Three-Dimensional Imaging System of Dairy Cow Based on Virtual Instrument

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Abstract: Studying out isochronous and automatic project about three-dimensional imaging system of dairy cow forming by computer, CCD video camera, frame grabber, photoelectric switch, SCM, automatic door, electric barrier etc. SCM detects signal of photoelectric switch, and it makes sure info of the orientation of dairy cow. Computer control frame grabber to grab image. The dynamic link libraries technology and multithreading technology are adopted to enhance the performance of the system. The experiment result shows image quality and imaging speed can satisfy the requirements of image processing after grabbing.

Keywords: Three-dimensional image of dairy cow, Synchronization imaging, Virtual instrument, Dynamic link libraries.

1. Introduction

Linear appraisal of dairy cow conformation based on image processing technique already has become an important part of optimizing breeding of which includes two step [1-2]: in focus and isochronous grabbing side, frontage, backside of cow three-dimensional image; image processing and identifying. Virtual instrument is adopted to develop three-dimensional imaging system of dairy cow, and its characteristic is cheap cost, short development periods and easy system upgrade and transplant [3-19]. SCM is adopted to obtain real time signal of photoelectric switch; RS232 is adopted to carry through serial communication from SCM to PC which controls frame grabber and SCM. Isochronous, automatic grabbing of cow three-dimensional image is realized to meet the demand of image processing and identifying.

2. Hardware Design of the System and Task Flow

The system is established with imaging equipment and orientation equipment. Modularization design is adopted which includes imaging equipment module, electric barrier module and two automatic door module. Pc is the controller of imaging equipment, and AVR SCM ATmega32 is the controller of automatic door and electric barrier. Each module has unattached controlling and transmission system, so that they may work all alone. Pc controls each module communication by RS232 serial port through voltage conversion chip MAX232 and coordinates module operation according to predetermined time sequence. SCM as guest computer is used for gathering data and controlling operation of automatic door or electric barrier. In this
way, a master and slave distributed system is constituted, in which host computer controls and communicates guest computers forming structure system of centralized manage and distributed control. Fig. 1 shows hardware composing. Fig. 2 shows effect diagram of cow image grabbing system. The cow advances through front door, electric barrier, back door, then induces on-off signal change of corresponding photoelectric switch. SCM gathers the change signal, communicates with PC through RS232 and controls operation of automatic door or electric barrier. PC controls DH-QP300--4-channel Color Frame Grabber to grab isochronous three-dimensional image of cow by three CCD video camera. System correspond each equipment operation according to schedule, and automatic grab three-dimensional image of cow with no man’s operation in the whole process. Fig. 3 shows working flow diagram of three-dimensional imaging system.

3. Software Design of the System

3.1. LabVIEW Program Design of Host Computer

LabVIEW program is adopted of host computer to realize grabbing image info and real time communication with the SCM. LabVIEW program includes two modules of grabbing image and serial communication. Fig. 4 shows LabVIEW program flow diagram.

Image grabbing program includes two function modules: LabVIEW program controls frame grabber to grab three route sequence image to memory and transfers data from static memory to image butter; Image should be grabbed is saved to appointed file. For reducing cost, NI frame grabber which can match LabVIEW program isn’t elected, but current frame grabber — DH-QP300 of which made by DaHeng company is used to realize image acquisition. Because LabVIEW program don’t straightly drive current frame grabber [20], interface function of dynamic link libraries which provided by DaHeng company is adopted to control DH—QP300 frame grabber in LabVIEW program. DH—QP300 frame grabbing development platform includes four steps and interface function: 1 appointed equipment is initialized: LBeginFGDevice(); 2 parameter of frame grabber is set in which includes data format: LSetVideoFormat(), grabbing mode: LSetVideoScan(), video frequency mode: LSetVideoStandard(), image signal fountain: LSetVideoSource(), grabbing window: LSetInputWindow(), LSetOutputWindow(), video frequency parameter(brightness, contrast, saturation etc): LAdjustVideo(), crystal oscillator frequency: LSetCRY_OSC(); 3 image is grabbed to memory in which includes starting grabbing: LStartSnap(), stopping grabbing: LStopSnap(); 4 data in static memory is transferred to image butter: ExportImageData(). Fig. 5 shows program diagram of dynamic link libraries.

To design serial communication program, communication protocol has the important function for normal communication of host computer and guest computer. RS-232 with three threads and half-duplex mode is adopted to simplify hardware system, and current baud rate 9600 b/s and one start bit, eight
data bit, one stop bit of data frames format are adopted to simplify software system. Table 1 shows, that host computer sends down command packet format which includes four bits of start bit BBH, stop bit EEH, address of guest computers (00H, 01H, 02H) and parameter word in which 00H denotes electromotor positive rotation, and 01H denotes electromotor rollback.

Fig. 3. Working flow chart of three-dimensional imaging system.

Fig. 4. LabVIEW program flow diagram.

Fig. 5. Calling dynamic link libraries program.
Table 1. Host sends down command packet format.

<table>
<thead>
<tr>
<th>Start bit</th>
<th>BBH</th>
</tr>
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<tbody>
<tr>
<td>Address of guest computers</td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td></td>
</tr>
<tr>
<td>Stop bit</td>
<td>EEH</td>
</tr>
</tbody>
</table>

“instrument I/O→serial” sub-module is adopted to realize design of serial communication program in which includes VISA configure serial module, VISA write module, VISA read module and VISA close module etc. Fig. 7 shows reading and writing program of LabVIEW serial communication.

Fig. 6. Imaging program front panel and saving image program diagram.
3.2. The Design of SCM Program

C language program and CVAVR of language exploitation circumstance are adopted to design SCM program which controls automatic door, electric barrier and serial communication. The paper mostly introduces serial communication program.

Multi-computer communication mode based on master-slave structure is adopted to design serial communication. 01H, 02H, 03H are the address of front door, electric barrier, back door according to communication protocol so that system makes certain one address for each SCM. Uploading command packet with four bits length has identical format of sending down command packet, in which 01H of parameter word denotes uploading data packet after SCM detects signal of photoelectric switch, and 02H of parameter word denotes returning answer package after SCM receives sending down data packet.

Three SCM incept data packet at same time while PC sends down data. Each SCM decodes address field of receiving data packet for confirming whether itself is addressing or not. SCM will receive the following sending down data packet if it is addressing. After receiving a complete data packet, it starts data processing and returns answer packet. Moreover, the others guest computers ignore sending down data package. Receiving program design of 02H SCM show:

```c
#define UART_BEGIN_STX 0xBB
#define UART_END_STX 0xEE
#define UPE 2
#define OVR 3
#define FE 4
#define FRAMING_ERROR (1<<FE)
#define PARITY_ERROR (1<<UPE)
#define DATA_OVERRUN (1<<OVR)

// USART Receiver interrupt service routine
interrupt [USART_RXC] void usart_rx_isr (void)
{
    unsigned char status, data;
    status = UCSRA;
    data = UDR;
    if (!Uart_RecvFlag) // SCM judges if receiving a new data packet allowed
    {
        if (((status & (FRAMING_ERROR | PARITY_ERROR | DATA_OVERRUN)) == 0))
        {
            rx_buffer [rx_counter] = data;
            rx_counter++;
            switch (rx_counter)
            {
                case 1: // detecting start character
                case 2: // SCM detects the character of guest address, and gives up the follow two character if which is not the address of itself.

```

Fig. 7. Reading and writing program of LabVIEW serial communication.
if (data != 0x02) rx_counter = 0; break;
case 4: // detecting end character
    rx_counter = 0; if (data == UART_END_STX)
        Uart_RecvFlag = 1;
    break; // Uart_RecvFlag=1, which denote receiving correct a data packet
} }

void main(void)
{
    // USART initialization
    UCSRA=0x00; // Communication Parameters: 8 Data, 1 Stop, No Parity
    UCSR8=0xD8; // USART Receiver: On, USART Transmitter: On
    UCSR=0x86; // USART Mode: Asynchronous, USART Baud Rate: 9600
    UBRRH=0x00;
    UBRRL=0x19;
    #asm("sei") // Global enable interrupts
    while (1)
    {
        //processing procedure of data packet
    }
}

4. Experiment and Result Analysis

For detecting capability of imaging system, system designs the synchronous imaging laboratory of cow three-dimensional image, which tests 100 Holstein cows of cattle farm of HeBei agricultural university. Fig. 8 shows three-dimensional image are isochronous grabbed of one cow.

Because uniform impersonality measure is lacked of image quality value all along, it can but rely on that continued arithmetic distill reliably feature point as standard. So obtained original figure of cow are analyzed through three steps, firstly image is grayed by saturation S as characteristic parameter, secondly image is de-noised by median filtering method, lastly image edge is extracted by Sobel operator [21]. The result of image pretreatment and image segmentation are shown in Fig. 9. As can be seen from Fig. 9, image noise is less, and edge information is saved clearly. So the image quality meets the demand of continued feature extraction algorithm.

Fig. 9. Result by image pretreatment and image segmentation.

5. Conclusions

1) Three video camera in frontage, backside, side of cow imaging region, DH-QP300--4-channel, 4-unattached image chip in hardware and dynamic link libraries, multithreading technique of LabVIEW program in software are adopted to realize isochronous grabbing of cow three-dimensional image.

2) Distributed control system is adopted to coordinate operating of cow imaging equipment and orientation equipment according to schedule. The whole course of image grabbing doesn’t need be handled by people, and three-dimensional image of cow is grabbed automatic.

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