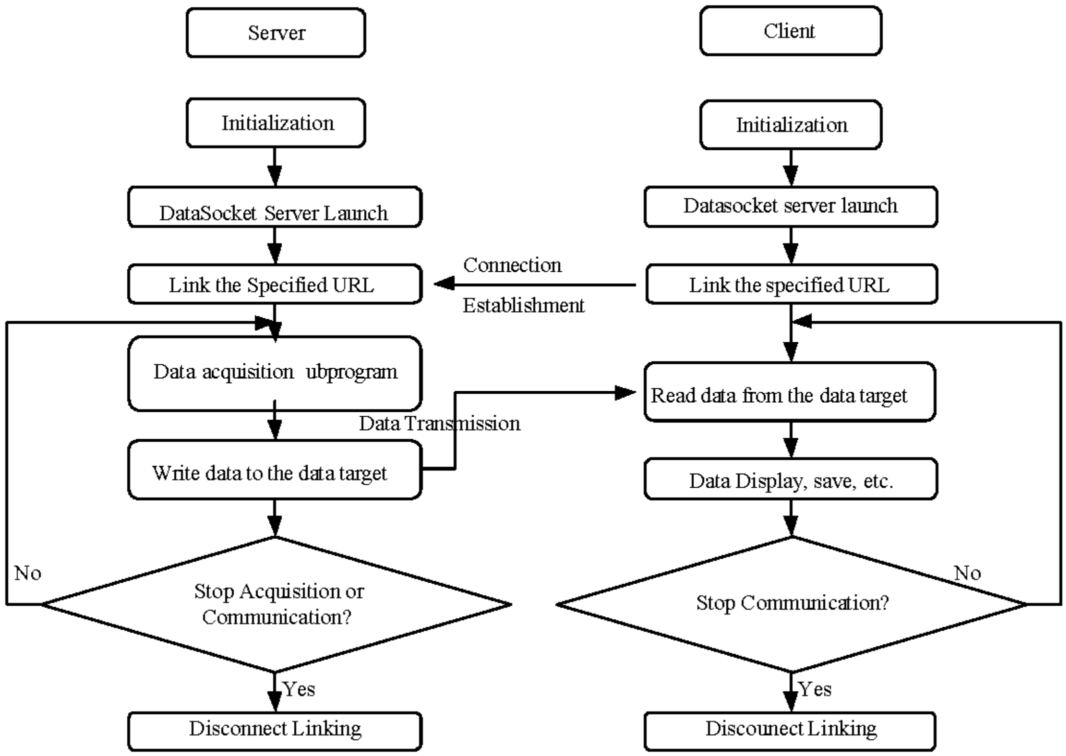

Fig. 3: Network communication flowchart

DataSocket transfers data in a self-describing format that can represent data in an unlimited number of formats, including strings, scalars, Booleans and waveforms. The DataSocket read and write operations transparently convert the measurements to and from the underlying byte streams, eliminating the need to write complicated parsing code. Furthermore, using the DataSocket data format, we can associate user-definable attributes with data. For example, you might associate a time stamp with a temperature measurement, or a sampling rate with an array. DataSocket greatly simplifies working with measurement data.

Programming realization: The remote data acquisition system of dairy farm uses the Client/Server mode. There are, therefore, two main functions of the network communication model-write operation on the server and read operation on the client based on the dstp transfer protocol. (National Instruments, 2013). The communication flow chart between the client and the server is shown in Fig. 3.

On the server and client, the DS_ControlLocalServer ( ) function must be used firstly to launch the DataSocket Server. Then in LabWindows/CVI, writing or reading data to/from a DataSocket server consists of three easy steps: 1) open a connection to a data source or target which specified by the URL on the DataSocket server using the DS_Open () function, 2) write or read item to/from the DataSocket Server by using the DS_SetDataValue () and DS_GetDataValue() function and 3) close the DataSocket connection with DS_DiscardObjHandle( ) function when the application is terminated.

Take the cow milk yield monitoring as the example, the URL of the data source is "dstp://192.168.1.12/ milkyeild". The "dstp" in the front tells DataSocket to open a data socket transfer protocol connection to the server that with IP address is "192.168.1.12" and fetch a signal called "milkyeild". The data packet to send includes live milk yield, milk conductivity, cow ID, milking shift and so on information. After reading the data packet, according to an appointment data format the client unpacks the data and displays, stores respectively. (National Instruments, 2013). Software interface shown in Fig. 4.

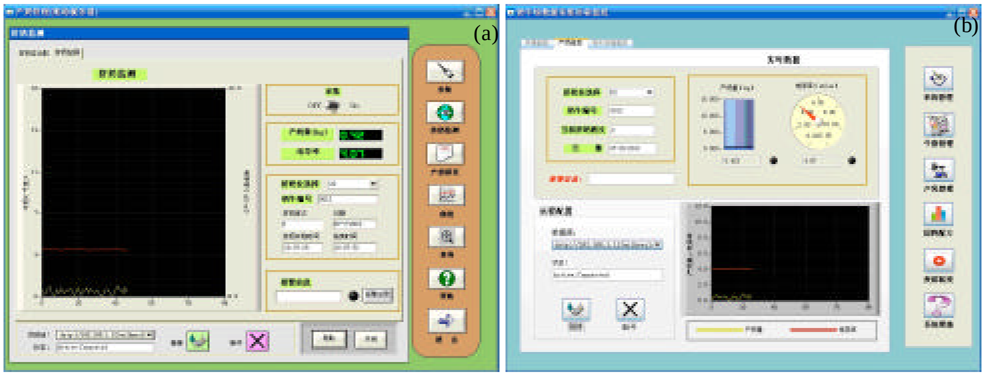

Fig. 4(a-b): Software interface of server and client in operation, (a) Milk management interface on the server, (b) Milk monitoring interface on the client

CONCLUSION

DataSocket is a single, easy-to-use interface that provides easy access to several I/O mechanisms without entangling the end user in the low-level details. The application results show that it provides the convenience for constructing remote data transmission system at dairy farm. The system can acquire information such as cow body temperature, activity amount, milk yield with high-performance and can transmit the both original live signals and the processed information of oestrus warning, diseases diagnosis through the network to multiple clients. This will help cattle farm managers to master the physical health status of herds, find the sick cattle and need insemination cattle in time. It could greatly increase cow's milk production performance and reproductive efficiency so that increase economic efficiency. The system was tested in cattle farm and has some advantages such as friendly interactive user interface, easy operation and practical.

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